INDEX TO

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THE BOILER MAKER

INDEX

Note—Illustrated articles are marked with an (*) asterisk.

ARTICLES

COMMUNICATIONS

EDITORIALS

ENGINEERING SPECIALTIES

LAYING-OUT PROBLEMS

PARAGRAPHS

QUESTIONS AND ANSWERS

TECHNICAL PUBLICATIONS

THE BOILER MAKER

JANUARY, 1916

Pneumatic Tools in the Boiler Shop

Wide Range of Usefulness for Pneumatic Drills and Hammers—Details of Efficient Labor-Saving Tools

BY FRANK C. PERKINS

Pneumatic riveters, chipping, calking, flue beading and scaling hammers, as well as pneumatic drills, reaming, tapping and flue-rolling machines, are among the most efficient labor-saving tools in service in the boiler shop today. The illustrations show several tools of this type manufactured by the Keller Pneumatic Tools Company, Fond du Lac, Wis. The rotary-type drills (Fig. 4) are powerful and durable, and all delicate parts are eliminated. The number of parts is very small as compared with piston drills, and the parts, it is claimed, are less liable to wear out or get out of order. The motor runs at a high speed, and this means an economical gear reduction and

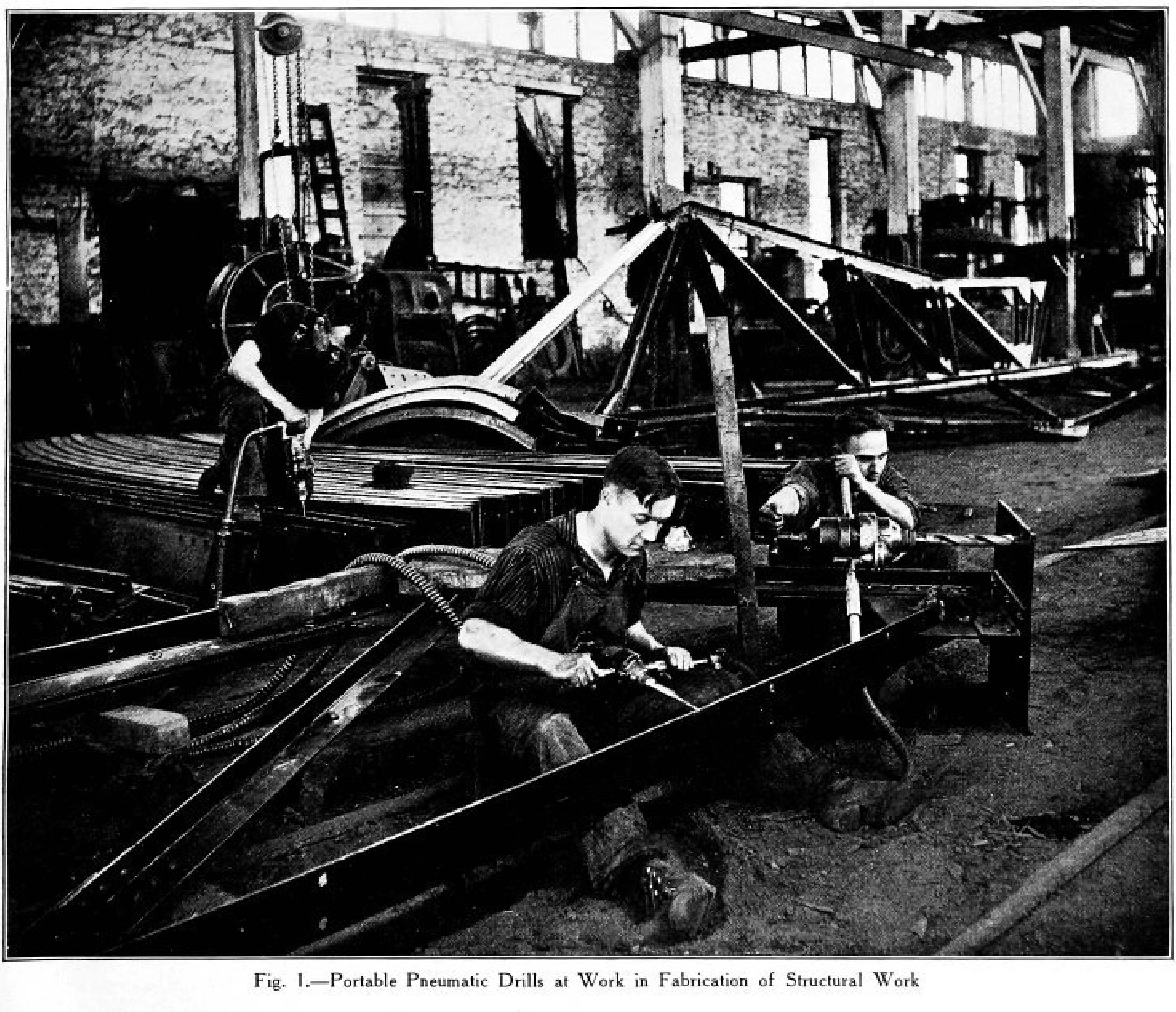


Fig. 1.—Portable Pneumatic Drills at Work in Fabrication of Structural Work

a light-weight machine. There is said to be no vibration when these tools are in operation, and they are therefore especially well adapted for reaming and tapping; besides being a steady tool for drilling and flue expanding.

The Keller pneumatic chipping hammers (Fig. 3) are made with differential pistons. The air is used only to deliver the blow, and the air that returns the piston is not

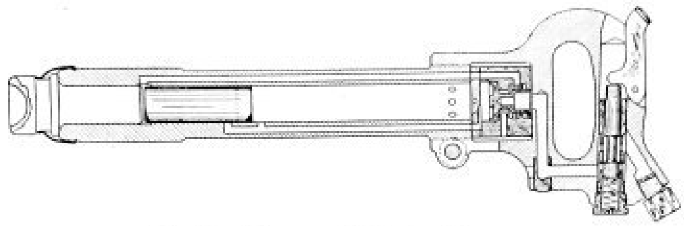


Fig. 2.—Pneumatic Riveting Hammer

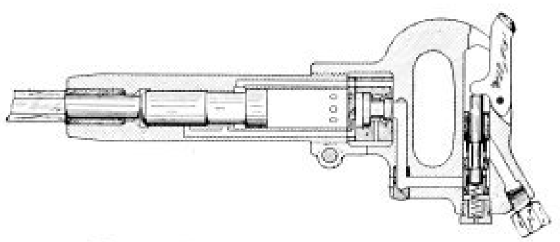


Fig. 3.—Pneumatic Chipping Hammer

exhausted. There is never any live air blowing out of the front of the tool. It is claimed that in the use of this construction a saving of nearly fifty percent in air consumption is effected. All working parts exposed to wear, including cylinders and valve boxes, are hardened and ground to a standard. The hardened cylinders will out-

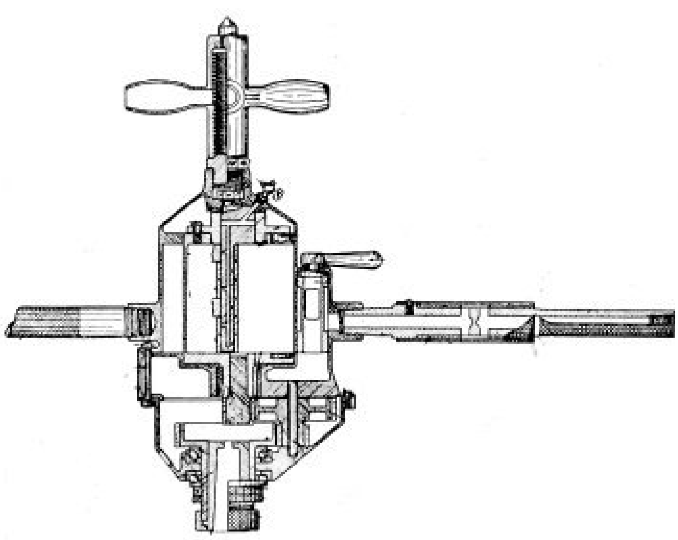


Fig. 4.—Rotary Pneumatic Drill

last soft ones four to one. The handles in these tools are made of drop-forged steel.

Some of these chipping hammers are arranged with outside throttle levers and others with "safety trigger lock handles." These handles are made so that the tool cannot be started accidentally. The operator must grip the handle in working position to start the tool when equipped with this kind of handle.

The pneumatic riveting hammers (Fig. 2) are made with cylinders, valve boxes and all parts exposed to wear, hardened and ground to a standard. The hardened cylinders will outwear soft ones four times to one. The valves are of simple construction and fit into one-piece valve boxes. The handles are made of drop-forged steel.

It is held that these hammers are made so that it is impossible to shoot out the piston. They have positive piston retainers, so that there can be no serious accidents from shooting out pistons when using this kind of tool.

Boiler Shell Stresses

The easiest way to understand boiler stress computations is to change the form of the boiler a little, as shown in Fig. 1. Make one side of the boiler flat and leave the rest round. It is plain that the stresses in the round portion will be just the same as though there were no change in the boiler's form at all. And it is also plain that the part of the round shell close to the flat part (as indicated in the drawing) will have to hold up one-half of the load

Fig. 1

on the flat plate. The load on the flat plate is easily computed, for it is simply length times width times the pressure in pounds per square inch, or,

$$P = D_1 p \times \text{length},$$

where P = total load in pounds,
D_1 = diameter of boiler in inches,
p = steam pressure in pounds per square inch.

Where the length of the boiler is only 1 inch (generally used for convenience) the formula becomes

$$P = D_1 p.$$

Now, where the thickness of the shell is t (see Fig. 1), and where the length of boiler is 1 inch, the cross-sectional area of metal holding up the load P is equal to $2\,t$ and the stress per square inch is therefore

$$f = \frac{P}{2\,t}$$

or,

$$P = 2\,t\,f.$$

Since P is also equal to $D_1 p$ we can say,

$$D_1 p = 2\,t\,f,$$

whence

$$f = \frac{D_1 p}{2\,t}$$ = unit stress in pounds per square inch in the boiler shell.

I am aware that this formula is old and that it is used every day by engineers and boiler makers, but it is a fact that it is not thoroughly understood by all who use it. That is why I have explained it in such detail. I was out of college several years before I really "grasped" the formula.

New York. N. G. NEAR.

When you take a piece of scrap to make a patch, look on both sides before you lay it out and shear it, as it may have been drilled half through by some one.

Throwing washers, bolts, nuts and rivets, or even punchings, at electric light bulbs costs the boss money and hurts the young boiler maker. Stop it, all hands!

Boiler Failures and Their Prevention*

What the American Society of Mechanical Engineers is Doing to Prevent Boiler Failures—The A. S. M. E. Boiler Code

BY E. R. FISH

The use of vessels for generating steam under pressure is as old as the use of steam itself, and for just that length of time there have been boiler failures of different kinds. The art and practice of boiler making has steadily progressed from its beginning with low-pressures, imperfect and ill-suited materials, mediocre workmanship and unscientific designs, but it is, however, still far from perfect, as is evidenced by continued disasters of varying magnitude.

Much has been written on the subject of boiler explosions, but Prof. R. H. Thurston was the first to put the matter in concrete and scientific shape, and I am quoting freely from his writings, for he expresses the conditions far better than I possibly can. Professor Thurston enunciated the following principles:

"(a) Steam boiler explosions are always the result of well understood causes and are only mysterious, in any case, in the sense that available evidence may not point out with certainty which of the various well-known causes may have operated in the given case.

"(b) Boiler explosions are always preventable; it is always practicable to so design, construct and manage steam boilers that there shall be absolutely no danger of explosion.

"(c) The proper course on the part of the designer, builder and user is to first use forms of boilers, wherever practicable, such that, as Col. John Stevens said a century ago, 'their explosion shall not be dangerous even should overpressure occur'; the same idea was enunciated by Fairbairn. Insure next good and well-tested materials, good and well-inspected workmanship and uniformly skillful management by men of experience and reliability. Regular, effective and thorough inspection constitutes a part of good management—and an essential part."

Explosive Energy of a Boiler

He further stated that "steam boilers are magazines of energy forcibly restraining explosive powers of such magnitude as few can compute or realize." As an example, I select from one of the tables he calculated, covering a number of different types and sizes of boilers, a return tubular boiler of 60 horsepower working at 75 pounds pressure. The weight of such a boiler is approximately 9,500 pounds, the water it contains weighs 8,200 pounds and the steam 21 pounds. The available stored energy in the water is 50,008,790 foot pounds, and in the steam 1,022,730 foot pounds, or a total of 51,031,520 foot pounds, which is sufficient to project the boiler to a height of 5,372 feet with an initial velocity of 588 feet per second.

Quoting further from Thurston:

"It is seen that the energy stored in the steam boiler, in the form of heat, is mainly that of the heated water and comparatively little resides in the steam; so that it follows that a boiler well filled with water is vastly more dangerous in case it explodes, than if exploded as a consequence of low water. The steam itself is quite incompetent to perform the work of the very destructive explosions often observed, and where the boiler is thrown, with the violence of a projectile from a piece of ordnance, against surrounding objects or hundreds of feet into the air; for it must be remembered that in no case can more than a small fraction of this computed total energy be actually applied to the propulsion of the boiler. Most of it is inevitably wasted in other directions.

"Comparing the energy of water and of steam in the steam boiler with that of gunpowder, as used in ordnance, it has been found that at high-pressures the former become possible rivals of the latter. Taking the value of gunpowder at what the writer would consider a fair figure, 250,000 foot pounds per pound, it is seen that a cubic foot of heated water, under a pressure of 60 or 70 pounds per square inch, has about the same energy as one pound of gunpowder.

"A powder magazine under one of our modern tall buildings, or under the sidewalk in Broadway, would be objected to very seriously by citizens compelled to make that great thoroughfare their daily walk, and if compelled to submit to its threatening presence, they would certainly insist upon the most stringent precautions being taken to insure safety against the liberation of its stored energy; but scores of steam boilers are so concealed and the laws of the city and of the State relating to their care are of the most lax and ineffective character.

Safeguards Against Destructive Explosions

"Good design, good workmanship and good management have been said to be the three safeguards against destructive explosion. Good design, in any case, presupposes a well read, well educated and an experienced designer.

"Good construction involves the selection of good materials and their proper use in building the boiler. This means, in turn, iron, or more commonly, steel in which ductility and toughness, rather than simple strength, are the special characteristics, and perfect uniformity in the several sheets of which the boiler is made up. Good construction involves the exact production of the required forms of parts and their riveting, or welding, together without loss of strength or introduction of stress. Good management means the regular and moderate firing of the furnace, constant inspection of the parts liable to corrosion or other injury, and maintenance in as perfect condition as possible by constant repairing of injured parts. It also includes the periodical inspection and test which now constitute the basis of insurance.

"All failures are due to preventable and familiar causes that might be evaded by the designer, the builder or the operator. Whatever may be said of the many known and possibly unknown, the certain, the probable and the possible causes, mysterious or otherwise, of boiler explosions, it is certain that a boiler is practically safe for all time in the hands of a good engineer or fireman if originally well designed, well constructed and properly set. Its safety is assured by a correct system of inspection either on the part of the person in charge or of the official inspector, or, more usually and properly, of both working together honestly and in good faith. A correct system of inspection is the check upon every defect of design, of construction and of operation.

* Presented at the St. Louis local section of The American Society of Mechanical Engineers, on June 16, 1915.

"Inspection should be made at fixed regular intervals and should be conducted by an inspector experienced, reliable, of good judgment and absolutely conscientious. He should be accompanied in his inspection by the responsible man in charge of the boiler, and his examination should be deliberate, thorough and unimpeachable. The time should be so chosen that the work may be done satisfactorily, without haste or interruption. The method should be—careful examination by eye, hand and a light hammer, of every sheet, stay, brace, tube and rivet in the boiler. Defective riveting, the most common defect, should be looked for in every seam. Cracks in the seam, under the lap, are not unusual and are very difficult to find in many cases, but if undiscovered they will be likely to prove disastrous. Corroded sheets and tubes, bad bracing, sediment and incrustation are all promptly detected and readily visible in any case. The thickness of thinned sheets, corroded on either side, or of blisters, may be judged by the action of the sheet under the hammer, and many defects, entirely invisible, are found by the experienced inspector by the hand and ear, reinforced by the use of this tool. It is evident that no inspection worthy of the name can be made unless with the boiler dry and empty, and accessible in every part. A design which does not permit this should be condemned offhand. Tests by hydraulic pressure, though useful, and in the judgment of the writer indispensable, cannot be, in any case, allowed to supersede the real inspection above outlined.

Inspection Must Be Legally Enforced

"Whatever may be the fact, however, more perfect and effective methods of inspection must be legally introduced and well enforced before the steam boiler explosion can become extinct, with its resultant destruction each year of hundreds of lives and millions of dollars' worth of property. With such methods, universally practiced, steam boiler explosions will become unknown."

Written some twenty-five years ago, the advice thus given has been to a considerable extent followed, but there still remains much to be accomplished, particularly as regards proper state legislation.

There are approximately 1,500 boiler explosions of varying intensities each year in this country, averaging 400 or 500 persons killed, 700 or 800 injured and many hundreds of thousands of dollars damage to property.

General methods for proportioning the several dimensions of the boiler structure have long been known and in general use, although modified from time to time by tacit consent as experience or new and improved materials and methods became available. These rules, if such they may be called, have varied greatly in details in various places, depending on the personal opinions and experiences of the man or men formulating them. It can readily be appreciated that with the great multiplication of such regulations in the past few years, manufacturers who do a wide interstate business have become confronted with a condition that is hard to meet. In addition there are the infinite variety of private specifications written by consulting engineers and others, that differ through exceedingly wide limits and which represent the judgment of one or at best a very few men. Under such conditions it is impossible to manufacture economically, for a boiler built to meet the requirements of one place may be rejected in some other locality.

In 1905 there occurred in Brockton, Mass., an explosion which caused $250,000 damage, the loss of 58 lives and 117 injuries. This aroused the State of Massachusetts to action, the result of which was the enactment of legislation providing for the licensing of engineers and firemen, and governing the construction, installation and inspection of boilers. A Board of Boiler Rules was created for the purpose of formulating construction standards; its labors resulted in the most complete, scientific and logical set of regulations that had ever been promulgated. These rules have been quite extensively copied all over the country.

However, the need of regulations that would represent the consensus of the opinion and experience of the whole country rather than that of any one locality, prompted Col. E. D. Meier, when president of the American Society of Mechanical Engineers, to appoint a committee to formulate such rules. After more than three and a half years' real work, including numerous and lengthy discussions, often heated and acrimonious, the A. S. M. E. Boiler Code, as it is popularly known, has resulted and represents as nearly as it is humanly possible what those who are best qualified to know believe to be the best boiler practice.

The A. S. M. E. Boiler Code

There is much in the Code that is absolutely new. Probably only such a body as formulated it could have prevailed upon certain antagonistic manufacturers of materials and fixtures to get together and agree on uniform specifications for their products. This is notably the case with safety valve manufacturers and tube makers; possibly the most remarkable achievement is the very definite regulations, most of which are entirely new relative to safety valves.

The Code covers the construction of stationary boilers and allowable working pressures, and is divided into two parts. Part I, Section I, applies to new installations of power boilers; Part I, Section II, to new installations of heating boilers, and Part II applies to existing installations of all boilers. Obviously it is necessary to extend considerable leniency to boilers now in use, as to do otherwise would work a tremendous hardship on thousands of steam users.

In brief, the subjects covered by the Code are indicated by the sub-headings: *Selection of Materials*, wherein is specified what grades of materials may be used for various parts and places in the boiler; *Ultimate Strength of Material Used in Computing Joints*, in which unit stresses forming the basis of calculations are given; *Minimum Thicknesses of Plates and Tubes*, to prevent "skinning" the job; *Specifications* for boiler plate steel, rivet steel, staybolt steel, steel bars, steel castings, gray iron castings, staybolt iron, rivet iron, and tubes, all, of course, as pertaining specifically to boiler practice. Then follow under the heading: *Construction and Maximum Allowable Working Pressures for Power Boilers*, detailed rules for determining strength and efficiencies of joints, etc., with examples and stating in what way much of the work shall be executed. Then come the subjects of *Manholes, Washout Holes, Threaded Openings, Safety Valves, Water and Steam Gauges*, and *Fittings and Appliances*, wherein are given methods for determining quantities, sizes, limitations as to location and kind of metals to be used. Some general regulations as to settings to promote safety in operation, s to how hydrostatic tests shall be made and finally the method of stamping to show conformity of the structure vith the Code are given.

The rules covering boilers used exclusively for heating cover substantially the same ground, but are much more brief.

In Part II appear the rules for determining the working pressure to be allowed on existing boilers, and what fittings must be provided and how applied. On boilers now in service, will be required many minor changes if the Code is followed, but there are none but what should be made in any event. This section also provides for the gradual amortization, to use a commercial and financial term, of boilers now in use and not built to the Society standard.

An Appendix gives full examples of various riveted joints and methods of calculation, as well as of braced and stayed surfaces, method of computing safety valves, also how fusible plugs should be located in the various types of boilers, and standard dimensions for flanged pipe fittings.

In my opinion it is amply sufficient for any one desiring to purchase a boiler plant, after having determined the working pressure and the size and type of units required, to merely specify that the boiler is to be built according to the A. S. M. E. Code. By so doing he will get from any reputable manufacturer a well-constructed structure entirely suited to its purpose. If preferred, the material and workmanship may be checked by some inspecting agency. From a manufacturer's standpoint, my plea is for country-wide uniformity of requirements, and this the general adoption of the Code makes possible. It couples together economical manufacturing with the all-pervading cry of Safety First.

ENACTMENT OF UNIFORM BOILER LAWS

In compiling this Code, therefore, the American Society of Mechanical Engineers has provided a substantial basis for boiler specifications and legislation. The Society cannot go further than to say that, in the estimation of those best qualified to judge, these are the most rational rules and regulations for boiler construction. The enforcement of the rules must be left to the activities of other agencies. A very considerable number of the boiler manufacturers of the country have already gotten together on two occasions, first on September 19, 1914, and again on March 29, 1915, with the avowed purpose of furthering the universal use of the Society's Code, and at the last-named meeting the Code was unanimously endorsed and steps taken to launch a movement to prevail upon the various States to enact legislation putting it into legal effect. It seems impracticable to do this in any other way. The State of Ohio has already made this enactment, and the State of Wisconsin will in all probability do so, to be effective January 1, 1916.

Educational movements will have to be started in various other States in order to be at all sure of any success at future State legislative sessions. Last fall it was hoped that the Code would be completed in time to present the matter definitely to the numerous legislatures that were in session early this year, but that proved to be impracticable. One of the forms of education is to persuade those who have positive ideas of their own that such should be subservient to this broader consensus of opinion, and only by so doing can country-wide uniformity, so exceedingly desirable, be attained. Already there are some objections raised to minor points, which indicate that there are difficulties to be overcome in arriving at the desired end.

That this effort of the society in bringing out the Code will help tremendously, primarily in bettering boiler construction generally, and, secondarily, in smoothing the way of manufacturers, thus redounding to the financial benefit of the user, needs no further argument. The Code has already attained such momentum as to make it a powerful factor.

It can truly be said that what the American Society of Mechanical Engineers is doing to prevent boiler failures in this country is something which could have been done by no other organization, and that the effect will be far-reaching and long-continued.

To find the cubical contents of a ball, multiply the circumference by the diameter and this result by one-third the radius.

Calculations for Size of Boilers

What is the best method used for figuring the size of boiler required for supplying a fore-and-aft compound engine with cylinders 10 and 20 inches diameter by 14 inches stroke, cutting off at 10½-inch stroke; working pressure of boiler, 160 to 165 pounds; piston speed, 600 feet per minute? Probably natural draft would be used, but what difference in the size of the boiler would it make if forced draft were applied? Would a Fitzgibbon type boiler or a submerged tube, vertical type answer just as well as a Scotch boiler?

The foregoing questions, of interest to boiler makers, were answered in a recent issue of *International Marine Engineering* as follows:

The best method is to determine the probable steam consumption of the engine and provide a boiler with sufficient grate and heating surfaces to supply this steam. This necessitates first a determination of the probable indicated horsepower of the engine. The general formula for mean effective pressure (theoretical) is

$$\text{M. E. P.} = p_1 \frac{1}{n} (1 + \log_e n) - p_3,$$

where p_1 = boiler pressure,
n = total number of expansions,
p_3 = back pressure,
if p_1 = 160 pounds per square inch,

$$n = \frac{10 \times 10 \times \pi \times 14}{5 \times 5 \times \pi \times 10.5} = 5.33,$$

and p_3 = 4 pounds per square inch (assumed),

$$\text{then M. E. P.} = 160 \times \frac{1}{5.33} (1 + \log_e 5.33) - 4,$$

$$= 160 \times \frac{1}{5.33} (1 + 1.6734) - 4,$$

$$= 80.2 - 4 = 76.2 \text{ pounds per square inch.}$$

The ratio of theoretical mean effective pressure to probable mean effective pressure is about .55 for this type of engine, so that the indicated horsepower to be expected is

$$\text{I. H. P.} = \frac{\text{M. E. P.} \times \text{Piston Speed} \times \text{Area L. P. Cyl.}}{33{,}000} = \frac{41.9 \times 600 \times 314}{33{,}000} = 239.$$

A steam consumption, including auxiliaries, of 25 pounds per horsepower hour is reasonable for this type of engine and gives 239 × 25 = 6,000 pounds per hour approximately, as the evaporation of the boiler. The equivalent evaporation from and at 212 degrees is

$$\frac{\text{Heat contents at 165 pounds} \times 6{,}000}{\text{Heat contents at 212 degrees}} = \frac{1{,}196 \times 6{,}000}{1{,}150} =$$

6,200 pounds approximately.

$$\text{Boiler H. P.} = \frac{6{,}200}{34.5} = 180.$$

For Scotch boilers about 7 pounds steam per square foot of total heating surface is as much as should be counted on, which would give 6,000 ÷ 7 = 857 square feet, and, allowing 35 square feet of heating surface per 1 square foot grate, the required grate area is 857 ÷ 35 = 24.5 square feet. Therefore, a Scotch boiler for the given conditions should have about 860 square feet of heating surface and 24.5 square feet of grate area.

If forced draft is used it is probable that the horsepower per square foot of grate area would be about 15, which would give a much smaller boiler.

Unless the weight is prohibitive, the Scotch boiler will probably be most satisfactory.

Design of a Watertube Boiler

Calculations for Heating Surface and Grate Area—Size of Drums and Tubes—Horsepower

BY C. W. R. EICHHOFF, M. E.

In designing a steam generator for a certain purpose in view, we have to consider the following items:

1. The type of boiler most suitable for existing conditions.
2. The quantity of steam required.
3. The quantity of fuel to be used.
4. The strength of the boiler.
5. The size of different openings.

Selection of a Boiler

In regard to the selection of the proper boiler for a certain purpose, much can be said. A person cannot be too careful in regard to this important subject. Many mistakes are made by engineers in this respect. There is at present a great tendency to select watertube boilers because they are considered safer than other types, are rapid steamers and have other good points to recommend them. In the selection of the proper style it should be considered if it is more advisable to choose a type with a large water volume or one with a small water capacity. The watertube boiler has a rather small water volume as compared with other boilers.

In our case the conditions are such that they warrant the installation of a watertube boiler. How to proceed in designing a boiler for a certain purpose is best shown by an example.

Example

A watertube boiler is to deliver 5,250 pounds of steam per hour at a gage pressure of 175 pounds, or 190 pounds absolute, per square inch. The boiler is to be provided with a superheater capable to superheat the steam to 572 degrees F. The temperature of the feed water before entering the boiler is 176 degrees F. The fuel available and to be used has a heating value of 13,500 British thermal units and a pound of same requires 16½ pounds of air for combustion.

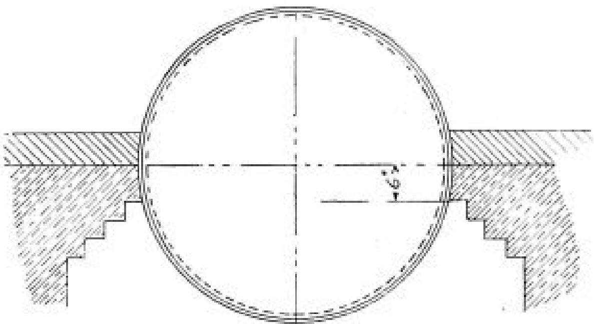


Fig. 1

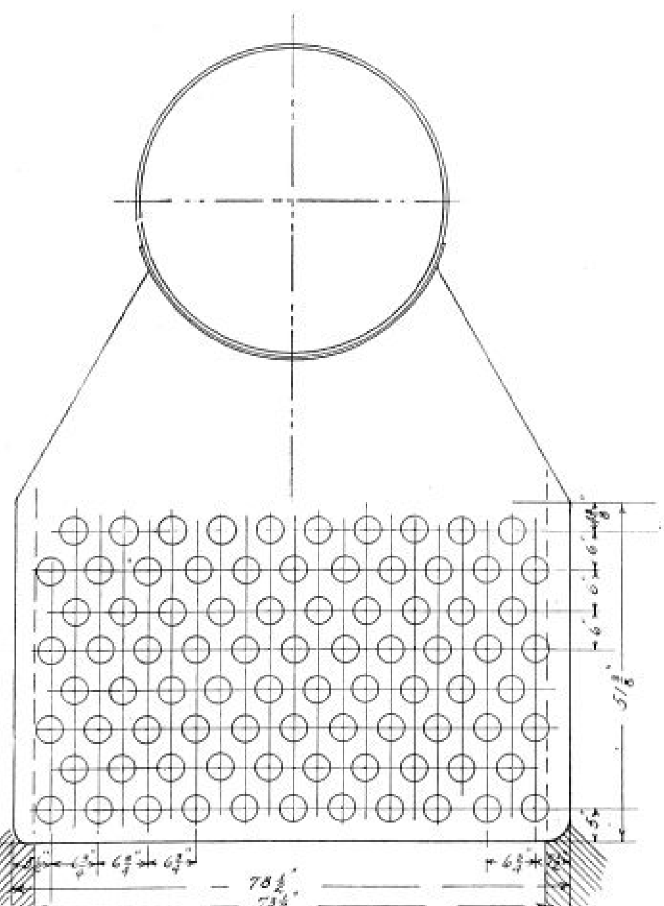


Fig. 2

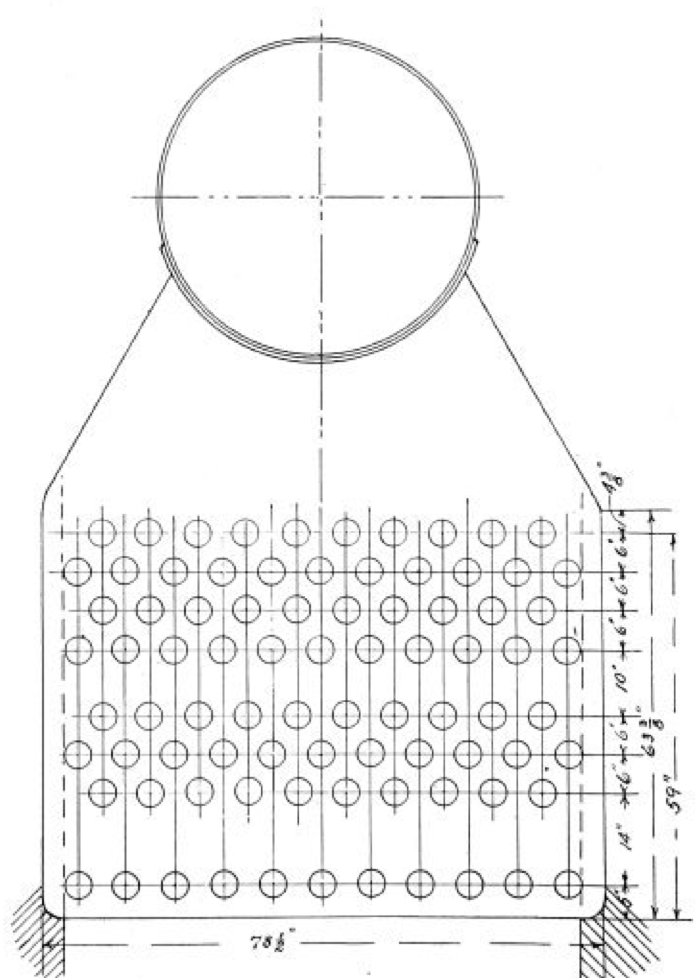


Fig. 3

Determination of the Heating Surface

As boilers, especially of the horizontal watertube type, seldom deliver dry steam, we will make a reasonable allowance for the moisture in the steam and assume that the same contains 3 percent moisture.

If S_1 is the quantity of saturated dry steam to be generated by the heating surface and S the original quantity specified, m the percentage of moisture in decimals, then

$$S_1 = S - S_1 m$$
$$S_1 + S_1 m = S$$
$$S_1 (1 + m) = S$$
$$S_1 = \frac{S}{(1 + m)}$$

or in our example the total quantity of steam required is

$$S_1 = \frac{5{,}250}{1 + 0.03} = \frac{5{,}250}{1.03} = 5{,}091, \text{ say } 5{,}100 \text{ pounds.}$$

In boilers of this type 3½ pounds of water can be evaporated per square foot of heating surface and we have with this assumption a heating surface of

$$\frac{5{,}100}{3.5} = 1{,}460 \text{ square feet.}$$

Size of Drum—Number and Dimensions of Tubes

The diameter of the steam drum we take as 48 inches and assume that the drum is bricked into about 6 inches below the center, as shown in Fig. 1. We have, then, for the drum

$$\frac{4}{2} \times \pi - 2 \times 0.5 = 2 \times 3.1416 - 1 = 6.28 - 1 = 5.28 \text{ feet}$$

of the circumference exposed to the hot gases in the flue. We further assume that 14 feet in length of the steam drum is to be used as heating surface, which will give us a heating surface

$$= 5.28 \times 14 = 73.92, \text{ say } 74 \text{ square feet}$$

For the tubes there will remain a heating surface of

$$1{,}460 - 74 = 1{,}386 \text{ square feet.}$$

A 4-inch tube has a heating surface of 1.05 square feet per foot of length. We have in each 4-inch tube 16 feet 6 inches long, $16.5 \times 1.05 = 17.3$ square feet heating surface. We require

$$\frac{1{,}386}{17.3} = 80 \text{ tubes.}$$

It is the usual practice in this style of boiler to arrange the tubes eight to ten rows high. On account of available head room we assume that we cannot take more than eight tubes high and the available floor space allows us to place only eleven tubes in a horizontal row.

We can now arrange the 80 tubes in eight rows, each containing 10 tubes. But on account of a peculiar furnace construction we have to cover some of the heating surface by fire tiles, and for this reason we increase our number of tubes to 84, which will also make a good tube layout. We have, then,

4 rows with 10 tubes = 40 tubes
4 rows with 11 tubes = 44 tubes
= 84 tubes

Our heating surface is now:

Drum	5.28 × 14 =	73.92 square feet
84—4" × 16' 6"	17.3 × 84 =	1453.2 " "
	Total =	1527.14 " "

or about 1,527 — 1,460 = 67 square feet more than required.

The evaporation per square foot of heating surface would be

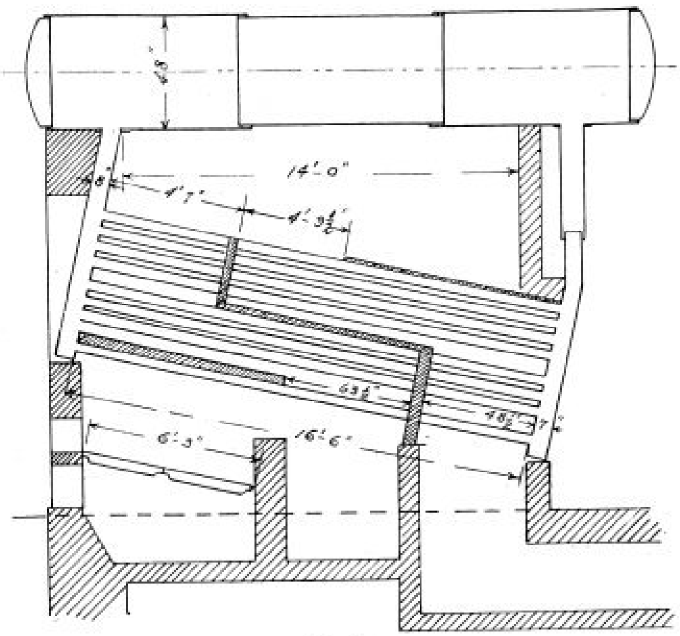


Fig. 4

$$\frac{5{,}100}{1{,}527} = 3.34 \text{ pounds.}$$

If we space the tubes 6¾ inches apart in horizontal rows and 6 inches in the vertical rows we have for the width of the water leg

$$(11 - 1) \times 6.75 + 2 \times 5.5 = 78.5 = 78\tfrac{1}{2} \text{ inches;}$$

and for the height

$$(8 - 1) \times 6 + 5 + 4.375 = 51\tfrac{3}{8} \text{ inches.}$$

If we leave a space of 14 inches between the first and second row of tubes and another space of 10 inches between the fourth and fifth row for a better furnace construction, as shown in Fig. 3, the total height of water leg would be

$$51\tfrac{3}{8} + \left(\frac{10 + 14}{2}\right) = 63\tfrac{3}{8} \text{ inches.}$$

The width of the rear water leg we make 7 inches, and for good circulation the front leg 1 inch wider, or 8 inches.

Determination of the Grate Surface

To evaporate 1 pound of water to steam at 175 pounds gage, or about 190 pounds absolute pressure, there are necessary, according to the steam table, 1,197.3 British thermal units. The feed water is to be preheated to 176 degrees F., so there are only

$$1197.3 - 176 = 1021.3 \text{ British thermal units}$$

necessary. But besides this the steam is to be superheated to 572 degrees F. The temperature of the steam at 190 degrees absolute is 377.6 degrees F. and the specific heat of superheated steam is .545. We require, then,

$$.545\ (572 - 377.6) = 194.4 \text{ British thermal units more,}$$

or

$$1021.3 + 194.4 = 1{,}215.7, \text{ say } 1{,}216 \text{ British thermal units.}$$

Taking the efficiency of the furnace = 0.90 and of the heating surface = .75, we can evaporate with one pound of the available coal

$$\frac{.90 \times .75 \times 13{,}500}{1{,}216} = \frac{9{,}212}{1{,}216} = 7\tfrac{1}{2} \text{ pounds of water.}$$

We have to evaporate per hour 5,100 pounds of water, or we need

$$\frac{5{,}100}{7.5} = 680 \text{ pounds of coal.}$$

At 60 degrees F. (the average temperature of air) 1 pound of air will occupy about 13 cubic feet. To find the volume of air required per pound of coal we multiply the weight by 13 for ordinary conditions. We assumed that we require 16½ pounds of air for the combustion of our coal, which will require, then,

$$16.5 \times 13 = 212\tfrac{1}{2} \text{ cubic feet of air.}$$

The air entering the grate should have a velocity of about 3 feet for natural draft and the total area of the air spaces in the grate should therefore be

$$\frac{212.5 \times 680}{3 \times 3{,}600} = 13.4, \text{ or, say, 13 square feet.}$$

If the area of the air space is taken as one-third of the total grate area, we have a total grate area of

$$3 \times 13 = 39 \text{ square feet.}$$

The width of the grate we make, according to Figs. 2 and 3, 73½ inches wide or 6.29, say 6.3 feet. The length of the grate will then be

$$\frac{39}{6.3} = 6.175, \text{ say 6 feet 3 inches.}$$

The area of the grate is

$$6.3 \times 6.25 = 39.375 \text{ square feet,}$$

say 39 square feet, and the rate of combustion

$$\frac{680}{39} = 15\tfrac{1}{2} \text{ pounds of coal}$$

per square foot of grate per hour.

The ratio of heating surface to grate surface is

$$\frac{1{,}527}{39} = 39.$$

SIZE OF THE FLUES

The area of the last flue between the tubes we make according to good practice one-fourth of the grate area, or

$$\frac{39}{4} = 9.75 \text{ square feet.}$$

The width of this flue is $73.5 - 11 \times 4 = 73.5 - 44 = 29.5$ inches, and the breadth will be

$$\frac{9.75 \times 144}{29.5} = 48\tfrac{1}{2} \text{ inches.}$$

The flue back of the bridge wall we make one-third of the grate area, or

$$\frac{39}{3} = 13 \text{ square feet.}$$

The width of this flue is, then,

$$73.5 - 11 \times 44 = 73.5 - 44 = 29.5 \text{ inches,}$$

and the breadth,

$$\frac{13 \times 144}{29.5} = 63.5 \text{ inches.}$$

The flue in front of the superheater is

$$\frac{39}{3.5} = 11.2 \text{ square feet,}$$

$$\frac{11.2 \times 144}{29.5} = 55 \text{ inches.}$$

The area of the chimney flue is one-fourth of grate area, or

$$\frac{39}{4} = 9.75 \text{ square feet,}$$

and if we make the breadth 3 feet we have a width of

$$\frac{9.75 \times 144}{36} = 39 \text{ inches.}$$

The flue between the last one and the one in front of superheater we make of a size between these two, say

$$\frac{55 + 48}{2} = \frac{103}{2} = 51\tfrac{1}{2} \text{ inches.}$$

HORSEPOWER

For all practical calculations a horsepower is equivalent to 30 pounds of water evaporated (not paying attention to the more exact definition of 30 pounds water evaporated from a feed water temperature of 100 degrees F. into steam at 70 pounds gage or equivalent to 34½ pounds from and at 212 degrees F. into steam of atmospheric pressure). The horsepower is, then,

$$\frac{5{,}100}{30} = 170 \text{ horsepower;}$$

or, if we figure 10 square feet of heating surface per horsepower,

$$\frac{1{,}527}{10} = 153 \text{ horsepower.}$$

The coal burned per square foot of heating surface is

$$\frac{680}{1{,}527} = .38 \text{ pound,}$$

and the coal per horsepower,

$$\frac{680}{170} = 4 \text{ pounds,}$$

$$\frac{680}{153} = 4.4 \text{ pounds.}$$

Cutting with the Oxygen Jet

The discovery that a jet of oxygen directed upon a previously heated steel or wrought iron section was capable of burning the metal-to-iron oxide, and furnishing, thereby a most convenient and effective means of cutting sections up to 30 inches in thickness, marked an epoch in the development of the world's metallurgical industry. It was early appreciated that, in order for oxygen metal-cutting apparatus to attain its recognized standard in metal-working fields, there were involved the factors of low-cost gas supply and minimum consumption of gases per square inch of metal oxidized.

With the establishment of oxygen generating stations and distributing service, the first of these requirements has been met; for the second, the time and energy of apparatus manufacturers have been devoted to making it possible to substitute the oxygen cutting torch in a rapidly increasing number of instances where formerly only most laborious and expensive methods were possible.

As indicating the wide range of application of the process, manufacturers of jewelry employ autogenous welding for the joining of precious metals requiring for their successful manipulation the production of high-temperature flames equaling the size of a needle point, under most exact adjustment and control.

Remember this idea when you start up a boiler: get the fire going slowly.

A five-pound squeeze of a man's hand shows friendship. Five pounds applied quickly with your fist on the end of a man's nose means war. It's the same amount of force, but differently applied.

Two Boiler Shops—A Comparison

The Success and Failure of Two Shops Established by Men who Learned the Trade Together

BY JAMES FRANCIS

I have been "visiting." I went out among the boiler shops and saw things done and left undone which it would require a "week of Sundays" to tell about. But I was particularly interested in two boiler shops, the owners of which started in business at about the same time. That was about the only point of similarity which I could find, and even that is not noticeable now, judging from the size of either shop and its business.

I learned something which made the matter all the more interesting, and it was that the two men who are proprietors of the two shops both learned the trade in the same shop and worked there until they quit to enter business for themselves. To-day, one shop employs ten men, the other shop about eighty. The owners, whom we will call Sid Short and Lem Long, because those are not their right names, began to show their characteristics very decidedly while working as journeyman boiler makers, and the same characteristics are now the distinguishing features of the two shops.

Characteristics of the Two Men

Short was a "pusher." He could turn out more work in a day than some men in two days, and he was always rushing everything for all it was worth. He was always sent out on contract work and no man could drive a gang through faster than Short could. But he sometimes had to go back and make good something which had been passed, which the final inspection would not stand for.

Long hardly ever worked on the same job with Short. Long never was satisfied to let a job go until he was sure that it could not be done any better. Long seemed to have absolutely no idea of the time which was being put into a job and he was never known to move one second faster in order to finish any work within a certain time. If four-fifty o'clock came around and half an hour's work was needed to finish that job before quitting time, Long never moved a hair to hurry the thing through so he could be ready to quit when the whistle blew. Long cared nothing whatever for the whistle or for twenty minutes' work overtime, which he never said anything about. He was just interested in making the best boiler possible—and he did it.

Long never turned out much more than half the work which Short dashed off, but no one ever knew of Long having to go back and finish something left undone. When Long said a job was finished, it was done, and done right, too. All the particular jobs went to Long. Every bit of difficult work which must be done absolutely just so was turned over to Long, and these jobs were always satisfactory to the customers and they asked to have Long sent back when other work was needed.

It chanced that Short and Long went into business for themselves about the same time—the same year, in fact—and Short interested some capital, built a small new shop with everything arranged so it could be readily enlarged as the business grew. It is ten years since the shop was built and it hasn't been enlarged yet! But it does show many signs of hard usage. The building is uncared for, looks some dilapidated, and the machines are very much the worse for wear. Indeed, the several machines and implements nearly all look as though they had just been resurrected from some junk shop or second-hand store. Each and all have that indescribable air of hard usage and neglect which is seen in second-hand machines.

Mr. Long bought into an old shop the business of which was very small indeed. The tools, though good, were badly in need of care. The buildings were badly neglected, the roof leaky, and as one workman stated: "They always went out of doors when it rained too hard!" The land around the shop was a grand clutter of old junk and vigorous weeds. The dirt floor of the shop resembled a relief map of Pennsylvania or Kentucky—just about as smooth, in fact. A man could always find a convenient hole for his foot when he wanted to strike left-handed with a sledge.

How Short Started in Business

When they started business, Short brought in a big bunch of orders, put on all the men he could work in the little shop, and rushed the work as fast as he could. He figured low on the orders—very low, in fact—and had to do so to get the orders away from the other bidders. But he landed the orders, and he made the boilers and delivered them on time, but when he had paid for the material he found himself "in a hole," for the boilers had cost every cent which he got for them and his work had brought no profit at all—barely paid the expenses and the overhead.

And the work came back, but the customers didn't. There was a continual demand for a man here, a man there, to tighten some rivets or roll some tubes, for the rush work surely showed itself. Short continued to get contracts, for he underbid everybody and got lots of work, but made no profits, and it is a very safe statement to make that the shop never had a repeat order since Short started it. If satisfied customers are the best paying customers—and that seems to be the fact—Short didn't seem to have any of either classification!

Short never read The Boiler Maker. He got a copy occasionally, same as he did of other technical publications which were sent to his shop, but I have seen a dozen papers lying in a corner with their wrappers on, and one was never opened unless a boiler maker wanted a piece of paper to mark out a templet on. Then the first technical journal he got his hands upon would be ripped out of the wrapper, a few pages torn out, and the rest of the journal dropped wherever the man happened to be standing.

Short's Employees

There are no apprentices in Short's shop. Says he has no time to bother with them. He hires all the hobo boiler makers he can get hold of, but they don't stay long. They size up Short in a "short" time, earn a little booze money and mosey along to a place more to their liking than is Short's hustle shop, where everything is "helletelarrup" and rush, slam and flash are the watchwords from Monday morning until Saturday night.

But that's enough about Short and his shop. We have all seen the kind, more's the pity, and the less we have to do with such concerns the better off we are. It was the writer's misfortune to work in such a shop while he was a young man, and he quickly realized the danger of doing work in like manner and did not stay long.

When Long moved into his little, old, run-down, apology for a shop, everybody shook their head and said, "Too bad for such a fine workman as Long to waste himself in that old tumble-down shop and business." But Long never stopped to listen to any talk of that kind. However, whenever anybody came to him with a suggestion, Long was all attention until the story was told. Then he grinned cordially, thanked the party for his trouble and went right on about his business, doing just as he had a mind to do; but if the suggestion was a good one, which Long hadn't thought of, it surely was salted down in the back of Long's head for use when possible and practical.

The first thing Long did, after taking over the old shop, was to subscribe for The Boiler Maker and to put an advertisement in his home paper. Then he went to work rustling for orders, of which he succeeded in capturing a few. He turned out the work in his usual careful manner and never had to go back to do "patchwork" on anything delivered from his shop.

The Cleaning-Up Process

Between whiles, when there was little work in the shop, Long started his men at a very aggressive "clean-up" campaign. The outside of the little shop was tightened up. Loose siding nailed, windows jointed in and weighted where they needed it. Sashes were glazed, then the roof was gone over and covered with some good two-ply waterproofing, well nailed, cemented and painted. After that the outside of the entire shop was given two coats of good paint—good thick coats, too, with promise of another in a few months.

A man with a couple of laborers was started after the land which surrounded the shop and tons of rank weeds were pulled, cut and otherwise removed, dried, piled and burned. There was found such a collection of junk in that yard as never was dreamed of, even by the "oldest inhabitant" of the home town. There were old boilers, old machines of various types, piles of scrap and tons of metal of no use whatever, save for scrap.

Long started two men to knocking off rivet heads with sledges, then he sent for a cutting torch and started one man with that tool and beat out the two sledge men in short order. The big curved sheets were cut up small enough to be packed and handled readily. Long didn't believe in handling material oftener than necessary, so a flat car was ordered and as fast as sheets were cut up they were packed on the car all ready for shipment.

Disposal of the Scrap

The entire yard was thoroughly gone over in this manner. Every piece of metal which could possibly be of future use was carefully piled in a shed which was erected for that purpose, and all the rest of the metal was remorselessly scrapped and piled on the waiting cars—not overlooking the proper sorting and piling together of the different grades of scrap.

This work outside the shop was carried on between jobs, every spare moment of each man being devoted to "cleaning up." And while all this was going on in the yard the inside of the shop was not neglected by any means. Each and every piece of loose metal was rooted out of corners and from out-of-the-way places and sent to the stock shed or to the scrap car. Not a thing was left in the shop or underfoot which did not belong there. Then the floors were gone after, filled and rammed where necessary, and some concrete put in around some of the machines.

Finally the entire shop had been cleaned and slicked up, inside and out, and, as one of the boiler makers said, "It looked twice as big as before clean-up!" One day, half-a-dozen sacks of hydrated lime came into the shop and Long detailed one man and a laborer to mix and spread whitewash. Each timber and board overhead was brushed well before the whitewash was applied, but the dust-brushing business proved such a dirty job that Long had a man make up a sort of vacuum cleaner nozzle out of thin sheet iron. Then some pieces of fiber scrubbing brush were nailed around the edges of the vacuum nozzle, to which a piece of 1½-inch steam hose had been attached and connected with the suction of an extra forge blower. The discharge of the blower was piped out of doors, a common tin water conductor of the cheapest kind being used. The whitewash was the subject of considerable thought. Long intended to use the United States Government formula for whitewash, in which glue is used. But as the formula in question calls for lump lime and Long was to use hydrated lime, he mixed the hydrated lime with skim milk from a nearby butter factory, put a steam hose into the barrel in which the whitewash was being mixed, and boiled the mixture, then put it on hot, heating it with the steam jet as required.

Whitewashing the Shop

Mr. Long borrowed a whitewashing machine which used compressed air for spraying the whitewash, but the men seemed to have poor success with its use, and went back to the whitewash brushes again. While trying to use the machine, they were greatly troubled by its clogging, necessitating the cleaning out of the machine at frequent intervals. While trying to unclog the machine, the foreman of the shop loosened a set-screw, when suddenly the screw blew out of the hole and a solid ⅜-inch stream of whitewash hit the foreman right in the collar button and naturally went pretty much all over him before he could get out of range. It is of no use to ask that man for a testimonial for pneumatic whitewash machines, for they certainly would not look well in print!

Two large orders came in before the shop was fairly cleaned up and matters were dropped for the time being until the orders were out of the way. Both these orders were from former customers of Short's shop, and he had been depending upon them for repeat orders, but they didn't repeat worth a cent. None of Short's customers ever placed a second order with him if they could help it, and these two orders went to Long's shop at a considerable advance over the prices paid to Short for the original and similar orders.

While the work was being gotten out, Mr. Long quietly took stock of each machine in the shop, made up his mind what each one needed and just what he would do. Then he ordered parts and repairs and had them on hand against the time they could be used. More orders, and large ones, came in before the repairs were finished, and it was not until six months had passed that Mr. Long was able to overhaul the shop tools and put in place the new parts. When he did this, each machine was painted neatly and a good-looking sign was fastened above the shop, the whole length of the ridge, and other signs were put up in front, where they were appropriate.

Short cut his prices even lower than they were, and consequently had to make a corresponding cut in the quality of the work turned out, for it is very true in the boiler business that a man gets just what he pays for. If he shops around and finds the cheapest boiler and lowest priced stack in the country, then it is a mighty sure thing that he is getting the poorest shell and the lightest metal in the stack, and the least possible work therein.

While Short has cut his prices twice, Mr. Long has raised prices and is just sending out another set of letters to his customers stating that after February 1, 1916, there would be a 10 percent advance in heating boilers and some other specialties. While Mr. Short is cutting prices and finding hard work to keep the shop busy, Mr. Long is advancing costs and planning another increase in shop room, the fourth since he moved into the little tumble-down shop which was formerly spoken of with an apology, but which is now put forth by the citizens as a representative manufacturing plant, which is always busy, turns out good work and obtains good prices therefor.

Mr. Long's shop waits long for repeat orders. In fact, hardly ever gets them to replace boilers sent out, for the boilers in question are so good that they don't have to be replaced in a lifetime. But the "repeat" orders, which are many, after all, come from customers who are using Long's boilers and who are enlarging or planning extensions and duplicate plants.

Many orders also come from the former customers of the Short shop. These customers have become disgusted with the light material, skimpy workmanship and short life of the "hurry-up" type of boilers obtained from the Short shop and are placing future orders with Long, where they know they will receive full value for the price paid. They know that when an order is given to Mr. Long they need not think of the order again until it is time to send a check therefor, that the boilers will be ready when agreed upon, that they will go right to work and require no patchwork or "tuning up" to place them in commission, and, furthermore, they know that they will never have to worry about what the boiler inspector will have to say regarding Long boilers, and they also know that, barring accidents, repairs needed will be few.

Boys, you are working in somebody's shop now, but of course you are thinking and planning against the time you, too, can "shake the boss" and start a shop of your own, no matter if there is only yourself and another man to begin with. That is the way—the right thing to do. But stop right now and think which will pay you best, to be a Short or a Long? Right now is the time to decide the matter. If you are rushing work around, getting it out of the way of the clock as quickly as possible—if you are a "quantity" man—then you are fast becoming a disciple of Short, not a follower of Mr. Long.

In one case you will take a contract and rush it through as cheaply as you can, caring nothing for the quality of the work done, only to get the job done well enough to pass inspection and to get a check therefor. Or will you adopt Mr. Long's methods and make the best boiler you can and charge a fair price for your work? The foregoing shows how each plan works out. Hadn't you better start right here and now and do the work by the "Long" method?

John and the Calking Edge

How Geometry Enters Into the Calking of a Boiler Seam—Action of a Calking Tool

BY JAMES F. HOBART, M. E.

"Good morning, Mr. Hobart, I haven't seen you since last August."

"Why, hello, John! Haven't you been working lately? Where have you been along back?"

"Yes, Mr. Hobart, I've been working every day, and nights and Sundays, too, most of the time. But, Mr. Hobart, please don't call me 'a long back,' for I aren't that kind of a fellow at all."

"All right, John, I won't. I didn't mean anything by it, anyway, no more than Tim Snyder did when he said he was going to quit, as his company were not going to make boilers any longer——."

"Great tube sheets! Say, Mr. Hobart, aren't Messrs. Tube & Sheet going to make boilers any longer?"

"No, John, that's the truth. They are not."

"Well, I declare! Wonder why they won't make 'em any longer?"

"Just for the very good reason, John, that their boilers are long enough now! See?"

"O pshaw, Mr. Hobart, that's wicked! I'll set up the cigars and won't say any more about 'along back,' but I wish you would tell me about geometry and the calking business? Last August you said something about using geometry for setting the tool when trimming sheets; also the best shape of calking tools and the proper angle for holding same. Tell me something about those things, will you?"

"All right, John, we'll tackle that question, but I tell you right now that *you* have got to figure it out for yourself. I'll ask the questions, but you have got to do the work and the thinking."

"All to the good, Mr. Hobart, I'll do the best I can in the matter."

"Good. That's the way to get at a thing. Now, John, what's the use of planing the edge of a sheet, anyway? Why not let it go as it comes from the shearing machine?"

"They could do that, but it is not as nice or as easy to calk. I have calked sheets which were not planed, and the boss made me chip them before he would have them calked. I had to chip those plates after the rivets had been driven, and I tell you it was some job to trim the plate clear down to the under sheet to make any kind of time and not to nick the lower sheet the least bit. That was where the work came in, keeping away from that sheet."

"Well, what angle did he have you chip the edge of that sheet?"

"I don't know what angle it was. He had me make a templet out of a bit of thin sheet iron; I took a bit of the hoop off a rivet keg. He made me cut one end to fit a file as shown by Fig. 1, where the file *A* was placed on a flat surface and one end of strip *B* was cut and filed until it fitted fair against file *A*, as shown. The end *B* was used against the plate, which had to be chipped to fit *B*."

"Then, John, the angle of the chipped plate was 60 degrees, wasn't it?"

"I think so, but how do you prove it? It fits the file; that is all I know about it."

"Yes, John, and as the three sides of the file are equal, each angle will be 120 degrees, will it not?"

"Yes, that's right. The angles are all equal to each other, and the three angles make up 180 degrees or a semicircle; therefore one of them would be one-third of 180 = 60. Yes, that's right. Now, the upper corner of the gage must be 60 degrees, while the lower angle, *D*, is 120 degrees. Is that right?"

"Yes, John, that figuring is correct. There is a good bit of confusion as to the angle to which a plate is to be beveled. Fig. 2 shows this and also indicates how the different angles given to the same planed plate have been obtained. If we state the angle of the plate-edge as being from *E* to *F*, then its angle must be stated as 120 degrees. But, John, I never could see the propriety of indicating the angle of the bevel in this way, although it is used in some books on boiler making—Ford's, for instance."

Angle of the Calking Edge

"But, tell me, what does line *E* have to do with the angle of the beveled edge? I can't see any connection at all. What is it?"

"I must acknowledge, John, that I don't know. It seems to me that the angle of edge *F* should be measured from line *H*, instead of from line *E*, which is the same line, all right, but why should we 'back up' past the 90-degree line from *H*, past *G*, instead of reading the angle direct from *H* to *F*? The only reason I can find for this is that, with a square plate, the angle will be 90 degrees, measured either from *E*, or from *H*. Then, starting from *E*, we increase the angle to *G* and beyond as the bevel is made, and we simply add to 90 the distance to line *G*, and add the 30 degrees between *G* and *F*, thereby making the angle *E F* equal to 120 degrees."

"Yes, I see that all right, and it looks as though we should have to call the plates 'beveled to 60 degrees,' instead of '120 degrees.' But, now tell me how is the best angle determined and how do we know that it should be 60 degrees, and not 55 or 65?"

"We will look into that a bit, John. First, draw a plate with a square (90 degrees) edge, as in Fig. 3. It is evident that when this edge is to be calked the calking tool must be held and driven in the direction of the arrow, which is parallel with the plates. Geometry shows us that 'action and reaction must be equal;' therefore, when a tool is driven in the direction of the arrow in Fig. 3, the metal will be forced in the directions indicated by the rays at *J*. This has the effect of driving a thin corner of the plate squarely against the lower plate, only a thin edge of the calking being thus driven into usefulness and, too, with the inclination to separate the plates at *K*, between the point or line of calking, and the row of rivets.

Calking a 90-Degree Edge

"Then, when we calk a square edge, the reaction is such that the metal flows away at nearly right angles to the line of drive, as shown by the arrow, and the edge of the plate is merely upset and a corner thereof driven against the lower plate because the calking, being done close to the lower edge of the plate, the line of least resistance is followed by the displaced metal driven away by the calking tool, and the narrow ridge shown at *J* is the result."

"That, John, is just what happens. We can calk the edge of the plate in this manner and secure a tight seam, but it does not work out as well as when the plate is beveled a certain amount. Try a plate beveled to 45 degrees as shown by Fig. 4. Here the calking tool should be applied in the direction of the arrow *L*, which is, of course, square with the calking edge, and therefore is also placed at 45 degrees with the sides of the plate. Here the tendency of the tool action is to throw up a thin neck of plate, as indicated by the rays at *M*. If the tool be placed close enough to the lower plate to avoid the thin section, then there must be a considerable portion of the hammer energy exerted directly against the lower plate *N* without doing any useful work in calking the plate edge. Indeed, too much hammering at this point may do damage, the lower plate may be actually indented by the constant hammering through the calking tool."

"Say: The calking edge should be a sort of balance between 90 degrees and 45, shouldn't it? Then why isn't a 45-degree bevel in balance? The angle of the plate edge is 45 degrees and the angle at which the tool is held at *L* is also 45 degrees; now, why doesn't that balance?"

"It may balance, John, but it don't bring the balance in the right place. What we want is an angle which, when the calking tool is driven to its full depth into the calking edge, shall exert its resultant force—we will call it that for want of a better name—just square with the lower plate—not a less angle, as shown by Fig. 3, or a greater angle, as shown by Fig. 4."

"Well, how are you going to find what this angle is?"

Action of a Calking Tool

"Let's see what we can do with a bit of geometrical construction, John. We will try it in Fig. 5. Draw one end of a round-end calking tool *R*, and let the radius of the working face be 1/8 inch, the diameter of the tool 1 1/4 inch, and assume that the tool may be driven into the plate one-half its radius, or 1/16 inch by the time the seam is made water tight. This gives 120 degrees of the face of the tool to be in contact with the beveled edge, as shown by lines *S* and *T*, the surface of the bevel coming to line *O*. Line *N* was the original beveled face, but the metal raises on each side under the action of the calking tool, therefore we will consider that the actual calked surface has been raised from line *N* to line *O*, and will base all future work upon this line.

"Line *Q* is through the center of the tool; line *P* is at the extreme end thereof, and consequently line *O* is half way between lines *P* and *Q*, and by geometry it can be proved that lines *S* and *T* are 120 degrees apart, or 30 degrees from lines *S* and *T* to line *Q*, which is parallel with the calking edge of the plate, while line *T* is square with the face of the plate. This means that it is exactly 30 degrees from line *S* or *T* to line *Q*, and geometry will also prove that it is 30 degrees also between the center line of tool *R* and the face of the plate. This also means that the calking edge is 120 degrees, or 60 degrees, from the plate surface also, and means that 30 degrees planed off the square edge of the plate will leave the geometrically balanced calking edge as shown by Fig. 6, with tool *T* working at 60 degrees and the plate *U* at 60."

"Gemini Swipkens! Say! That's awful! Almost enough to make a boy strike his daddy. Have I got to dope all that out?"

"It's all doped out now, John. All you have to do is to go to the trough, put in your head and both feet and eat! You've had worse than that before; what's the matter with you?"

"Oh, nothin', only it looked a bit fierce at first sight, after several months without any geometry dope at all. But I reckon I can surround it after a bit. Say, how about the shape of calking tools? Bill Swipe has a dandy. You can tighten a leak with that tool in no time at all. But Bill never uses it here in the shop, only when he is out on a job. What do you think makes him do that?"

"What sort of a tool is it? What does it look like?"

"Here it is in Fig. 7."

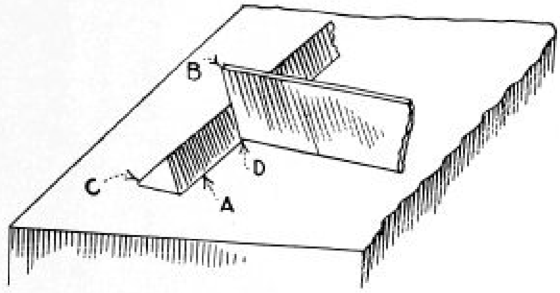


FIG 1 - Making a Plate Chipping Gage

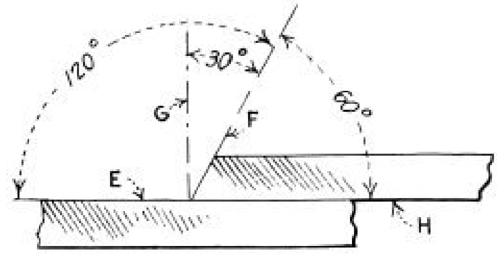


FIG.2 - Angle of the Calking Edge

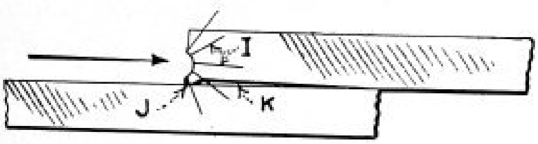


FIG 3 - Calking a 90-Degree Edge

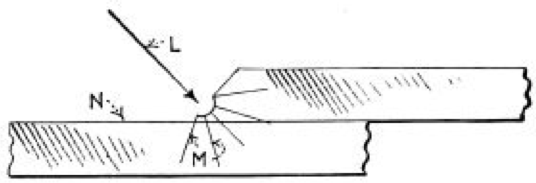


FIG.4 - Calking a 45-Degree Edge

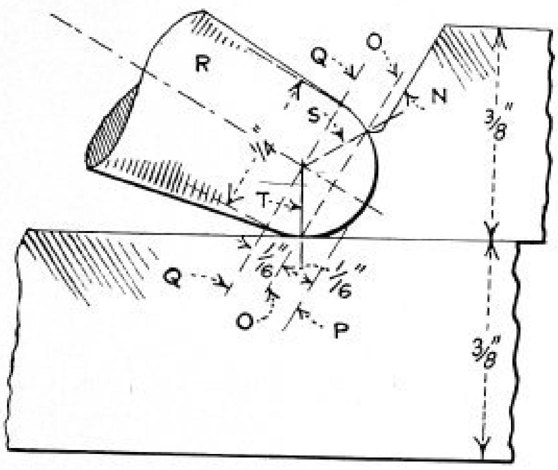


FIG 5 - Action of a Calking Tool

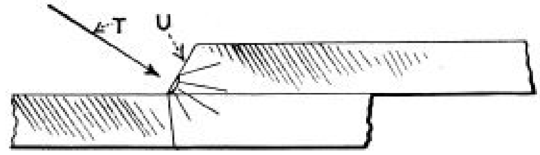


FIG. 6 - Calking a 60-Degree Edge

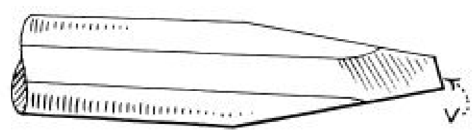


FIG.7 - Square Calking Tool, "The Outlaw"

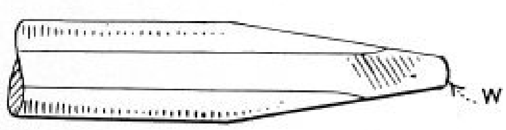


FIG 8 - Round Nose Calking Tool

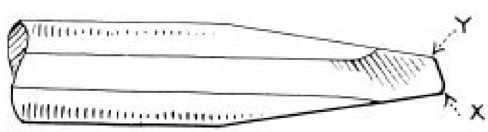


FIG.9 - Combination Calking Tool

Action of Calking Tools on Plate Edges Beveled at Various Angles

"Why, that is the old 'square' tool. It is a very easy tool to work with; drives a seam tight with the least work of any style of calking, but it is an outlaw tool, and its use is not permitted by some boiler insurance companies. The sharp corner *V* will get down into the lower plate and cut it, sometimes so badly as to be dangerous."

"Well, anyway, Bill can calk a seam in a hurry with that tool. He can calk twice as far in the same time as I can with the round-nose tool."

"That's too true, John. The round-nose tool is a very hard one to work with. Here it is in Fig. 8, and the round end *W* is made the same as shown at *R* in Fig. 5."

"But I don't see why tool *W*, Fig. 8, works so much harder than the square tool? Why is it?"

"That is a pretty hard matter to explain, John. When Bill uses the square tool, don't he usually turn it upside down and 'split' the plate first, then turn the tool sharp corner down and finish the work."

"Yes, that's the way he does it."

"Well, John, the reason why the square tool works easier than the round one is the same reason why a sharp wedge can be driven into almost any material easier than a blunt wedge can be driven in."

"O! Ho! So that's the idea, is it? A matter of big end or small end of the tool?"

"Exactly. And for that reason, when heavy plates must be calked with round-nose tools—'concave calking'—then it may be necessary to start the work with a very narow tool, follow with a wider one and finish calking the seam with a round-end tool of the desired radius."

"They have a combination tool, don't they, which has some of the good points of both the square and the round tools?"

"Yes, a tool of this character, and sometimes like that shown by Fig. 9, was patented several years ago, but the patent has expired before this time and the tool may be made and used by anybody. It is shown by Fig. 9. It has one round corner at *X*, same as at *W*, Fig. 8, and one square corner, *Y*, same as the upper side of *V*, Fig. 7."

"But I don't see how this tool can work any easier than the one shown by Fig. 8; what makes the difference?"

"The wedge, John. The combination tool is much more of a wedge than is the round-nose tool, therefore it penetrates the metal easier and takes less driving to finish the calking. There is but very little difference between the working of the square tool and the combination, but the square one will still work a trifle the easier."

"Mr. Hobart, why are all the calking tools made so blamed short? There are places where a long tool could be worked with much more comfort than a short tool could be used, but you can't find a long calking tool in the shop unless it is some freak thing which somebody had made to do a repair job with in some place where short calking tools could not be used.

"Say! I wonder why it is so much work to calk a seam with a very long tool which Bill had made in order to get at some rivets behind a steel channel. Why, it was a very bad job, calking with that tool. Seems as though the hammer blows didn't do any good, for, hit as hard as you please, the tool will not bite into the calking edge half as well as usual. Was it the length of the tool which caused the trouble?"

"Yes, John, calking tools should be made as short and "chunked" as possible, and they must also be made perfectly straight if good work and lots of it is sought by the man who is doing the calking."

"Well, by crackee! there goes the whistle! Good-bye!"

"Good-bye, John. Can you see where geometry hooks on to calking?"

"Well, I rather think I can. Say, is there anything which geometry doesn't mix up with?"

"Mighty little, John; mighty little!"

Layout of an Oblique Pipe Joint

Construction Views of Branch Pipes Intersecting at an Angle—Development of Miter Lines and Patterns

BY C. B. LINSTROM

Cylindrical pipe work of the kind illustrated arises in blower piping work, where branches are taken from machines to connect with the main pipe or duct. The important feature in making developments of such problems is to find by construction such views of the pipes and the miter or line of connection between them, from which the patterns may be developed.

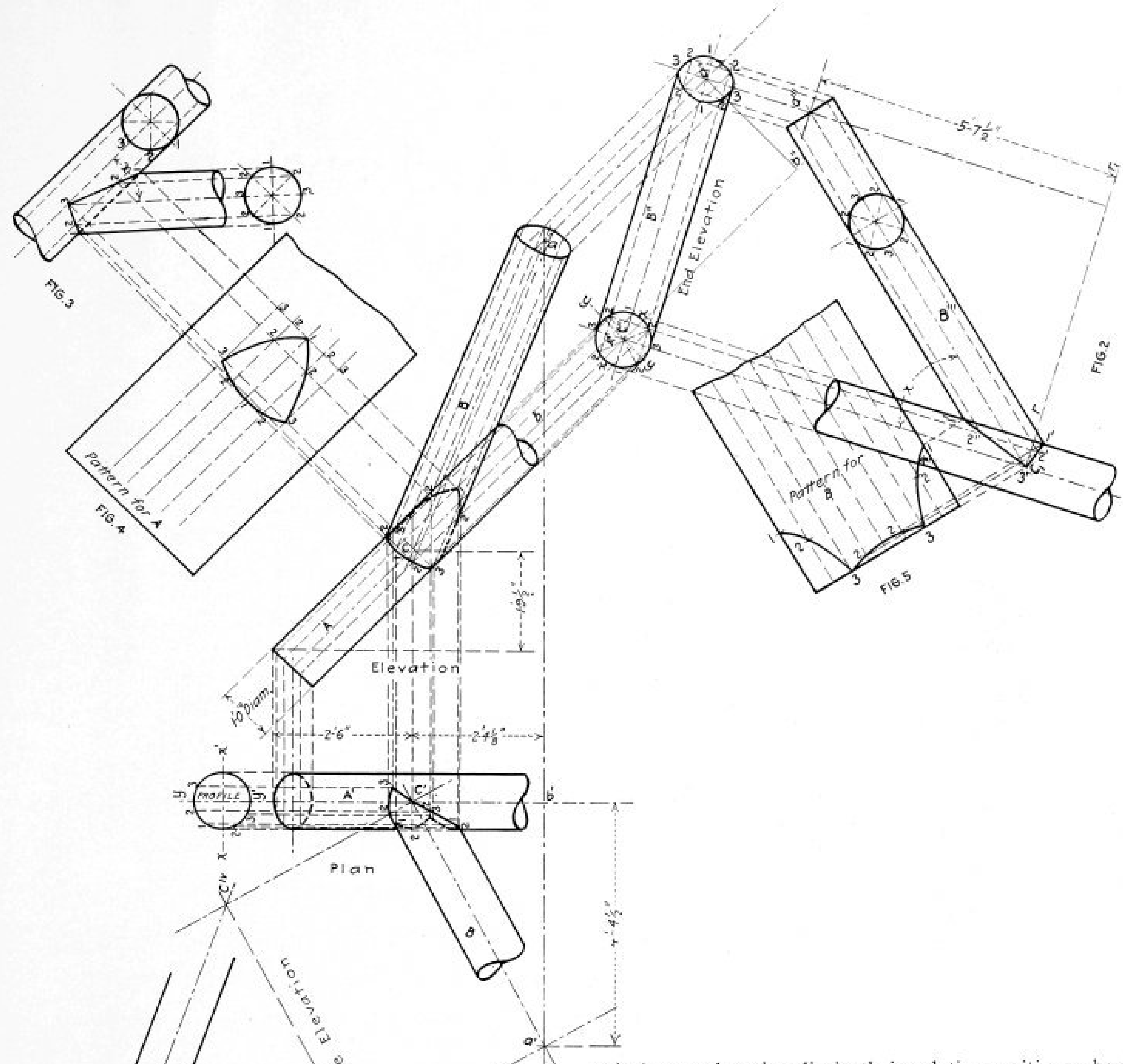
In Fig. 1 is represented an arrangement of a two-way connection. Pipe *A* is inclined to the horizontal and side planes, but is parallel to the front plane; its full view is shown in the front elevation. Pipe *B* intersects pipe *A* obliquely, and its horizontal projection shows a' in front of the axis $c'b'$ of *A* at a distance of 4 feet 4½ inches. The front view shows the point *a* above the point *c* equal to 5 feet 7½ inches. The axis *ac* of *B* in both views is foreshortened and it may be understood that in order to get the proper connection between pipes *A* and *C* that pipe *B* must be turned or twisted about its axis into place. This, however, is not necessary, since a full view of both pipes can be had showing their true relationship, miter line and angle between. Fig. 2 illustrates this, and is constructed as follows:

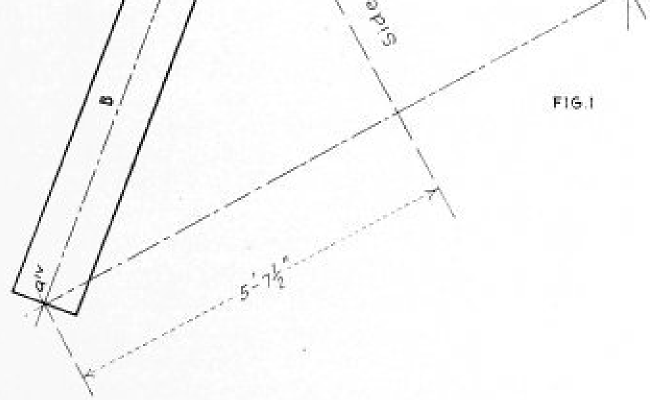
From the dimensions of the pipes given in Fig. 1, lay off the end elevation by first constructing the triangle $a''\ b''\ c''$; $b''\ c''$ equals 4 feet 4½ inches. The distance between points a'' and b'' is found by projecting a line from point *a* of the front elevation to intersect the perpendicular $a''\ b''$ in point a''; then line $a''\ c''$ is the axis of pipe *B* in the end view. With point c'' as a center draw a circle 1 foot in diameter, which represents a view taken of pipe *A* at right angles to its axis. Divide this circle as shown and draw construction lines from them parallel with $a''\ c''$. At right angles to line $a''\ c''$ and from points a'' and c'' draw the perpendicular lines as shown. The one drawn from c'' contains the axis of pipe *A*. At some convenient point upon this line as C_1 and at right angles to it draw the line r-r_1, which should be parallel with axis $a''\ c''$. Then upon the perpendicular from point a'' and from the line r-r_1 measure off a distance of 5 feet 7½ inches, thus locating point a''.

Axis $a''\ C$ is the true length of pipe *B*, as shown at B''. Draw in a profile of this pipe, making it 1 foot in diameter, and divide it into the same number of parts as in the circle of the end elevation. Complete the miter line by drawing projectors from the points on the profile and on the circle end view, which intersect in points 1'2'3'2'1'. The upper end of pipe *B* in the end elevation may now be completed as shown.

Sufficient views have now been located in order to lay off the patterns, but before explaining their development it may be of interest to some to know how the views of the miter are drawn in the plan and elevation, Fig. 1.

This is accomplished as follows: Draw Fig. 3 by transferring the dimensions of Fig. 2. Number the points in Fig. 3 to correspond with those in Fig. 2. Then at right angles to axis *c-b* of pipe *A*, Fig. 1, draw the lines from the points on the miter, Fig. 3, as indicated and to intersect those drawn from the circle located in the end view, which fixes points that lie on the fore-shortened view of the miter in the elevation. Draw from these points just





Layout of Oblique Pipe Joint

determined lines parallel with the axis *ac* of pipe *B*, and from the points on the ellipse shown in the end elevation draw projectors parallel with the line *c″ b″* to intersect the lines drawn in the view of pipe *B*. Complete the end view of *B* by drawing in the ellipse. The miter in the plan may now be laid off and in this manner. First draw the profile in the plan, then transfer the points of the circle end view so that they lie in their relative positions about the lines *x-x* and *y-y*. Parallel to the axis *c′ b′* of *A′* draw lines from the points 3, 2, 1, 2, 3 to intersect the vertical drawn from the elevation, thus establishing points in the miter shown in the plan.

Summing up what has been done in this development, we find that there are two principal steps in work of this nature.

First. From the given projections of the axes of the pipes full views are found which furnish the data for the development of the pipe sections. *Second.* From the full views, Figs. 2 and 3, the fore-shortened views of the oblique pipes, Fig. 1, may be completed by projection.

Development of Patterns

This part of the layout is shown in Figs. 4 and 5. The opening in pattern of pipe *A*, Fig. 4, is laid out by first locating the line 1-1 in the center of the sheet. Spaces 1-2 and 2-3, etc., are equal to those on the profile. Having drawn the lines 1-1, 2-2, 3-3, etc., draw the projectors from the points on the miter, Fig. 3, thus locating the points 1, 2, 3, 2, 1, etc.

In this class of work it is good practice, when figuring the stretchout for the pipes, to multiply the neutral diameter of the pipes (that is, the diameter taken at the neutral layer of the plate) by 3.1416. This calculation will give a result that takes care of the allowances that must be made for rolling the plate in the shop when the pipes are made. The pattern for *B* is laid out in a similar way as explained for pattern *A*.

How to Read Working Drawings–III

Arrangement of Different Views of an Object on a Working Drawing

BY FRED WEST

Working drawings in a boiler shop represent a system of doing work. The working drawing is like a trip through the shop, beginning with an inspection of the plates, rivets, attachments and the like, and winding up the journey with an admiring study of the finished boiler loaded on the car for shipment.

The comparison between a working drawing and the work system in a boiler shop will be observed in the lay-

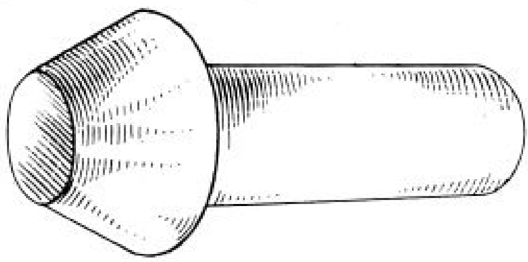


Fig. 11.—Cone Head Boiler Rivet

out of the plates or sheets. First, there is a flat surface on which certain center lines may be drawn, and from these various outlines are struck off. The openings are marked, and the rivets, braces, flanges and fittings located. Then, again, the layout is made in a systematic way, saving materiai and reducing the cost of construction to as great an extent as possible consistent with the production of first quality work.

In previous installments of this article it was stated that the alphabet of the subject—the A, B, and the C of it—consisted of the kinds of lines used; second, the arrangement of the views in their relation to each other on the paper; and third, the scaling or dimensioning of the parts, sectioning, detailing, assembling, coloring, shading, titles, dates, notes, and the use of many conventional short cuts.

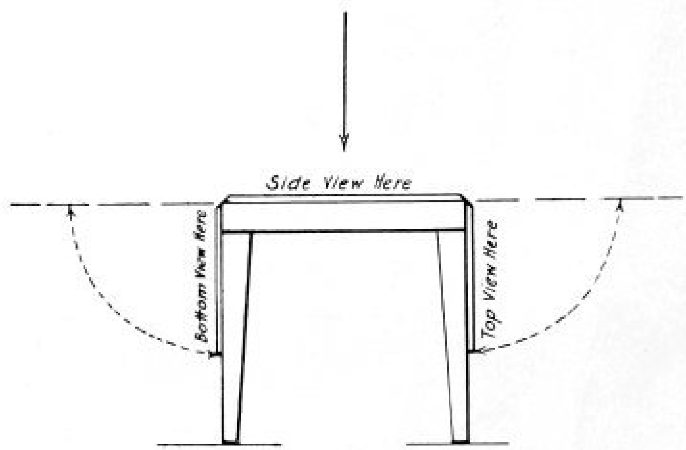


Fig. 14.—Three Views on Table

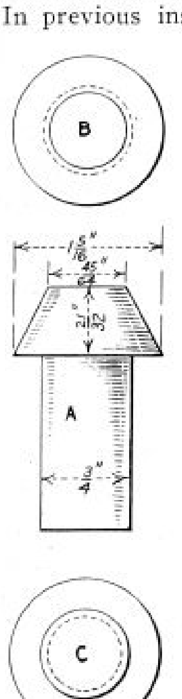


Fig. 12.—¾-Inch Cone Head Rivet

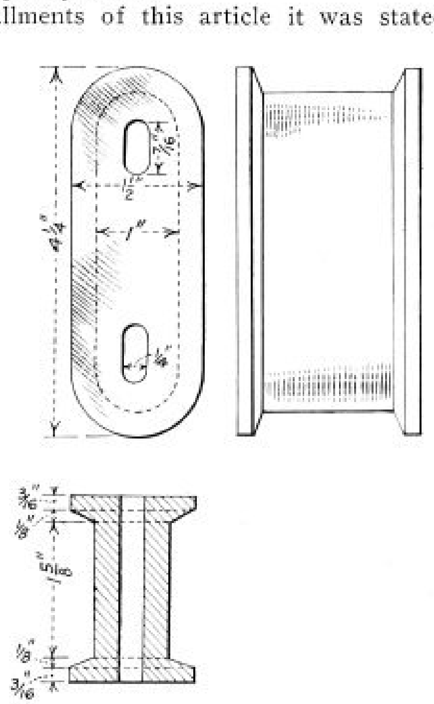


Fig. 13.—Distance Piece or Separator

The present article will deal with the arrangement of the several views that are used to show the object. Of course many working drawings consist of but one view, because the object is round or otherwise symmetrical, and the reader is supposed to know the subject well enough to imagine the proper appearance of the ends. The following drawings are presented for illustrative purposes, more views being given than necessary for a working drawing. But these simple examples are shown in order to make clear to the reader the *why* of the things. Then, with an understanding of the method, working drawings of complicated combinations can be reasoned out with certainty and at a reasonable speed.

For the first illustration, take that of a cone-head rivet which is shown in perspective in Fig. 11. As previously explained, this perspective or photograph of an object shows two faces or sides in the one view.

The working drawing of this rivet is shown in Fig. 12. For demonstration purposes three views are made—the front view *A*, the top view *B* and the bottom view *C*. The difference between the top and the bottom views will be noted in the dotted circles. In the bottom view the inner circle is dotted, while in the top view the second, or intermediate circle, is the one that is not seen when looking at the lower end of the rivet.

A second example showing the arrangement of three views is given in Fig. 13. This is a working drawing of a distance piece used to separate two metal plates that are to be riveted together.

The idea of arranging the views is illustrated in Fig. 14. This represents a table with two drop leaves. For example, suppose that the front view of the rivet, as *A* in Fig. 12, be made on the table top with the rivet head at the right-hand side of the table; then the top view of the rivet will be on the right-hand drop leaf, and the bottom view will be on the left-hand leaf. The views will be the ones as seen when looking through the table top and the leaves—imagining them to be transparent—when

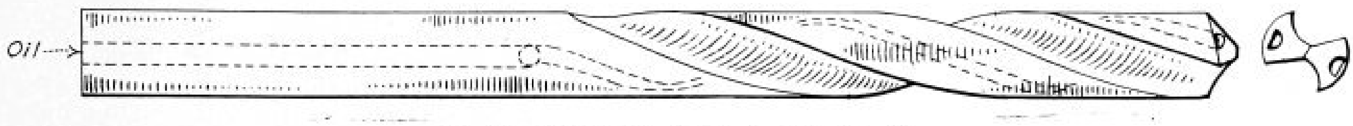


Fig. 15.—Twist Drill with Internal Oil Conduit

the rivet is suspended in the space under the table. Then after the leaves have been swung to a horizontal position, the form of the views and their relation to each other will be as shown on one flat surface as in the regular drawing. The circular lines and the arrowheads indicate how the three views are brought into one plane or continuous flat surface.

A straight shank twist drill is illustrated in Fig. 15. Two mechanical views are shown, not only to give the form of the drill, but to show the location and arrangement of the two internal oil conduits for lubricating the point.

(*To be continued.*)

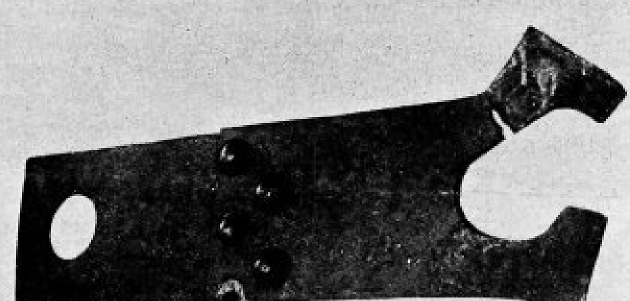
Shearing Strength of Rivets

In a pamphlet recently published by the Champion Rivet Company, Cleveland, Ohio, a report is given of tests made by Professor R. H. Danforth, department of mechanics and hydraulics, Case School of Applied Science, Cleveland, of six sections of boiler plate joints made up with Victor rivets manufactured by the Champion Rivet Company. The plate was supplied and the riveting done by the D. Connelly Boiler Company, of Cleveland, who also supplied the rivets, certifying that they were from their regular stock of soft steel rivets made by the Champion Rivet Company, which meet the requirements of the American Society for Testing Materials for Boiler Rivets. The riveting was done in the usual way, on a hydraulic riveter having a nominal closing pressure on the rivets of 75 tons. No special care was taken to select plate, rivets or to do anything better than the usual good commercial job.

The joints included two butt joints with double cover plates, single riveted, and four lap joints, double riveted, all as shown in the accompanying photographs. The plate was of various thicknesses for different joints, as shown in the appended table. The rivets were all ¾ inch diame-

No. 1

No. 2



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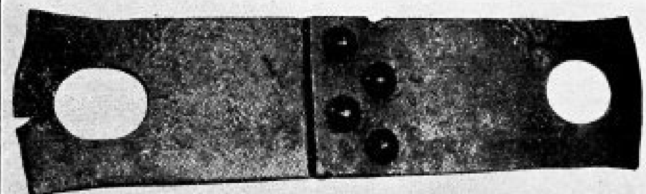

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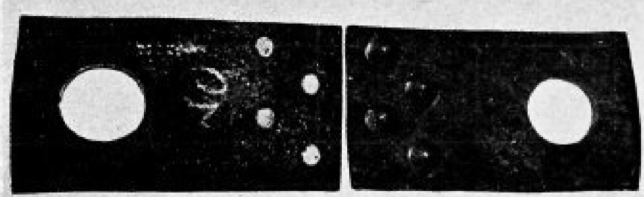

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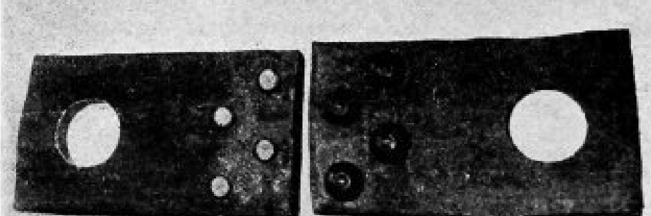

No. 6

Sections of Boiler Plate Riveted Joints after Testing for Shearing Strength of Rivets ter, driven in 13/16-inch holes. The joints were so proportioned that they would fail by shearing of the rivets, it being desired to check the assumed strength of the rivets in shear.

The specimens were pulled in a vertical universal Olsen testing machine of 200,000 pounds capacity, which is sensitive to about 50 pounds at a total load of 100,000 pounds, so that the results may be considered correct within about 1/10 of 1 percent. The pull was applied to the specimens through pins 3 inches in diameter, which were passed through the main plates on each side of the joint, as shown in the photographs, in such a way as to allow the joint sections to adjust themselves so that all rivets would take their share of the pull if all were equally well driven.

The two butt joints failed with loads of 88,540 pounds and 94,630 pounds, respectively, giving an average strength of the rivet material, figured from the driven area of the rivets, of 44,135 pounds per square inch, single shear, or 88,270 pounds per square inch in double shear.

Two of the lap joints failed by tearing the plate through the holes for the 3-inch equalizing pins, without developing the strength of the joints. The other two lap-joint specimens, made of thicker plate, sheared their rivets at loads of 97,900 pounds and 104,800 pounds, respectively, giving an average strength in single shear, based upon the driven area, of 48,843 pounds per square inch.

A tabulation of the details of each test is given below:

Joint No.	Description.	Number of Rivets	Area in Shear. Sq. In.	Maximum Load, Lbs.	Stress per Sq. In. Single Shear.	Stress per Sq. In. Do'ble Shear.	Remarks.
1.	Butt joint with double cover plates, single riveted.	2 Rivets in double shear.	2.075	88,540	42,670	85,340	Main plates 9-16". Cover plates ½". Failed by shear of two rivets.
2.	Butt joint with double cover plates, single riveted.	2 Rivets in double shear.	2,075	94,630	45,600	91,200	Main plate 9-16". Cover plates ½". Failed by shear of one rivet.
3.	Lap joint, double riveted, rivets staggered.	4 Rivets in single Shear.	2,075	65,420	......	......	Plates 7-16". Failed by tearing plate outside of joint.
4.	Lap joint, double riveted, rivets staggered.	4 Rivets in single shear.	2.075	67,540	......	......	Plates 7-16." Failed by tearing plate outside of joint.
5.	Lap joint, double riveted, rivets staggered.	4 Rivets in single shear.	2,705	97,900	47,180	......	Plates ¾". Failed by shear of all four rivets.
6.	Lap joint, double riveted. rivets staggered.	4 Rivets in single shear.	2.075	104800	50,506	......	Plates ¾". Failed by shear of all four rivets.

Personal

M. J. Dacey, foreman boiler maker of the Union Pacific Railroad Company, Green River, Wyo., has asked to be retired and placed on the company's pension roll after nearly thirty-nine years of continuous service for the company.

L. L. Ritchie, for the past two years general foreman of Leslie Elliot & Co., Paterson, N. J., has opened a plate and general boiler repair shop at the corner of Beckwith avenue and State street, Paterson, for the manufacture of stacks, tanks and all kinds of sheet iron work, as well as general repair work. Mr. Ritchie was formerly with the New York Central Iron Works of Geneva, N. Y., and later of Hagerstown, Md., as their general foreman.

Oversize Allowance for Hot Rivets

BY A. L. HAAS

The question of limits, tolerances and allowance for error in various directions has become established practice in nearly all sections of the engineering industry. In actual fact, although it is rank heresy even to doubt present practice, much nonsense prevails upon the subject. While for work of refinement there is real and indubitable value, the question of error expressed in thousandths of an inch becomes a mere farce in rough and tumble work, of which by necessity much exists. If the diameter of a boiler barrel is one-half inch less or more, it really makes no difference to its utility; at the same time in fitting the rings of plate together, very close correspondence is necessary if a first-class job is to be made.

The question of refinement in a boiler shop receives scant consideration, at all events. In most shops "near enough" is "good enough," and serves to describe much of the work done. More reliance is placed upon our much maligned friend, the rivet, to close up windage between plates than should be the case. It is considered that calking rectifies the sins of omission and commission, and the responsibility for a tight seam is laid to the charge of calking.

It is scarcely possible to imagine a boiler shell tight without calking, but by revision of methods it should be possible to produce seams which would merely weep slightly under a standing liquid without calking at all. Many boilers uncalked would leak like the proverbial sieve and no amount of pumping would serve to keep them full under uncalked conditions.

A nut and bolt are capable of exerting considerable pressure, but in the boiler rivet, heated and closed by hydraulic pressure, there exists the maximum amount of direct pull short of overstressing its material.

Consider the matter for a moment, due to the use of the rivet hot. It obtains by its deformation in this condition an absolute fair bearing on the plate. The hydraulic squeeze makes it intimately and absolutely fill the hole. Its annealed condition, due to heating, finds its material in the softest possible shape for deformation, while the contraction due to cooling is greater than any other form of attachment can ever produce.

The actual alterations going on inside the rivet are complex. The sudden (comparatively) deformation to the head, the partial annealing due to the heat left in the rivet, the contraction due to cooling bringing the plates together, the elongation of the rivet in a soft state under the stress exerted by itself, the final permanent set in the rivet stretching as it cools: these form a series of complicated phenomena impossible to analyze or adequately describe. Certain it is that only the very best of material can cope with the unusual conditions which are present nowhere else that similar material is employed.

Yet in spite of these undoubted merits, or possibly by reason of them, a riveted seam has to be heavily calked to make it tight. It seems to point to the fact that the merits of the hot rivet lead to poor workmanship and the subsequent possibility of making good by calking serves to establish poor practice.

It is almost a pity that the boiler maker is deprived of practice in cold riveting for pressure work, since the methods needed make greater demands upon exact workmanship. Actually, in present-day practice, what cold riveting is in evidence is for small sized rivets in tank plates and only in rare instances is the work black. Gal-

(*Continued on page 28.*)

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A radical departure from the conventional methods of handling boiler troubles, due to corrosion, was described by Mr. Allen H. Babcock at the annual meeting of the American Society of Mechanical Engineers. The method was first applied by the author at one of the power stations of the Southern Pacific Railroad Company, where the boiler equipment consisted of twelve watertube boilers, each of 645 boiler horsepower. Since its successful application at this plant, the method has been used by the Southern Pacific Company in various stationary power plants in the oil fields, and also on locomotives in the same district.

The trouble at the first plant consisted of serious corrosion which had begun a very short time after the plant was started. The plant was put in service in the fall of 1911, and by June, 1912, the feed elements of the boilers were all in a serious condition. With a total of 3,360 tubes in all the boilers, 252 tubes were requisitioned for replacement during practically the first eight months of operation. As time went on, no means were found to diminish this trouble, and in the fall of 1913 the entire steam plant was in a very critical condition; 1,160 tubes out of 3,360 had been replaced and there was no end in sight. Almost every known method was tried to check the corrosion, but without success until the author learned of the investigations and experiments conducted by Lieutenant-Commander Frank Lyon, U. S. N., on the corrosion of boilers and piping.

This work by Commander Lyon led to the proposal of a compound known as the "Navy Standard Boiler Compound," which is composed of sodium carbonate, tri-sodium phosphate, starch and tannic acid. The sodium carbonate takes care of any chemical reaction and renders the solution non-corrosive. The tannic acid and starch are added to prevent the formation of scale, the action being to hold the impurities in suspension in a colloidal state. The tri-sodium phosphate prevents the rise of the surface tension of the solution and consequent priming caused by the impurities in the water and by the application of the other ingredients in the compound. In using this compound to prevent corrosion, a sufficient quantity must be added to each boiler to render the alkaline strength of the water in the boiler 3 percent of normal or above.

The result of the application of this navy compound in the boilers which were giving so much trouble was the almost complete cessation of corrosion in the boilers. Instead of replacing hundreds of tubes within a few weeks, practically no tubes were replaced on account of failures. The cost in labor and material for repairs and upkeep dropped from $10,256 in the previous year to less than a hundred dollars a month for everything, including the ordinary wear and tear of the plant, washing of boilers, etc. The boiler treatment costs only about $80 a month, depending upon the amount of compound used.

The first two months' operation of the stationary power plant with the navy compound in use showed such very satisfactory results that the management ordered a trial of the method on probably one of the worst locomotive water districts in the Southern Pacific system. A test was started on a freight Mallet locomotive which had just come out of the shop with a new set of flues. The boiler was free from scale with the exception of a thin deposit on the crown sheet and crown and staybolts that were not removed during back shopping. At first an effort was made to carry the alkalinity at 3 percent, as had been the case in the stationary plant, but subsequent experience showed that the best results were obtained with from .5 percent to .7 percent normal alkalinity, on account of the effect of various features in the design of a Mallet locomotive. The water used for locomotive purposes in this case contained a large amount of solid matter, which would tend to cause priming. The compound was pumped in a concentrated solution through the injector, giving the desired percent of normal alkalinity in the boiler, with the result that there was no further trouble from scale and foaming of the boiler was greatly reduced.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Portable Channel Iron Punch

The W. A. Whitney Manufacturing Company, of Rockford, Ill., has just added a portable channel iron punch to their line of portable hand metal punches. All parts of their No. 2 punch are interchangeable with this new channel iron punch, including punches and dies. The only

Whitney Portable Channel Iron Punch

part that is different from the No. 2 punch is the drop forged lower jaw, which has an opening back of the die socket that allows channel and angle iron to be pushed through and punched in the web between the flanges. The capacity of this channel iron punch is a ¼-inch hole through ¼-inch iron. It punches to the center of 4-inch channel iron, with 1½-inch flanges.

Oswego Internally Fired Watertube Boilers

Almost all watertube boilers are of the externally fired type. A notable exception, however, is to be found in the Oswego watertube boiler manufactured by A. D. Granger Company, 90 West street, New York. As shown by the illustrations, the boiler consists of an inner and

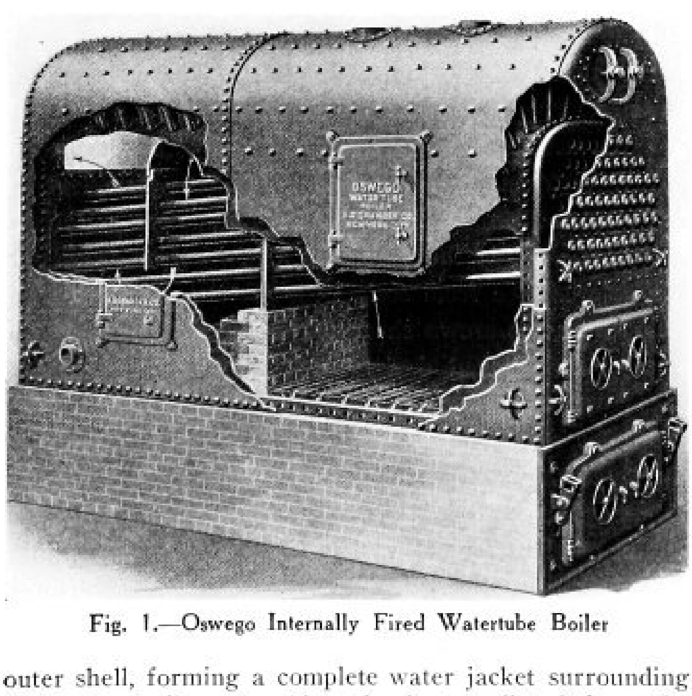


Fig. 1.—Oswego Internally Fired Watertube Boiler

outer shell, forming a complete water jacket surrounding the entire boiler, absorbing the heat radiated from the furnace and eliminating the losses of heat commonly experienced through the setting of a brick-set boiler. The front and back water spaces are connected by straight inclined tubes, so that the circulation is from the coolest to the hottest parts of the boiler. These tubes can be drawn forward when being renewed into the firing space, so that no additional length at the rear of the boiler is required for this purpose. The materials used throughout are of the highest grade; door rings and mud-rings are forgings and no cast iron is used in the construction of the boiler proper. These boilers are built to the latest

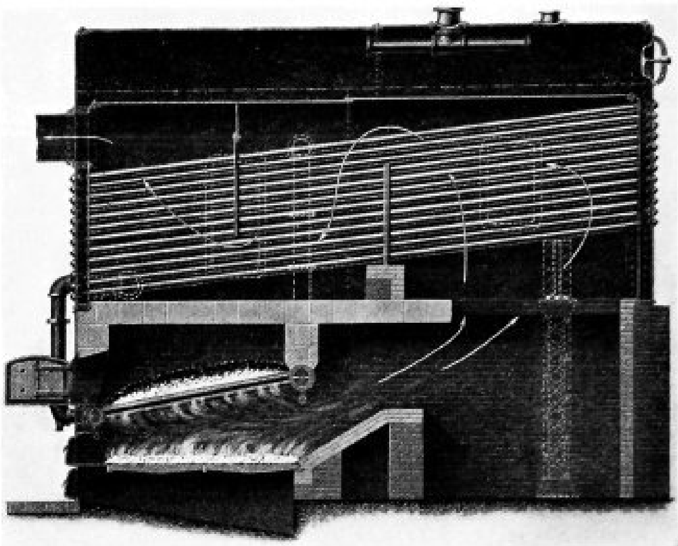


Fig. 2.—Oswego Watertube Boiler with Hawley Down Draft Furnace

insurance company rules, with a high factor of safety, or to the requirements of State legislation, as desired. The fusible plug is placed near the front of the crown sheet, so it can be easily reached from the manhole. Side cleaning doors are mounted upon hinges and can be easily and quickly opened for inspection and cleaning. Hand holes are located so that all parts of the boiler can be easily and thoroughly cleaned. The tube caps, giving access to the tubes, are inside caps, so that the pressure is against the joint, eliminating any possibility of blowing off the cap.

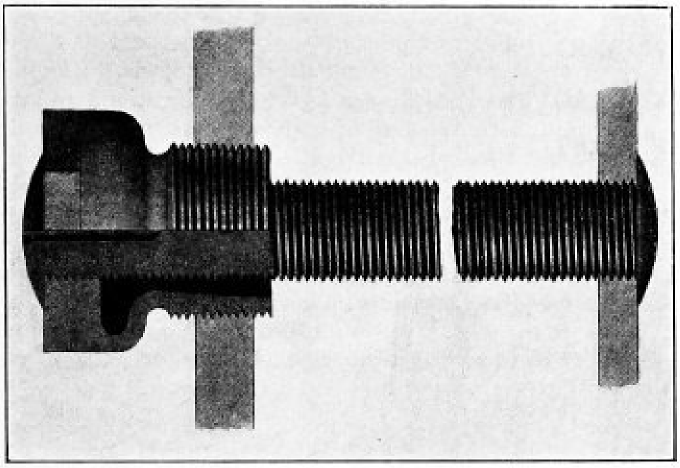
Some of the special advantages claimed for the Oswego boiler are that it occupies a minimum space per horsepower, only one-third of the floor area being required as compared with a corresponding size of horizontal return tubular boiler with brick setting. Maximum fuel economy is also claimed, due to the fact that the furnace is entirely surrounded by water surface, and the water tubes are directly exposed to the radiant heat from the fire. As shown by the illustrations, the gases of combustion make three passes across the bank of tubes.

The Oswego boiler is also built with Dutch oven settings, with the combustion chamber arranged for bituminous coal or oil fuel and for either hand firing or mechanical stokers. For smokeless combustion furnaces, the manufacturers have adopted as their standard design the original Hawley down draft furnace as built by the Hawley Down Draft Furnace Company, Easton, Pa. Fig. 2 shows the application of the Hawley furnace to the Oswego watertube boiler, and the following important claims are made for this design:

In placing the Hawley furnace under the boiler no greater length is required for a given unit than with a standard boiler, the width being increased only by the thickness of the brick wall. In this design the necessary additional travel of the gases essential for smokeless combustion is obtained. The coking arch is so placed and proportioned as to give the best efficiency of the downdraft grate in connection with soft coal fuel. The piping connections are all external, eliminating the objections commonly made to adaptations of the Hawley design to internally fired boilers. The drums, with their cleaning hand holes, are all accessible, not only for cleaning, but also for examination and repair.

R & P Flexible Plug for Staybolts

A. G. Ruber and C. H. Porter, employees in the locomotive department of the West Albany Shops of the New York Central Railroad Company, have invented a flexible plug for installing staybolts in a locomotive boiler, the design of which is intended to prolong the life of ordinary staybolts to a great extent and reduce the breakage of the staybolts to a minimum. As shown by the illustration, the plug is composed of but one part. It is screwed into the outer plate and an ordinary staybolt is applied through the inner sheet and plug precisely in the same manner as the installation of rigid staybolts, not even disregarding the telltale hole which is required by law. There is no part to remove for inspection and the staybolt is at all times easily tested in the usual manner.



R & P Flexible Plug

The flexible part of the R & P plug is in the curved portion between the threaded part entering the outside plate and the part where the staybolt is screwed into the plug and riveted over. The qualities possessed by this plug for resisting vibration of the bolt due to unequal expansion are shown by the following test which was recently made:

One of the plugs was screwed into a ⅝-inch boiler plate and a 1-inch staybolt was screwed into the plug and riveted over on the head of the plug. The plate was then firmly clamped to the table of a drill press with the head of the plug underneath between two solid blocks. A socket into which a 1-inch hole ¾-inch deep had been drilled 1/16-inch off center was inserted into the spindle of the machine and lowered over the end of the staybolt, leaving 4¼ inches of the staybolt from the socket to the inside of the boiler plate exposed. The machine was then started and kept running continuously for 104,100 revolutions without causing the slightest fracture in the bolt or plug. The staybolt was then shortened 1 inch and the machine again started and run continuously for 27,000 revolutions. The same plug and staybolt, therefore, had been subjected to 131,000 vibrations without developing any fracture in either the plug or staybolt.

The staybolt was then removed from the plug and the plug subjected to a direct crushing pressure of 46,100 pounds, causing a compression of 3/16 inch and a slight fracture in the outer side of the curved portion of the plug. The plug was then placed in a tensile testing machine and elongated 3/16 inch, developing an elastic limit of 33,860 pounds per square inch.

Another plug equipped with a 1-inch staybolt was subjected to a direct pull of the same nature as would actually occur in service, and it was found that no noticeable compression occurred in the plug under a stress of 5,000 pounds. At 5,500 pounds a depression of approximately 1/128 inch was evident. The actual elastic limit was reached at 21,520 pounds. At this stage the compression in the sleeve was approximately 5/128 inch.

A patent covering this invention was recently applied for by the designers.

Protection of Alternating Current Motors

In alternating-current motor installations it is common practice to provide means for automatically disconnecting the motor from the circuit in the event of sustained overload. It is also usual, except in the case of some small motors which can be thrown directly on the line underload, to cut the motor out of circuit when the line voltage drops to a certain predetermined percentage of normal. Protection against overload is to prevent too great heating and consequent damage to the motor. Cutting the motors off the line when the voltage drops sufficiently to cause them to stop or be largely reduced in speed prevents the occurrence of various disturbances that might arise when the motors suddenly drew current greatly in excess of normal on the resumption of the regular line voltage.

To provide for both overload and low-voltage protection of alternating-current motors up to 2,500 volts and 300 amperes, the General Electric Company, Schenectady, N. Y., has developed a new relay for use in conjunction with the usual type of G. E. low-voltage release. The relay consists of a solenoid and plunger, a set of contacts that are opened when the plunger rises, and a time-delay arrangement, known as an inverse time-limit dashpot, for retarding the upward movement of the plunger. The dashpot consists of a small covered cylindrical vessel partly filled with a special oil, and a disk containing an opening whose size can be adjusted outside of the dashpot by a needle valve on the lower end of a rod between the disk and the lower end of the solenoid plunger. The size of the opening in the disk determines its resistance to moving upward in the oil when the relay operates, and thus the time delay between the beginning of movement of the plunger and the opening of the relay contacts. The needle valve can be adjusted to give a delay opening of the relay contacts of from 10 seconds to 5 minutes at 25 percent overload. The current at which the relay will operate can be varied from normal to twice normal, depending on the setting of the plunger.

Under operating conditions the relay coil is connected in series with the motor circuit and the low-voltage release coil, across one phase in series with the contacts of the relay. Thus when the current in the circuit remains at a point equal to or greater than the relay current setting for a period equal to the time setting of the dashpot, the plunger will rise, open the relay contacts, cut current of the low-voltage release coil and cause the motor circuit to open.

This relay is mostly employed with motors using self-contained compensator control, but sometimes for switchboard service when both low voltage and time delay overload protection are required. Here series relays replace the secondary relays, current transformers and oil switch tripping coils otherwise required.

Although, as previously mentioned, the current calibration is from normal to twice normal, and time adjustment from 10 seconds to 5 minutes on 25 percent overload, the delay recommended is about 15 seconds at the starting current of the motor. This affords ample protection to the motor against damage from overload or single-phase operation, but prevents the circuit from being opened while the motor is starting.

The new relay is a vast improvement over the one previously manufactured. The contacts, dashpot and calibrating tube are inclosed by dustproof, stamped steel covers. Current and time adjustment are accomplished outside of the dashpot simply with the aid of a screwdriver. The settings are constant, for an adjusting nut is locked in place after each setting is made.

NEW BOOKS FOR BOILER MAKERS

DESIGN OF STEAM BOILERS AND PRESSURE VESSELS. By George B. Haven, S. B., and George W. Swett, S. B. Size, 5¾ by 9 inches. Pages, 416. Illustrations, 197. New York, 1915: John Wiley & Sons, Inc. Price, $3 net.

In writing this book the aim of the authors, who are professors of machine design at the Massachusetts Institute of Technology, has been, as stated in the preface, to give the most practical procedure possible in the design of boilers and other pressure apparatus.

Wherever possible results have been obtained by rational rather than empirical methods. The usages of current boiler making practice have been kept constantly in view. In the application of the principles and formulæ deduced in the early chapters of the book to the practical design of various types of boilers and pressure vessels, the data and constants assumed are derived from actual practice and represent wide margins of safety in regard to boiler performance and construction.

In the first chapter, which discusses general principles, reference is made to the increasing difficulty in the design and manufacture of steam boilers. First, the use of steam turbines and reciprocating engines of multiple stage and expansion has led to a great increase in steam pressures, so that at present boilers are often designed to carry from 200 to 250 pounds per square inch. The power of single units has also greatly increased. In the case of watertube boilers, single units ranging as high as 600 and 700 horsepower are frequently encountered. Another difficulty is found in the congested condition of manufacturing enterprises in cities, calling for the greatest economy in the utilization of floor space for the boiler plant. The increased cost of fuel has also led to a wider use of inferior grades of fuel, which in turn has led to important changes in the design of furnaces. Other important factors which influence the design are the impurity of feed water, the introduction of superheaters and the necessity of securing a large capacity for overload. This latter is of special importance, as frequently provision must be made in the design of a boiler plant for carrying peak loads from two to three times the normal horsepower.

The increased difficulties in design, however, have been accompanied by noteworthy improvements not only in the quality of the materials used, but also in the machines and tools which are now available for manufacturing boilers. With these facts in mind, it is obvious that a book dealing with modern boiler design and construction must present new data and methods covering the changed conditions and requirements of modern practice.

In discussing the general principles of boiler design, the authors take up types of boilers, circulation, materials, the factor of safety, thermal efficiency, boiler horsepower, size of units, range of pressure, superheaters, fuel, grates and settings, and a summary is given of the Massachusetts Boiler Rules, which well represent the requirements of modern practice.

Chapter II contains a mathematical discussion of the stresses in pressure vessels, and gives practical rules and formulæ by means of which such problems are solved in actual practice. Chapter III is a very complete discussion of the subject of riveted joints and is splendidly illustrated, not only by diagrams of the various joints with an explanation of the calculations for efficiency and strength, but also by numerous diagrams and tables which give the volume of rivet heads, the allowance for rivet heads, rivet strength and maximum value of pitch and efficiency of various joints. Chapter IV is on general proportions of boilers, and here the data are based on actual practice and are presented in most convenient form, frequently by tables and plots.

The remaining five chapters illustrate the application of the principles and formulæ to the practical design of various types of boilers and pressure vessels. Chapters V, VI, VII and VIII give complete specifications and calculations for the design of a horizontal return tubular boiler, a dry back Scotch boiler with combustion chamber in shell extension, a vertical straight shell multitubular boiler and a locomotive type boiler for contractors' use. The final chapter is on tank design. To illustrate the problems in design, large plates are shown, giving the complete drawings.

As a whole, the book is an extremely valuable contribution to the literature on steam boiler design, and particularly to the practical boiler maker.

SECRETS OF PERSONAL CULTURE AND BUSINESS POWER. By Bernard Meador. Size, 6½ by 8½ inches. Pages, 161. New York, 1915: David Williams Company. Price, $2.

It is reasonable to assume that the majority of young men who enter a trade are ambitious to succeed. Too often, however, they fail to realize the value of a knowledge of subjects fundamentally important in the scheme of life which have no direct bearing upon the trade they are endeavoring to master. To such men this book is a splendid tonic.

It is composed of a series of articles dealing in an interesting and entertaining way with the commonplace aspects of life which inevitably influence a man's progress towards success or failure. The fact that ninety-five percent of men at the age of sixty-five are either working for a daily wage or are entirely dependent on some one else for support substantiates the author's statement that beyond any question there are too many failures, too many half successes and too much random guessing at the kind of principles and plans that lead to success. The seven mistakes of life, he says, are the delusion that individual advancement is made by crushing down others, the tendency to worry about things that cannot be changed or corrected, insisting that a thing is impossible because we ourselves cannot accomplish it, attempting to compel other men to believe and live as we do, neglect in developing and refining the mind by not acquiring the habit of reading fine literature, refusing to set aside trivial preferences in order that important things may be accomplished, and finally the failure to establish the habit of saving money. If these conclusions seem reasonable to the reader we advise him to study carefully the other fifty-seven chapters of the book and see how they apply to his own life.

Letters from Practical Boiler Makers

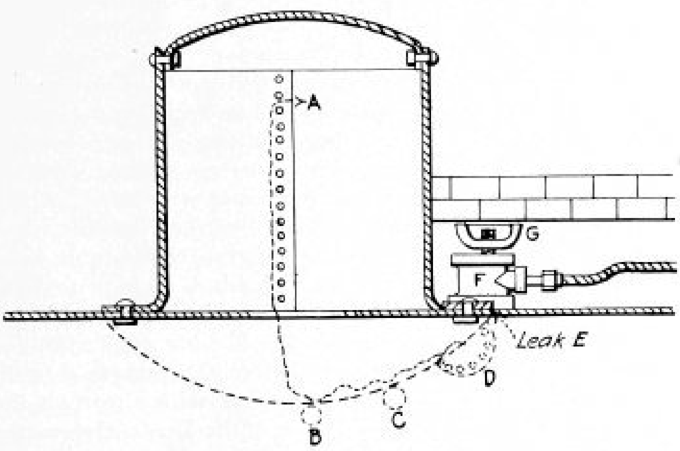
This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

How to Locate a Leak in a Boiler Seam

The following is a description of locating a steam leak in a boiler dome which occurred November 27, 1915, at a plant near Trenton, N. J. For the past three or four months continual trouble was experienced with the saddle joint of the steam dome on No. 2 boiler, of a battery of three horizontal tubular boilers.

The boilers are 66 inches in diameter and 16 feet long and were built in Trenton in 1902 for a pressure of 125 pounds. The longitudinal seams were triple riveted butted joints, with double butt straps, thickness of material 7/16 inch, pitch of rivets 3½ inches by 7 inches.

No evidence of weakness developed until July, 1915, when a leak was discovered on the saddle joint of the steam dome on No. 2 boiler nearly in line with the longitudinal seam of the dome. A slight grooving had occurred, which was remedied by installing a mushroom head rivet and calking the edge of the flange.



Sketch Showing Location of Steam Leak in Boiler Dome. A, Original Leak; B, First Outlet; C, Second Outlet; D, Third Outlet (Patched); E, Fourth Outlet; F, Reduced Tee Fitted on Saddle Seam.

Some weeks later another leak developed about 12 inches away from the first one. This was also drilled and a mushroom head rivet installed and edge of flange calked.

In October another leak was found which had grooved the sheet in two places about 5/16 inch deep on either side of a rivet. A patch was fitted over this defect and several of the rivets were calked. About November 10 another leak developed still further around the flange of the dome and almost on the crown of the boiler sheet. This also leaked on the sides of a rivet and when discovered had cut two grooves in the sheet also about 5/16 inch deep.

The owners of the boilers were becoming anxious by this time and considered that this leak disease had become chronic. All repairs on these boilers had been made by the original makers, but owing to labor trouble their shop was closed, and a machinist doing other work in the mill heard of the trouble they had experienced. No. 2 boiler had been down for several days, and as the plant used all the power developed, they were handicapped by the loss of this boiler. The machinist stated that he would stop the leak for them or give his time and trouble for nothing. The offer was accepted.

After two unsuccessful attempts he was struck with the idea of reversing the usual order of things by making the boiler leak on the inside and then finding the original source of trouble. To effect this he cut away part of a 3-inch tee to a fairly good fit over the flange of the saddle seam and boiler shell. The upper opening of the tee was plugged and a ¾-inch nipple fitted to the reduced end (see sketch). A steam hose was fitted to the nipple, then a special screw jack was made to accommodate the height between the tee and the brickwork.

A thin lead gasket was placed under the tee and the screw jack forced the fitting onto the boiler shell and saddle flange, leaving the two grooves in the boiler shell inside of the gasket. The steam hose was then connected to the adjoining boiler, and when steam was turned on a jet of steam shot across the dome from a point 28 inches above the boiler shell in the calking edge of the dome longitudinal seam. This seam was calked, the boiler refilled and a hydrostatic pressure of 125 pounds was applied with perfect success. There was no sign of a leak, although nothing had been done to the saddle joint. Later the grooves in the boiler shell were welded over, making a perfect job.

One interesting feature of this job is the distance the leak traveled, showing that leaks in seams may not originate anywhere near the point of outlet. The fact is also shown that repairing the outside of a leaky seam is only a subterfuge and the next weakest point in the seam will give way if the original source of the leak is not discovered and remedied.

The writer hopes that this will not only interest readers of The Boiler Maker, but may also be of practical use to any of them having a similar experience. The materials are always at hand and the ingenuity of applying them as in this instance deserves to be recognized.

Philadelphia, Pa. R. W. Robinson.

Is He Right ?

Among boiler makers are *you* an exception to the rule? Have you ever asked yourself that question? This rule, according to a friend of mine, is that boiler makers do not like to think.

Now I disagree with my friend, but for the sake of those few who might be benefited by an exposition of their faults (there may be a few so-called boiler makers of that type) I give the following extracts from a letter which my friend had the kindness to write to me on the subject:

"Few boiler makers approach the work before them in a receptive, inquiring frame of mind: they do not become deeply interested; ideas do not crowd themselves for expression in the man's mind as they do in the mind of the foreman, for instance. That's why the foreman is a foreman.

"I do not mean to say that all boiler makers are unimaginative, but I'm satisfied that fully ninety percent of them accept conditions as they find them in the shop, wherever they may be employed. They do not concern themselves very much with the 'whys' and 'wherefores' that interest a man of an investigating turn of mind who is ambitious to rise above his surroundings and become a leader among his fellow workmen. To them 'sufficient unto the day is the labor thereof' and the wage on Saturday nights.

"They have no ambition to get ahead; they do not collect material as they go along doing their daily work; all days are alike to them physically and educationally; they never think of *thinking* at their work, and they all dub the foreman as being a 'lucky dog' and a man who just pulled the political string at the proper time. They have the idea that as soon as a man becomes a foreman there is a sort of alchemy that immediately puts a boss's thoughts into the foreman."

I believe I have given enough of his letter. You can at least get his *idea*. It is full of good, wholesome food for thought, and if there is a word here or there that fits our case, why, it's up to us to put on the coat. My friend surely means well. He is honest. And honest criticism can hardly do us any harm.

New York. N. G. NEAR.

Staybolts

To many people the installation of staybolts is a mean and common job and it is believed that almost anyone is capable of performing the operation. In many shops this belief is put into practice, and the entire job of tapping out staybolt holes, running the bolts in, setting and cutting the bolts off, is left in the hands of men with very poor conception of the importance of the humble staybolt and the part it plays in the steam boiler.

A short time ago I visited a modern locomotive works, and spent a very pleasant time in the boiler shop. Here everything was up to date: massive hydraulic presses for flanging, powerful deep-gapped riveting machines, large electrically-driven bending rolls, and multispindle drill presses for drilling flue sheets and other parts of the boiler, and last, but not the least, the staybolt riveting machine. Here the men handling staybolts have become skilled in the various operations from long service, and know what is required of them. Taps are kept sharp and the threads are not allowed to become flat or broken. So they are always sure of getting good threads in the sheets and a neat fit with the bolts. At the time an order is placed in the boiler shop for one or more boilers, one is also placed in the blacksmith's shop for staybolts, braces, etc. All staybolt ends are squared and are then passed along to the machine shop for screw cutting, and by the time the first boiler of the order is on the floor the braces are ready to be fitted and the staybolts ready for the tappers. All staybolts are made long enough to get four bolts out of each piece.

Cutting off staybolts is done with a clipper with a capacity of about 600 bolts per hour. All bolts when cut off are taken to the grinding shop and the points are ground. The bolts are then passed along to the screw-cutting machine for repointing and then returned to the boiler shop, ready for another installation. So closely is this work figured out that when the last bolt is in position there is nothing left to be cut off only a short stump nearly all square used for running the bolt in.

The cost of repointing is not great; a man is paid 25 cents an hour for doing this work and is kept very busy the whole day. Radial stays and crown bar bolts are made on the bull-dozer, the operator getting 35 cents an hour and is kept well employed.

Staybolts are driven by machine, air hammer and by hand, as occasion requires. I have seen staybolt holes tapped and bolts applied at the rate of 22 per hour, and radial stay holes reamed, tapped and bolts run into within 1/4 inch of the crown sheet, ready to be finished by hand at the rate of five per hour. Finishing the operation by hand was made necessary by the fact that there was a taper in the bolts close under the head which required the slower application to insure the bolts from being stripped.

I cannot say that the application of these bolts was done in record time, but I am quite satisfied that the work was quite lively and at the same time was good, which is the main thing. This methodical way of working was made possible only by keeping the men at the one job until they became expert, and, when necessary to put a new man to work, he was put with one of these experts and kept there until he became expert also.

Now when we look at the system adopted by firms doing an immense business, where many of their orders are penalty orders (that is, if the orders are not completed by a certain date from the time the order is received the firm has to pay so many dollars for each day they are behind with their work and delivery made—in fact, many of the orders are given on this condition alone), we wonder why some such system is not adopted by all railways, where repairs are made on a large scale. There is a great saving in it. Delays are avoided, and bolts in large or small quantities are available at short notice. When this work is done on stock orders and bolts used, they can be charged to the job they are drawn for.

Of course it is not always possible to install special machinery for this purpose, like that used by the above-mentioned works, where they cut twelve long bolts at one time. The ordinary screw-cutting machine can do this, only in less quantities, or, better still, why not buy the bolts from firms that are in the market for this work, get your bolts cut to the proper length, with telltale holes drilled and end squared for machine socket or hand wrench, and avoid the cost of high-priced men repointing and threading the staybolts by the old-time stock and dies, when you could use them to better advantage at some other job? If you are not provided with the tools for doing the work the way it is done at the locomotive works, it is far better to carry a stock of short bolts; for I have seen men take long staybolts, intended to be used with a machine, and, having no square on the ends, put a Stilson wrench on the middle of the threaded bolts and work it into its place, nick it a couple of times, and break it off with a piece of pipe, and in doing so bend the end, and between the Stilson wrench and the bend a good bolt was spoiled, where, had it been a short bolt with square end, there would have been no waste. Again, shops doing general repair work and changing several fireboxes during the year, would find it to their advantage to install a staybolt clipper as part of their shop equipment, for it would pay for itself in a short time in the cost of labor, being so much quicker than either the air hammer or the acetylene torch.

While there are many shops that are very particular about the repairs to the machinery of their locomotives, I am sorry to say that the same attention is not paid to staybolts, and when an engine is in for a washout, should there be broken staybolts, there is scarcely proper time given to do the work as it should be done, and the men doing the work are expected to make time notwithstanding the fact that air cylinders and pipes are not always removed for free access to the bolt, with the result that the bolts are not always properly riveted up. In justice to the boiler maker, and to live up to the letter of the law, every foreman in charge of work of this kind should see to it that their men are given every advantage possible, so that they can get at their work with ease and a certain degree of comfort; for, although they can work in almost any position, there is nothing more provoking when working under a running board than to strike a pipe while the hammer is on the down-stroke. With pipes and cylinders removed, there is more freedom of action, and more can be accomplished and in far less time than it would be possible to do with those things in their place.

Many of your readers may think it impossible that such a state of affairs can exist to-day, but it is a fact the writer has been up against, and he has demonstrated to those higher up the use of the short bolt in repair work, repointing bolts at the screw-cutting machine, and the removal of all obstacles that come in the way. When staybolts have to be changed, the saving possible by doing work this way was plainly shown, but to no purpose; for to-day they are doing work in the same old way that our grandfathers used to do.

Pittsburg, Pa. FLEX IBLE.

Talks to Young Boiler Makers

Yes, these mornings are awful dark and the shop is cold, and when you pick up a chisel or handle a plate a cold shiver runs down your back and your fingers are cramped and cold and perhaps stick to the metal. The boys are grouchy and maybe you think you are getting no sort of a show. The boiler making trade is no good, anyhow; it is not like the old days Dad tells you about and you feel like chucking up the job!

There are many young boiler makers in this country who feel this way and are getting very much discouraged. It is a hard trade, but to my mind a splendid one, but it is not one that a sissy boy should go into or continue. In fact, unless a young man is really fond of his trade he will never get along.

Let us look a little at some of the other trades. Quite often any trade than the one we are working at looks good to us. Here is a machinist. He has a nice, warm shop where things are pretty quiet, and all he has to do is to watch a machine do the work. That's the way many people look at it; yet if he takes off a thousandth of an inch too much he can spoil a valuable job. He has to have a mighty nice and expensive kit of tools. His pay is less and his hours are longer than those of the boiler maker. In short, he has his troubles also.

Then there is the pattern maker's trade. All he has to do is to whittle out something in wood which is nice and soft. He can keep his hands clean and he gets first-rate pay. That sounds as if the trade was a cinch. He works from drawings and has only to work with a shrink rule to have everything come out just right.

Is this the fact, however? Not by any means. When he gets a drawing and makes the pattern there will be a lot of knots and bumps for core prints that don't show on the drawing at all. Then he has to make a lot of core boxes for which there are no drawings whatever. After the pattern and core boxes are all done the foreman of the foundry puts up a great holler because the cores don't fit the prints and there is not enough draft here or there, and the foreman of the machine shop has a tale of woe because there is too much stock left here or not enough left there. In short, the pattern maker's job is not all beer and skittles by any means.

The trade that seems to have no trouble in it is that of the moulder. He gets his pattern, sticks it in the sand, rams it up, closes the mould and pours the metal. If things are not right, it is not up to him. However, there are in this trade—bumps. Perhaps he has sponged his mould so that the castings come out so chilled in places that they cannot be machined, or in order to get the patterns out of the sand he has to wrap them so that they are all out of shape, or he may even forget to set a core and then there is enough noise from the machine shop foreman to raise the dead. Toting the melted metal and pouring is dangerous and tiresome. Taking it all around, the young man should look twice before learning the moulder's trade if he is looking for a nice, clean, easy job.

No, my young boiler maker friends, if there was a job where everything was easy, hours short, big money and surrounding comforts and no trouble, it has not been made known to the general public, and if there were it would be so crowded by day after to-morrow that you could not get into it. The boiler maker's trade, taking it all around, has no more trouble than any other trade. The troubles in it are known to you, therefore they seem very large. The troubles in the other trades, because you do not know them, seem small to you. What you need is determination and pluck to succeed anywhere, and you do not want to have a few cold, dark mornings completely discourage you and make you faint-hearted.

What you want is to study the requirements of the work which comes to your hand. There are no end of improvements yet to be made in boilers and boiler work. There are better ways of doing what you do every day and it is up to you to try and discover these and profit by them. There is much to learn concerning the material which goes into boilers. The art of laying out is one which can be learned very largely from books. Geometry and trigonometry, while the names sound hard, are not difficult studies. There are night schools you can go to and correspondence schools that you can enroll in, and there is no excuse for you not becoming proficient as a layerout, and the work pays.

New London, Conn. W. D. FORBES.

Opportunity for Boiler Makers and Engineers at Murray Hill Lyceum Evening Trade School, New York

The Murray Hill Evening Trade School, located on Thirty-seventh street near Second avenue, New York City, affords a golden opportunity to young men ambitious to become engineers, boiler makers and boiler inspectors. The school has a variety of classes in which are taught the different subjects required in these trades.

The boiler making class is conducted by Mr. J. H. Sheridan, who has had over twenty years of practical experience in the boiler making industry, and who is a thorough and competent instructor. The course is free and I sincerely hope that young readers of THE BOILER MAKER and others interested in this work will take advantage of this wonderful opportunity as I have done.

Boiler makers and engineers, wake up and make yourselves more proficient! The new course starts the first Tuesday in January; registration, evenings from 7.45 to 9.45 P. M.

Port Richmond, N. Y. H. KLEIN.

CORRECTION.—On page 393 of our December, 1915, issue the cuts illustrating patents Nos. 1,152,248 and 1,152,341 were inadvertently transposed. The cut illustrating patent No. 1,152,248 should accompany patent No. 1,152,341, and vice versa.

Layout of Patterns for Bottom of Tank

Circular Tank with Tapered Bottom Leading to Inclined Square Opening, Offset from Axis of Tank

BY H. S. HATTEN

Fig. 1 in the drawing shows the outline of the tank as it would appear on the working drawing. The layout of the bottom part and the different performances to obtain the patterns are shown by the figures indicated by the capital letters G^1-H^1-I^1-J^1-G^2-H^2-I^2-J^2, etc.

As the drawing shows, four operations are to be performed to lay out the plates G^4-H^4-I^4-J^4.

First: Lay down, full size, if possible, to reach accurate results, the top and front view, as shown, G^2-H^2-I^2-J^2 and G^1-H^1-I^1-J^1, respectively. Only one-half of the top view will be required, the other half being the same. By laying down these dimensions we must take the thickness of the plate (3/8 inch) into consideration. So the semi-circle in the top view is struck with a radius of

$$\frac{13' 6'' + 3/4'' + 3/8''}{2} = 6' 9\ 9/16''.$$

The opening at the bottom *A B C D* should be 23 5/8 inches square. The circumferential seam in the front view is drawn parallel to the circumferential seams of the tank.

To obtain the top view of the square opening, project the point *A* (bottom) perpendicular into the top view, making the length of this projector in the top view one-half the width of the square. Do the same with point *B*, so that we have two points, *A* and *B*, in the top view. Connect these points with the line *A B*, and the result is the projection of the half square in the top view.

In this projection two lines (*A E* and *B F*) show their true lengths, while the true length of *A B* shows in the front view. Having now the two views of the outlines, we take the second operation, which is: Dividing the surfaces between the outlines into triangles so that the number of triangles in the front view will be equal to that in the top view and in relation to one another.

To do this we divide the semi-circle into equal spaces. The more spaces, the more accurate will be the result. The number of spaces on this drawing is only 12, which avoids confusion. These spaces are numbered 1 to 13. We now project these points square to the horizontal center line of the semi-circle 1′-13′, as shown by the projection lines 2-2′, 3-3′, 4-4′, etc. Only one-half the number of projectors is shown on the drawing. We have now established the spaces on the top line of the front view, as 1′-2′-3′, etc.

Next we draw lines from 1-2-3, etc. (top view), to the points *A*-*B* (top view) so that 1 to 7 connect with *A* and 7 to 13 with *B*. If this operation is repeated in the front view the surfaces will be divided into triangles.

The circumferential seam divides the bottom into two sections. It is necessary to find the true sectional view. The seam intersects the sides of the triangles previously drawn at the points 1, 2, 3, etc. (front view). These points are to be projected perpendicularly into the top view so that the projectors intersect the sides of the triangles in the top view which correspond to those in the front view; i. e., where the projector from point 1 (front view intersects the side 1-*A* (top view), we establish the point 1. When all these points from the front view are projected into the top view in the same manner we have points through which a curve is drawn. This curve denotes the outline of the true sectional view. Again, in the drawing only a part of these projectors is shown.

It will now be noticed that when the bottom section is taken away it will leave the bottom part divided into triangles. But the top section will be left divided into quadrilaterals.

To divide it into triangles again, draw dotted lines from the points on the semi-circle to the next higher point in the curve, thus from 1 (circle) to 2 (curve), and so on. Repeating this in the top section of the front view we complete the division into triangles in both top and bottom section.

The reason for drawing these lines dotted is to facilitate the construction of the true lengths on the pattern, as will be seen later on. Having completed the second operation, we now will proceed with the third, which is to find the true lengths of the sides of the triangles, as none of them shows its true length. To obtain this we must construct right triangles, or triangles having one angle 90 degrees. The sides enclosing that angle of 90 degrees are called the legs, and the side opposite that angle is the hypothenuse When the length of each of the legs is known it follows that the length of the hypothenuse will present itself.

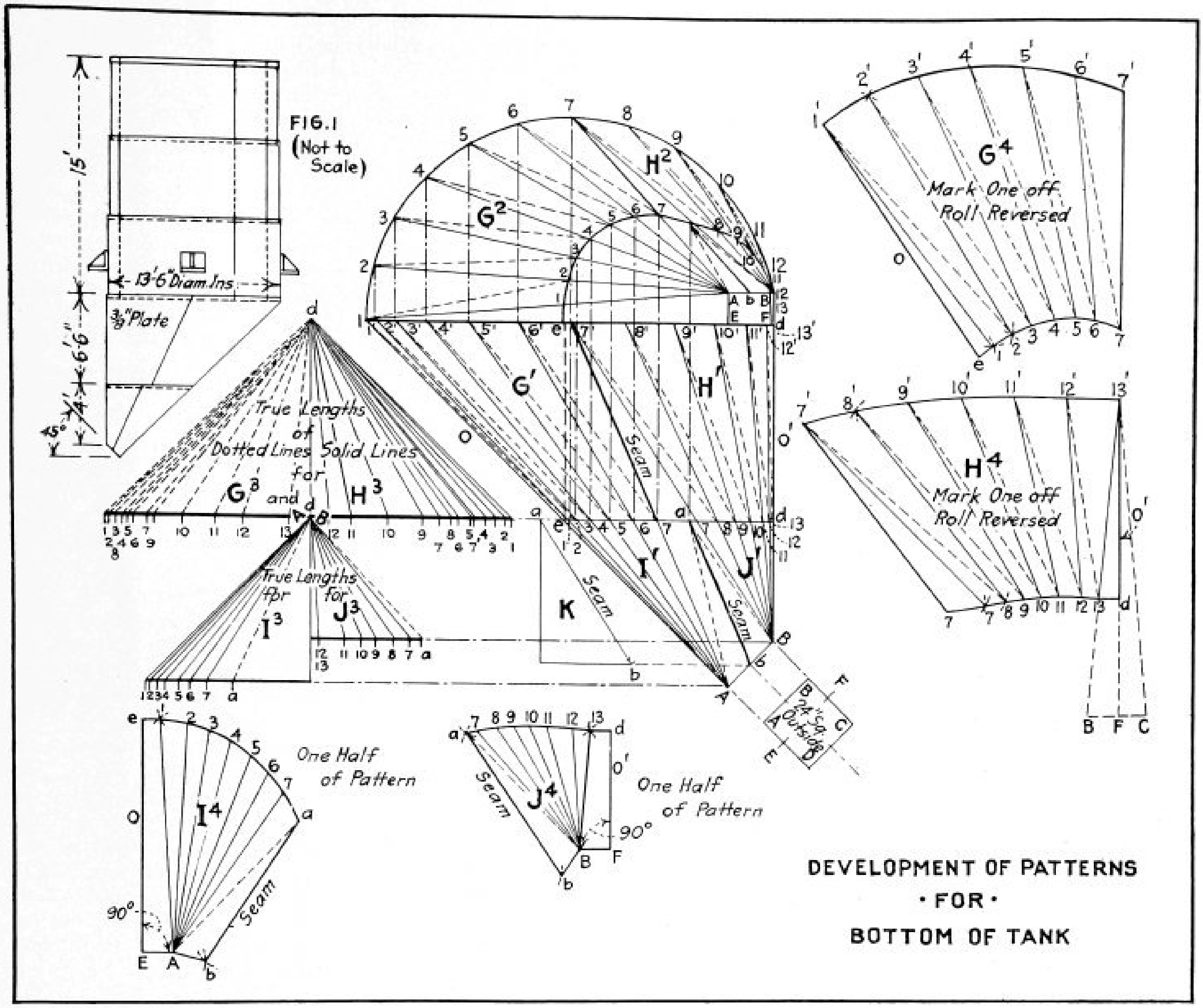
In triangulation it is the length of the hypothenuse which we have to put on the templets. Now, suppose we fold the drawing on the line 1-13 so that the plane on which the top view is located makes an angle of 90 degrees with the front plane. This brings the top view parallel to the plane on which the sectional view is located. the distance between those planes being d-d = 6 feet 6 inches. This will be the length of one of the legs of all the triangles in the top section.

Now we draw a horizontal line of indefinite length at G^3 H^3, and erect a perpendicular to it, making its height d-d = 6 feet 6 inches. Then we take the lengths of the other legs from the top view. We first take the dimensions of the solid lines and place them on the horizontal line at the right of *d*-*d*. These lengths will be 1 to 1, 2 to 2, etc. Having located all these points on the given line, we draw solid lines from them toward the top at d^1. These lines or hypothenuses will be the true length for the templets.

On the left side of the perpendicular, place the lengths of the dotted lines with the same result, giving all the true lengths for the top section.

This operation must be repeated for the bottom sections, taking the length of the perpendicular for the triangles between the points 1 to 7 and *A* equal to the perpendicular distance between the point *A* and the plane on which the sectional view is located, as shown by projection lines. Do the same for the triangles between the points 7 to 13 and *B*. Then we have the length of one leg for all the triangles in the bottom section. Taking the lengths from the top view and placing them on the horizontal lines in their proper relation results again in obtaining the hypothenuses, or true lengths, for the templets.

As shown, the top section is constructed of four plates, the seams running in line with the quarter divisions, as indicated by the heavy lines. The bottom section consists of two plates, the seams so placed on the flat sides that they will clear the top seams. To find the true length



DEVELOPMENT OF PATTERNS
· FOR ·
BOTTOM OF TANK

of the bottom seam it will be necessary to construct a triangle *K*, this being done as in the foregoing. We now have all the true lengths required, so the templets may be laid out, which is the fourth operation.

This consists of putting all the triangles in their true dimensions together, which, when properly done, will result in giving us the required shape of all the patterns. The outlines obtained by this will give us the center line of the rivets for the seams and the flange line on the top so that the laps must be added.

To lay out plate G^4 we place a line *O* on the left side of the plate, making its length equal to 1-*e* (front view), this being the only line showing its true length in the left side of the front view. Having two dividers and a trammel ready, we set one of the dividers to the distance *e*-1 (sectional view), and with a center at *e* on the plate we strike an arc to the right. Then with the trammels set to the solid line 1 (at H^3) and a center on the plate at 1^1 we intersect the arc just struck. Mark this intersection 1.

With the dividers set to the distance 1-2 (sectional view) and a center at 1, strike an arc. With the trammel set to the dotted line 2 (G^3) and a center at 1^1 (G^4) intersect the arc struck from 1, marking this intersection 2. Taking the other dividers and setting them to one of the equal spaces on the semi-circle and with a center 1^1 strike an arc to the right. With the length of the solid line 2 in the trammels and a center at 2 intersect the arc struck from 1^1. If we connect the obtained points with lines it shows that we have put three triangles in their proper dimensions and relation on the plate.

By repeating this operation till the solid line 7 is placed, the templet G^4 is completed. With the same line 7^1-7 the templet H^4 can be started, and continuing the triangulation in the same manner as in G^4 will finish this templet as well. The triangle 13^1-*B*-*C* shows the true dimensions of the flat side at the right side of the front view.

The templets G^4 and H^4 complete one-half of the top section, the other half being the same. One plate can be marked off from each templet, the marked plates to be rolled reversed.

To lay out the templet I^4 we start at the center of the plate with the line *e*-*E*, having its length taken from the front view at *e*-*A*. Square to this line we place the line *E*-*A*, making its length equal to *A*-*E* in the top view.

The drawing shows only one-half of the required templet, so in the actual layout the triangles shown on the right side of *e*-*E* should be placed on the left side as well. With the dividers set to *e*-1 (top view) and a center at *e* (plate) strike an arc to the left and right. With the trammels set to length *A*-1 (I^3) and a center at *A* (plate) intersect the arc just struck from 1.

By repeating the same with all the points and lines we construct all the triangles between *A*-*e*-*a*. With the point *A* and a radius *E*-*A* strike an arc to the left of *A*, and the trammels set to *a*-*b* (*K*) and a center *a* (plate) intersects the arc at *C*. When this is done on both sides of *e-E* templet I^4 will be completed.

This process for templet J^4 (being the same) will finish the four templets.

The circumference at the top of the bottom section must be larger than the circumference at the bottom of the top section on account of the top section fitting inside the bottom section (Fig. 1). To obtain this, we add one-quarter of the difference to each side of the bottom templets at the points *a* (I^4) and *a* (J^4). This is not the exact method, but when the holes are spaced this addition must be observed and a satisfying result will be obtained.

Toronto, Ont., Canada. H. HATTEN.

Oversize Allowance for Hot Rivets

(*Continued from page 18.*)

vanizing compensates for the irregularity of open seams. Much of such thin work is to-day welded, where it is to be left black more especially, so the experience in cold riveting for pressure work is nearly extinct.

There is, however, one point with regard to welded work worth citing. This is that although a welded tank is *prima facie* a better job, the heat of welding does not give a pleasing result. All the flat plates are buckled as a direct result of the process. Circular work does not suffer this defect. As a consequence, in many shops doing thin plate work the flat work is riveted up and the circular portions spot welded. Most of such work is galvanized if for liquid, but large numbers of casings, etc., are simply painted for a finish.

The present demand for welded tanks is largely due to the difficulty of obtaining a tight job in the black. If galvanized, the seams are tight enough riveted. Black work, to stand pressure in thin plates where calking must be lightly done, is nearly the worst job a shop can tackle. Some such tanks would perhaps be coal tight, but not against water.

In boiler shop practice allowance has to be made for the excess size of the rivet when heated. From the writer's own experience and that of published data concerning strength of boiler seams, the universal practice is to allow 1/16 inch oversize, irrespective of diameter of rivet. Every boiler specification mentions "size of hole in plate," not size of rivet. That the practice may be recognized as universal, reference may be made to the rules of the Hartford Steam Boiler Inspection and Insurance Company, to the Board of Trade and Lloyd's rules, and those of any insurance company in Great Britain.

Drawings in any boiler shop give the size of the necessary rivets as 1/16 inch less than that of the holes. Conversation with draftsmen, boiler shop owners and workmen elicits the unanimous opinion that the 1/16 inch tolerance is reasonable, considering the variation in the size of the rivets, the expansion caused by heat and the presence of scale.

The practice and custom being universal, led the writer to investigate the matter and obtain the reasons in support of the practice. His reasons for so doing were disbelief in precedent unsupported by definite fact and that nobody appealed to could supply the needed information.

Boiler shop practice has so altered in recent years that it was possible an alteration could be effected. We have progressed from punched holes and inferior workmanship with its half blind holes and senseless drifting over to more exact methods. It was evident that the discarded practice needed large tolerance. To-day no boiler worth the name has punched holes, and to find a hole not perfectly fair is practically impossible.

There is, by the way, a strong case for the prohibition of punched holes by statute in boilers. The extra cost of drilling under modern conditions is so trifling that it is cheaper, all things considered, to drill. Hydraulic closing of rivets is so superior to all other methods that it is to-day applied wherever it is possible. With a pressure on the rivet from 40 to 80 tons, there is little question but that the rivet, if of sufficient length, fills the hole.

In the case of hand or pneumatic riveting, which is necessary where hydraulic closing is impossible, the question as to the maximum tolerance oversize is more pertinent. If this is excessive and unless the riveter has a conscience, has his rivet extremely hot and works it practically cold, it leads to imperfectly filled holes with leaky seams and rivets followed by heavy calking.

The considerable advantages of hydraulic riveting, proved beyond dispute, rest on solid grounds. A gradually applied pressure stresses the material less than a large number of relatively light blows. The pressure is of short duration at proper heat, leaving a perfect head without further tinkering.

In the case of mild steel, heating the rivet too hot at the start and continuing to work at a low temperature leaves the rivet material in a treacherous condition. Hence the survival of iron rivets long after the advent of mild steel plates. Wrought iron will suffer greater abuse than mild steel.

It is not unusual by reason of poor drilling to find holes 1/64 inch larger than the drill, sometimes more. The possibility of this and its not uncommon occurrence may serve to explain the slowly dying prejudice on the part of the older generation of workmen in favor of the punched hole. A punch cannot make a hole larger than itself on the face of the plate. Actually it makes a hole perceptibly smaller on this side; witness the necessity for strippers on the punch. On the other hand, a drill cannot but drill oversize. If properly cared for the amount is very small, but it may be a serious factor.

To review the question of size of rivets which are alleged to vary considerably. It is a matter largely of the user. The maker of rivets, knowing the tolerance in vogue, trades upon the fact, and thus bad practice reacts upon another trade. The most serious factor is that rivets of nominal diameters are invariably found to exceed these considerably. Two distinct types of rivets are made. The first is made cold up to ½ inch in diameter. These are made from drawn wire of the necessary size and have only one defect—a small radius exists under the head at junction of tail. Now these rivets are exact to size right up to the head. The usual limits for drawn wire are $\pm$ .002 inch, so that in using these rivets the present allowance, as will presently be shown, is far too great.

The second type of rivet is made from rolled bar headed hot, and is from 1/50 inch to 1/32 inch in excess of nominal size for about ¼ to ⅜ inch from head. The remainder of tail is pretty exact within $\pm$ .004 inch of actual diameter. The reason for this lies with the rivet maker, and the remedy is in the hands of the customer.

In heading the rivet hot the neck takes the size of the die. The die must admit the rolled bar and must allow for its variation. The rivet maker must perforce allow for expansion by heat and the normal run of bar rivets thus made must consequently be oversize below the head. At the same time the practice of the trade permits the use of dies much worn and will continue to assist the rivet maker by keeping his old dies in use so long as they do not specify their requirements more exactly.

Taking next the question of scale. A usual assumption as to its ingredients is that it is half metal. A piece of scale, newspaper thickness, is .004 inch, and the corresponding amount of metal would be .002 inch. This amount of scale sheds itself; under usual conditions this amount of wastage would be a minimum and might be much more. The wastage represents 4/1,000 inch in diameter of the rivet. The presence of scale indicates a wastage of metal and does not materially hamper the placing of rivet.

Now for some simple arithmetic on the subject of heat expansion. The volumetric expansion of mild steel is given in a well-known pocket book as .00020 per degree F. This figure divided by 3 gives the linear coefficient per degree rise.

From the same pocket book Pouillet is quoted as to the temperatures corresponding to appearance and color:

Clear cherry red................	1,832 degrees F.
Deep orange	2,012 degrees F.
White heat	2,372 degrees F.

Taking an example. A rivet 1 inch in diameter, at 60 degrees F., and utilizing the figures above.

Raised to clear cherry it is then 1.0116 inches diameter, to deep orange 1.0134 inches diameter, to white heat 1.0152 inches diameter. Turning up the decimal equivalents in the same pocket book 1 1/64 inches equals 1.0156, so that 1/64 inch of the oversize allowance is due to heat alone. If scaling is taken into account, its diameter would be reduced to 1.0132 inches at white heat, and it must always be remembered that the hotter the temperature the larger the amount of scale and consequent wastage.

At proper temperature (deep orange) its diameter (assuming 2/1,000 inch wastage) is 1.0114 inches, and this is considerably under 1 1/64 inch.

Take a rivet 1 1/32 inch (about the maximum) with .006 inch due to added scale heated to white heat, we then get

$$\begin{array}{lrl} & 1.0312 & \\ & .006 & \\ & .0152 & \\ \hline \text{subtract} & 1.0524 & \quad 1\ 1/16 = 1.0625 \\ \hline & 1.0625 & \\ \hline & 1.0101 & \end{array}$$

Leaving 1/100 inch clearance in the usual sized hole.

If the rivet were 1 1/100 inch to commence with, then the sum comes out to 1.0312 inches, which is 1 1/32 inches exactly. The thickness of scale considered is abnormal and would shed itself at a touch. If the rivet were of exact size and proper temperature, and neglecting scale altogether, it allows a clearance of 1/64 inch in a 1 1/32 inch hole.

From the foregoing it appears that the 1/16 inch customary allowance is made up of 1/32 inch error of rivet maker, a bare 1/64 inch due to expansion by heat, a full 1/64 inch allowance for scale and easy placing in hole. A tolerance of 1/100 inch oversize in the rivet seems a generous allowance; and it should not be impossible to obtain commercial rivets with this as a guaranteed basis, in which case we might halve the present practice.

If to the customary allowance we add the oversize error of the drill, very small though this may be, the case is even worse. If we take the case of smaller rivets, ½, ⅝, ¾ inch, all getting the 1/16 inch allowance, the tolerance is proportionately worse, again. Expansion due to heat is strictly determined by difference in size. A ½-inch rivet expands exactly half the amounts calculated above for a 1-inch rivet.

It is submitted that sufficient evidence has been produced to make a strong case for reconsideration of existing practice both with regard to the purchase of rivets and to the allowance needed. If the present tolerance is necessary from the variation in size of rivets, and the oversize permitted is by far the largest factor in the case, then the rivet maker must be brought into line in the matter. There is no excuse for the isolated specimen in a bag of rivets proving recalcitrant, and in the manufacture of repetition work like rivets fairly exact work might be expected.

Were the necessary tolerance needed by the rivet maker to be fixed, he could be held to very close adherence. It would be dead easy, by simple alteration of conditions, that the maker of rivets should buy his bars, say, 1/64 inch under size and give no exact size rivets ± .002 inch under head, in which case less than half the present allowance would be sufficient.

Any effort towards more exact workmanship is worth making. If the reduction of allowance can be made common sense will approve of the change, it must seem a stupid proceeding to make holes unnecessarily large merely to fill them again. To follow precedent, even though it has historic sanction, when intervening time has effected radical changes in conditions and practice, must be an irrational proceeding.

Selected Boiler Patents

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

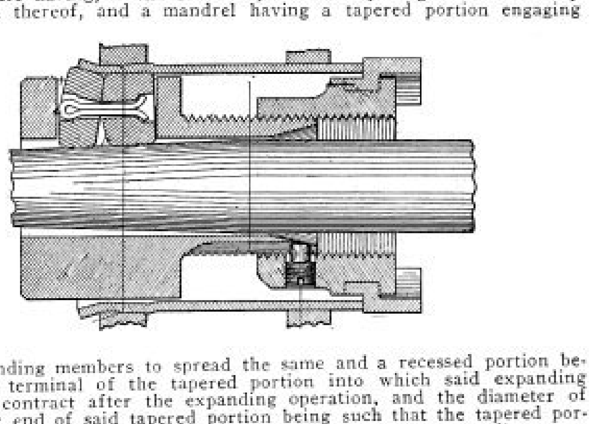
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,149,265. METHOD OF AND APPARATUS FOR REGULATING THE TEMPERATURE OF SUPERHEATED STEAM. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—The method of regulating the temperature of superheated steam, which consists in subjecting the steam to the action of a cooling medium to reduce the temperature to a predetermined constant, and then causing any variation from that constant to effect a corresponding variation in the volume of the cooling medium to thereby restore the steam temperature to substantially that of the constant. Twelve claims.

1,153,663. BOILER-TUBE EXPANDER. OTTO WIEDEKE, OF DAYTON, OHIO, ASSIGNOR OF ONE-HALF TO GUSTAV WIEDEKE, OF DAYTON, OHIO.

Claim 1.—A tube expander comprising a series of elongated expanding members having, when assembled, an axial opening of substantially the length thereof, and a mandrel having a tapered portion engaging



said expanding members to spread the same and a recessed portion beyond the terminal of the tapered portion into which said expanding members contract after the expanding operation, and the diameter of the larger end of said tapered portion being such that the tapered portion may pass through the expanding members when the expanding members are expanded and within the tube. Three claims.

1,150,138. BLOWER FOR WATER-TUBE BOILERS. JOHN MAGEE, OF DETROIT, MICH., ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

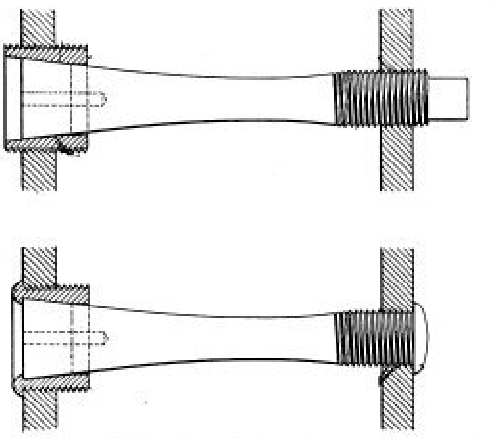
Claim 1.—In a boiler having sets of water tubes disposed transversely to each other in oblique relation and a setting therefor, means disposed transversely to the tubes in the angular spaces formed between the sets and adapted to direct cleaning jets across, between and along the tubes of the sets adjacent the angles and over the interior surfaces of the boiler. Five claims.

1,156,933. SAFETY WATER-GAGE COCK. WILLIAM N. ROWE, OF HIBBING, MINN.

Claim 1.—In a device, the combination of upper and lower gage cocks having a gage glass therebetween, each cock comprising a casing having an inner valve seat, a separable member provided with a second valve seat, valves controlled by a single stem and adapted to act upon said valve seats singly, and a vented bonnet secured to each casing. Three claims.

1,154,469. STAYBOLT. HENRY V. WILLE, OF PHILADELPHIA, PA., ASSIGNOR TO THE BALDWIN LOCOMOTIVE WORKS, OF PHILADELPHIA, PA., A CORPORATION OF PENNSYLVANIA.

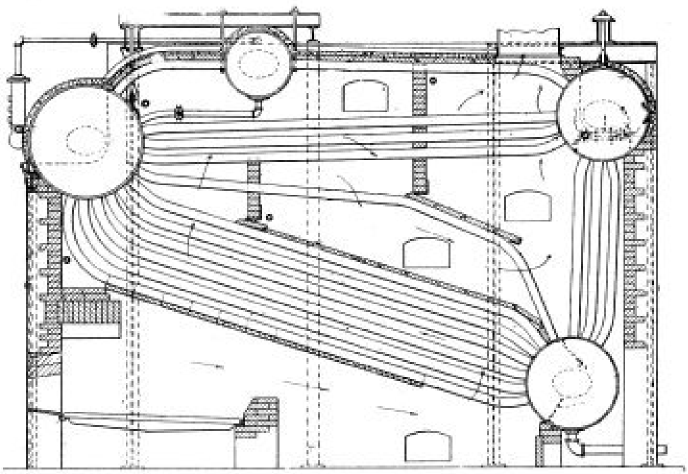
Claim 1.—The combination of a staybolt having a threaded portion at one end and a seat portion at the opposite end; two plates, one having a threaded opening to receive the threaded portion of the plate, the



other having a large threaded opening; and a bushing mounted in the threaded opening and having a seat for the seat portion of the bolt, the bushing extending beyond the plate and beyond the bolt and flanged over the bolt to hold said bolt to its seat. Three claims.

1,157,736. BOILER. SOREN THURSTENSEN, OF LOUISVILLE, KY., ASSIGNOR TO HENRY VOGT MACHINE COMPANY, OF LOUISVILLE, KY., A CORPORATION OF KENTUCKY.

Claim.—In a boiler of the class described, the combination of a water drum, a mud drum, a lower steam drum and an upper steam drum, a series of vertical tubes connecting the water and mud drums, a first set of tubes connecting the mud and lower steam drums, a second set of tubes connecting the water and lower steam drums, a third set of tubes connecting the lower and upper steam drums, a fourth set of tubes connecting the upper steam and water drums, a first baffle below the first



set of tubes, said baffle extending from the front of the boiler to adjacent the mud drum, a second baffle extending from the mud drum to adjacent the front of the boiler and above the first set of tubes, a first vertical baffle extending from the second baffle to the second set of tubes, a second vertical baffle to the rear of the first vertical baffle and extending from the second to the fourth set of tubes, a third baffle extending rearwardly from the rear vertical baffle along the top and in contact with the uppermost of the second set of tubes to a point adjacent the vertical tubes, and a smokestack at the top of the boiler above the third baffle.

1,155,499. BLOWER UNIT FOR BOILERS. JOHN MAGEE, OF DETROIT, MICH., ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

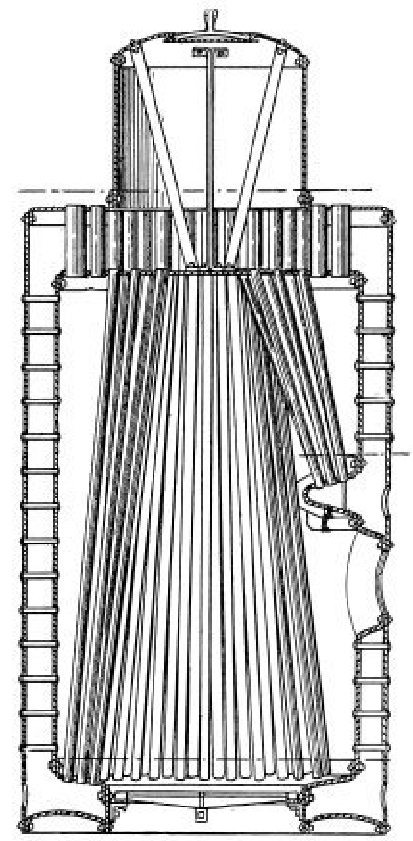
Claim 1.—A blower unit for boilers comprising a steam pipe, a series of lateral jet nozzles extending therefrom, a casing secured in spaced relation concentrically around the pipe and provided with apertures engaged by the nozzles, inner and outer bearing members for supporting the corresponding end portions of the casing, a bracket secured to the outer bearing member, a steam supply fitting mounted on the bracket in axial alinement with the steam pipe, and a packing joint between the supply fitting and the pipe and adapted to turn the pipe. Six claims.

1,157,114. BOILER TUBE CLEANER. FREDERICK W. LINAKER, OF DUBOIS, PA., ASSIGNOR TO THE VULCAN SOOT CLEANER CO., OF PITTSBURG, PA., OF DUBOIS, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—In a tube cleaner, a fluid distributing pipe arranged transversely of the tubes of a boiler above the same and adapted for step by step adjustment on its axis, said pipe having outlet openings in its walls, and a plurality of stationary nozzles in which the pipe is adjustable, said nozzles having discharge ports with which the outlet openings in the pipe are brought into coincidence as the pipe is adjusted. Eighteen claims.

1,157,813. BOILER. THOMAS J. SHEA, OF PORTLAND, ORE.

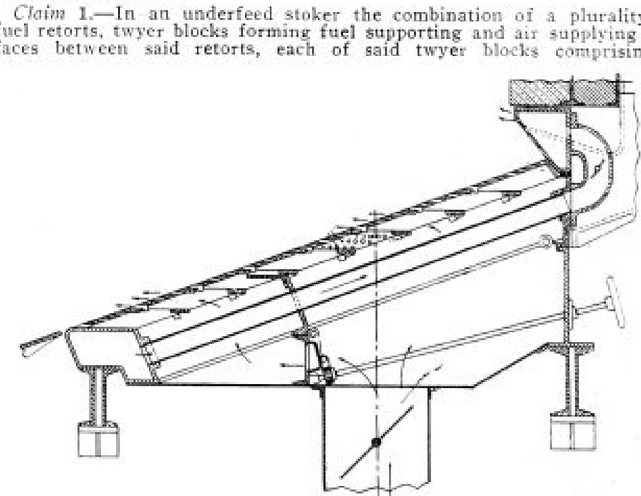
Claim 1.—In a boiler, inner and outer shells forming an interior fire chamber, an overhead water space, a water leg and an enlargement at the lower end of the water leg, a closed steam dome mounted on the top of the outer shell in communication at its bottom with said overhead water space, water tubes extending upward through the fire chamber



and opening communication between said water leg enlargement and the overhead water space, said water tubes being arranged in a circular set and inwardly inclined from their lower ends upwardly, fire tubes extending upward through the overhead water space and opening communication between the fire chamber without the upper ends of the water tubes, and the atmosphere around said steam dome. Two claims.

1,159,862. FURNACE. OSCAR P. OSTERGREN, OF BROOKLYN, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE WESTINGHOUSE MACHINE COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1.—In an underfeed stoker the combination of a plurality of fuel retorts, twyer blocks forming fuel supporting and air supplying surfaces between said retorts, each of said twyer blocks comprising a



hollow arched member provided with perforations adapted to emit air, said perforations being distributed throughout the entire fuel supporting surface of said twyer blocks and decreasing in effective area toward the longitudinal cross-sectional center of said twyer blocks. Seven claims.

1,158,776. ARCH CONSTRUCTION. LOUIS BERNHARD, OF BOSTON, MASS.

Claim 1.—An arch construction comprising a bridge; an expansible lining therefor separated from the bridge so as to leave a space for the movements of the lining; and means connecting the bridge and lining to support the latter, but permitting relative movement between the bridge and lining, said means moving outwardly when the lining expands, but supporting the lining during the expansion. Ten claims.

THE BOILER MAKER

FEBRUARY, 1916

Use of the Oxy-Acetylene Process in Welding Boiler Work

BY C. R. SUTTON

A large percentage of the readers of THE BOILER MAKER are now using the oxy-acetylene process, especially in railroad shops, where rapid strides have been made, and are familiar with the general principles of the process. This article is for the readers of THE BOILER MAKER who are not already familiar with the subject.

In general, welding the outside shell of a boiler is not recommended, but considerable work can be done on the firebox (where most of the cracks occur), and this work has proved successful. Though no general rule can be laid down, it is usually necessary to remove a few rivets or staybolts on each side of the crack in order to allow the metal to expand and contract during the welding operation. These can be replaced later.

Where a patch is to be put in, use a round or oval patch in preference to a square one, and either corrugate or belly

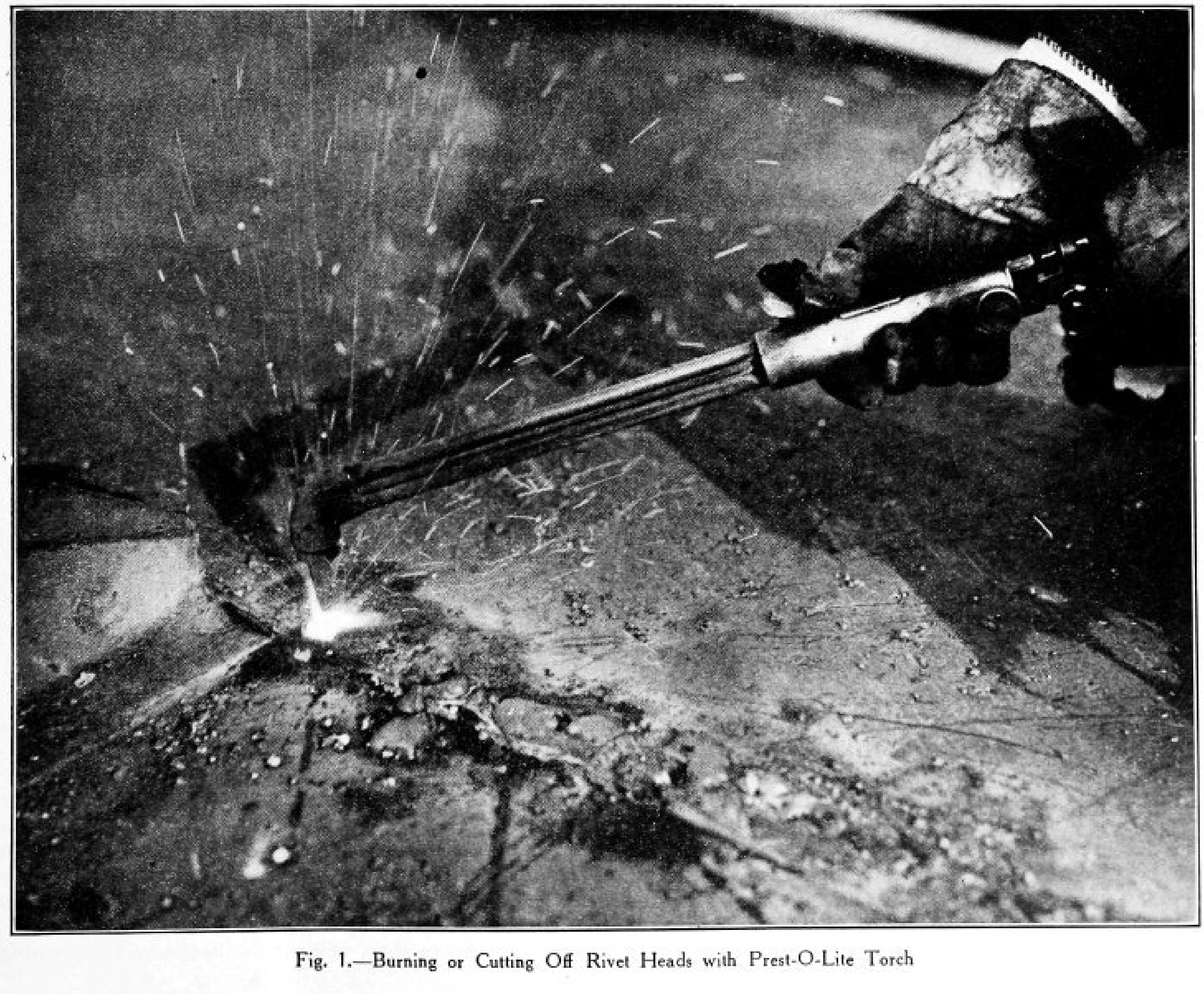


Fig. 1.—Burning or Cutting Off Rivet Heads with Prest-O-Lite Torch

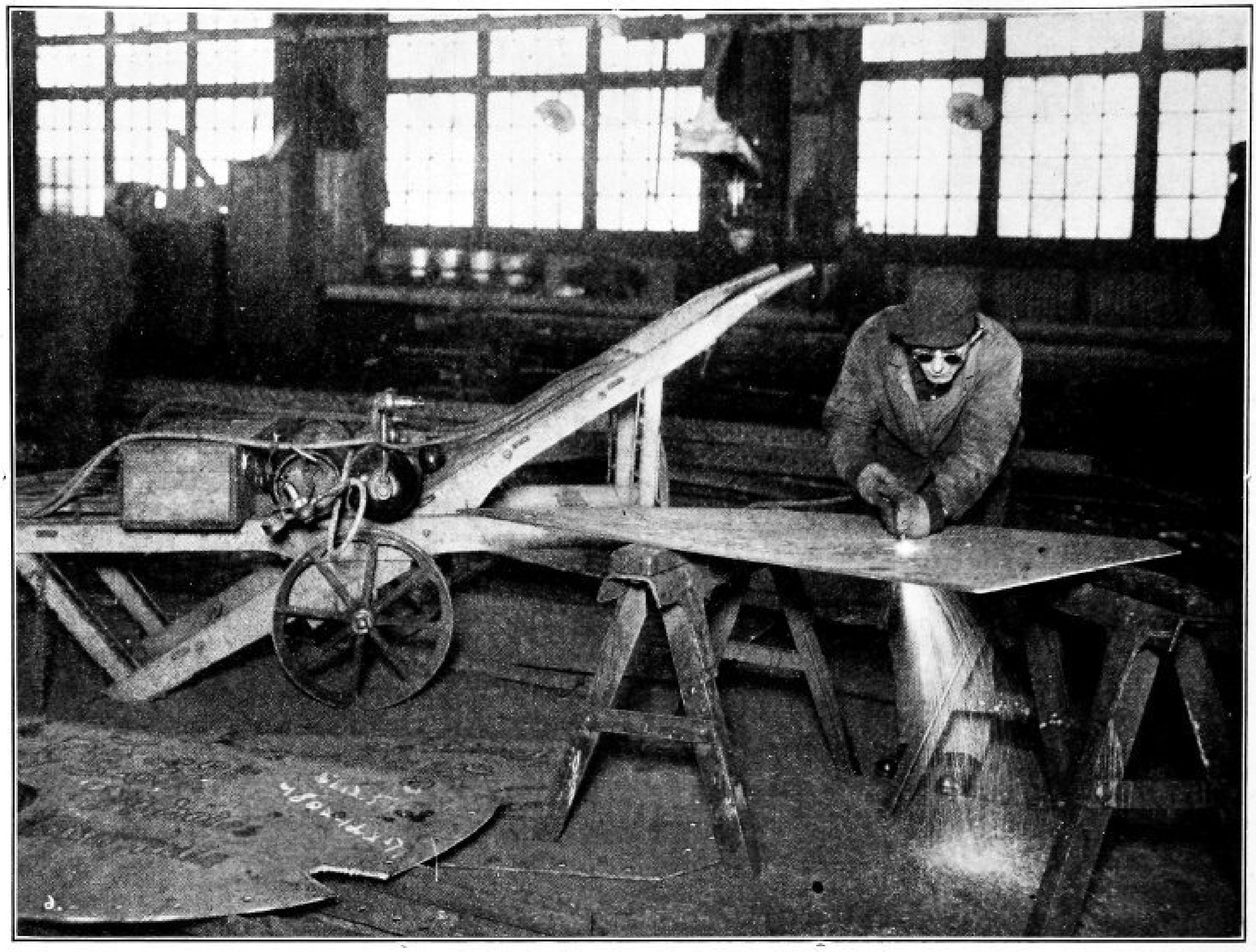


Fig. 2.—Cutting Holes in Boiler Plates

the patch slightly, as this will give the metal a chance to contract without causing a new crack. Where a patch runs down to the mud ring of the boiler, let the portion at the mud ring be the last to be welded, so that there will be a chance for the metal to give during the entire welding operation. The metal should, of course, be beveled in the usual manner; that is, at an angle of 45 degrees. Use Norway iron filling rod of the best grade.

This sort of work is rather difficult for the ordinary operator at first, because most of it has to be done in a vertical position, or even overhead, and the average operator is used to working in a horizontal position. Practice is the only thing that will bring skill.

In training men for boiler welding it is best to let them weld on scrap boiler plate clamped in a vertical position, and then when the weld is finished, break it with a sledge hammer and examine the metal. The first welds made are usually of uncertain quality, but after a little practice any man who is a good welder on ordinary work can produce sound, homogeneous welds in a vertical position just as well as he can in a horizontal position.

Several points which should be emphasized were made in a very good article on this subject published recently in the *Railway Journal*, by A. R. Hodges, master boiler maker, Memphis, Tenn., from which we quote the following:

"The foreman boiler makers throughout the country deserve a great deal of credit for the success achieved by oxy-acetylene welding, for these men were among the very first to conceive of its possibilities in making repairs.

"On account of the imperfect knowledge of this art many failures resulted. The welding appeared good, but failed under test. A storm of adverse criticism arose from all quarters; even many foremen boiler makers and inspectors who were favorably impressed at first joined the ranks of the critics. But a few heroic men stayed with it, subjected themselves to criticism and even reprimands, and were instructed by their superior officers to discontinue its use. But argument was brought to bear, sound reason prevailed, and they were permitted to continue until success began to attend their efforts. To-day their vision has become a reality.

"Some may ask—what are the essential factors to the successful application of this process in effecting repairs? I answer: First, pure gases—in the initial stage the writer manufactured his own gases, and experienced a great deal of trouble from their impurities. But gas manufacturers now supply acetylene and oxygen as pure as can be made."

The above is agreed to in every particular, but it seems that a few words of explanation in regard to the necessity of using "pure gases" are necessary for those not already familiar with the proper fuel gases employed in oxy-acetylene welding. While the acquiring of better knowledge and broader experience had been a very important development of the oxy-acetylene process, no less important has been the building of extensive plants throughout the country for the production, purification and compression of oxygen and acetylene, thus providing the facilities necessary for bringing the process within the reach of practically every shop, without the necessity of operating a "gas factory." Let the gases be manufactured elsewhere.

My experience has been mostly with purified, dissolved acetylene, generally known as "Prest-O-Lite gas." The Prest-O-Lite Company operates recharging plants in various parts of the country, and keeps a large stock of cylinders for exchange. The acetylene with which these cylinders are charged is produced from a high grade of carbide of calcium in mammoth generators, each of which holds a thousand pounds of carbide and a thousand gallons of water. By very slow, cool generation they are able to produce a very high grade of acetylene. The gas is purified to remove phosphorous compounds and sulphur, which always have an injurious effect on the weld.

I have found that acetylene as delivered from any carbide generator usually contains a considerable amount of water vapor, which is carried over with the gas to the welding blowpipe. When this vapor of "steam" enters the welding flame it breaks up into oxygen and hydrogen. This chemical action takes considerable heat from the welding flame, thereby reducing its temperature. Therefore, to get the proper amount of heat for efficient welding, a

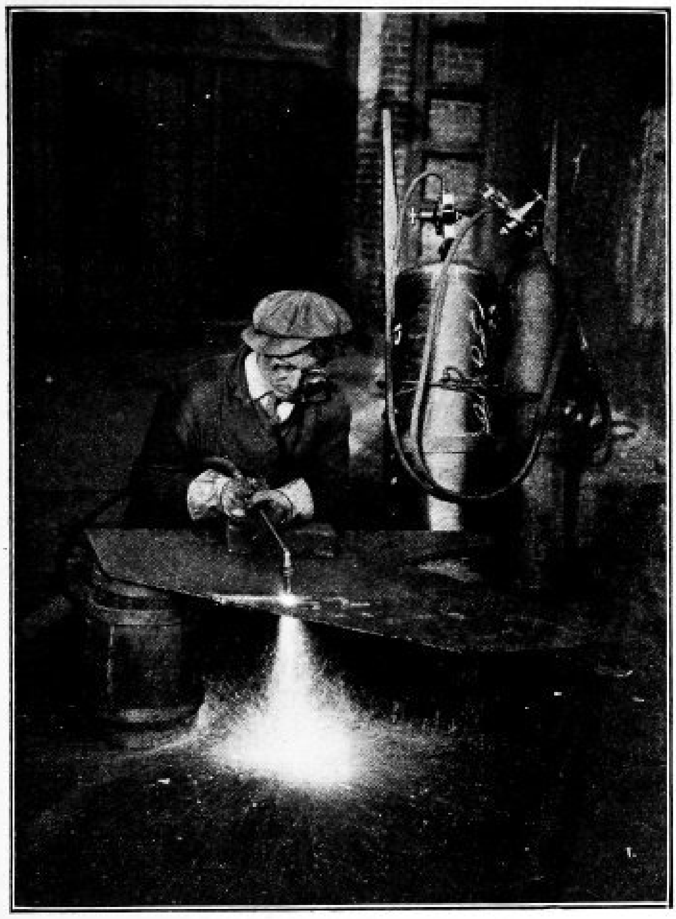


Fig. 3.—Cutting Boiler Plates. A Very Fine Cut can be Made by this Method

larger blow-pipe is necessary, using more gas than is necessary when the moisture is removed, as is the case with ready-made acetylene. Moist, or "wet," acetylene, as it is called, is therefore not economical.

There are several other advantages of compressed acetylene in addition to purity and dryness, which I believe are most important. For instance, it is furnished in convenient-size portable steel cylinders, and to start work you simply turn on a valve and your supply of gas is at once ready to use. Acetylene and oxygen cylinders may be moved from place to place in or out of the shop with absolute safety. They will not freeze, and can go through a fire without exploding, as each cylinder is equipped with safety plugs.

Every boiler maker is interested in operating his oxy-acetylene outfit with the greatest economy and efficiency. In this respect compressed acetylene contributes another big advantage which I desire to emphasize, and that is the employment of the equal-pressure blow-pipe, which, in addition to being the simplest in design, means an actual saving in oxygen consumption as compared to the injector type of blow-pipe. This saving is about one-

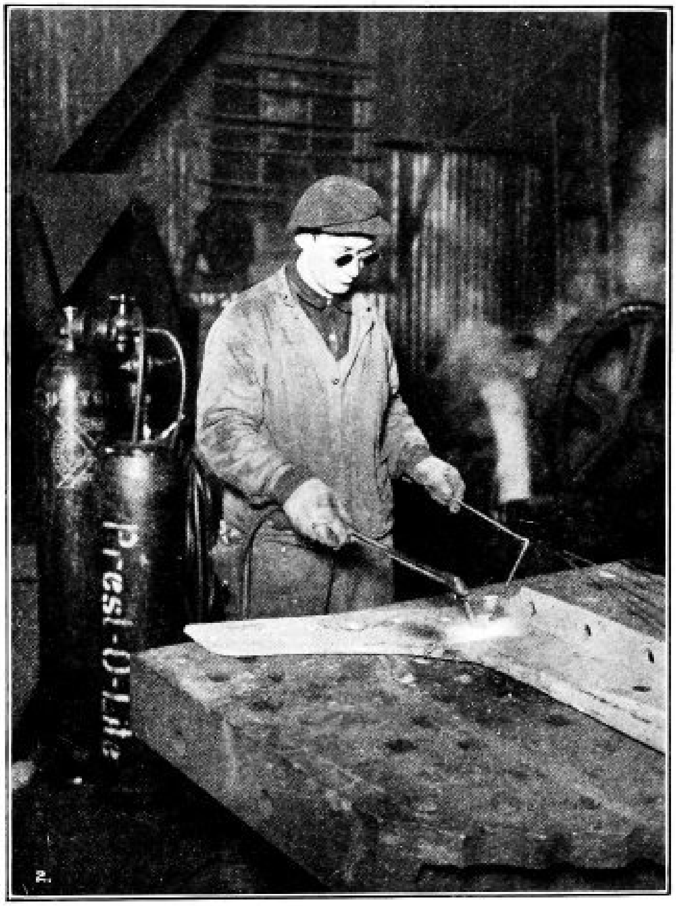


Fig. 4.—Welding Cracks in Iron Plates, Using Swedish Iron

fifth of a cubic foot of oxygen for every foot of acetylene used.

Another element of success is the proper preparation and correct application of patches, side sheets, flue sheets, door collars, and whatever is to be welded. They should be fitted up and correctly assembled for successful welding in the same manner as they should when riveted or applied with patch bolts.

The next element of success is to weld slowly. Many times men try to make a big showing and finish the work in a certain time, or become impatient, and the tendency under these circumstances is to hurry. In order to progress more rapidly they begin to slight the work—the weld is made in a careless manner. This should never be done, however strong the temptation. The welder should never lose his head, but should maintain an even composure, and do a thorough job regardless of the efforts of others to have the work hurried. Experience teaches that the more proficient a man becomes in the art of welding the faster he can do successful work.

To summarize: to do highly successful boiler welding one should have the benefit of a good knowledge of the principles of boiler welding, gained from experience, pure gas should be used with a good blow-pipe and good filling material, and, equally important, care and good judgment should be used. These are the essentials of good boiler welding.

Electric and Oxy-Acetylene Welding

The welding process of repairing boilers has made rapid advancement during the past three years. It has unquestionably solved some problems of repairing boilers in an inexpensive and satisfactory manner, but there still remains the fact that in many cases work attempted by this process has proved a failure. Most of the failures, however, are due to the lack of knowledge of the effects of the electric arc and the flame of the oxy-acetylene torch by the operator. Both skill in applying the process and knowledge of the effects are absolutely necessary for the successful operation of this process.

The larger concerns who do this kind of work employ only skilled operators, but there are many smaller concerns who do not have sufficient work of this kind to make it profitable enough to pay the high wages commanded by skilled men, the result being that many times work is done that should not have been attempted. The writer has seen some of these instances and hopes that a description of them will be of benefit to the practical operating engineer.

The side sheets in the furnaces of a leg boiler in a tugboat had cracked between the staybolts in several places and it was decided by the concern which owned the boat to have the cracks repaired by the welding process. A firm which had authority to use this process on marine work was communicated with and one of their representatives stated, after examining the boiler, that it could be satisfactorily repaired by the oxy-acetylene welding process, the kind used by them. They sent one of their operators with appliances for doing the work and he began operations on a crack that extended from a staybolt hole for a distance of three inches when he began. Before he had done much welding the crack had extended to the next staybolt hole. When he had welded this crack its entire length he discovered that a new crack had started between two staybolt holes two feet away from the one he was working on. He welded the new crack and found that this had started another crack between two other staybolt holes. The same result took place when this crack was welded and the operator became discouraged, as did the superintendent of the concern who owned the boat.

A telegram brought on the next train another representative of the firm which had contracted to do the work, and he took charge of the work. Being an expert in this kind of work he soon discovered that the oxy-acetylene welding process would not successfully repair cracks in side sheets that had become extremely brittle by reason of crystallization. A few cuts with a hammer and cold chisel revealed the brittleness of these sheets, and had this expert examined the boiler the first time he would not have undertaken the job. The old sheets were cut out and replaced with new material.

In another case the top of the back ends of two corrugated furnaces in a Scotch boiler had cracked out from the rivet holes to the edge of the furnaces. These ends were cut off all the way around and the furnaces lengthened on the front ends by riveting pieces on them and then drilling new holes in the back ends and refastening them in place. In a short time they again cracked in the top of the back ends where the flame of the fires struck. A firm which did repair work by the electric welding process claimed that the cracks could be repaired by their process and were given the job. When it was completed there was at least one-half inch of material welded on the top of the back ends of the furnaces, extending in over the rivets. With two thicknesses of metal—the flanges of the flue sheets and the furnaces—and this addition of welded material, between the fire and water there could only be failure, and the welded ends of the furnaces soon burned, leaking worse than ever and had to be replaced with new ones. Only a person who lacked knowledge of the effects of fire on metal would have undertaken to do this job in this manner. Undoubtedly these cracks could have been welded by cutting them V-shaped and then filling up the V's level with the sheet.

Another instance of the lack of knowledge of the effects of the heat of the electric arc on the material on which it was being used occurred on a pleasure steamer. This yacht was constructed of steel and the plates of the hull were of extremely light material. These plates had corroded in places under deadlights, toilets and bath tubs, and it was thought that they could be reinforced in these places, which were not of very great area, by the welding process. This opinion was confirmed by a representative of a firm who did this work and he was given the job. When he had completed the reinforcing of the first spot the plate he was working on had wrinkles in it between the frames that surprised the operator and horrified the owner of the yacht. The operator had no knowledge of the effects of the heat of the electric arc on light steel plates.

It was then decided to cut out the portions of the plates that were deteriorated. This was attempted by the use of the electric arc, but this also proved a failure. The edges of the plates when cut were too uneven to calk and required chipping. On starting to do this it was found that the material had hardened so much that it was a slow and expensive job to chip the edges and the use of the electric arc was abandoned.

None of these jobs would have been attempted had an expert in the use of the welding process been in charge of the jobs in the first instance, and these failures prove that this work should not be entrusted to any but experts.

J. S.

Chunks of Wisdom

The electric light has made boiler repair work more agreeable to do, therefore use the lights with reasonable care. Don't waste electricity by leaving lamps burning where they are of no use.

It is a long way up to the traveling crane, but it pays to have some one go, oil it, and for safety's sake look it over. The man to do this latter should be a competent man and not one of the laborers.

Many boiler makers dislike measurements that are in tenths; say decimal to him and he says he can't understand them. He would rather say quarter of an inch than .25, yet the boiler maker gets his pay in decimals and is perfectly willing to call a quarter twenty-five cents without getting upset about it.

Sometimes you can do a thing too quickly, as, for instance, turning a flange or bending a piece of metal cold. Quick work here is apt to strain the metal. Use your judgment when you do anything in the boiler shop. Main strength and awkwardness are believed to be the big part of a boiler maker's equipment, but that is not true.

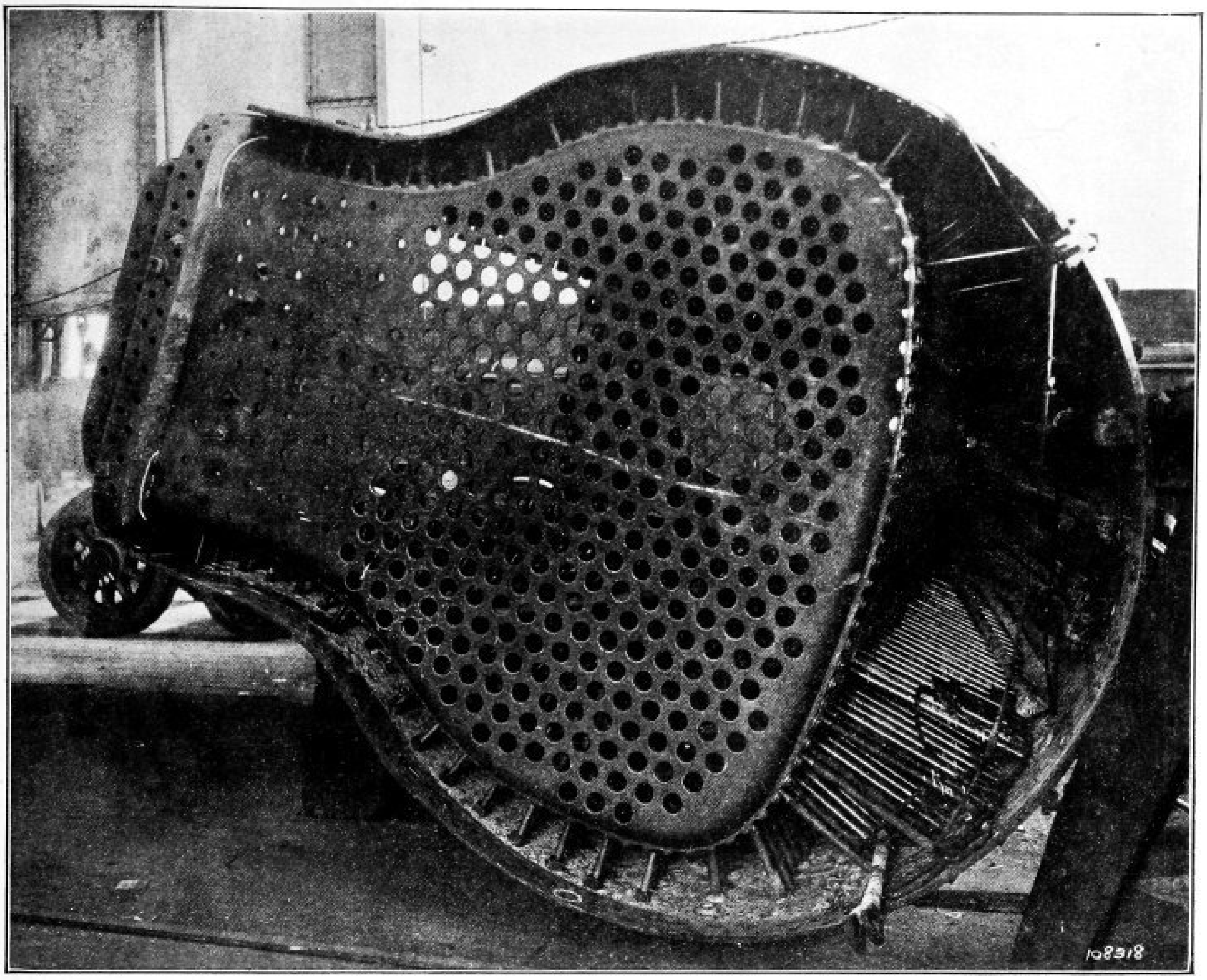


Fig. 1.—Staybolts Cut Away from Locomotive Boiler Preparatory to Welding by Electric Arc

Progress in Electric Arc Welding

Practically Every Large Railroad Shop in the United States Now Using the Electric Arc Process

BY J. H. BRYAN

Electric arc welding is being used so widely in manufacturing and in railroad service that the processes are generally familiar. Of more interest are the results which are being obtained with this process; while what is said hereafter applies directly to repairs made in locomotive boilers, it must be understood that the original construction of and the repairs to stationary boilers may be made with equal success.

Practically every large railroad shop in this country is using the electric arc process with metal electrodes for flue welding. Welded flues are practically permanent since the flue and the sheet are bonded together without a joint and hence gives virtually no chance for leaks to develop. The attitude of the railroads toward welded flues is well shown in the following quotations from the Report of the Committee on Autogenous Welding in the Proceedings of the International Railway General Foremen's Association for 1914. It is referring definitely to the experience of one road. "We have in service to-day over ninety locomotives with flues welded to back flue sheets, making a total of almost 27,000 flues. Out of this number of locomotives in service with the flues welded, we have our first engine to fail on line of road with flues."

It has been found that the flue sheet, after the flues have been removed, is in better condition than where flues have not been welded in. The welding builds up the sheet around the flue holes to almost the original thickness. It is essential that only a first-class operator be allowed to do work on the repair of boilers, because of the dangers that are attendant upon defective workmanship where the welded plates are subject to pressure.

Firebox repairs are closely related to flue-welding and are being made with equal success. They include cracks in the side, flue, door and crown sheets, leaky staybolts, seams, etc. Patches may be put on when the sheets have become weakened so that repairs are impossible. The carbon electrode is ordinarily used to cut out

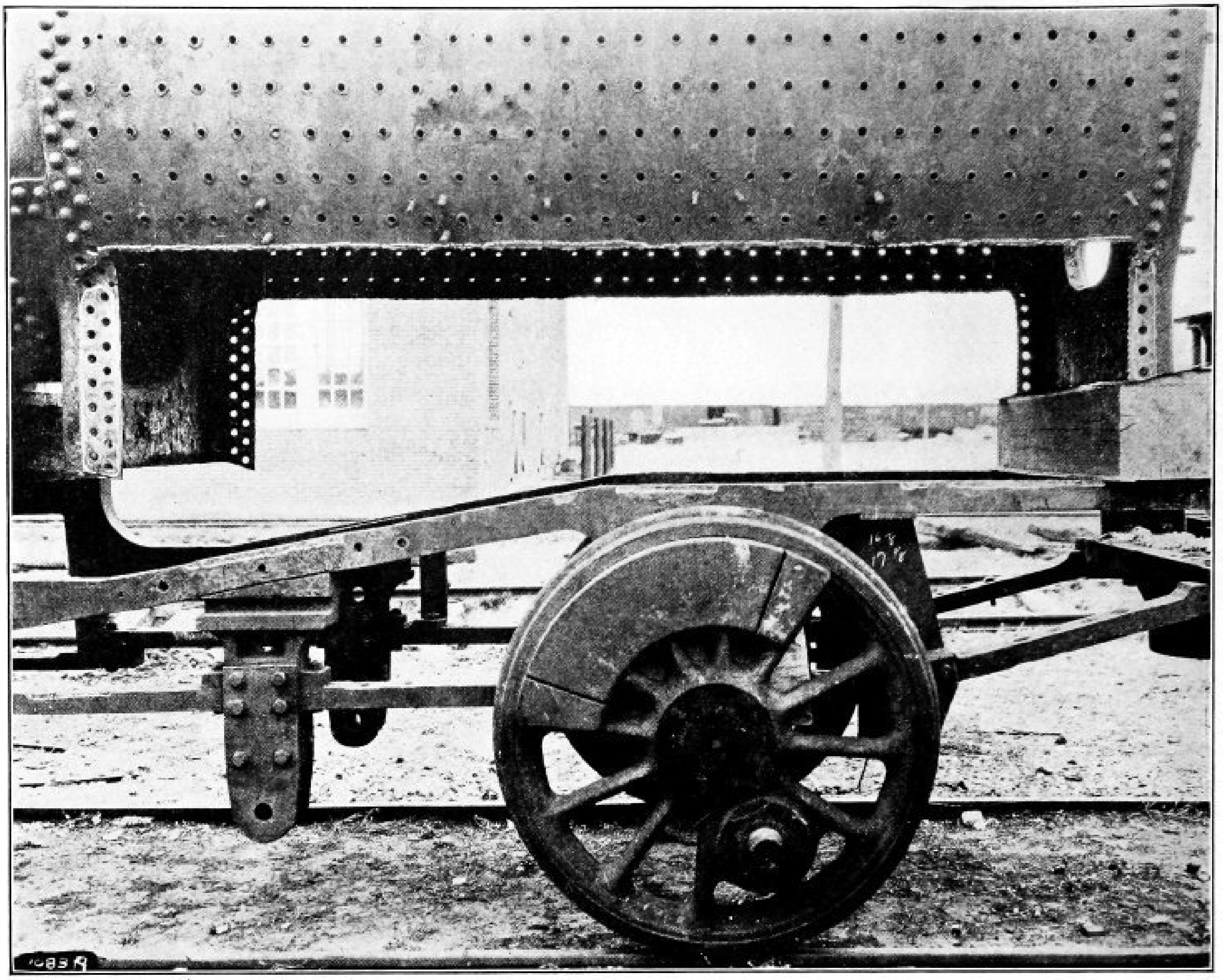


Fig. 2.—Firebox Side Sheets Cut Away Preparatory to Welding in New Sheets. Electric Arc Used for Cutting and Welding

the defective part and a new section is then welded in place. Half-side sheets, door sheets, etc., are welded in without difficulty.

Broken locomotive frames are very successfully repaired by the use of the electric arc. The great advantage in this work is the great speed that may be obtained, as no dismantling of the locomotive is necessary beyond that required to give the welder access to the broken parts. There are cases where frames have been welded without drawing the fire.

The actual cost of repairs made in a large railroad shop in the Middle West is tabulated below, with the cost of the method previously used to secure the same results. In some instances replacement was the only method possible until the electric arc was used. The arc welding costs were based on a power cost of 51 cents an hour with the carbon electrode, and 17 cents with the metal electrode, together with the cost of labor and an overhead charge of 40 percent.

	Cost of Welding	Cost by Other Methods
Plugging 51 holes in expansion plate, holes 1 inch diameter by ½ inch deep	$2.75	$10.15
Repairing mud ring	6.50	34.57
Cutting four 6-inch holes in tender deck sheet ½ inch thick	1.08	8.35
Welding electric strap, broken through neck	1.08	41.28
Welding two spokes in driving wheel center	7.98	99.98
Welding cracks in side sheets	26.15	31.79
Repairing firebox	134.89	869.58
Building up flat spots on locomotive driver	.40	225.00

On the last item the large saving is due to the making of the repair at the roundhouse without withdrawing the locomotive from service, while any other method would require a week or 10 days' loss of time while the locomotive was shopped and the drivers turned down. If the loss of time be considered the cost of the older method might easily be $500 or more.

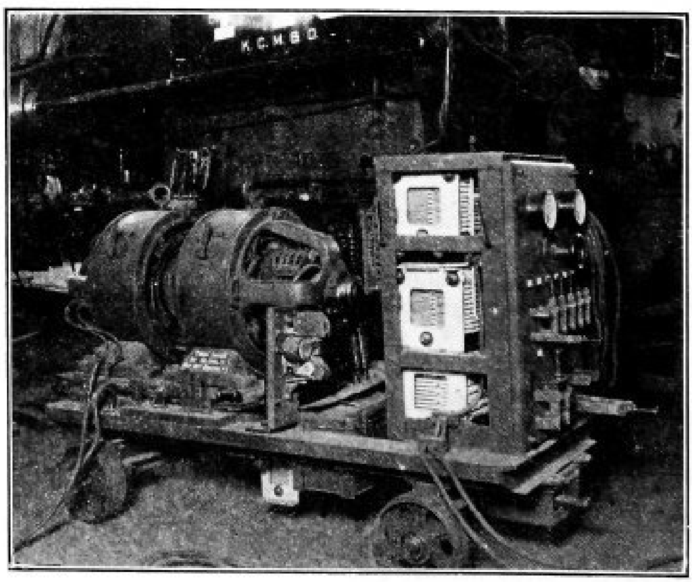


Fig. 3.—Westinghouse Electric Arc Welding Motor Generator Set Used in Orient Shops, Wichita, Kan.

The system best adapted for use is dependent upon the class of work to be done.

It has become universally accepted that a special motor-generator set gives the best results, because it supplies current of the necessary characteristics and does it at the lowest cost. The question that remains to be decided is the size of the set. Originally a separate set was supplied for each operator, but experience has proved that in a shop where two or more welders are employed that it is better and cheaper to have one set supply several operators. Arc welding is necessarily an intermittent process, and hence the average load on the motor generator is low. Practice has shown that the arc will not be in use more than 50 percent of the total time in most cases. This makes the cost of power higher than if the average load were nearer the capacity of the set.

Furthermore, the single set for several operators is cheaper to install than a set for each operator. The efficiency of the smaller set will of necessity be lower than that of the larger set. The general practice now is to install a motor generator of sufficient capacity to supply all operators within a range of 500 to 600 feet of the set with permanent wiring and outlet panels for the individual operators installed at the most convenient points where welding is to be done.

For miscellaneous repair work around large industrial plants a 300-ampere equipment, sufficient to allow two operators to work simultaneously with the metal electrodes, is usually satisfactory. Where more operators are employed for welding, and where carbon electrodes are used, it is usually desirable to put in a large set, though if the welding booths are scattered over a very wide area the use of several sets for two operators each may be found desirable. Individual consideration of the conditions must be made and the system best suited then installed.

Portable Oxy-Acetylene Apparatus Used in Welding High-Pressure Natural Gas Mains

Considerable welding of high-pressure natural gas mains has been done by the Wichita Pipe Line Company, at Bartlesville, Okla. According to Mr. H. O. Ballard, superintendent of lines, experience has shown that the welded line is far superior to any coupler line, as there is no chance for a line discrepancy when once constructed with the welding process.

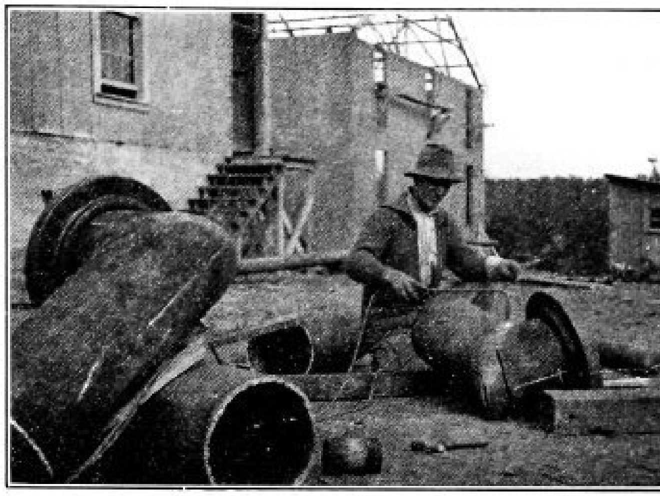


Fig. 1.—Constructing Elbows with Cutting and Welding Torch

The Wichita Pipe Line Company took up the welded construction after extensive investigations of lines laid in California and elsewhere which carry a pressure of 100 to 125 pounds, but were not entirely satisfied until they had made their own experiments and tests up to 400 and 500 pounds pressure. Mr. Ballard says:

"After making several of these tests and finding the welded part to be as strong as the pipe, the management decided to adopt this method of construction, and I can safely say that in view of the good results we have obtained, we believe it is but a question of time when there will be nothing else but the welding process used in the construction of gas lines."

The following illustrations represent the class of pipe welding done by the Wichita Pipe Line Company, employing the Prest-O-Lite process:

Fig. 1 shows a welding operator constructing elbows from pipe by means of the oxy-acetylene cutting and welding process. The pipe lengths are cut at the angle desired by means of the cutting blow-pipe and are then welded as shown in the illustration. In the background are the pumping houses of the Wichita Pipe Line Company, in which are located the huge compressors which pump the gas into the mains.

In the cooling pipes and gate valves just outside compressor house (Fig. 2) the vibration is excessive—in

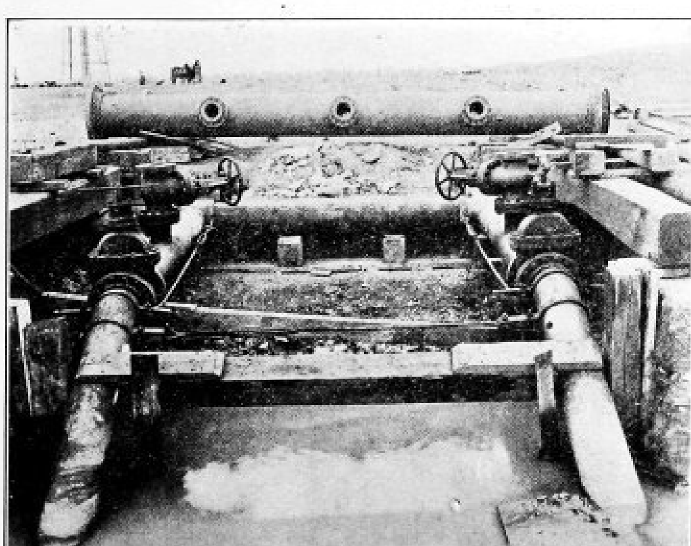


Fig. 2.—Gate Valves Leading to Gas-Cooling Pipes

Fig. 3.—Welding in Small Gas-Cooling Pipes

Fig. 4.—Method of Carrying Oxygen and Acetylene Cylinders through Rough Country for Welding Gas Mains

fact, so great that ordinary threaded couplings on the pipes coming out of the water gave way. The welded joints were unaffected by the jerking caused by the compressors. About 25,000,000 cubic feet of gas can go through the two pipes shown in twenty-four hours.

After the gas is cooled and passes through the gate valves it goes through the series of small pipes illustrated in Fig. 3. It then enters the large pipes, on which the operators are welding, by which time the "jerking" has been completely eliminated. This original method of eliminating the vibration in the mains was devised by Mr. Ballard. All of the small pipes are welded into the larger ones by the Prest-O-Lite oxy-acetylene process.

Fig. 4 shows the convenient method of carrying acetylene and oxygen cylinders, comprising the fuel supply for the welding outfit used by the Wichita Pipe Line Company on a 20-mile stretch of welded main. Full cylinders are distributed in advance of the welders and exchanges made when necessary without interfering with the progress of the work.

The method of "tacking" two pipe ends before welding is shown in Fig. 5. In many cases it is better to turn the pipe so that the welding will always be on top. However, it is possible to weld entirely around a pipe without turning, by digging a bell-hole for the operator or by elevating the pipe so that the work can be carried out on the under side without difficulty. The Prest-O-Lite welding outfit is moved from joint to joint on the high-wheeled carrier illustrated in Fig. 4.

In a great deal of the construction work done by the Wichita Pipe Line Company pipe lines have to be laid through wooded, hilly country. In overcoming such natural difficulties, the portability of the welding outfit plays an important part. Fig. 6 shows a particularly rugged section of country, but is by no means the worst that was encountered.

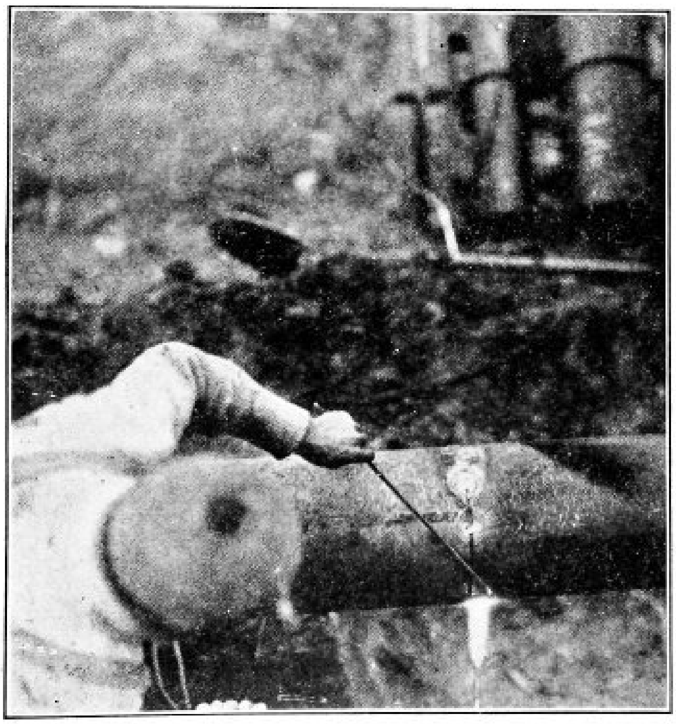


Fig. 5.—"Tacking" Pipe Ends Before Welding

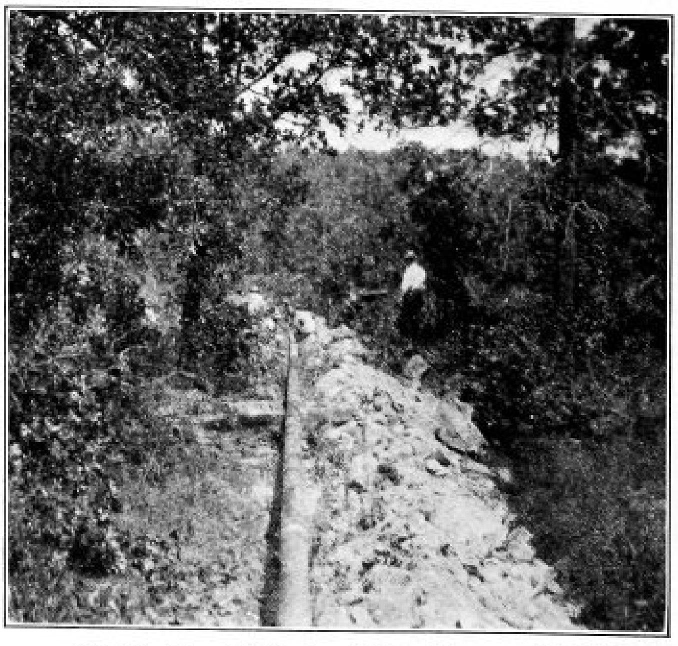


Fig. 6.—Rugged Country Where Pipe was Welded

Cutting Steel Piling with Acetylene Torch

Day's Work of an Ordinary Laborer Accomplished in From Five to Ten Minutes with Portable Oxy-Acetylene Apparatus

The accompanying photographs show an application of the oxy-acetylene torch which saved a great deal of time and money for a firm of contractors on some important harbor work. These contractors were driving a cut-off wall of interlocking steel piling on a line more than a hundred feet in length, and were rushing their work so as to make way for the next stage of construction. On account of a delay on the part of equipment manufacturers, they were unable to get the proper driving cap which is placed over the head of the pile to protect it from bending under the strokes of the hammer. They were therefore compelled to go ahead with the work, driving directly on the heads of the piles with as great care as possible, but when about 8 feet from the final level they struck a hard

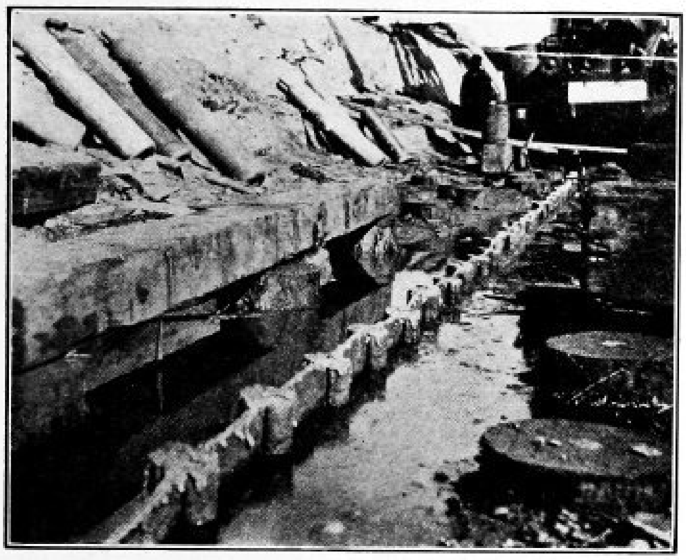


Fig. 1.—Heads of a Row of Sheet Piles Cut Off by the Gas Flames

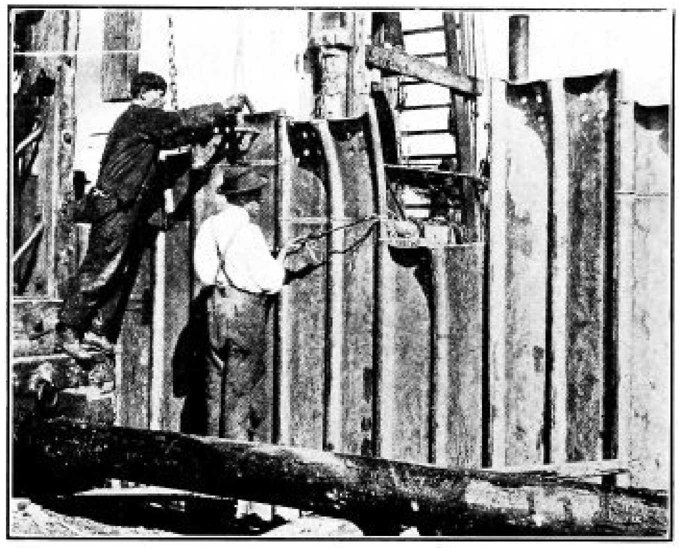


Fig. 2.—Cutting Steel Sheet Piles with Oxy-Acetylene Torch

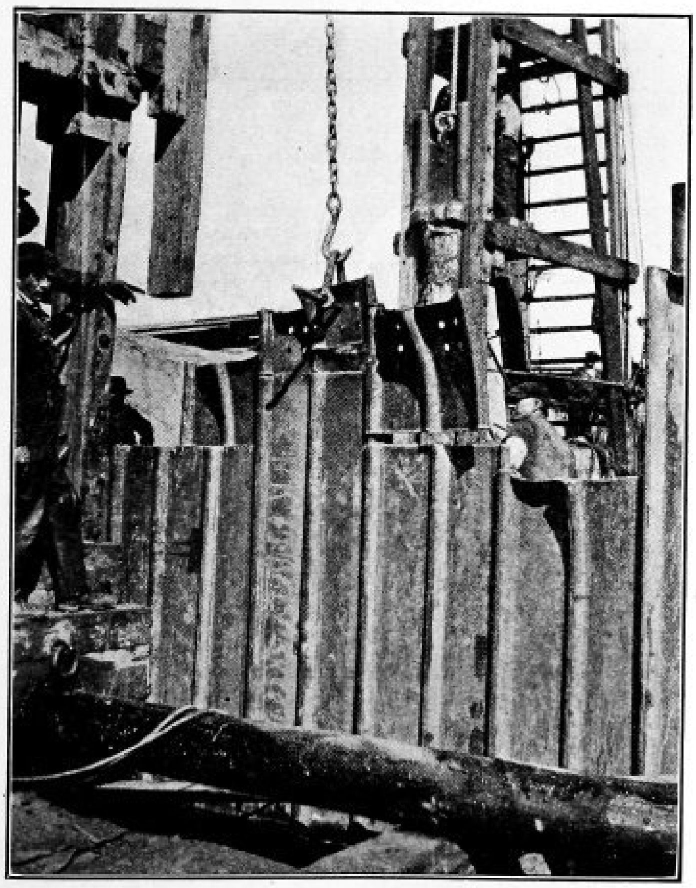


Fig. 3.—Lifting Top Pieces of Piles after being Cut Off

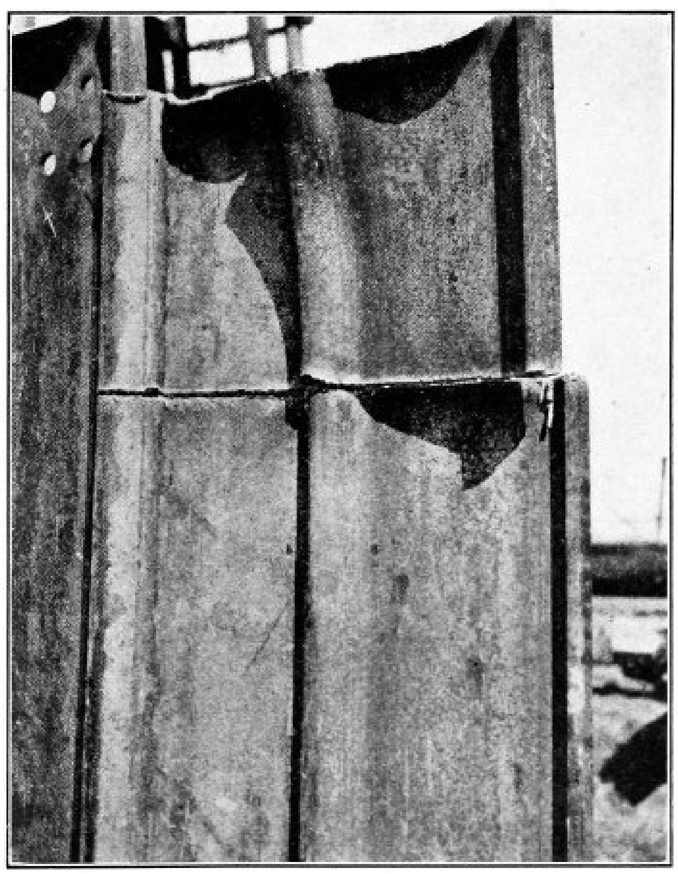


Fig. 4.—Close View of Finished Cut Through Two Piles

stratum and the heads of the piles began to curl over when struck. When this occurred with the first pile, an immediate tie-up of the job resulted, holding inactive a pile-driver and large crew of workmen.

At this point the oxy-acetylene process was called into assistance, and the head of the pile was cut off below the bend. The work was then continued, and as each succeeding pile started to bend, it was abandoned and the driver moved on to the next. The cutting operator followed the pile-driver, taking off the short top section of the pile and providing a new straight surface for further driving.

A total of 250 to 300 cuts were made on the job, the sheet piling being 12½-inch, 38-pound section. The work was somewhat intermittent on account of being held up by the pile-driver, and from 6 to 12 pieces were cut at a time on an average. The work progressed at a rate of from 12 to 15 piles per hour. The pile-driving foreman stated that a laborer with a hack-saw would do well to get one of these sections cut in a day, and would probably get a medal for cutting two, so the oxy-acetylene torch accomplished a day's work of an ordinary laborer in from five to ten minutes. The saving is apparent. The work was done with apparatus manufactured by the Alexander Milburn Company, of Baltimore, Md.

Design of Fire-Tube Boilers and Steam Drums*

Riveted Joints—Braces—Reinforcing Fireboxes of Vertical Boilers —Dished Heads for Steam Drums — Flush Head Boilers

BY F. W. DEAN

As is now generally understood, the most prolific cause of explosions of fire-tube boilers has been lap longitudinal joints, and the use of butt joints with inside and outside covering plates has, so far, prevented such explosions. The lap joint makes the boiler non-circular at and in the vicinity of the joint; and when pressure is applied the plate, in its effort to become circular, bends somewhat, and on the reduction or removal of pressure it tends to return to its original form. The frequent repetition of these actions causes the plate to crack and finally to become too weak to stand the stress caused by the working pressure. Boiler plates with lap joints have often cracked entirely through for a greater or less distance, and the escape of steam has given warning in time to prevent an explosion.

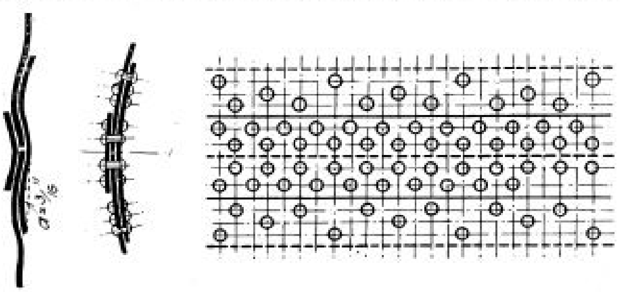


Fig. 1.—Bending of Butt Joint Tested to Destruction

THE DESIGN OF BUTT JOINTS

The joint which has a narrow butt strap on one side of the shell and a wide one on the other is one-sided, and its center of resistance does not coincide with the center of pull of the shell plate. That part of the wide strap which extends beyond the narrow one is riveted to the shell, and this outer part of the joint is a lap joint with its peculiar defects. The rivets in this part of the joint are overhung, and in service tend to tip over and bend the joint. This is only another way of stating that the joint is a non-central resisting device, and must cause the plate in and near the joint to bend when the boiler is subjected to pressure. Fig. 1 shows how this bending occurs when such a joint is tested to destruction, this being the result of several actual tests.

In order to prevent a joint from bending, a butt joint with straps of the same width and with all rivets in double shear should be used, as is always done in Europe. The center of resistance of such a joint coincides with the center of pull in the shell. The joint when tested to destruction remains straight without bending; and by its use the only probable cause of boiler explosions so far as the design of the joint is concerned is eliminated. There are various designs of such joints ranging from the simplest joint with double covering plates of equal width to the joints shown in Figs. 2 and 3.

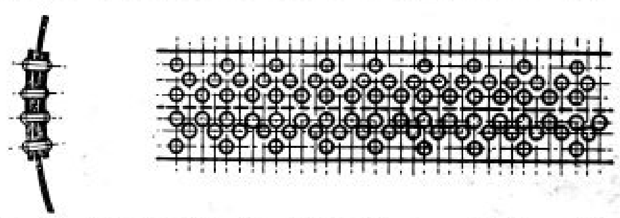


Fig. 2.—Butt Joint Used in Marine Practice. Efficiency About 85 Percent

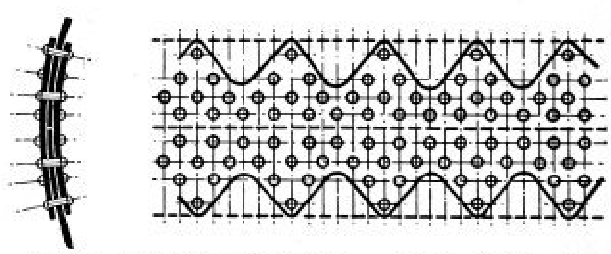


Fig. 3.—Butt Joint with Efficiency of 92 to 94 Percent

Fig. 2 illustrates a design which is used largely in marine practice in this country and abroad, and which has a theoretical efficiency of about 85 percent. Fig. 3 shows a more efficient joint, having a theoretical efficiency of from 92 to 94 percent. In the joint in Fig. 3 the outer strap is cut away between the rivets in order that it may

* Paper read before the American Society of Mechanical Engineers, New York, December, 1915.

stand calking; the high efficiency is secured by the wide pitch of the outer rows of rivets.

BRACES

Boiler-head braces of the crow-foot or similar types are usually designed so thin that they bend in service where the foot joins the rod, and are likely to break finally at this point. This detail should be made stiffer than is commonly done.

Through rods above the tubes of horizontal return tubular boilers should be supported so that they cannot vibrate, and the supports should be stiff enough to prevent movement in any direction, instead of merely supporting the weight. If any braces are used below the tubes, through or head-to-head braces, rather than braces riveted to the shell, should be employed. Such braces should not, however, pass through the back head on account of the nuts being in contact with the fire. The rods should be secured to angles riveted to the back head, but separated from it 2 to 4 inches by ferrules around the rivets, in order to permit the removal of dirt between the angles and the head.

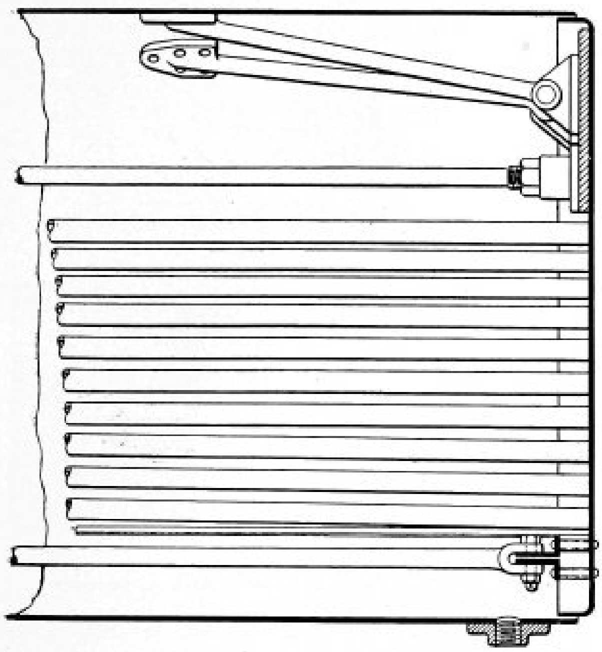


Fig. 4.—Diagonal and Longitudinal Stays without Outside Units

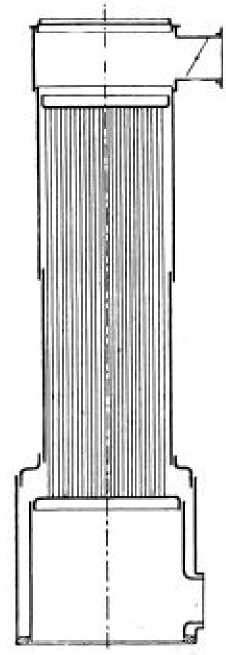


Fig. 5.—Vertical Boiler with Reversed Flange

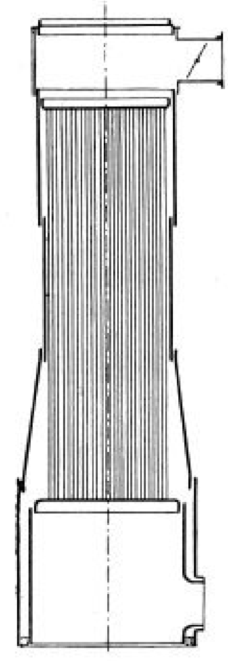


Fig. 6.—Vertical Boiler with Conical Course

Although not related to safety, it is best not to have the rods above the tubes pass through the back head, because the nuts interfere with an efficient method of covering the back connection with fire brick. There are various ways in which nuts can be avoided, and Fig. 4 shows methods of staying both above and below the tubes. In the former case diagonal braces are used for staying the upper parts of the tube plates in order to give more room for inspection, and the heads are stiffened by riveting on thick plates. In England, plate gusset stays are preferred to through rods or diagonal stays, but in this country they are seldom used. There is, however, no reason to doubt their efficiency, although any head stay attached to the shell tends to bend the latter and throw it out of equilibrium. Nevertheless, I have never heard of a rupture coming from this cause.

RIVET HOLES AND RIVETING

Riveting is now generally done by hydraulic machines, which have shown themselves superior to any other kind. In consequence of the slow movement of a hydraulic plunger the rivets have time to enlarge and fill the holes; and from the solidity of action and steady holding power of the machine the plates are firmly pressed together, with the result that joints riveted by this type of machine are tighter than those made by any other.

It is the common practice in this country to punch the holes of boilers 1/8 inch or 1/4 inch small and then to drill them to size with all plates and covering plates in place. This is a great advance in practice over punching to size, but it is not satisfying to the imagination, and it may be one reason why plates exposed to the hottest gases crack between the rivets and their edges. Another reason for such cracking may be bulging caused by too much pressure by the riveting machine on the rivet. Sometimes such bulging is very apparent. A still further advance in practice is to punch one butt strap for each joint with small holes and use it as a template for drilling not only itself, but the main plate and the other butt strap. Similarly, the holes in one plate of a circular seam may be punched small and used for a template for drilling the other holes. The best way, however, and the one which I hope to see adopted everywhere, is to drill all holes from the solid. I think it will be found that with proper tools this is the cheapest method. The conical rivet head is being displaced by one of more or less spherical form, which has the advantage over the former in having a thicker edge and increased holding power.

REINFORCING PLATES FOR THE OUTSIDE FIREBOXES OF VERTICAL BOILERS

Above the staybolt level of vertical boilers the outside fireboxes are subjected to the full stress that comes from the steam pressure, unreduced by any connection to the inside firebox by the staybolts. In some designs the whole outside firebox is made of the thickness required to stand the pressure as if unstayed; in other designs there is a short course of increased thickness just above the staybolts, and in still another design the outside firebox is thin for its whole height and is reinforced above the staybolts by riveting a band of steel around the inside of the plate.

I disapprove of the last of these methods and mention the fact here because the object of this paper is to point out the causes of boiler explosions and to advocate methods of construction that will reduce, if not do away with them. I have already stated that shell explosions are nearly always caused by the bending of the plates, and the inside reinforcing plates of vertical boilers, just described, can do no good without bending. They cannot then prevent the main plates from being overstrained, and they are therefore possible causes of explosions.

Reversed Flanges in Vertical Boilers

Still further in accordance with the object of this paper, I shall describe the action of that type of vertical boiler which is changed in diameter above the firebox by means of a reversed flange, Fig. 5. On account of the ease with which this flange bends, this type of boiler elongates when subjected to pressure, and, under test pressure, to a considerable exent. Even the pulsations in pressure coming from the opening and closing of the inlet valves of steam engines cause the boiler to change its length each time, and this action and others have caused many of the reversed flanges to crack. The effect has been reduced by making this flange of a less flexible form and increasing its thickness. It is not a good plan, however, to have flexible means of connecting the ends of boilers, and when the flange is made so thick that it is not flexible its object is no longer accomplished.

Another harmful effect of the elongation of boilers of this type is the bending of the lower tube plate upward and the upper one downward. This tends to pull the outer tubes from the tube plates and may cause explosions.

In order to obviate the two defects described, the reduction in diameter should be made, as it has been many times, by a conical course, Fig. 6, instead of by a reversed flange. An incidental advantage of this is that the circulation of the water is a little freer.

Dished Heads for Steam Drums

Several explosions have been caused by dished heads cracking around the edges where they join the spherical portions. Apparently it has been thought by designers in general that if a head is pressed into spherical form and flanged, the radius being made equal to the diameter of the drum and the thickness equal to that of the drum, nothing more is necessary. There is no doubt, however, that such heads breathe and that the cracking is due to this. It is the same phenomenon that causes the rupture of lap joints and breaks staybolts. I believe that such heads should be made of thinner plates than usual and braced like flat heads. The braces should be strong enough to carry the total pressure on the heads, and thin plates would stand the flanging process better than thick ones and with less liability of being injured at the corners.

In regard to the method of bracing such heads I am inclined to think that radial plate gussets would be best, and, if placed at equal distances completely around the drum, the latter would not be distorted by supporting the head. I think that anybody who has a boiler with unbraced drum heads should view them with anxiety.

Flush Head Horizontal Return Tubular Boilers

In New England, horizontal return tubular boilers are always built with the front tube plate flanged forward, but in other parts of the country it is frequently, if not usually, flanged backward. The latter is known as the *flush head* or *New York* boiler. I consider the New England method the better because all the riveting can be done by machine. With the other construction, one circular joint must be riveted by hand or pneumatically. Another advantage of the New England method is that it makes a tight smokebox, while the other, especially if the boiler has a brick smokebox, which is usually the case, is likely to leak air. A leaky smokebox diminishes draft and cools the gases, and thus diminishes the effect of an economizer if one is used.

The object of the flush head boiler is to have the joint between the front head and the shell plate always in contact with water, so that if it is not protected by brickwork it will not be injured by heat. In the New England design there is, however, no difficulty in keeping the joint protected, and there probably has never been a case of burning the joint.

Brickwork

Generally speaking, brickwork will stand without cracks in boiler settings unless it is pushed by the boiler; and it is only necessary to so place it, and have such details about the boiler that it will not receive any serious pushing. The brickwork should not touch the boiler anywhere, and the

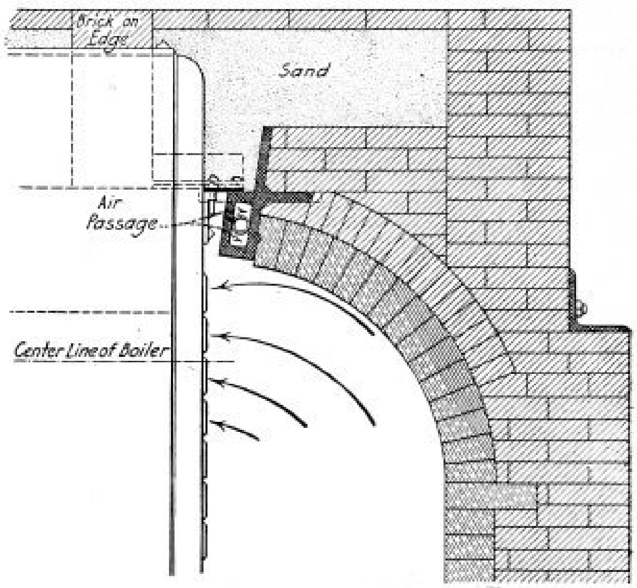


Fig. 7.—Woolson's Gas-Tight Back Arch Connection

space between it and the boiler should be stuffed with asbestos fibre. Although this filling may tend to leak air, the covering over the top of the boiler, which rests on the brickwork, prevents this. The front end of the boiler should be fixed and the other end should have attached to it some back connection covering device which will slide and not tend to push the back wall over. Such a device has been made by Orosco C. Woolson, Mem. Am. Soc. M. E., and is reproduced in Fig. 7.

The vertical thickness of the brickwork on the sides of the boiler, and almost in contact herewith, should not, I think, be more than 12 inches. It has been made 24 inches, and in such cases I have seen the part raised bodily, apparently by the expansion of the boiler. This part of the brickwork is usually above the center of the boiler, but it should be equally above and below the center, as thereby there is less chance of any of its weight being supported at all by the boiler. If the boiler supports it there is a chance that its weight will bend the plates, and the arguments against this have already been given.

Use of Air Spaces in Boiler Brickwork

It is common to use buckstays on the sides of boiler settings, but I also use them on front and back in order to prevent cracks. Buckstays should be usually of 8-inch I-beams of the lightest section, instead of cast iron, which is unreliable.

It has always been customary in this country to build the side and back wall of boiler settings with air spaces in order to diminish loss of heat by radiation. It is probable that these spaces cause loss of heat by convection and leakage, and it has been proved by experiments carried out by the United States Bureau of Mines (Bulletin 8) that this is true. If it is advisable to use spaces in the walls in order to prevent cracking of the brickwork, it is best to fill them with some material, such as ashes, crushed brick, sand or other loose material, which will entrap air, but diminish its movement. Solid brick walls form a better non-conductor than walls with air spaces.

Method of Supporting Horizontal Return Tubular Boilers

The method of supporting horizontal return tubular boilers is of more importance than is usually realized. Such boilers, no matter what their length or size, should be supported at no more than four points. If boilers are long it is common to support them at six points. In order to prevent the end supports from leaving their bearings, springs are often placed under the middle brackets, but this does not render the pressures on the supports equal, and is only a makeshift.

It is a principle in mechanics that if a body rests on three points the pressures on these points can be determined and will not change even if the points change their positions or levels. A three-legged stool always rests properly on its legs, even when it rests on an irregular floor, but a stool with more than three legs never presses equally on each.

This shows that in supporting a horizontal boiler the three-point principle should be applied. To obtain this effect and yet have the boiler held up at four points, two points at one end are supported in the usual manner and the other two are connected by links to an equalizing lever working on a pin passing through overhead supporting beams. This was first done by Mr. Woolson, as described in a paper by him before the society[1] in 1898. When a boiler is supported in this way the stress in the plates due to the weight can be made proper and will never change, no matter how much the brickwork may settle, but if this system is not used the stress at one point may be sufficiently great to be a serious matter.

[1] Hanging and Setting of Horizontal Firetube Boilers, O. C. Woolson, Trans. Am. Soc. M. E., Vol. 19, p. 781.

Electric Welding in Boiler and Tank Shops

Specific Applications of the Process—Relative Costs of Riveting and Welding for Steel Tank Building—Descriptions of Various Operations

BY GEO. W. CRAVENS*

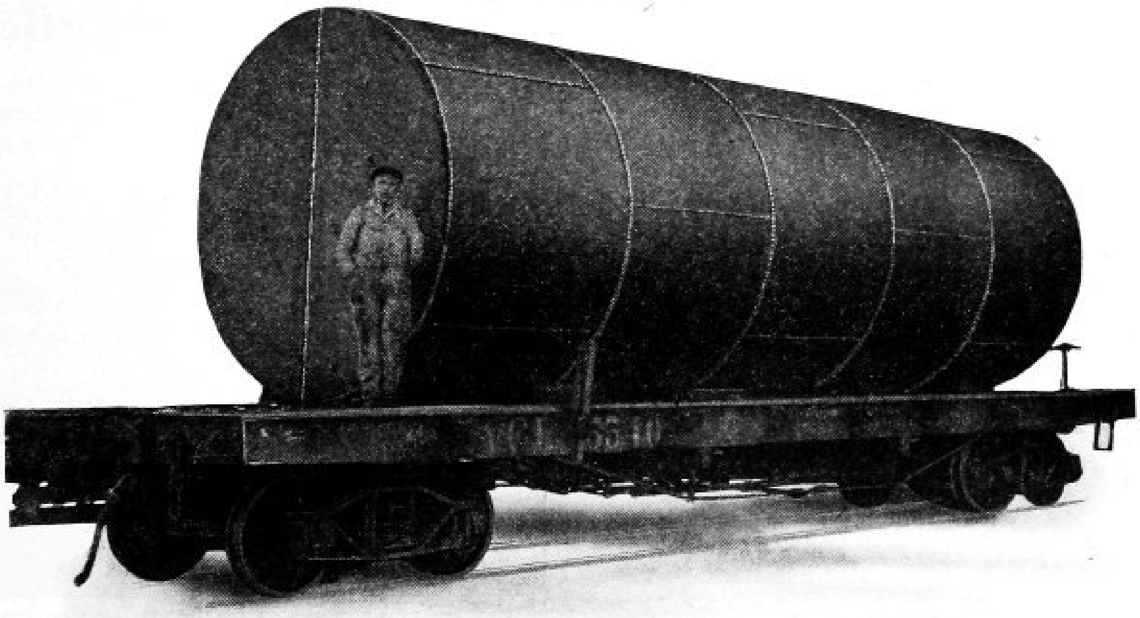


Fig. 1.—10-Foot by 30-Foot Oil Tank, Electric Arc Welded with C. & C. Apparatus

The rapid adoption of the electric arc welding process in tank and boiler shops has taken place so quietly that but few people outside of the industry realize the great extent to which it is used. So true is this that there are even many among the boiler inspectors and insurance companies who still feel that riveting is the only safe process to use for boilers. Fortunately for the industry, however, there is an increasing number of them who are abreast of progress, and rules are being made more liberal each year. A number of companies are making low-pressure boilers with welded joints, and high-pressure boilers are made with many parts and plates welded. Many of the largest tank builders are using arc welders exclusively, and the marine boiler inspectors of both the Canadian and United States governments approve the process for many kinds of repairs, calking, etc., so the outlook is very favorable to the continued increase of application of the process.

For building boilers and tanks, the heat of the electric arc is used to fuse iron or steel wire into place to form the joint by amalgamating with both pieces and filling the space between them. Direct current at a comparatively low voltage is used, the positive side of the circuit being

* General sales manager, C. & C. Electric & Manufacturing Company, Garwood, N. J.

attached to the job, and the negative side being carried to a suitable holder, which carries the wire for welding. The arc is established by bringing the welding wire or negative electrode lightly into contact with the job or positive electrode and withdrawing it a short distance. The heat of the arc then fuses both the job and the wire and causes the wire to deposit on the job in fine particles, thus forming the joint. Corroded surfaces may also be built up by this

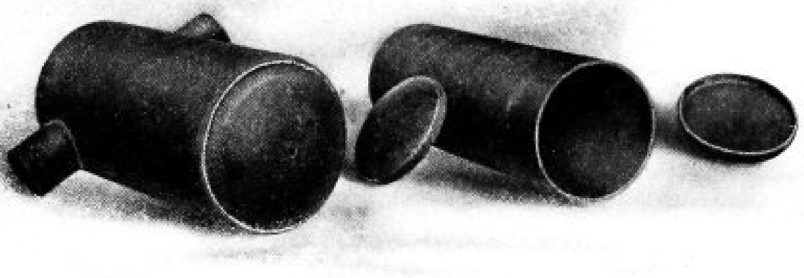


Fig. 2.—12-Inch and 16-Inch Drums Welded with Metallic Electrode

process, and large numbers of flues have been welded in by calking around the edges of the beads to tie them to the flue sheets.

For boiler building the joints must be formed to suit the nature and location of the seam and the pressure to be withstood, and will also be influenced by the thickness of the sheets. For girth seams, butt welds may be used for low and medium pressures, but lapped joints should be used for high pressures or for joints in thick plates. Longitudinal seams are subjected to greater strains than girth seams, and should be made as butted joints only for low-pressure work. For medium pressures lapped joints are required, and for extra high pressures or very heavy plates it is best to use butted joints overlaid with a butt strap. In case a butt strap is required, the plates should

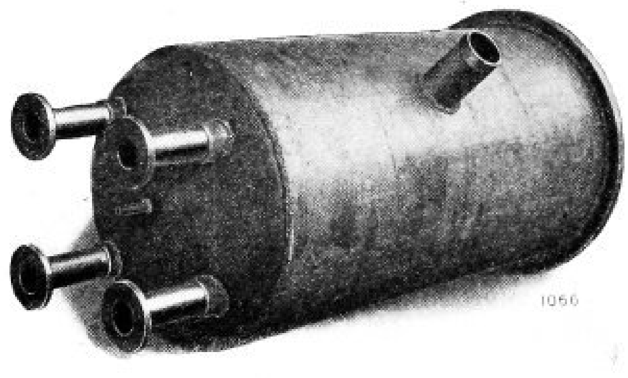


Fig. 3.—Large Tank with All Seams Welded with Metallic Electrode

first be welded edge to edge and then the butt strap laid to overlap and welded along both edges to the plates. For butt joints the edges of the plates should be sheared or machined to give a beveled edge with sides slanting from 30 to 45 degrees so as to form a "V" groove in which the metal filler can be deposited.

For tank building, the foregoing statements will also apply to a very large degree, although most tanks are made of thinner stock than boilers. Side seams may be formed with butted joints for all but the largest tanks, unless heavy pressures are to be met, and the heads may be formed as usual and then welded in. The edges of the heads may be flanged if desired, but for most purposes this would be an extra expense, and may be omitted. The heads can be flat or slightly dished outwards and welded in by going along the edge and depositing sufficient metal to tie them to the cylinder or body of the tank. Rectangular, round or other shapes can be made very easily, and irregularities in cutting the plates can be overcome by filling in when forming the joints, instead of having them cause trouble as when rivets are used.

For ease in handling and assembling the plates, when building large tanks or boiler shells having lapped joints,

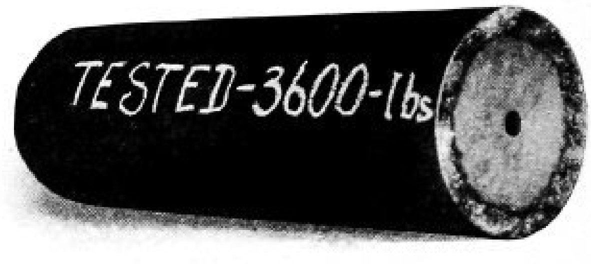


Fig. 4.—High-Pressure Cylinder Welded with Metallic Electrode

it is preferable to place a bolt hole about every 18 inches and bolt the plates in place until welded. After the joint is made, these holes can be filled in with the metallic electrode, work being done overhead or against a vertical wall very easily. Where butted joints are necessary, the plates can be held in proper relation with clamps or by "tacking" at intervals by welding short amounts in the joints, although the latter practice sometimes leads to trouble. Clamps are much better, and should be used wherever possible.

COST OF WELDING

In the average or moderate-sized tank and boiler shop there is generally about a dozen men when rivets are used, but half that number are sufficient when welding is

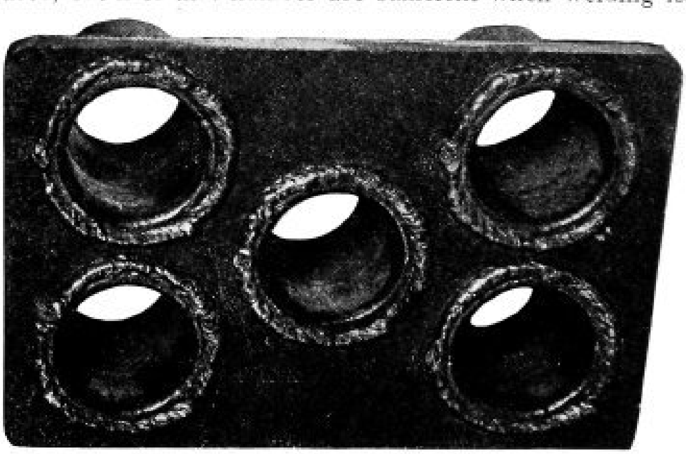


Fig. 5.—Boiler Tubes Electrically Welded into Tube Sheet, Using Metallic Electrode

done. In a tank shop using rivets the number and duties of the men would be about as follows:

2 punchmen,
2 tappers and fitters,
2 rollmen,
1 general helper,
2 riveters,
2 calkers,
1 tester.

The minimum wages of these men will be about $30 per day, and their combined output is limited to what the riveters and calkers can finish. Since 20 feet per hour is a

fair average for tank riveting on medium and thin stock, and most shops will do less, the cost will be as follows:

Labor, per hour (ten-hour day)	$3.00
Rivets, assorted sizes	.60
Fuel for rivet heating	.10
	$3.70

At 20 feet per hour, this equals 18½ cents per foot. When electric arc welding is used for this class of tank work the labor required is reduced to the following:

2 rolling and punching,
1 tapping and testing,
1 electric arc welding,
1 general helper.

Since welding can be done at the rate of from 6 to 22 feet per hour on medium and thin stock, and many shops do better, we get an average rate of 14 feet per hour of welded seam. The cost should be about as follows:

Labor, per hour (10-hour day)	$1.50
Wire filling electrode	.40
Current, average 2 cents kilowatt-hour	.10
	$2.00

At 14 feet per hour, this equals 15 cents per foot.

The welding labor was figured higher than usual, whereas a less experienced class of men may be used for all operations except handling the arc. In shops doing riveting the wages are usually higher, to insure good work on calking, and other operations omitted when welding is done.

While the foregoing figures are correct for the class of shop from which they came, the following figures are from the averages of several shops doing large quantities of tank work, and should be equaled in any up-to-date and properly managed shop doing repetition work.

ELECTRIC ARC WELDING

Metal Thickness	Average Speed	Approximate Cost Per Foot
Under 1/16 inch	22 ft. per hour	$0.0175
1/16 inch to 3/32 inch	20 ft. per hour	0.0225
3/32 inch to 1/8 inch	18 ft. per hour	0.0275
1/8 inch to 3/16 inch	16 ft. per hour	0.035
3/16 inch to 1/4 inch	14 ft. per hour	0.0475
1/4 inch to 5/16 inch	11 ft. per hour	0.075
5/16 inch to 3/8 inch	8 ft. per hour	0.105
3/8 inch to 1/2 inch	6 ft. per hour	0.14

The foregoing figures are based upon labor at 30 cents per hour, current at 2 cents per kilowatt-hour and filling wire at 6 cents a pound. They apply to butt-welded joints only, the cost of lap-welded joints being about double for sheets of same thickness. Butt joints should be used in all cases for sheets up to 5/16 inch thick, and preferably up to ½ inch unless high pressures are to be maintained under conditions imposing other strains on the joints.

STRENGTH OF JOINTS

In view of the opposition to electric and gas welding for boiler work by those who are not doing welding every day, it is important that the truth be known as to the possible strength obtainable with properly welded steel plates. In the hands of the average electric arc welder, properly instructed and using apparatus of reliable make, the joints can be made as strong as the original sheet and much stronger than riveted joints. The average of riveted joints is from 60 to 85 percent, depending upon the type of joint used, whereas the average of electric arc welded joints is from 80 to 100 percent for similar work. One of the illustrations herewith shows a small tank which with-

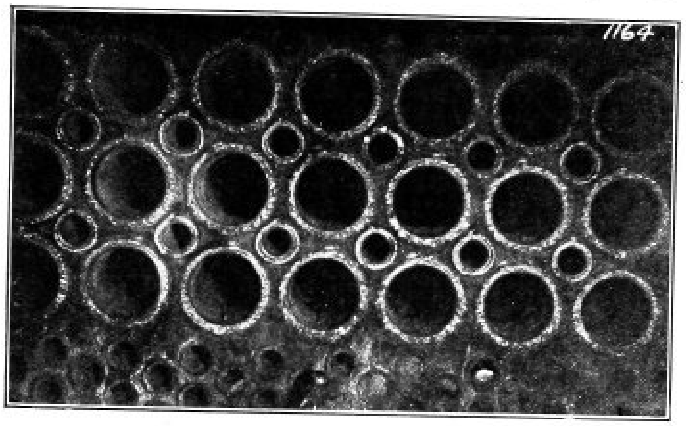


Fig. 6

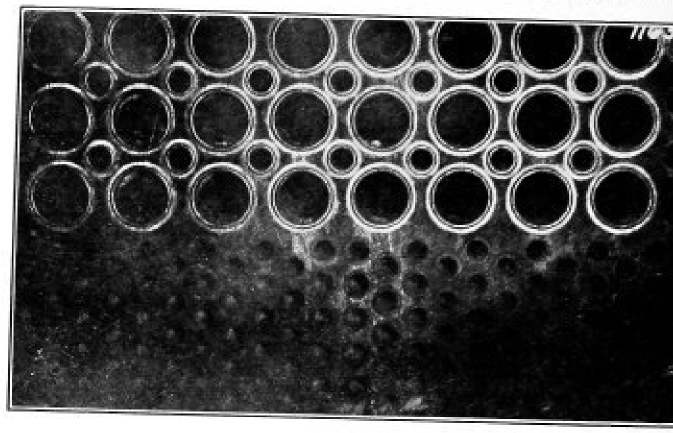


Fig. 7

stood a pressure of 3,600 pounds per square inch, hydraulic pressure, without fracture, and steel tubes for superheaters have been tested to 5,500 pounds per square inch without rupture, after welding.

Owing to the structure of the weld, the elongation is not quite so high as in the steel plates, but its ductility can be improved slightly by hammering while still hot. On the other hand, the tensile strength of the weld is very high, and this is the most important feature in the long run, especially for tank work. Plates properly welded will also stand bending double at the weld without breaking, and by using fillers of extra-high strength any desired result may be obtained.

For repair work on boilers, the electric arc welding system is the very best yet devised. Large numbers of tank, boiler, railroad and marine repair shops are using this process with great success and to their profit. Flues can be welded to prevent leaking; corroded sheets can be built up to any desired thickness; patches can be applied; cracks can be welded shut; broken bridges mended; cracked mud rings joined without removal; domes added or changed; holes cut at any point (by using a graphite electrode instead of a metal pencil); leaky seams permanently calked, etc. Hand hole frames and fire doors can be attached; rivets tightened or built up; staybolts attached or cut out; safe ends welded onto flues; new fireboxes put in, and, in fact, anything done which has heretofore been riveted or made by other processes.

The illustrations herewith show a number of jobs done with the electric arc welding process, and the many possible applications of the system are so numerous that it is not possible to describe them all here. That electric arc welding has come to stay, and more applications will be made each year, is beyond doubt, and will be the cause of great reductions in costs of boiler and tank work of all kinds.

How to Read Working Drawings—IV

General and Detail Drawings—How They Are Classified and What They Show—Example of Sectional Drawing

BY FRED WEST

The great need to-day is for men who can direct themselves—that is, for men who can produce without the necessity of the directions of a boss. This is a very simple statement, but there are countless thousands who cannot fill its specifications.

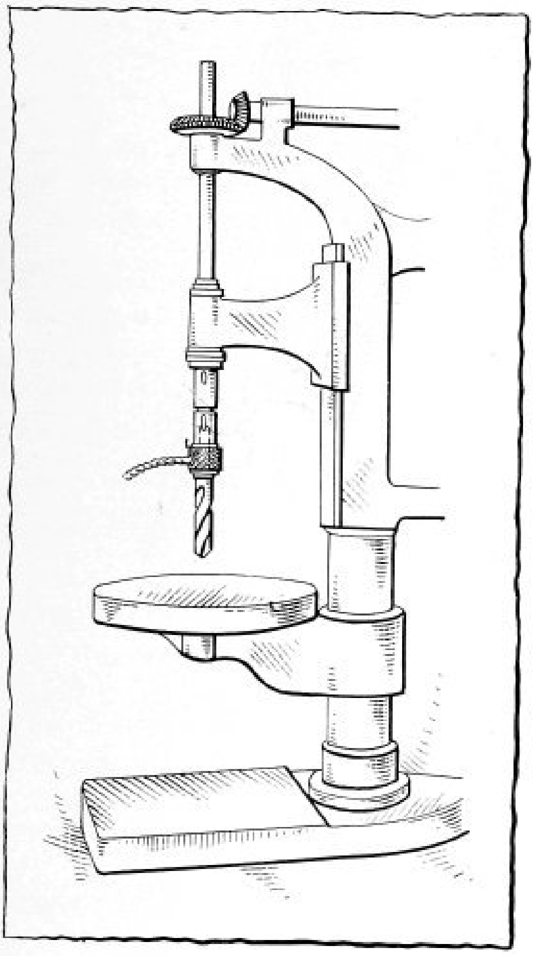


Fig. 16.—A General Drawing

It is the condition of manufacturing generally that a few individuals know what to do and how to do it, and that these few must give their time to the directing of the motions of the untrained masses. There is no one item in the mental training of boiler makers that will give its possessor admission to "upper classdom" as certainly as will that of a thorough understanding of the reading of working drawings.

There is many a puzzle in boiler construction. These puzzles appear in the drawings, and it is not uncommon to see several men with their heads together over a drawing trying to get the answer to one of the puzzles. It is absolutely necessary to get a correct reading of the drawing before the construction can be carried out. And if the mechanic cannot get the reading, he cannot trust himself to supervise the construction work.

In the previous article the alphabet of the subject has been outlined. For simplicity the "A" was taken as the kinds of lines used on working drawings, together with their meanings; for the "B" the arrangement of the views and their number; and for the "C" a list of special things, such as the dimensions, sectioning, detailing, assembling, coloring, shading, titles, dates, notes, short cuts, and a variety of cross-references that overlap "A" and "B." It is necessary, therefore, to repeat many of the points already mentioned, in order to enlarge on them and to explain their use from different viewpoints. It is important to study the subject as a whole. Where every one about the plant from the manager to the laborer can talk in the common language of the working drawing, there is a common interest that promotes efficiency.

Working drawings may be grouped in two classes; namely, general drawings and detail drawings. The general drawing shows the assembled machine or device taken as a whole. It may or may not have the dimensions marked on it. Fig. 16 will serve to illustrate a general drawing of a drilling machine. As a machine of this or similar construction is used in many boiler shops, the reader will easily recognize its arrangement.

The general drawing is quite useful. It enables the builder to get a bird's-eye view of the thing to be made. Then he can observe the shape of the various parts and how they must be put together. If the dimensions are given, these can be checked up and compared with those on the detail drawings.

As compared with Fig. 16, note the detail drawing in Fig. 17 of a draw-pin specially designed to hold work on a lathe chuck. In this case it will be seen that every dimension is given and the finish required on each surface is indicated. The corners of the large end, the head, are to be turned off at an angle of 45 degrees, two parts must

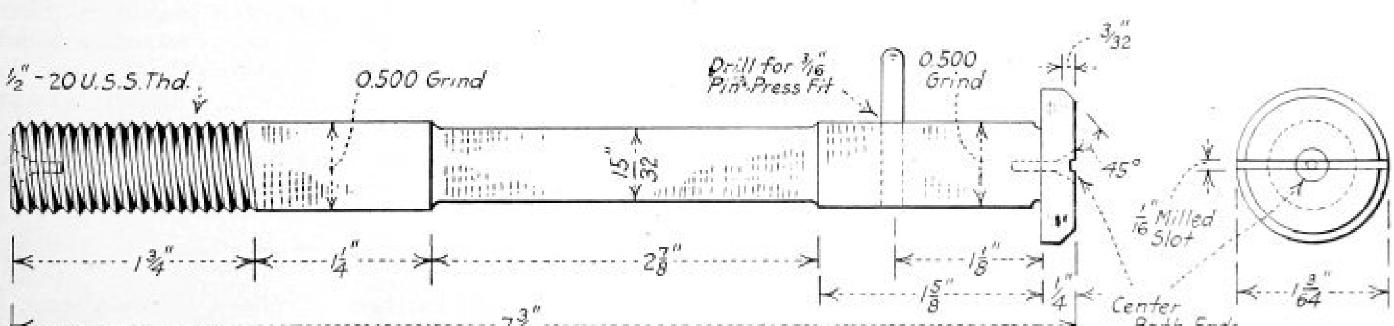


Fig. 17.—Detail Drawing of a Draw Pin

be ground, the end is to cut with 20 United States Standard threads, both ends must be centered, a 3/16-inch pin must be provided for by a drilled hole that will make a driving fit, a 1/16-inch notch is to be milled across the head, and one pin is to be made after these specifications of nickel steel.

Another form of general drawing that the mechanic must read very often is shown in Fig. 18. This represents a section of a Yeakley air-driven hammer.

The following reading could be made of this general drawing: There are two cast-iron cylinders *A* and *B*, molded solidly to a connecting frame between them. There is a ram in cylinder *B* which is made to strike the work on the anvil below. The anvil is mounted on a separate foundation clear of the hammer, so that the hammer frame will not be jarred and broken by the blows.

The cylinder *A* contains a piston that is driven by a connecting-rod, that is in turn driven by a flywheel. The flywheel shaft may be motor-driven.

Between the cylinders *A* and *B* is a cylindrical valve *D* that may be rotated in a sleeve *C* that has openings, or ports, *E*, *F*, *G* and *N*. The valve *D* also has ports *I*, *J*, *K*, *L* and *M* with flexible covers, or flippers over *J* and *L*, as shown.

The positions of the various parts are shown at the time when the ram is striking. The piston in cylinder *A* has compressed the air above it, forcing the air through the open valve ports into the upper part of the cylinder *B* and driving down the ram. On the return stroke there is a release of pressure over the ram and a partial vacuum created, so that the ram is driven upward by the outside pressure of the atmosphere. The relationship and the number of the various parts, and suggestions for making the detail drawing, would be derived from this general drawing.

(*To be continued.*)

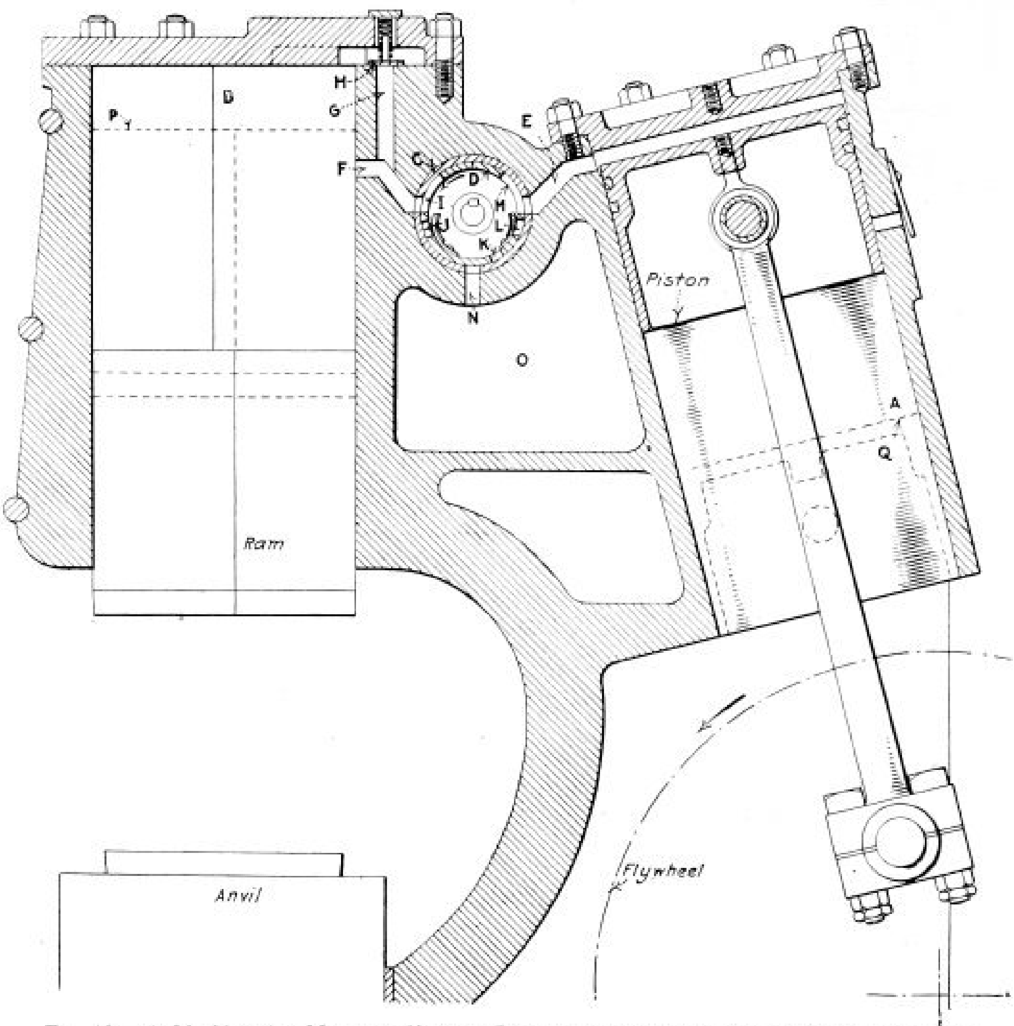


Fig. 18.—A Yeakley Air Hammer, Showing Position of Valve During Operation of Machine

There is considerable room for improvement in boiler front doors. They are often very poorly fitted, allowing air to seep into the firebox. A novel way of fitting a door, seen lately, looked good and worked well. The lower lug on the front was drilled, or rather countersunk, with a round-nosed tool after a small hole was drilled through the same as a pilot. Into this seat was set a steel ball about one inch diameter, and the lower lug on the door was machined to meet this ball. The upper lug on the door was drilled out and a steel plug dropped into it; the plug had a shoulder and its top was countersunk for the point of a ¾-inch set screw. The top lug of the front was tapped for the set screw. This arrangement made the door swing very easily. It cost more than just straight holes and a pin or rod, but it certainly was a neat-looking rig and a refinement.

The dinner pail has been to college, it would seem, if you look at what most men now carry and compare it with what they used to carry, and it is a good thing, but the question still remains how to fill them.

The Boiler Maker

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In the entire history of the boiler making industry few innovations or new processes have made more rapid or greater progress than the application of the oxy-acetylene and electric arc processes of welding and cutting metals. The commercial application of these methods was practically unknown in this country ten years ago, and the first attempts to use them resulted in as many, if not more, failures than successes. This was due, however, both to faulty apparatus and to lack of experience and knowledge of the processes by the operators. But the inherent possibilities of these methods were so apparent that no stone was left unturned to develop satisfactory apparatus and to train skilled men in its operation. The result has been a vast amount of experimental and research work leading to the production of highly perfected apparatus and methods of application, so that to-day the majority of up-to-date boiler and sheet metal shops are equipped with some form of such apparatus, and it is constantly finding a wider field of application with remarkable savings to boiler manufacturers and users.

In the case of the oxy-acetylene process, one of the most essential factors is the use of pure gases. To-day extensive plants have been established throughout the country for the production, purification and compression of pure oxygen and acetylene gases, so that the user of the process is not obliged to concern himself with the manufacture of the gases unless it is to his economical advantage to do so. On the other hand, highly perfected apparatus for generating the gases is available in the market, so that the user can install in his works a thoroughly reliable plant for the production of the gases in such quantities as may be necessary for the volume of welding and cutting work that he is handling. In the large railroad shops, shipyards and boiler shops such stationary installations are being widely adopted, while the applications for portable apparatus using compressed gases are legion. In short, the early difficulties due to the use of impure gases seem to have been satisfactorily overcome so that there is little excuse for failure on this account.

With electrical welding and cutting apparatus the success has been no less remarkable. For boiler repairs, for welding tubes in tube sheets, for building up broken or defective parts, and for hundreds of other purposes, the apparatus is finding ready application, with savings in time and money hitherto undreamed of. The strength of welds, of course, is a factor of the utmost importance in pressure work, and until some method is devised of actually determining the soundness of a weld without an actual destructive test of the welded piece, this uncertainty will retard its substitution for riveted joints in unstayed parts of steam boilers.

An interesting case was cited in our last issue showing an ingenious method of locating a leak in a boiler seam. A leak developed in the saddle joint of a steam dome on a horizontal tubular boiler. The seam was calked on the outside where the leak occurred, but other leaks soon developed at other points in the same seam near the first leak. Further calking of the outside of the joint was resorted to and at one place a patch was applied. This failed to remedy the trouble, however, until finally an ingenious scheme was proposed for applying steam pressure to the joint from the outside, when it was found that the original source of the leak was at a point in the longitudinal seam of the steam drum 28 inches above the shell of the boiler. The seam was calked at this point and there was no further trouble from leaks in the saddle joint.

This case shows very plainly that leaks in boiler seams, if calked only on the outside, may not originate anywhere near the point of outlet. Repairing the outside of a leaky seam, as the author of this article points out, is only a subterfuge and the next weakest point in the seam will give way if the original source of the leak is not discovered and remedied. The ingenuity in this case surely deserves to be recognized and others should profit by it.

That the honors in the case cited fell to a machinist and not to a boiler maker should be a sufficient incentive for other readers to tell of their experiences in such emergencies.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

I. O. C. Bipolar Oxygen and Hydrogen Generator

The demand for oxygen and hydrogen for various industrial uses has grown very rapidly in the last five years. Certain lines of manufacture have been built up based on the oxygen process of welding, such as welded tanks, steel barrels, automobile parts, tubes, etc., while for repairing broken machinery, for reclaiming castings, for metal cutting of every nature, oxygen and hydrogen or oxygen and acetylene are used in steel mills, railroad shops, foundries and down to the smallest machine shop. Hydrogen likewise is in active demand; it is used more and more for cutting purposes and for light welding. This rapid development in the uses of two gases was facilitated by the introduction into this country of oxygen and hydrogen generating apparatus several years ago. Large users of one or both of these gases were thus enabled to obtain their supply direct from their own generating plant at low cost, in a manner suitable to their individual requirements.

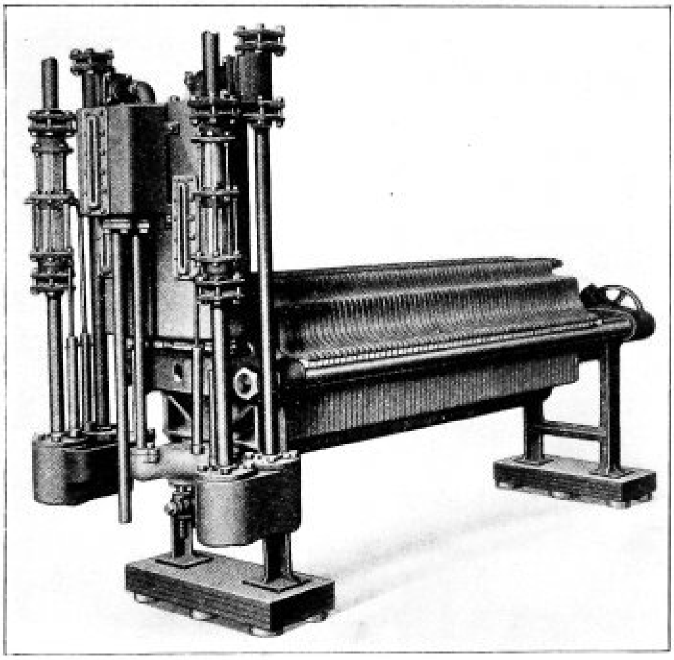


Fig. 1.—I. O. C. Bipolar Oxygen and Hydrogen Generator

In the field of oxygen and hydrogen generating equipment the International Oxygen Company, of New York, from the beginning set a standard for high-grade apparatus of workmanlike design and security of operation. The type of machine manufactured by this company known as the I. O. C. unit type is recognized as a most efficient and high-class apparatus and is in successful operation in numerous plants throughout the country. To-day the International Oxygen Company is bringing out a new style of oxygen and hydrogen generator under the name of the I. O. C. bipolar generator. This type of generator resembles outwardly a filter press such as used in many chemical industries. Moritz, of Wasquehal, France, patented this type of apparatus in the United States and elsewhere, and I. H. Levin, of the International Oxygen Company, who studied under Moritz and Flamand, perfected this machine.

Briefly described, the I. O. C. bipolar generator consists of a series of metallic plates (electrodes) clamped up together in a heavy frame, electrically insulated from one another, and separated by diaphragms of porous fabric.

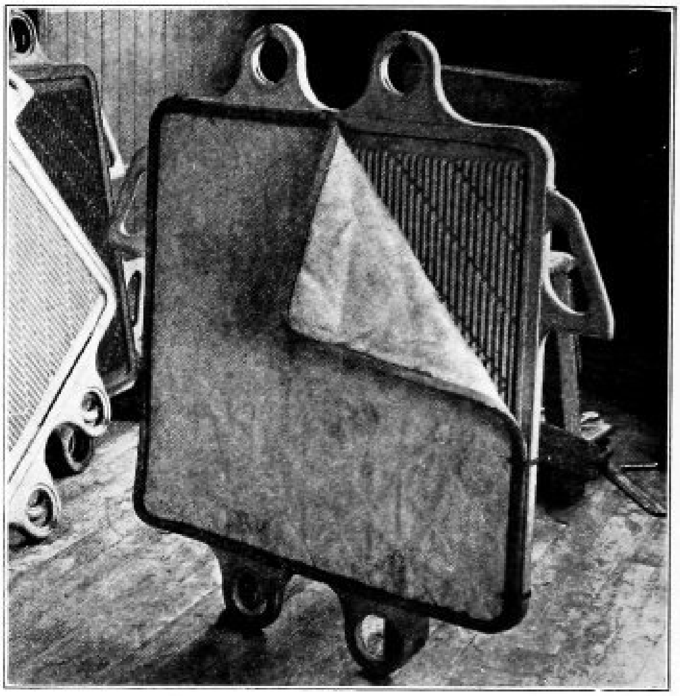


Fig. 2.—Electrode and Diaphragm

Each pair of these electrodes forms a closed cell divided by the diaphragm. These cells are filled with the electrolyte (caustic potash or soda), which acts as a conductor. An electric current admitted at one end plate passes on through the plates and the solution to the other end plate. In its passage it decomposes the water in the

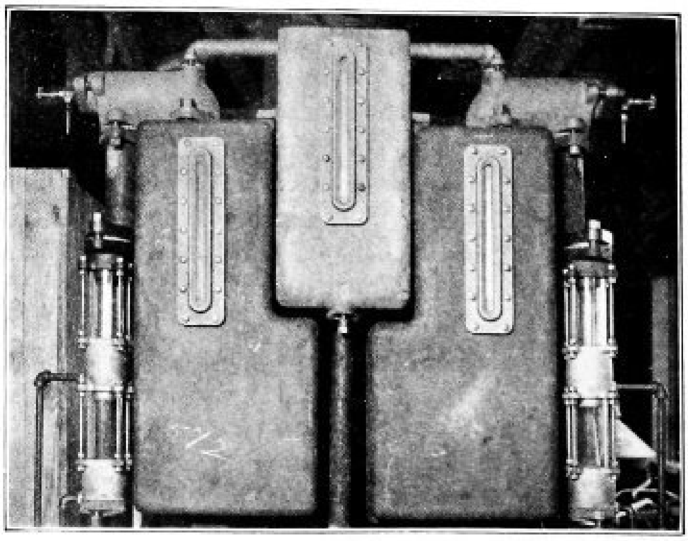


Fig. 3.—Water Tank and Gas Domes

solution into the two gases—oxygen and hydrogen—which are released on opposite sides of each plate and emerge upward into the gas off-takes. The mingling of the oxygen and hydrogen in each cell or compartment is prevented by the diaphragm, which, while permitting the passage of the fluid, resists the passage of the gases, according to a well-known physical law. As the gases are released and withdrawn the solution is automatically replenished from a supply tank. The operation is continuous so long as current and electrolyte are supplied.

The electrodes are of a special patented design, the anode side being heavily nickeled, while the cathode side is of commercially pure iron. The two gas off-takes discharge into two independent gas domes, the gas emerging below the fluid surface through an inverted "U." The pressure on both gases, clear back to the individual cells, is the same—being that determined by the hydrostatic head in the domes through the two independent risers from the water-feed manifold. This balanced pressure in both gas off-takes forbids any mixture of the gases and contributes to the balancing of pressures on the diaphragms. Both gas and water pressures are predetermined and constant.

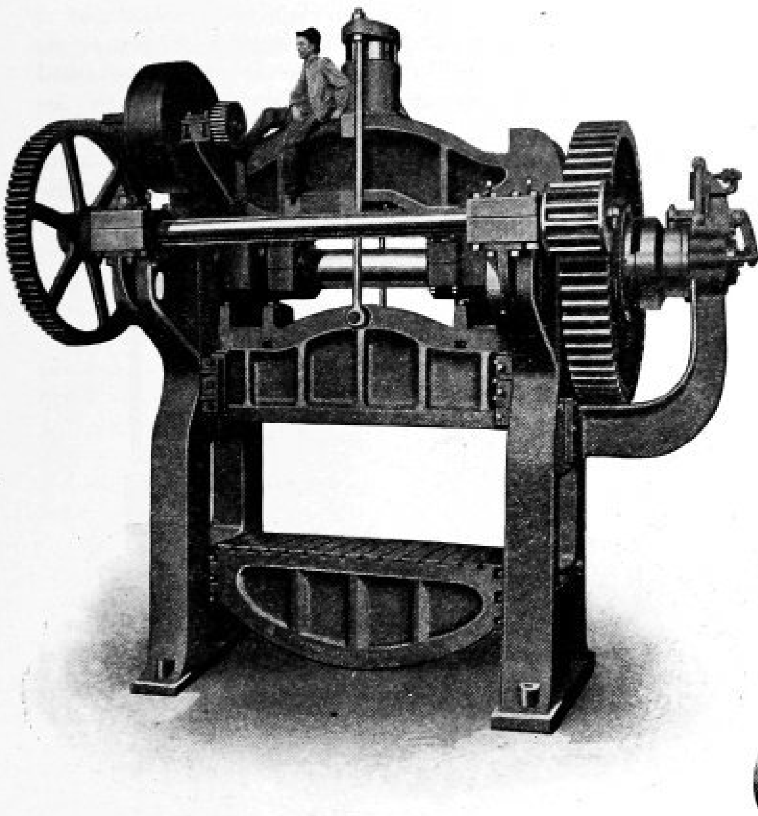


Fig. 1.—Covington Multiple Punch

The gases, escaping from the gas off-takes, rise through the fluid in the gas domes and pass out through discharge pipes at the top of the domes—thence downward to purgers in either side. The function of these purgers is threefold: first, to catch any entrained fluid in the gas; second, to cool the gas; third, to act as a water-check valve protecting the pressure system of the generator from any undue pressure of the gas-holders.

Covington Punches

The Covington Machine Company, Covington, Va., has on the market a special line of tools for boiler shop work, including punches, shears, bending rolls and plate planers.

Fig. 1 shows a large multiple punch located at the plant of the Pressed Steel Car Company, McKees Rock, Pa. This machine was designed for punching, among other operations, four sides of what is known as the "bath tub bolster" at one stroke. Its capacity is sixty 13/16-inch holes and one 2½-inch hole through ¾-inch mild steel plate at a single stroke. The dies and holders are not shown in this photograph,, but are fastened to the head and bedplate, respectively. The weight of this machine is 185,000 pounds; the main frames and bolsters are of steel castings, and the width between housings is 122 inches. By the use of modern spacing tables, which the Covington Company furnishes, a multiple punch of less size than the one illustrated can be made to produce large returns for punching flat sheets. The end rows of holes are all punched at one stroke, the girth seam holes being punched on both sides at once. A spacing table can be arranged to punch approximately rectangular sheets so that slightly conical sections can be automatically punched. The advantages of such an arrangement for boiler shops handling a large amount of work are obvious.

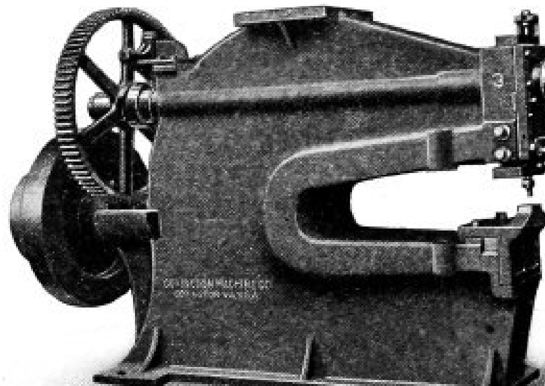


Fig. 2.—Universal Jaw—Punch

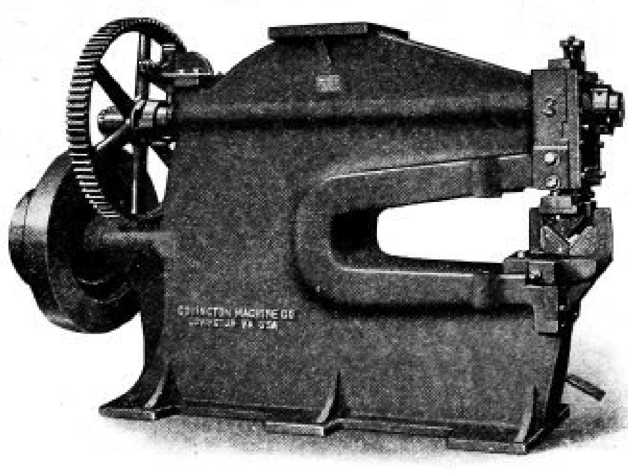


Fig. 3.—Universal Jaw—Angle Shear

In Figs. 2 and 3 are shown the application of universal jaws on punches, an arrangement which is not fully appreciated by many boiler makers. While this form of jaw is not recommended for machines that are to be used almost exclusively for shearing work, nevertheless in small shops, where a wide range of duty is desired from a single tool, the construction is very desirable, as flanges and channels and deep angle irons can be punched with ease, and at the same time shear blades can be attached if desired. In larger shops the universal jaw for a punch would be applicable in many cases.

National Electrolytic Oxygen and Hydrogen Producing Plant

The National electrolyzer, maufactured by the National Ox-Hydric Company, Chicago, Ill., is of the improved filter press type of oxy-hydrogen generator and consists mainly of a number of decomposition chambers connected in series. These chambers are formed by clamping together a series of cast iron electrodes so recessed and grooved that each plate, with its neighbor, forms a chamber which holds the electrolyte and in which the disassociation of the gases takes place.

The electrodes are carefully insulated one from the other by means of patented rubber-bound asbestos diaphragms. The electrodes and diaphragms are arranged alternately and are supported by the insulated frame of the filter press. The required number of electrodes and diaphragms with the corresponding end plates are then pressed tightly together by means of a heavy screw standard, thus making the whole equipment form a hermetically sealed tank of the filter-press type, the diaphragms serving both as an insulation and gasket also serve to form the sides of the cells, preventing any mixture of the two gases generated. The electrodes being thus separated by the diaphragms causes one side of the plate to act as the anode of the chamber and the other side as the cathode of the adjacent chamber.

The electrodes are composed of a special composition of metal and are heavily coated with nickel, which makes them neutral to oxygen, alkali (from the potash) or electric current, and prevents the formation of deposits or the oxidization of the electrodes themselves.

The electrolyte is a 21 percent solution of electrolytically pure caustic potash in distilled water. After the electrolyzers are once filled with this solution distilled water is added from time to time to take the place of the water decomposed, and the potash, renewing itself, lasts many months. The distilled water is fed to the electrolyzer by an automatic device which maintains a constant level of the electrolyte throughout the machine.

The National electrolyzer can be connected directly to an alternating-current circuit through a motor generator set, which tends to transpose the current from alternating current to direct current.

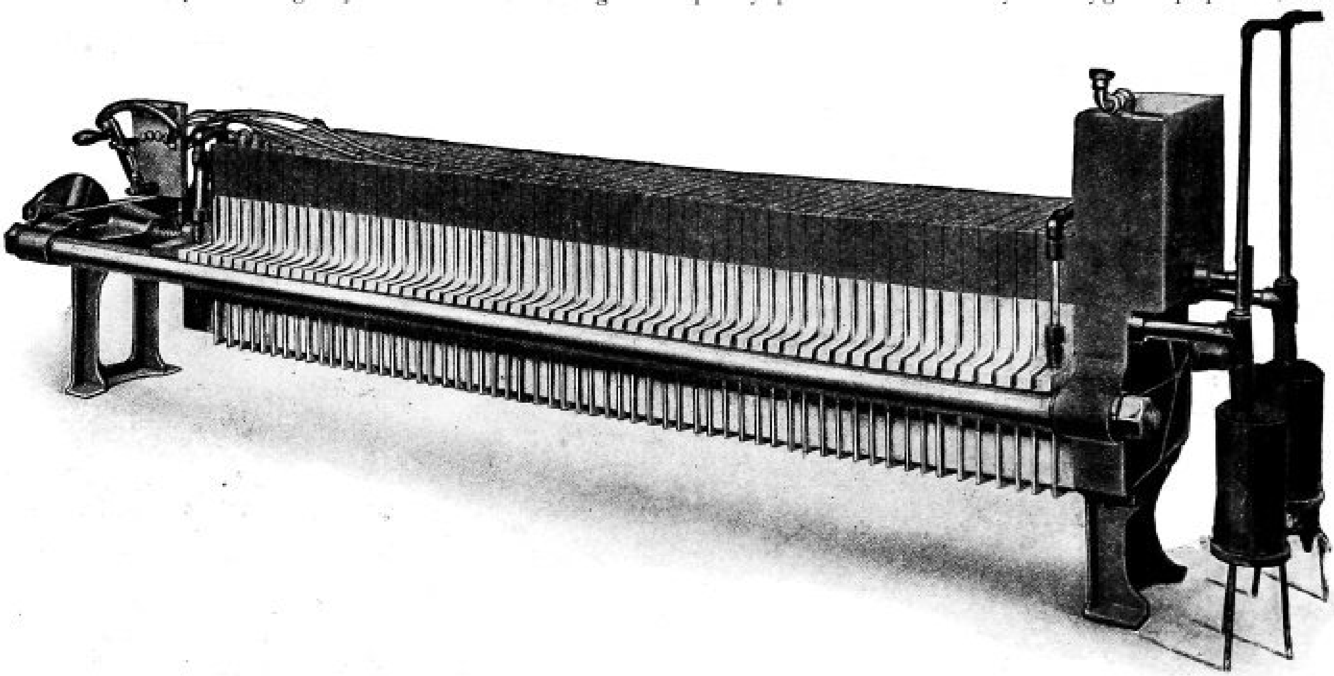
Under normal-load conditions the voltage required per cell is two volts or less. Therefore it can be seen that to operate on a 110-volt circuit an electrolyzer containing 55 chambers or cells is necessary, and on the same basis 110 cells are necessary for a 220-volt circuit.

The apparatus is provided with one collector for hydrogen and one for oxygen, whereas the individual type cell system must have a separate draw-off or collector for each cell in use, which necessitates more labor and a considerable increase in upkeep.

Insulation difficulties have been eliminated which prohibit short circuits and groundings, and makes the cost of maintainence very small, the labor operating cost being practically nil.

Assuming continuous operation and normal load conditions, the electrolyzers will develop an efficiency of 4 cubic feet of oxygen and 8 cubic feet of hydrogen at atmospheric pressure per kilowatt-hour of power consumed when the plant is operated at a temperature of 68 degrees F.

The gases produced, it is claimed, are of the greatest purity possible in electrolytic oxygen equipment, the impurities in oxygen never being greater than one-half of 1 percent, thus producing oxygen of 99.5 percent purity. The electrolyzer will stand an overload of 50 percent without any ill effects.



National Electrolizer

The electrodes are practically indestructible, being impervious to either oxygen, alkali or electric current. The asbestos diaphragms are very durable, and, being neutral to the elements with which they come in contact, have a life fully equal to that of the electrodes. All other parts of the equipment are not subject to any wear and tear and last practically a lifetime.

One of the main features of the National electrolizer is the fact that the conduits are kept free from the electrolyte by one of the most practical devices known to the gas industry. This device is cast integral with each plate, thereby eliminating any possibility of a short circuit, even should the conduit become filled with the solution. At regular intervals the operator should make a chemical analysis of the oxygen and hydrogen produced, otherwise his only duty is to maintain a proper water column level of the electrolytic solution.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Steam Tight Bolts

During the washout period is the time that broken staybolts are usually found, and many of them are located behind pads, frames or braces, and usually there is little or no time allowed for the removal of pads or braces. The law calls for the removal of the broken staybolt, and of course we fall back upon the old makeshift steam tight or blind bolts. So common has this kind of work become that even when there is time and it is possible to remove the obstruction, on account of the extra expense and trouble it is going to cause some machinist, or possibly a pipe fitter, where there is an air drum in the way of bolts being cut out from the outside, we have to do the work from the firebox side and the spindle tap is called into use. Now, strange to say, the spindle tap and its proper use is not as well known to all of our boiler makers (who have spent much of their time on hot work) as it should be.

It may seem a very simple matter to take out and replace a broken stay behind a pad or frame, but to do it right and get good results require both skill and patience, for should the bolt be broken only half way through, or just enough to let the water through the telltale hole, the chances are very much against it breaking off even when it is cut loose on the firebox side. Should this occur, as it frequently does, the man unacquainted with this kind of work finds himself up against it good and hard, for the uneven surface of the bolt must be made smooth enough to allow the drill to turn freely, otherwise the high side of the bolt will force the drill over to one side and cut the wrapper sheet. It is advisable to use a drill that will have about ⅛ inch of the bolt in the hole. This provides against drilling into the sheet should the bolt be uneven, or the telltale hole not in the center of the bolt, and leaves a little burr, which can be removed with a long, thin gouge by taking one cut clear through the same as burrs are removed from the wrapper sheet when the work is done on the outside.

One of the most trying things met with on jobs of this kind is getting a good light in the water space. A very fair light can be had by getting a strand of lagging wire, twisting it so that it becomes double, form an eye at one end, then get some white asbestos packing and fasten in the eye, close the eye by gently hammering or with pliers. This should not be too large or it will not pass through the staybolt hole. Now get some carbon oil in an old can, soak the asbestos in the oil, light and pass through the staybolt hole into the water space, and get busy while the light is good. With high proof oil there will be no danger whatever. Repeat the dipping every time the light gets dim.

For steam tight, or blind bolt work, there should be two taps; the first one is to straighten up the threads, the second one is the full size of the new bolt.

Having removed the broken bolt and the burr in the wrapper sheet, insert the spindle by passing it through the hole in the side sheet into the one in the wrapper sheet. This forms a fair lead for the tap. Put the first tap on the spindle and tap in the usual way, being careful not to force the tap until the point is clear of the side sheet, on account of the very short taper on the point of the tap; should there be clearance enough between the pad and the wrapper sheet, the end of the spindle will pass through and allow the point of the tap to enter well into the sheet, so that the thread can be cleaned, otherwise the tap must be backed out, the spindle withdrawn, and the same tap run in the second time, and the same process must be observed with the second tap. If this is carefully done, there should be no difficulty in getting the staybolt to hit the hole in the wrapper sheet.

Before tapping, it is usual to measure the distance from the inside of side sheet to the outside of wrapper sheet. To this distance add two threads, mark this on the taps and tap until the marks are up against the side sheet. See that the bolts to be applied are the same taper as the tap, and screw into place, and if properly done the bolt should project through the wrapper sheet just two threads and be perfectly steam tight.

If there are other bolts to be changed that require riveting on both sides, do so, leaving the steam tight bolts in their full length until after the water is turned on. Should there be no leaks, cut off the bolts and hammer up and finish, but should there be a leak, it will be a very easy matter to back out the bolt and find out the trouble. The object in doing it this way is that you have a chance to tighten up the bolts and possibly take up the leak or remove it for examination. Should the bolt be cut off and a leak develop after the bolts have been riveted up, you are in a worse predicament than you were in the first place, for now you have a solid bolt to remove.

There is always a possibility of cutting the thread in the outside sheet when gouging out the burr, and it is not always possible to raise a full thread when tapping with a single tap, hence the use of two taps.

Many object to trying the steam tight bolt by turning the water into the boiler before cutting off the end, and finishing up the bolt, but in my own experience I have found that it works very satisfactorily. Very recently I was asked by an old boiler maker what I thought of the steam tight bolt (did it have the same holding power the other bolts have?) and in the course of our conversation the question was raised, did the Federal Inspection laws allow its use? I am well aware that the steam tight bolt is a necessary evil, and in lots of cases its use cannot well be avoided, especially when they come behind the frames, but when they come behind pads or like obstructions I think that the obstruction should be removed and a proper staybolt put in, for it is very evident to any ordinary thinking person acquainted with staybolts that the steam tight bolt is nothing more or less than a makeshift, and in too many cases is put to do extra duty. The very form of the bolt is convincing that its holding power is very small on account of the end being tapered and being forced into a taper hole to make the fit. Now when this bolt is applied behind a frame and it is possible to drive a wedge between the bolt and frame, a bolt with less taper can be used and a fairly good holding bolt is the result. It is a well-known fact that a staybolt with a riveted head can sustain a greater load than one that is merely screwed into the sheet.

It is also patent to many familiar with this kind of work that anything is good enough for the boiler maker. Now I contend that if we must install steam tight bolts, all pads should be drilled so that a bar can be got on to the head of the staybolt and the end fullered down to the sheet, thus giving the bolt a greater holding power. I am of the opinion that this is a question that could be looked into to advantage by the Federal inspectors, and once looked into I think that there will be less steam tight bolts installed in the future.

I know of instances where several of this kind of bolt have been installed in groups. Of course the law was complied with where the broken bolts were removed, but the danger of a rupture was increased rather than diminished.

Pittsburgh, Pa. FLEX IBLE.

The Flue Question

In reading THE BOILER MAKER of late, I have noted several articles on flues—how they should be put in, what tools should be used, and how to obtain the best results after the engine has been put in service.

While talking with an Interstate Commerce man some time ago he told me of a case of how he had to start at St. Paul to eliminate the breaking in two of trains on a mountain division over 1,800 miles away. The cause of the breaking in two of the trains was that every division was allowing cars with defective draw heads and draft rigging to get by without the proper repairs. By making each division do its repair work and allowing no cars to be shipped to the next division, the breaking in two of trains on the mountain division became a rare thing.

The above will apply very well to the flue question. You may not have to go so far back to eliminate the flue trouble, but it will be some distance. For instance, a man working piece work, setting flues in an engine that is going to run on a division 700 or 1,000 miles away, cares very little if the flues last one month or one year. No boiler maker likes to put in flues steadily, especially working piece work. And, having worked piece work myself, I know that nobody suffers but the company and the flues.

I have seen the effect of piece work on flues, such defects as all flues prossered on the sheet, some only partly prossered and others not prossered at all, big beads and very small beads, coppers under the beads, and burrs left in the flue holes that should have been reamed out before the flues were put in. To improve these conditions, each division should do its own flue work when possible. Get a good, practical man on flues, give him a reasonable length of time to do a good job, and you will surely get good results.

About the filing of flues: Any boiler maker that has worked on the desert divisions knows why the scale should be removed or filed off the firebox end of the flues—if not filed they will not last long.

In putting in flues, see that all scale, dirt and oil are removed from the sheet and flue holes. Roll the coppers in good and tight. Chip the coppers off flush with the sheet, as it is very hard to keep a flue tight that has copper under the beads. All flues should be swaged and the scale filed off to insure a good, tight job. Remove the burr on the inside of the flue left by the flue cutter; if not removed it may be the cause of splitting the end of the flue when turning it over, or belling it out, and makes a poor-looking job when the flue is beaded.

The flues should be driven into the sheet good and tight to prevent stretching as much as possible. Turn the flues over enough so that the prossers will reach in far enough to set the inside bead tight up against the sheet, and at no time allow the prossers to prosser the flue on the sheet. I think the 9/16 prossers are the best for a ½-inch sheet. Drive the prosser pin in good and tight, and turn the prossers twice to insure good work. A light rolling before the flues are beaded will insure a good, tight job and make the flue perfectly round. Some men say that to roll the flue at this stage does no good, but for a test, fill the boiler with water and test before rolling the flues; then roll the flues and test again.

The distance that the flue should extend out from the sheet for a bead should be determined by the gage of the flue. Generally, 3/16 to ¼ inch will make a good average bead. When beading the flues, keep the beads rather high and do not flatten them on the sheet, as flat beads do not have the resistance to the fire and are easily collared. On marine boilers on which I have worked that had to stand a test of 325 pounds cold water they insisted on the flues being rolled after beading, to insure a tight job, and they were tight under that pressure.

In the front end, if the flues are properly shimmed and rolled tight they will never give any trouble.

THE RAMBLER.

A New Kind of Boiler Maker

Readers of THE BOILER MAKER may be interested in knowing that there are other boiler makers besides the regular kind, such as yourself.

I, too, am a boiler maker. I make them with a pointed brush, with an air brush, with india ink, and with water colors.

Many of the "photographs" of boilers which you see in THE BOILER MAKER aren't actual photographs at all, but have been made from blueprints and sometimes from rough sketches turned over to an artist like myself, and we have to "build" the boiler so well that you can "hardly tell the difference."

This may sound "fakey" to some readers, but it isn't fakey at all. Manufacturers always like to show their product as distinctly as possible with all details in place, and sometimes the only way to get around it is to have the photograph built from the ground up or to have a photograph taken and then retouched. I also do retouching, which is about as hard as making the whole boiler—so I think.

The thing that usually gives me a "pain" is the riveting job. I often wonder if real riveters feel the same way about it. I work all day painting rivets on a boiler, get an awful headache (worse even than the kind you carry around the day after), and when night comes I can't see that I have done much. It seems that there are millions of rivets in boilers. Often I get instructions like this: "The rivets in the boiler are 2 inches apart, center to center. Reduced to the size of the photograph you will therefore make them two-hundredths of an inch apart." If you don't believe it, gentle reader, just take a look at the rivets on a picture in THE BOILER MAKER, measure the distance apart, and convince yourself that I am telling the absolute truth.

Rivets, I believe, are the things that will keep me out of heaven if anything will.

Sometimes "practical men" come around, look over my shoulder, and tell me what a "cinch" I've got alongside the man who has to put up with the noise of the hammering. But I don't believe it. I believe my job of painting in rivets is the hardest in the world. I hate it. So, brother boiler makers, please pity me when you look at the pictures in your paper. They may look good, but they're mighty tedious to make.

New York. BOILER PAINTER.

It pays to file or ream the burrs in the end of a pipe, especially on small diameters. A taper reamer is better than a round file for such a purpose.

Honest Criticism

The letter of our friend, N. G. Near, in the January issue, which gives us his friend's opinion of the general run of boiler makers, is worthy of serious consideration. On first thoughts we would say that the picture was greatly overdrawn, but as he is evidently honest in his remarks, the probability is that his own personal experience is the base on which he forms his opinion. Let us suppose this condition is general, that ninety percent of boiler makers lack ambition and imagination; there must be a cause, and it would be folly to think that the failure of the ninety percent is due to personality.

No, sir, the fault lies to a great extent with the manner of the man's training in the business. Have they received the encouragement and moral support in their daily lives in the shops they should receive? Have they been led to understand and know of a surety that the company appreciates the hardships of their work and also recognizes any unusual ability where it is shown? The old conception of a boiler maker was that he was a person with a strong arm and a weak head, for it was figured that a man with brains would never go into the business, that there's only one set of brains needed in a boiler shop, and that is the foreman's, and he is barely safe in using them sometimes, for, if he does, and sets in motion something out of the general order, somebody higher up will come down on him like a thousand of bricks.

If only one out of ten men in a shop took interest in their work, it would be a sorry look-out for the output of that shop.

In how many shops will you find the official in charge willing or able to try out any idea suggested by one of the gang? It may be a good idea and would save time and money in the long run, but the foreman is tied down to his appropriation, and so the boiler maker gets the cold splash, and, as a consequence, his attitude in general is, "Oh, h——, what's the use!"

Now let us take up the charge that the boiler maker looks upon the foreman as a "lucky dog."

Some twenty years ago it may have been true in a great many cases to make that statement, for of a truth the foreman's position was looked on with something akin to envy, for as far as my own experience goes he was "monarch of all he surveyed." There were no I. C. C. laws to live up to, and he could use his own sweet will as to when to hold an engine for repairs. He didn't have the daily fear of someone tying a red tag on them if they sprinkled the right of way as they sped along, and he didn't have a company's traveling inspector come along and give him a bawling out because engine so and so had a wash-out plug that simmered a little. There was none of this to disturb his sweet dreams.

He could live like a human being and not be tied down to the shop on an average of twelve hours per day and half a day on Sundays. And, into the bargain, just when he is slipping into sweet repose, the 'phone rings. It's the night man, and he wants to know what the continental does he think he, the night man, is. Two washouts in the house and three up on the dump leaking like sieves. He's hollering for more help, and you can't blame him. Oh, yes, the foreman's job is to be envied, so much that ninety-nine percent of the men in the shop wouldn't have it for a pension.

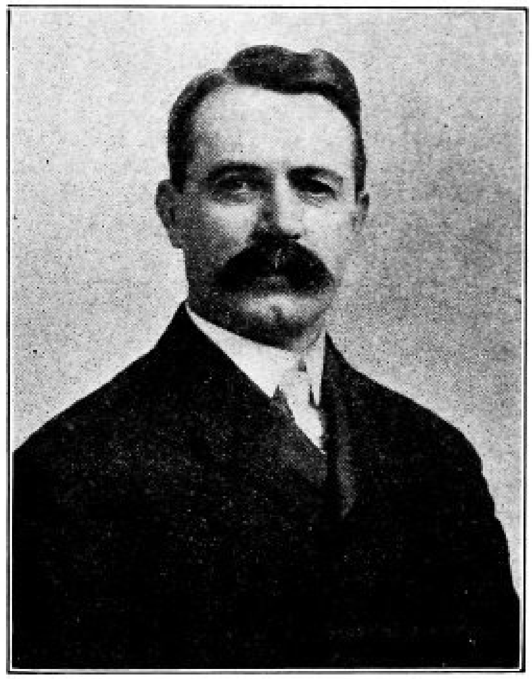
Thanks are due to N. G. Near for giving us his friend's views on the question. Honest criticism, like honest confession, is good for the soul. May I hope these remarks of mine will be taken in the same spirit?

Lorain, Ohio. Joseph Smith.

OBITUARY

The sad news of the sudden death of James D. Farasey at Cleveland, Ohio, on January 25, after submitting to a serious operation for stomach trouble, was a great shock to his immediate family, as well as to his many friends in Cleveland and throughout the boiler manufacturing and iron and steel industries of the United States, his acquaintance being national.

Mr. Farasey was born at Cleveland in the year 1858. His preliminary education was in the public and parochial schools of that city, after which he was sent by his father to the University of Dublin, Ireland, to complete his education. He was engaged in marine and railroad work as expert accountant and auditor for a number of years, and was well known in marine and railroad circles on the Great



James D. Farasey

Lakes. In 1887 he became associated with the late D. Connelly, of Cleveland, in the boiler business, and continued until 1892, when he acquired the H. E. Teachout Boiler Works, which he operated successfully up to the time of his death.

Mr. Farasey early identified himself with the American Boiler Manufacturers' Association, and spent his time and own money freely in his efforts toward increasing the standard of quality, workmanship and uniformity of boiler construction throughout the United States and Canada. As a mark of respect and appreciation of his efforts, that association elected him its secretary about twenty years ago, which position he held up to the time of his decease.

Less than a year ago he was largely instrumental in prevailing on the National Tubular Boiler Manufacturers' Association to co-operate with the American Boiler Manufacturers' Association to enforce legislation toward securing national uniform boiler construction and inspection laws, the first meeting for the purpose being held at Erie, Pa., June, 1915.

Mr. Farasey was especially a home-loving man of a congenial nature, with a large circle of friends, who, together with his family, consisting of his wife, daughter and four sons, will greatly mourn his loss. His eldest son, J. D. Farasey, Jr., a graduate of the Case School of Applied Science, will succeed his father in the management of the business.

Double-Angle Pipe Connection

Layout of Patterns for Sections of Twisted Elbow in a Pipe Connection—Method of Projection

BY GEORGE A. JONES

Before patterns for such a piece of pipe work as the one shown in the sketch can be developed, a correct plan and elevation must be drawn, because the correctness of the plan and elevation will determine the correctness of the patterns. Before starting to lay out this job, in order to make it more plain, assume that Section 1 will be a horizontal pipe when in its proper position; also Section 3 will be horizontal.

Begin the layout by erecting the line *A′-P*. On this line at any place, as at *A*, draw the base line of Section 1 at right angles to *A′-P*. Now set down the length of Section 1, as *A* to *B*. On the line *A′-P* lay out the horizontal distance between the bends or elbows, as *B* to *N*. At right angles to *A-P* and through *N* draw *N-C*, equal to the distance elbow *C* will be set over from elbow *B*. Now set down the center line, *C-D*, of Section 3 at the required angle to Section 2. Extend this center line *C-D* beyond the end *D* any distance, as shown. This completes the center lines for the elevation.

Now draw the outlines, as shown. Below *A* in the elevation locate *A″*. About *A″* strike a circle the required diameter. Below *A″* locate *A′* the required vertical distance or height between the two horizontal pipes, Section 1 and Section 3. Now draw the line *A′-D* at right angles to *A′-A″* and make *A′-C* equal to *N-C* of the elevation and *A′-D* equal to *P-D* of the elevation. Then draw the diagonal lines *A″-C* and *A″-D*. We must now draw an elevation showing the correct angle of the elbow *B* of the elevation.

Obtaining Correct Angles of Elbow *B*

Extend the base line *A* of Section 1 to the right, as shown at *A-A′*. At any place on this line locate *A*. At right angles to *A-A′*, Fig. 1, erect the line *A-B* the length of the horizontal pipe. Now take the distance *A″-C* in the plan and set it down in Fig. 1, as *A-A′*, which is the diagonal distance between the two elbows, and erect the line *A′-C′* at right angles to *A-A′*. Make *A′-C′* in Fig. 1 equal *A-N* of the elevation, or the horizontal length of these two sections. Now draw the line *B-C′*, which is the correct length of Section 2.

Parallel with *A-B*, Fig. 1, draw the outlines of the pipe at the required diameter and obtain the miter line *O-7*. About *A* strike the semi-circle and divide this into six equal spaces, as shown and numbered 1 to 7. Erect the perpendicular lines through these points to the miter line *O-7*. This completes the layout for this elbow.

Now if the elevation of Section 3 was parallel with Section 1 there would be no twist in Fig. 2—that is, in the developing lines—for on the throat line on one end of Section 2 would be the back line of the elbow on the other end—that is, both ends would be developed from the same lines. But in this case Section 3 is not parallel with Section 1, therefore there will be some twist in Section 2—that is, the lines we use on one end to obtain the miter for the elbow, *B*, will be set around from those on the other end, or elbow *C*.

Go back to the plan again and the line *A″-C* represents the direction, or axis, of Section 2, and where this line crosses the circle drawn about *A″* will locate the throat and back of elbow *B;* 1 will be the throat and 7 the back, and the line drawn through *A″* at right angles to *A″-C* will locate the sides of the elbow as 4 and 4. Now space each one of these quarters into three equal spaces, the same as we did in Fig. 1. On profile *A* erect lines through these points to the miter line *B* in the elevation parallel with the center line *A-B* of Section 1. These lines are not shown here as it might confuse the reader later on. But the lines 1-4-7 have been drawn so that it will be clearly understood.

Now where the lines 1 to 7, Fig. 1, touch the miter line *O-B-7*, Fig. 1, draw lines back over to the elevation through these points and parallel with the base *A-A′*, Fig. 1. Where these lines meet similar numbered lines at *B* in the elevation will locate points through which trace the line and form the ellipse, as shown.

This ellipse represents the seam or miter line of elbow *B* as it will appear when the pipe is put together and placed in the proper position, as shown in the plan and elevation. The solid line is the top half and the dotted line is the bottom half of the pipe.

Now before we can obtain the amount of twist needed in Section 2 we must locate some point, either the throat or back of elbow *C*, in its proper location in the elevation, and to find such a point we must first obtain a true angle of elbow *C*.

Obtaining Correct Angle of Elbow *C*

In Fig. 2 draw the line *E-F* and make *E-F* equal to *A″-D* of the plan, which is the diagonal distance between elbow *B* and the end of Section 3. Erect *F-H* at right angles to *E-F* and through *F*. Now make *F-H*, Fig. 2, equal to *B-P* of the elevation, or the horizontal length between the elbow *B* and the end of Section 3. Now with the trammels set to the correct length of Section 3, which is *C* to *D* in the elevation, strike an arc from *H* to *K* in Fig. 2 and with the trammels set to the true length of Section 2, which is *B* to *C′* in Fig. 1, strike an arc from *E* to *K* in Fig. 2. Where these arcs cross at *K* in Fig. 2 will locate the center of elbow *C*.

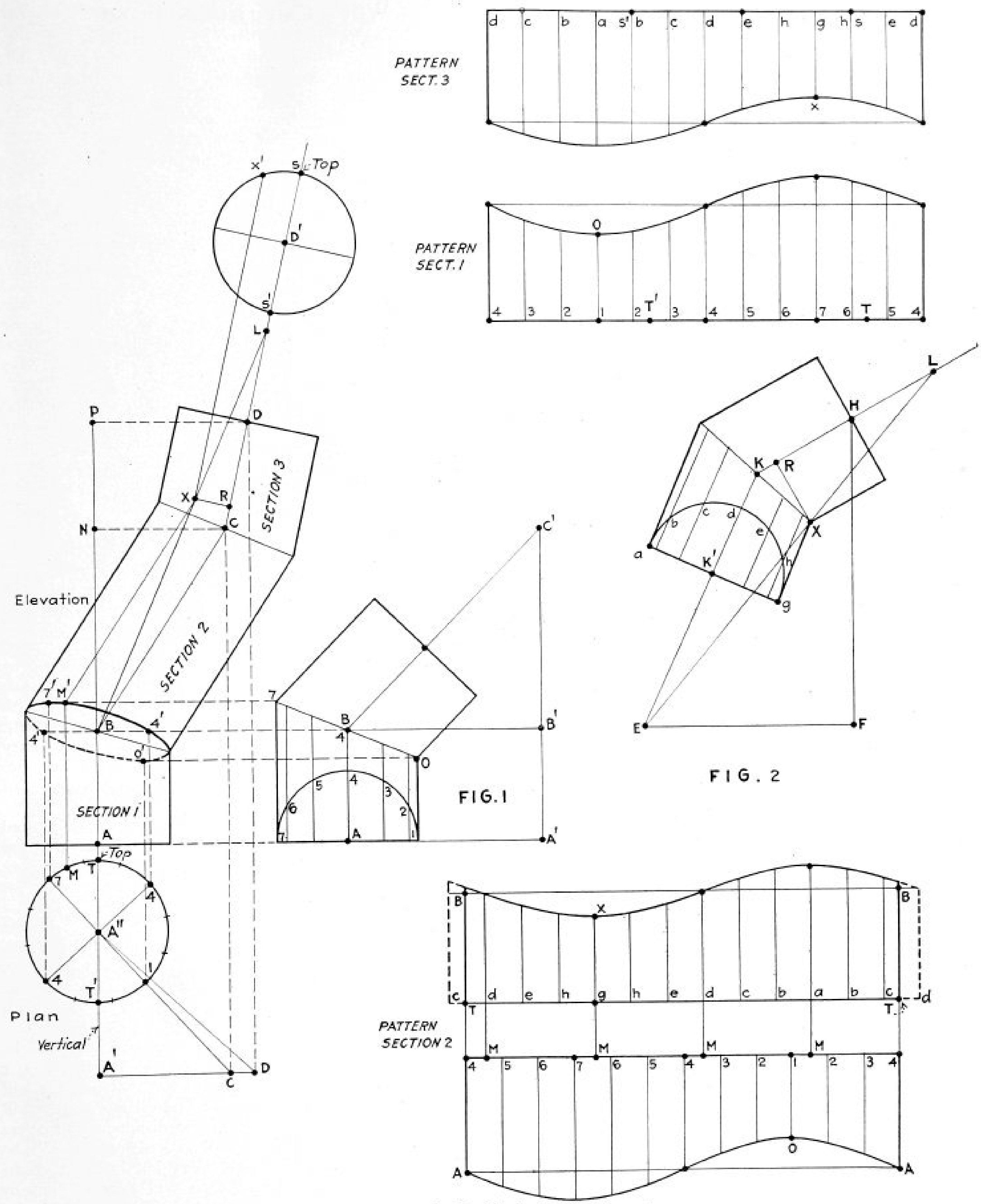
Now draw the center lines *E-K* and *K* to *H*. Continue the center line *K* to *H*, as shown. Erect the base line through *H*, make the distance *K′-K* the same as *K* to *H* and erect the base line through *K′*. Draw the outlines, and this is the true angle of elbow *C* of the elevation.

At *K′* in Fig. 2 strike a half circle of the required diameter and space this half circle into six equal spaces, or the same number as in circle *A*, Fig. 1, and letter these *a-b-c-d-e-h-g*. Draw lines through these points to the miter line and parallel to line *E-K*.

To Obtain the Twist in Section 2

In Fig. 2, with the straight edge on point *E* and on the throat *X*, or shortest part of the elbow, draw a line to the center line, *K-H*, and locate point *L*, and with the square on the line *K H* and on the point *X* locate the point *R* on the line *K-H*. Now as we have just located the line *E-L* and the throat *X* upon this line in Fig. 2, we can locate the throat or point *X* in the elevation by using the line *E-L* in its proper position in the elevation.

To locate this line in the elevation we must locate points *L* and *R*. As the center line *C-D* of the elevation is horizontal, it is shown in its true length. Also point *C* is in its proper position, so take the length *K-R-L* in Fig.



Layout of Patterns for Double-Angle Pipe Connection

2 and transfer it to the elevation as *C-R-L*, locating point *L*. The point *B* is already located. Now draw the line *B-L*. This corresponds to the line *E-L* in Fig. 2. Upon this line *X* will be located and through point *R* at right angles to *C-L* draw the line *R-X*, which locates the throat *X* in its proper position.

On the center line *C-L*, at any place, strike a circle as at *D'*, the required diameter. Parallel with *C-L* and through *X* draw a line to this circle and locate *X'*. Parallel with *B-C* and through point *X* draw a line to the ellipse and locate point *M'*. Now parallel with the line *A-B* and through *M'* draw a line to the plan and locate point *M*. As point 7 is the back of elbow *B* and point *M* the throat of elbow *C*, the distance 7 to *M* measured around the circle in the plan is the required twist to be used in laying out the pattern for Section 2.

LAYING OUT PATTERNS*

Starting first with Section 1, pattern 1 is the same as any elbow work. The lengths are obtained from Fig. 1 for the miter. The points *T′* and *T* would be the vertical top and bottom centers in case a flange was wanted on this end, and the distances 1 to *T′* and 7 to *T* are measured around the circle in the plan.

Taking pattern 3 next, which is the same in circumference as pattern 1, the lengths for the miter are taken from Fig. 2. Points *S* and *S′* would be the top and bottom vertical centers for the flange on this end. *X′* to *S* in the elevation equals *g* to *S* in pattern 3.

We will now take pattern 2. Erect the line *A-A* equal to the circumference, square up the sheet and erect the lines *A-B*. Make the distance *A-B* equal to *B-C′* in Fig. 1, and draw the line *B-B*. Take the distance *A-B* in Fig. 1 and lay it out on lines *A-B* of the pattern as *A* to 4. Draw line 4-4. Divide this line into 12 spaces and through these points draw lines to the line *A-A* parallel with the line *A-B*.

Go back to pattern 1 and, as the throat is 3 spaces in from the left side, so in pattern 2 the throat will be 3 spaces in from the right side, and this point will be 1. Now take the length of the lines 1 to 7 in Fig. 1 and lay them out on similarly numbered lines in the pattern. Draw the curve through these points, and this completes the end for elbow *B*.

Take the distance *K* to *K′* in Fig. 2 and lay it out in pattern 2 on the lines *B-A*, as *B* to *T*, and draw the line *T-T*. Now go to the plan and take the distance 7 to *M* measured around the circle, which is the distance from the back of elbow *B* to the throat of elbow *C*, and set this distance down in the pattern on the line 4-4, as shown at 7 to *M*. As this is the distance between back and throat, it is also the distance between the sides of the elbows, so set it down as shown at 4 to *M* and also 1 to *M*. Draw lines through points *M* to the line *B-B* parallel with lines *B-A*. As 7 to *M* locates the throat, which is marked *g-X* in Fig. 2, where this line crosses line *T-T* mark it *g*. As the space 4 to *M* is the side of the elbow, mark it in the pattern *d*, as shown. 1 to *M* is the back, mark it in the pattern *a*.

Now, between the points *d-g-d-a* lay out on the line *T-T* between these points 3 equal spaces, and mark them as shown, *a-b-c-d-e-h-g*. Draw the parallel lines through these points as shown, and take the lengths of these lines from Fig. 2 and lay them out on similarly lettered lines in the pattern. Draw the curve through these points, and this completes the pattern.

The spaces on the outside of the pattern as *c* and *d* are only used to complete the curve at *B* and *B*, and are not left on the pattern when putting these patterns together; for elbow *B*, patterns 1 and 2, the points *O* and *O* go together, and for elbow *C*, patterns 2 and 3, the points *X* and *X* go together.

Now check up the patterns and everything is ready to go to the punch. In measuring 7 to *M* it must be measured on a circle which is the neutral diameter of Section 2, and in measuring 7 to *T* and *X′* to *S* they must be measured on a circle which is the neutral diameter of Sections 1 and 2. Be careful in locating the point *M′* on the ellipse that you locate it on the right part; that is, the top or bottom. In this case Section 2 is inclined downward to elbow *C* and Section 3 is horizontal; therefore the throat *X* in the elevation will be on the top half of the pipe, likewise *M′* will be located on the top half of the ellipse, and *M* in the plan will be on the top half of the semi-circle.

* These patterns are shown as they were laid out and must be turned over to roll.

What Constitutes Proof?

What kind of boiler is "best"? Watertube or fire-tube? In answering that question many men would say: "For large plants the watertube boiler is best. For small plants the fire-tube boiler is best." And they let it go at that.

Ask for proof of their statement and they will give a long list of arguments for each case. If one has twenty points and the other only 15, the one with most points "wins."

We frequently read arguments of this kind. A certain product has an overwhelming number of points on its side and the reader is naturally led to believe that that product is the "best." Maybe it is. And maybe it isn't. Are arguments absolute proof?

Take, for example, the matter of boiler welding, whether by the oxy-acetylene process or otherwise. The "perfectly" welded joint has many more "points" on its side than has the riveted joint. We would like very much to own seamless, rivetless boilers.

Have you ever thought, though, of the "personal equation" in boiler welding? There certainly can be no slipshod work anywhere, for the boiler is no stronger than its weakest spot. The welder who does the work has a more responsible task than has the cashier of a bank; he must be absolutely honest; he must have a conscience that will not permit his doing anything but the very best work possible. He must have the best torch that can be procured for him. He must understand the dangers of slag and burned and oxidized spots. He should know the mathematics of boilers and the real magnitude of pressures so that his conscience will gain the proper impetus toward perfect work requirement. The welder's mind must ever be on the alert. It must not be weakened by any outside agent such as tobacco or alcohol, if such agencies have a weakening action. The honest man, with the quick conscience, will not use either of these agents, if he knows that they hurt him. If he knows that they help he will or may use the amount his conscience dictates. I would not lay down the law to such a man, but prefer to put it "up to him."

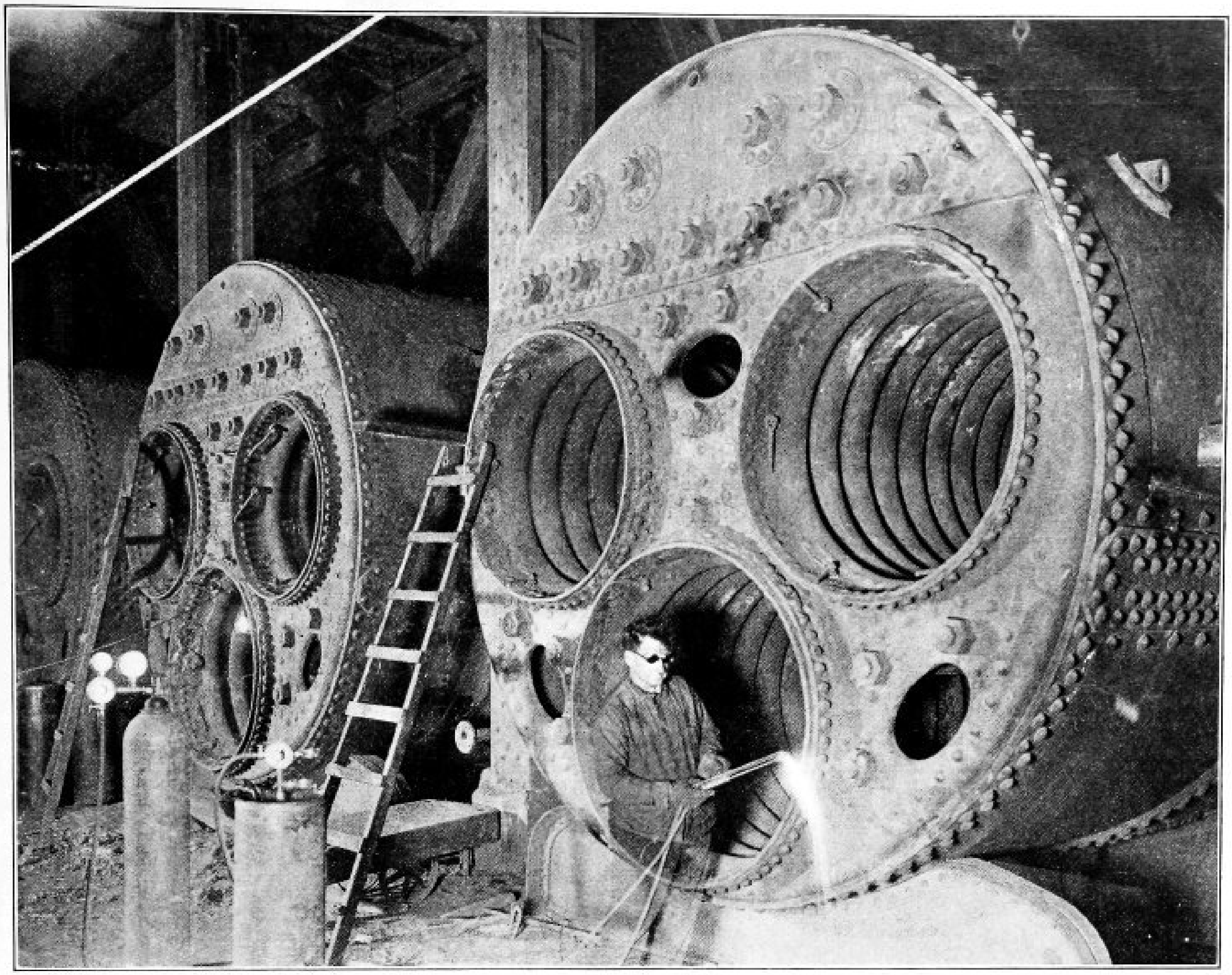
Boiler welding has not yet reached a very advanced stage, in spite of its many advantages. Why? Because we haven't the "proof" that welding is best. We have the arguments and the equipment for doing the work but we still lack sound proof.

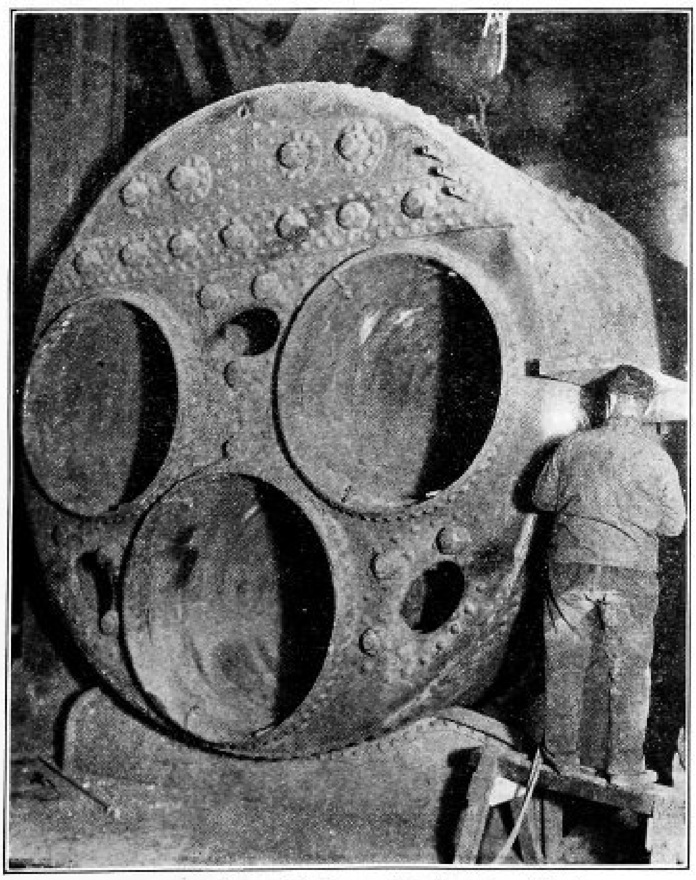
The best way to prove that a watertube boiler is best is by testing the two kinds side by side in actual installations. These tests have been made in years gone by, not in a very orderly manner, perhaps, but in a way that permits of comparison. So we have actual *proof* with which to back up our arguments.

In my opinion the day will come when rivets will be relics of museums. Boilers will be welded either by our present processes or by better processes that perhaps will soon be discovered. Honest men and dishonest men will do the welding. On account of the dishonest men there will be trouble—explosions perhaps. Progress will be impeded, due to the dishonest men, but in the end the "best" will prevail. Honest men will "prove," not by argument, but by actual examples, that the welded boiler is less expensive, stronger, and better in every way than the riveted boiler. And when that day comes this question can be answered: What kind of joint is best, welded or riveted?

New York. N. G. NEAR.

Some boiler makers seem to think it is the position of a vertical or horizontal seam which effects its strength instead of its condition.





Dismantling Large Boilers with Acetylene Torch

Fourteen Large Boilers Dismantled with Oxy-Acetylene Cutting Torch

Oxy-acetylene cutting played an important part in the dismantling and removal of fourteen large boilers at the plant of the Union Electric Light & Power Company, St. Louis, Mo. These boilers were so located that it was impossible to dispose of them without cutting them up into small parts. Had the work been carried out by means of the hammer and chisel a considerable delay would have been occasioned and the cost for labor would have been proportionately increased.

Each boiler was 11 feet in diameter by 21 feet long. The oxy-acetylene blowpipe permitted the cutting up of the boilers into small sections, such as could be easily removed without the necessity of tearing down a part of the building. The portable type of outfit was used, employing compressed oxygen and Prest-O-Lite gas. The cutting outfit was moved from boiler to boiler as the work progressed. In this manner the dismantling was accomplished with greater speed and economy than would be possible by any other method.

The photographs on this page give a vivid impression of the size of the undertaking.

When flue holes are being cut the job does not simply consist in cutting the hole in its proper position, but care should be taken to see that the cut is smooth, as you cannot make a tight joint in a flue sheet with flue holes all chewed up.

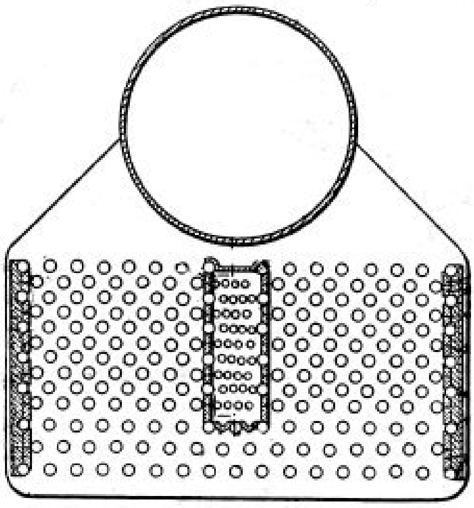
Selected Boiler Patents

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

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

1,159,783. STEAM BOILER. EDWARD C. MEIER, OF PHŒNIXVILLE, PA.

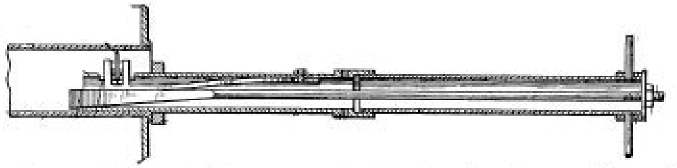
Claim 4.—The combination with a boiler having horizontal watertubes arranged in staggered series, partitions forming a chamber, the vertical partitions of said chamber consisting of tile located between vertical series of watertubes, the tile between each pair of watertubes comprising upper and lower sections having tongue and groove interlock, said



tongue and groove extending longtitudinally of the tile at their meeting edges, the opposite edges of said tile curved and bearing against the vertical series of tubes, and said tile at their meeting edges bearing against tubes of an adjacent series. Six claims.

1,160,019. FLUE-CUTTER. PAUL WAGNER, OF CULBERTSON, MONTANA.

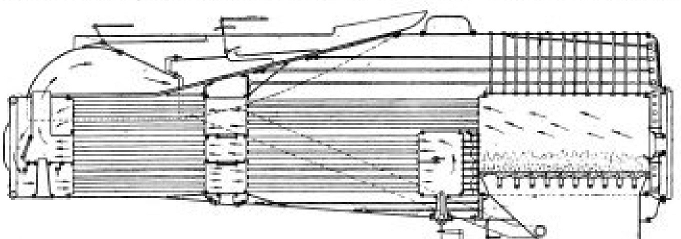
Claim.—In a flue cutter, the combination of a hollow stock having a spring member provided with an angular head secured therein, a longitudinal wedge-shape fulcrum member upon which the spring member rests, and a cutter wheel arranged upon the angular head of the spring,



said stock being provided with a longitudinal opening in one of its ends to receive the head of the spring, the adjacent walls provided by the opening at the terminal of the said opening and at a distance from the said terminal being slitted laterally and the portions between the slits being bent toward each other to contact with the opposite sides of the spring head to provide guides therefor.

1,159,180. STEAM BOILER. CHARLES WAKEFIELD CROWELL, OF KNOXVILLE, TENN.

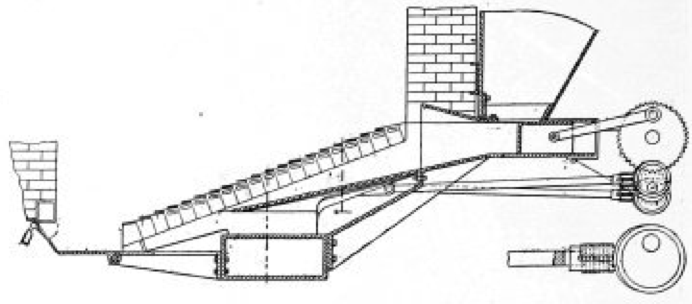
Claim 23.—The combination of a substantially cylindrical boiler shell having an opening in its bottom, and a substantially arc shaped fire box shell in cross section, a substantially circular flue sheet, having heating flues extending forward therefrom, a crescent shaped back head of boiler shell, inner and outer heads secured in the rear end of the



fire box, and a mud frame comprising an open bottom fire box, said shells being spaced apart forming the water and steam space between them, are both substantially arc shaped in cross section about the length of the fire box, said flue sheet being secured in the front portion of the fire box, said back head of boiler shell being secured between said spaced apart shells at the rear end of the boiler inclosing said water and steam space at the rear end, said mud frame being secured to the arc ends of said shells on each side, and extending across between said cylindrical shell, fire box, and flue sheet and secured thereto, the rear ends of the mud frame are turned upward and outward and secured to said shells and back head, inclosing the lower portions of said water space and forming the fire box opening, said inner and outer heads inclosing the rear end of said fire box and form the back water wall thereof. Forty-three claims.

1,160,324. UNDERFEED FURNACE. ROBERT SANFORD RILEY, OF PROVIDENCE, R. I., ASSIGNOR TO SANFORD RILEY STOKER CO., LTD., OF WORCESTER, MASS., A CORPORATION OF MASSACHUSETTS.

Cliam 1.—In a furnace a fuel burning retort having a fuel inlet at one end and extending therefrom toward a refuse discharge point, said retort being formed in part of side walls, each of which is independent of



the other and is mounted with capability for movement as a whole independently of the other, means for feeding fuel into the retort through the inlet thereof, and means for moving said walls to propel the fuel and refuse in the furnace toward such discharge point. Thirty claims.

1,160,651. PURIFIER FOR STEAM BOILERS. HARRY H. RALPH, OF PHILADELPHIA, PA.

Claim 1.—A water purifier embracing a hollow casing made up of a series of sections bolted together, of which one end section is provided with an inlet connection and of which the opposite end section is provided with a port having an outwardly opening valve, a vertical baffle

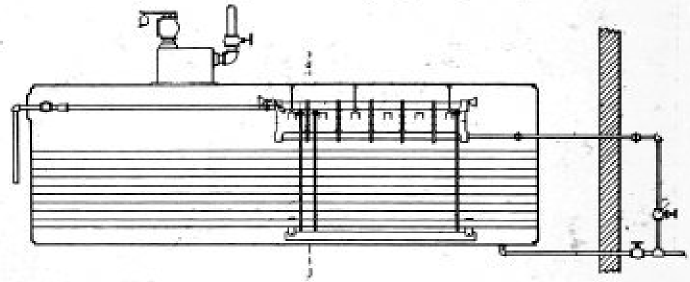
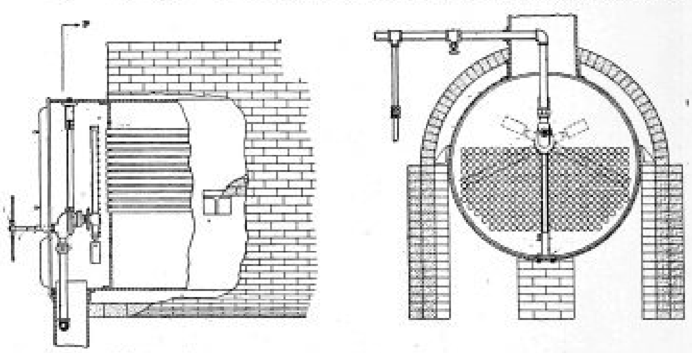


plate within the inlet section spaced apart from but immediately adjacent said inlet and extended from the casing top to within a short distance of the bottom thereof and a second baffle plate abutting against the first-mentioned baffle plate and extended horizontally of said section substantially midway of the height of the casing. Nine claims.

1,160,658. FLUE CLEANER. ANTON C. SCHMELZER, OF SPRINGFIELD, MASS., ASSIGNOR TO SCHMELZER & ARTHUR MFG. CO., OF SPRINGFIELD, MASS.

Claim 1.—The combination in a boiler of a rod, a casing on said rod formed of two members, a cylinder rotatable in one member, a collar on said cylinder, a gear on the opposite end of said cylinder, a pinion re-



cessed in said member and engaged with said gear, said gear and pinion being arranged along the plane of contact of both members, means held in the other member for actuating said pinion, means on said last-named member to lead steam to said cylinder, a tube carried at the end of said cylinder, and a plurality of nipples along said tube. Two claims.

1,159,497. COMBINED BOILER SUPPORT AND CINDER CHUTE. BENJAMIN JACOBY AND CHARLES S. JOHNSON, OF MARION, OHIO, ASSIGNORS TO THE MARION STEAM SHOVEL COMPANY, OF MARION, OHIO, A CORPORATION OF OHIO.

Claim 1.—The combination, with a boiler having a chamber communicating with a smokestack, and a supporting frame having an opening beneath said boiler, of a supporting member interposed between said boiler and said frame to support said boiler and having a gravity chute formed therein, said chute communicating at its upper end with the chamber in said boiler and at its lower end with the opening in said frame. Two claims.

1,157,722. SUPERHEATER. JOHN PRIMROSE, OF DONGAN HILLS, N. Y.

Claim 1.—The combination of a boiler of the ordinary type, of a superheater located between the first and second banks of watertubes comprising upper and lower headers and superheating units connecting said headers, each of said units consisting of two portions bent at substantially right angles to each other to afford access to the superheater and to permit freedom of expansion of said superheater and a baffle for the first bank of tubes therein stopped off at the level of the top of the lower or inlet superheater header and carried to the back of the same and continued up at the rear of the superheater. Seven claims.

The Boiler Maker

MARCH, 1916

Welded Fireboxes

Method of Welding and Results Obtained

BY C. E. LESTER

The accompanying photographs illustrate one of several types of oxyacetylene welded fireboxes now in service on the railroad where the writer is employed. The first welded box was applied about three years ago and is an unqualified success in point of durability and efficiency. As stated in other articles on welded fireboxes, boxes welded in this manner are practically as efficient as is possible to obtain with fireboxes of these types, due to the fact that there are no riveted seams to leak and no rivet heads to collect scale and retard circulation. They are also much more elastic than the riveted type of construction.

The box illustrated is for a passenger locomotive of the 4-6-2 type, with an 84-inch, three-course combustion chamber boiler with 38 5½-inch and 207 2¼-inch tubes 17 feet long. The boiler is designed to carry 215 pounds pressure at a factor of safety of 4.43. The requirements are heavy and the construction needs to be good to stand the strain.

The firebox plates are all of ⅜-inch plate, except the back flue sheet, which is of the regulation ½-inch plate. The flanged plates are all milled to an angle of 60 degrees and the flat plates all bevel sheared the same. The plates are cleaned of the bloom for about ½ inch from the

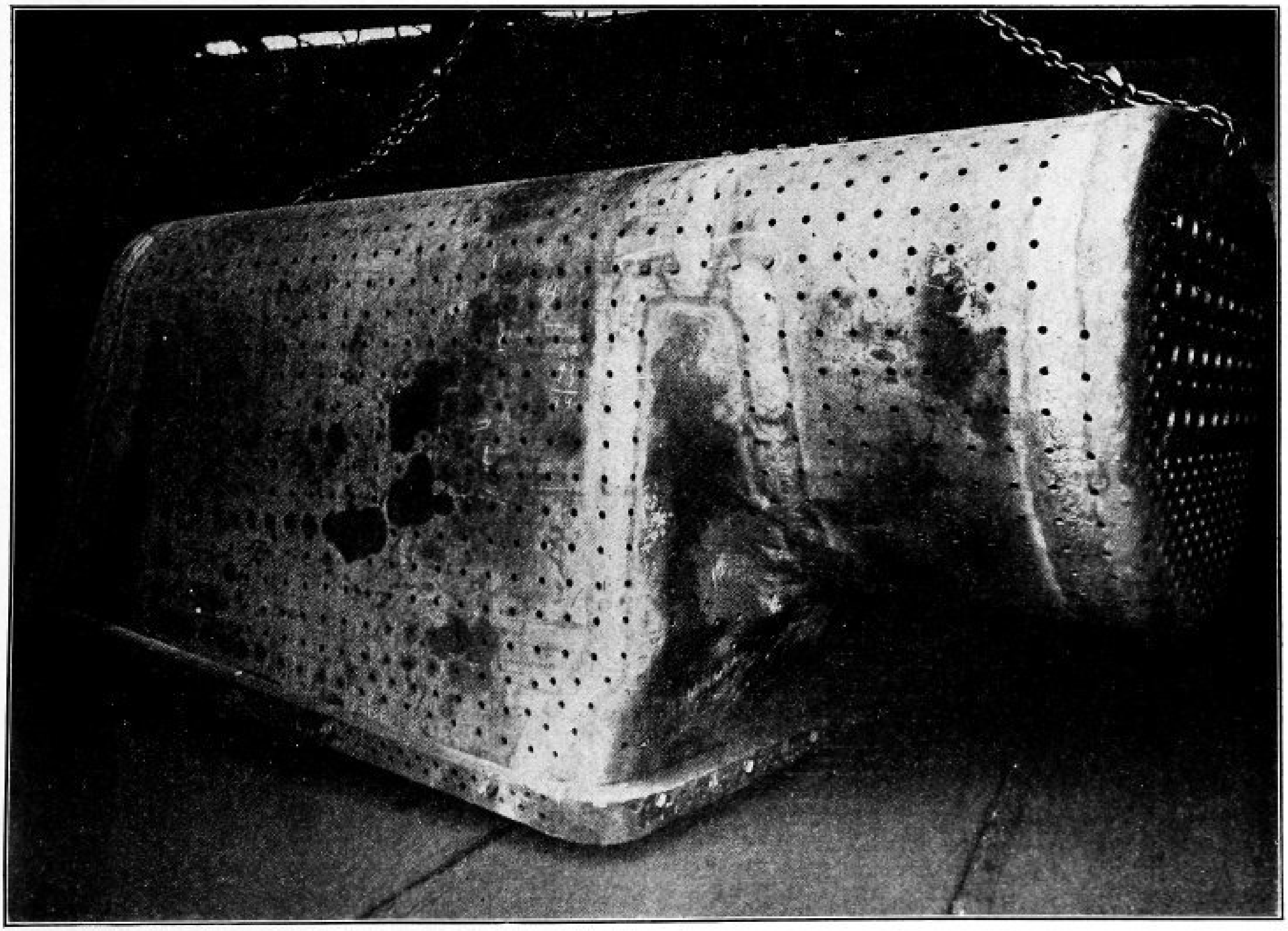


Fig. 1.—Welded Firebox for Passenger Locomotive of the 4-6-2 Type, Designed to Carry a Working Pressure of 215 Pounds, with a Factor of Safety of 4.43

opening, to keep the weld perfectly clean of foreign matter.

Fig. 1 shows the completed firebox ready for installation. It will be noted that the welds are all shown between the staybolt rows, giving about 6-inch flanges. It was thought that this method would make the weld more secure by getting it away from the flange. This idea has been given up and boxes now under construction have a flange of about 2 inches. A flange of 2 inches on a 3/8-inch plate is self-supporting and the weld makes a good, secure job.

The first weld is made from the interior of the box, the box being turned to suit the convenience of the welders. After the interior is completed, the weld is dressed up on the outside and slightly reinforced. Fig. 2 shows the interior of the box after the welding is completed and before the "strong backs" have been removed.

The methods used in preparing for the welds are first to clamp all sections of the box together after the mudring is in position—that is, the shell is erected, the throat sheet bolted in position, the mudring is bolted to the throat and lines taken to get it in line and plumb. The flue sheet is clamped to the combustion chamber sheet and welded. All parts are then assembled in position fast to the mudring and clamped fast. "Strong backs" are bolted fast to keep the parts from warping out of shape. The box is then removed from the ring and welded.

For anyone attempting to weld this type of box there should be no scarcity of "strong backs." It will be found that the box will warp badly if not prolificly braced while welding. This trouble was, in a measure, experienced on the first box welded, due to the crown sheet not keeping its contour, with the result that the crown sheet had to be spotted to get the crown bolt heads flat against the sheet.

After the box proper is welded it is placed in the boiler and the fire hole flange on the door sheet is welded to the back head, and the mudring and sheets welded at all inside and outside corners.

The sketch (Fig. 4) of another type of box illustrates the positions of the welds and the dimensions used in preparing for the welds. The argument is sometimes advanced that the cost is in excess of the riveted type of box and hence makes it prohibitive.

I am not prepared to combat the argument when it applies to good water districts where fireboxes last many years, but in bad water districts riveted seams are a constant source of trouble with the accompanying expense and any style of box that will get away from this is a money saver even if the first cost is somewhat greater. The welded box, however, without a combustion chamber costs about the same as a riveted box, but the combustion chamber box welded costs a little more.

You who handle combustion boxes would appreciate one that did not leak and require patches at the wings. An innovation but recently tried, but now a regular part of shop practice, is the application of welded fireboxes to semi-wide boxes in the erecting shop without removing boilers from the frames.

The application of a new firebox of the usual riveted type would mean the choice of four things—none of them desirable and each one of them costly—viz.: (a) removal of boiler from frames and delivery to boiler shop; (b)

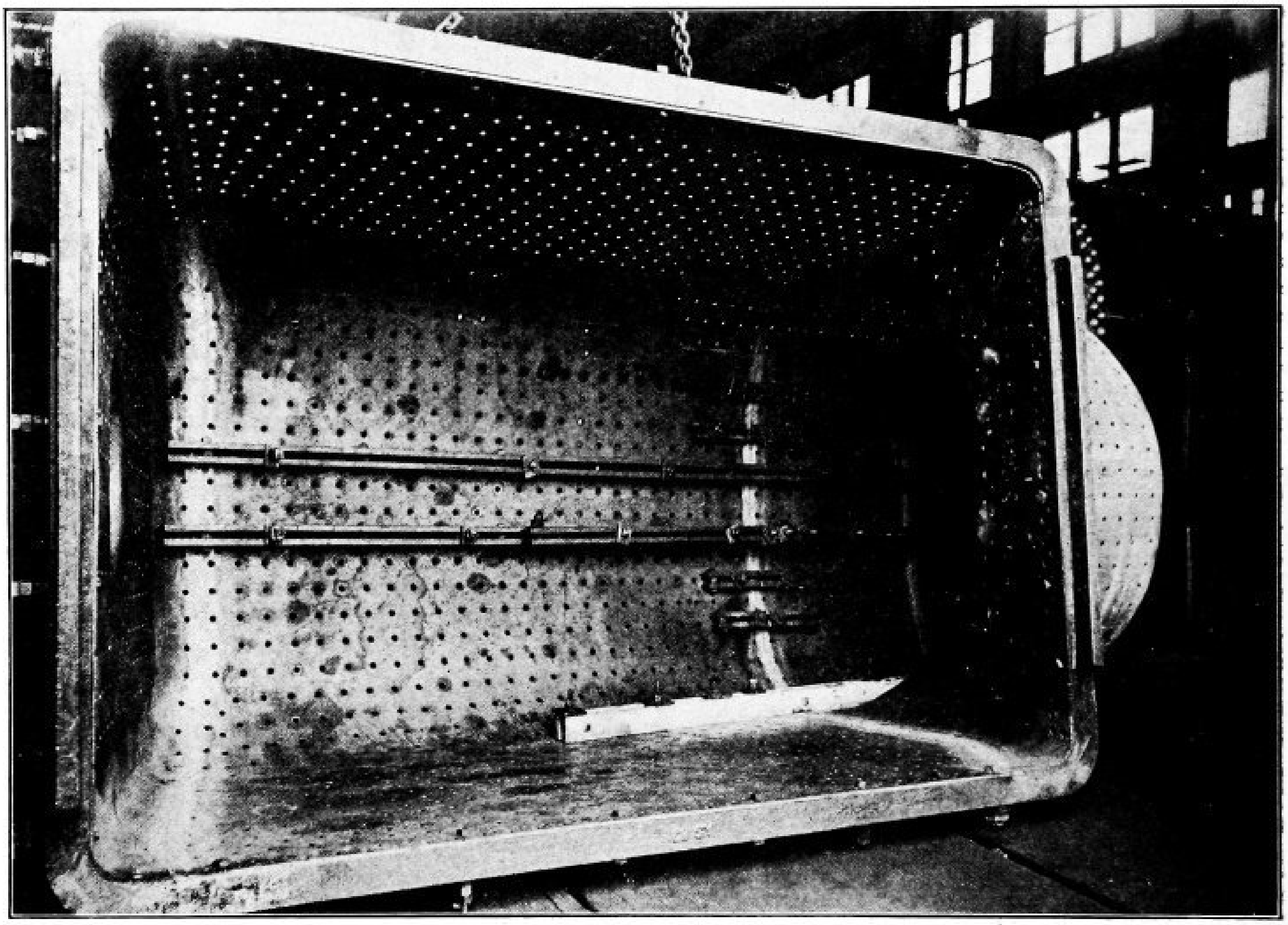


Fig. 2.—Interior of Firebox After Welds Are Finished, Showing "Strong Backs" in Place

remove back head and slip firebox in; (c) apply box in sections and rivet without disturbing boiler; (d) cut loose at connection sheet and take the whole back end to the boiler shop.

The last-named practice had been in vogue until the welding job was attempted and has been abandoned in favor of welding in position. The practice now is first to drop the mudring to fit the new box to it. This is required on account of considerable variation found in the class of boilers and might not be required on others.

The staybolts and radial stays are drilled through the outside sheet. The sheets are cut in sections with the oxyacetylene torch, and it is then but a short job to take a sledge and punch and knock them loose. In burning out the sheets the crown sheet is ripped through the middle both longitudinally and transversely, the side sheets are cut loose from the crown sheet, the flue sheet is ripped through the heel of the flange and the door sheet is ripped through the heel of the flange and also ripped off just outside the seam in the door hole. The firebox is all fitted to the mudring in the same manner as the box previously described, and then taken down and delivered piecemeal to the erecting bay. The tail plate having been removed from underneath the back end of the mudring, the ring is put in position and held there by pins through the back head and throat. The wrapper sheet is slipped under the casing and hoisted into position by means of two long eyebolts dropped down through the crown bolt holes in the wagon top and bolted to the wrapper sheet and lifted with the overhead crane. The flue and door sheets are then lifted into position and clamped fast to the wrapper sheet. The box is then trued up with the outer casing and held in position with a few bolts here and there to stiffen it for the welder.

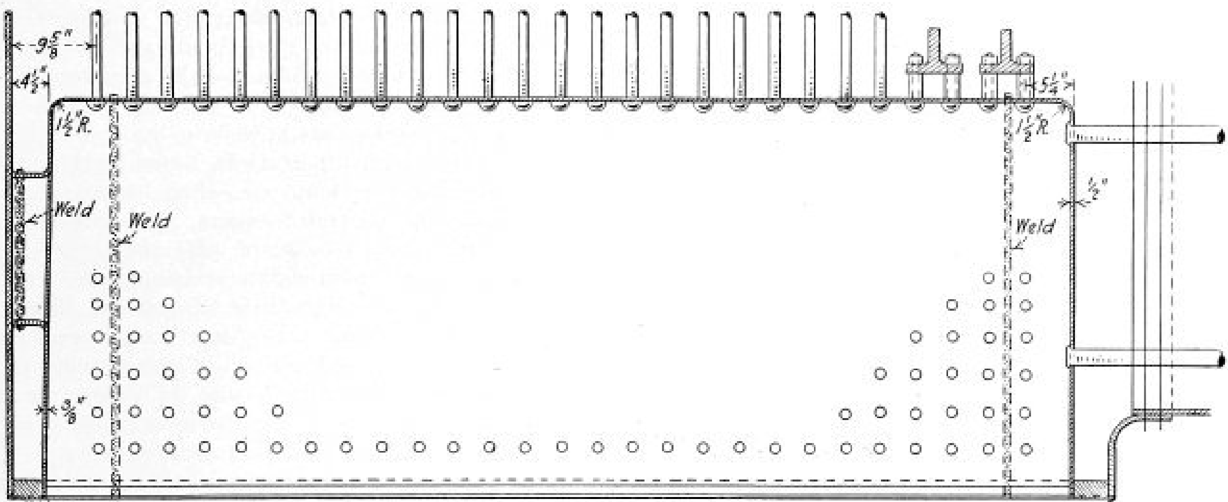


Fig. 4.—Position of the Welds

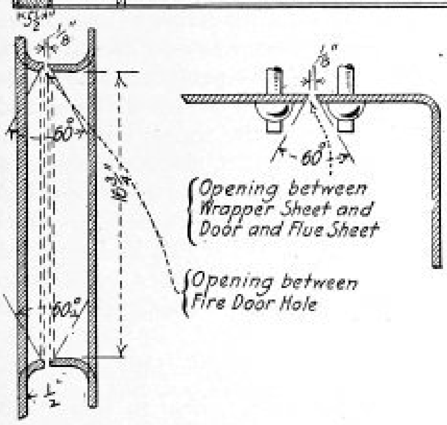


Fig. 3.—How the Welds Are Made

It takes two welders about fifteen hours each to do the welding, and the box is ready for the staybolters, riveters and calkers. This type of box seems to require no "strong backs," as the welding does not seem to alter its contour enough to be noticeable.

The writer has no data to prove the actual saving, but it must be considerable. The actual cost of the removal and application of the box is about the same as a boiler on the floor in the boiler shop, but the saving in time and in other work is considerable. We are given but about twenty-five days from the time engine arrives in shop until it leaves, and they are handled easily in that time.

A new stunt that the writer just tried out is to weld up a door hole flange on an old boiler—that is, to eliminate the seam. The job in detail was on a Wootten type firebox with two round door holes about 16 inches in diameter that leaked very much. The sheets had apparently been patchbolted repeatedly, as the holes ran as high as 1 3/16 inch in diameter, the calking edge was driven under the sheet, and the lap was very short, showing that the job had never been "iron to iron" and that each successive job improved matters but temporarily. Other than two fire cracks about ¾ inch long the sheets were in good shape.

The oxyacetylene torch was used to rip the door hole seams right through the center of the patchbolts. This removed a strip of steel about 1 inch wide from the inside and outside of the seam. The inner strip was burned into short pieces so that it could be readily removed from the mudring. The burning off of these pieces left an opening about 3/16 inch between all the holes and half holes all the way round the fire holes in both sheets. The sheets were then chipped back to leave a 1-inch opening all the way around. The door sheet was then heated and by means of a maul, sledge and top swage set out to the same diameter as the back head; this left an opening of about 3/16 inch between the sheets, just about right for welding. The sheets were welded together without the least difficulty. The holes were enlarged about 1 inch, which made no material difference, as the door frame compensated for this variation.

The two holes complete cost about $18 for all labor and gas and were completed in about twenty hours. By the old methods the job would have been either a door sheet patchbolted in or two door collars patchbolted in, either of them expensive and unsatisfactory jobs.

Shop Efficiency*

The Importance of Competent Supervision

BY GEORGE H. LOGAN†

The greatest factor in effecting and maintaining shop efficiency is competent supervision. The most modern shop with the best facilities, latest improved tools and an unlimited payroll allowance, as regards the employment of skilled and unskilled labor, when supervised by incompetent or indifferent departmental foremen cannot compete with the older shop lacking in modern facilities, but supervised by competent men. When competent supervision is lacking, machines and men do not work to capacity in a shop where labor is paid by an hourly or daily rate, or, in other words, where men are paid for their labor whether they labor or not. With a few exceptions, it does not take much to make a modern machine not worked to its capacity by an indifferent workman much less efficient than an older machine worked to its capacity by a conscientious operator.

Workmen in the poorly supervised shop, with a few exceptions, it is safe to assume, will, instead of working to their capacity, do as little as they can and hold their positions; while in the shop where supervision is close, men must perform a fair day's labor or step aside for the men who are willing to do so. Competent supervision, insuring competent workmen, make it possible then for an old shop, with less modern tools and facilities, to not only equal but exceed the output of the modern shop with the latest improved facilities, which, however, is poorly supervised.

The foreman and the gang foreman who is in direct touch with the individual workman is the man who makes most largely for efficiency and his qualifications necessarily must be many. A combination of executive and mechanical ability is to be desired, and if he lacks in either, I would rather his executive ability be the greater, as it has been demonstrated times without number that a good executive, though an indifferent mechanic, has made good where thorough mechanics, lacking in executive ability, have failed. He must be able to gain and hold the respect of his men by quiet insistence of rules in effect being recognized and the performance of a fair day's work by all. He must be quick to recognize men's individual capabilities and assign them work for which they are best qualified. He must be able to systematize and outline his work so that there are no lost movements or delays, always doing the first thing necessary first, then each succeeding consecutive move in its turn. He should be diplomatic in his dealings with department foremen, insuring harmony, though insistent upon work required from them being handled promptly. He should enthuse his men to such an extent that they take a pride in equaling or excelling an exceptionally good performance made a matter of record by another department or shop. He should be active and energetic as an example to his men, dealing absolutely fair with them, never, under any circumstances, allowing personal feelings or prejudice to influence his treatment of them and should be able to hold the competent, conscientious workmen and lose the slothful, incompetent workmen.

The above are a few of the necessary qualifications of a foreman who makes for efficiency, and the amount of labor he conserves, thereby lessening time of engines through shops for repairs, plus material saved, is a considerable item.

The number of men allotted to foremen directly in charge must naturally be governed by conditions which vary so greatly that no exact number can be specified as the absolutely correct quota which a foreman can supervise to obtain maximum efficiency. However, close supervision is conceded to be profitable, and no foreman should have under him more men than he can keep in touch with intelligently. He should be able not only to know what each man is doing, but how he is doing it.

The other shop supervisors not directly in touch with the individual workman, viz., shop foreman, assistant general foreman, general foreman, shop superintendent and master mechanic, of course, play their part in efficiency, but due to the positions they occupy they can make for efficiency only through their subordinate supervisors, and while their systems, plans, instructions and suggestions, if carried out, would make for the ultimate in efficiency, that aggravating little word "If" must be eliminated through the efforts of the foremen directly in charge of the men, to obtain the expected results.

The master mechanic, through reports from road foremen of engines, division foremen, roundhouse foremen, engineers, time limits prescribed by the Interstate Commerce Commission, and his personal observation, has a record of condition of power on his division and lines up the engines for repairs at the shops, with the shop superintendent or general foreman always seeing that an engine with suitable repairs for first shop opening is available at time pit is vacated by engine on which repairs have been completed. By doing this he insures shop being filled with desired number of engines and class of repairs best suited for shop to handle expediently.

Foremen's Weekly Meetings

Weekly foremen's meetings, held in some suitable office and presided over by shop superintendent or general foreman, make for efficiency. All department foremen and a representative from the store department should attend these meetings. Engines undergoing repairs are considered, each in their turn (it being assumed that a schedule time is set for all class of repairs). If waiting for material, the store department representative can advise date it will be received or what he will do to hurry shipment. Every department being represented insures dates given for completion of repairs as being nearly accurate, and a thorough understanding of conditions is reached by all concerned.

Shop Schedules

No shop can be efficient unless there is a fixed time set for the completion of repairs on engines through shop. There is no real need of an elaborate schedule which covers the time each separate part of an engine must be finished, but there is an absolute need of a schedule which allows a certain number of hours for each class of repairs handled, consistent with facilities the shop affords. Unless dates are set for completion of repairs there is nothing to regulate or govern the handling of work through shops in its proper turn, and it is undeniably essential that if efficiency is desired each move must be

* Paper read before International Railway General Foremen's Association in Chicago, July, 1915.
† Foreman, Chicago & Northwestern Railway, Clinton, Iowa.

made successively to insure completion of work being done in minimum amount of time.

The Chicago & Northwestern Railway has had a schedule in force for a great many years past and its worth was proven very shortly after its inauguration. Forms termed "In-and-out" sheet, spaced so as to show engines on pits in each gang under head: Gang 1-2-3-4-5, etc., and form is headed in printed letters: Eng. No.—Division—Date in—Date out—Class repairs. These are made out each week and show all engines in shop with their schedule dates and at foremen's meeting if it is found that repairs cannot be finished on schedule date a later date is set and is shown on form under heading "Engines delayed." All foremen are given a copy of this "In-and-out" sheet weekly, and all are therefore equally well posted on every engine in the shop as regards completion dates.

Several large blackboards are placed in conspicuous parts of the shop, and engine numbers and dates out of shop are shown on these boards, and boards are kept up to date, engine numbers being added daily as they are booked in shop. In addition to boards, a number of slips are printed each week after dates have been confirmed or changed at foremen's meeting. These slips are cut only wide enough to shop engine number, date out, the first engine out being shown at top of list, the rest following below in their respective positions as regards dates. The slips are distributed to all men on machines who do a special line of work and to the various special men who work on the erecting floor. The men post these slips on their cupboards or in other place where they can be readily seen by their foreman, and as they complete their work for an engine, they draw a line through its number on the slip, and foreman in passing can see at a glance whether or not man is within the time allowance set for the completion of his particular work, and if found behind he is helped out sufficiently to again put him even with schedule.

FACILITIES

Modern facilities make for efficiency, and where an improved tool or appliance will show a consistent increased output sufficient to pay a good rate of interest on investment, it should be bought and installed. Too often a shop's efficiency is retarded by reason of initial cost of tools or appliances being considered rather than the ultimate profit it would make for. Then, again, tools or appliances are purchased because of their price rather than their worth, installed, and because they do not duplicate the output or come up to the standard of some similar tool or appliance, higher priced and of higher efficiency, men in charge are criticised and oftentimes termed incompetent.

To obtain efficiency through the medium of efficient tools ought to be easy in these "show me" days, as far as tools are concerned at least. It is not necessary to specify tools because they look good pictured in a catalogue. They can and should be seen in actual service, and the manufacturers take pleasure not only in demonstrating a new tool, but in referring you to some shop or plant where their tools are in daily use. Tools should not be specified that have not actually been tried out in service and their worth a known quality, and when they are specified by shop supervisors a substitute tool should not be furnished until they are advised of substitution contemplated and given an opportunity to state their objections, if any. Whatever the equipment, it can and should be worked to its limit.

Machines should be so located that there are no retrograde movements necessary on work which several machines must care for, the shortest movements possible should be made from time work is delivered to initial machine until its completion at last machine. In a large shop, with machines on one side and erecting pits on the other, machines should be so located that each end of shop is given equal service. A sufficient number of air hammers and motors to supply all men who need them at all times are absolutely necessary, the use of a ratchet and drill where a motor can be used being a crime against efficiency. High speed drills are as essential as high speed tools for the various machines, and the shop which does not use them is a back number. Jigs and gages for drilling and laying out cost money to make, but this cost is negligible when results are considered and you must have them to be efficient.

A sufficient supply of small tools in good condition must be available, such as taps, dies, reamers, cutters, wrenches, files, etc. Of items mentioned, taps and files must be watched closely or they will be kept in service at an absolute loss. The cost of small taps and files is so small that it is possible for a machinist working with either a tap or file in unserviceable condition to consume enough extra time in three hours' work to pay for a brand-new tap or file. Do not venerate or respect age in commercial small tools or files. Oslerize them at proper time to make for efficiency. Acetylene and electric welding outfits are absolutely essential, but each would require a paper in itself to analyze. Thermit welding is a proven success and makes largely for efficiency wherever used.

TOOL ROOM

Tool rooms need especially efficient supervision, modern machines of sufficient variety and number to meet requirements, competent men to operate them and equally competent bench men. Stationary racks for larger tools and revolving racks for smaller tools, each tool in its own particular place and easy of access to distributors, are necessary adjuncts and should always be designed and located so that minimum movement of distributor is obtained in getting and passing out tools.

In a large shop where mechanics get their own tools on checks from the tool room, the delay of a minute multiplied by the number of times they occur in a day and by the number of men affected run into hours, which in turn mean dollars. Therefore energetic, quick moving and thinking men, who know the condition of all tools in their charge by reason of careful inspection and do not leave a defective tool where it may get in service, but turn it in for renewal or repairs, who are quick to detect and report a tool turned in defective which was passed out in first class condition, so that necessary action can be taken with person responsible. Men who do not visit, but transact their business in as few words as possible with those they serve, and who insist on men whom they serve being equally concise and brief, are the only men to fill these positions efficiently.

APPRENTICES

An apprentice makes for efficiency in proportional ratio to the amount of interest he shows and the amount of interest you take in him. Without his taking an interest in his work he is valueless, and if you do not take an interest in him he is handicapped. Select boys with as good an education as possible and who have a real desire to master the trade they wish to follow. Give him every opportunity to thoroughly learn his trade. Apprentice schools make for efficiency in some shops—why not schools in all shops? Employ all apprentices on probation, and if it is seen at the expiration of six months, after an earnest and conscientious effort to make him qualify, that he is not adapted to the trade, dismiss him, as he may make a splendid success in some other line of business, and you will have done him an injustice if you allow him to serve his time and then be obliged to put up with his incompetency or dismiss him, with four years of his time wasted.

SHOP DEMONSTRATOR

A thoroughly competent demonstrator in a shop of any size is an absolute necessity. It is through his efforts largely that maximum capacity of machine output is obtained. He is invaluable because of his intimate knowledge of machines, enabling him to break in a new machine or a new operator on any machine which is at all complex. His work is not confined to machines, but to any proposition which needs close checking to insure results. He conducts or supervises comparative tests of machines and machine tools and his reports largely govern purchases made. It takes an intelligent and absolutely fair-minded man to qualify for this position, and qualifying, he certainly does much to insure efficiency.

STORE DEPARTMENT

The store department makes for efficiency by keeping a stock consistent with the mechanical department's needs, and the prompt shipment of necessary material to the unfortunately located foreman of shops at an outside point where only stock common to ordinary requirements is carried. Storekeepers and shop supervisors must keep in close touch. Advance notice of engines to be shopped and the probable material which will be needed given to the storekeeper enables him to make special requisitions for this material, and it is usually available when engine is finally shopped. Where shops are located some distance from the general storehouse, material needed should be wired for only if absolutely necessary, and shipment made by passenger train or first time freight, and if material wanted cannot be furnished, point ordering material should be so advised and also told when they might expect shipment. Orders for material should be handled promptly and care taken that correct material is shipped. The one ordering material must order in such a way that there will be no doubt as to exactly what is wanted. Much time is lost by placing a vague or indefinite order, as it means correspondence, telegrams and oftentimes the shipment of a part that cannot be used, and a consequent delay. No substitute material should ever be sent to an outside point until after it has been taken up with person placing order or unless it is positively known that substitute article will answer for what was originally specified. If the store department is able, through careful study of the mechanical department's needs, to have in stock and furnish material without delaying engines, through shops, they make greater efficiency possible in shops.

SCRAP AND RECLAMATION

This is a subject by itself, but enters into efficiency so greatly that it must be touched upon. Usable material should never be allowed to get into scrap bin or pile, as scrap bin and pile are intended for scrap only, and the utmost care should be taken to see that it is used for the purpose intended only. Reclamation means reclaiming, and should refer to such material as is discarded as scrap, and is then again made into usable material through forging, rolling, casting or altering. There is a distinction which must not be lost sight of in reclamation, as anything which can be repaired is not scrap, any more than the locomotive which is out of service, because of broken parts which can be renewed or repaired, is scrap, and therefore cannot be credited to reclamation. Repair department for tools and appliances with labor employed, such as will permit of repairs being made at known profit, should be a part of efficient shops.

APPEARANCE OF SHOPS AND PREMISES

Shops should be roomy and well ventilated, windows so designed and lighting systems so planned that there are no dark spaces and glare of sun or lights so modified that the eyes of employees are not subjected to any undue strain; lockers and toilet rooms sufficient for the convenience of all employees should be installed and maintained in an absolutely sanitary condition. Clear passageways through shops should be located so that there is a minimum amount of waste movement, and being so located must be kept absolutely free from obstructions. Shops should be kept clean and tidy. Material and engine parts piled up, grouping parts of same description and never be allowed to be thrown promiscuously around the floor. The grounds about shops should be kept as neat as interior of shops and should be less difficult to keep so. If racks are used outside of erecting pits for the storage of material, there is one way and one way only to prevent the accumulation of material, and that is to not only instruct, but insist on these racks being absolutely cleaned of material when engine it cared for is completed and taken from the shop.

SAFETY FIRST

All railroads have recognized the efficiency obtained through the inauguration of the "safety first" movement on the Chicago & Northwestern Railway by R. C. Richards, and have been quick to adopt it. The good it has done cannot be overestimated. Lives and limbs have been saved and the number of injuries it has been the means of preventing is almost past belief. Improved conditions, cleaner premises, safer machines—not only because of guards which have been applied to old machines—but because the machine manufacturer was quick to recognize what this movement meant, and so designed his new machines that all dangerous parts were covered. Greater efficiency is also obtained from employees, as if fewer of them are being injured it means more competent men in service and fewer inexperienced men to break in with the attendant greater liability of injury due to their lack of experience. We, as supervisors, have made for conservation of time and material, and have been termed efficient. Mr. Richards, however, has been efficient in a much higher sense, for through his initiative and efforts has sprung a wonderful organization which conserves life and limb.

If harmony is maintained between the various departments and supervisors are such that they show the same interest in the transaction of the railroad company's business as they would in their own, efficiency will be effected and maintained.

New Wisconsin Boiler Code

The Industrial Commission of Wisconsin has just issued the new Wisconsin boiler code to govern all steam boilers except those regularly inspected by the Federal Government, steam fire engines, those used exclusively for agricultural purposes, all of less than 10 horsepower, and those on which pressure does not exceed 15 pounds per square inch. The code follows the requirements of the National Association of Stationary Engineers and was recommended by a special committee consisting of Theodore O. Vilter, Milwaukee; H. F. Bowie, inspector, Hartford Steam Boiler Inspection & Insurance Company; W. D. Johnson, secretary, Milwaukee Boiler Company, Milwaukee; R. Kunz, chief examiner, Milwaukee board of stationary engineers' examiners, and H. E. Pressinger, deputy Industrial Commission of Wisconsin.

Boiler Feed Pumps

Injectors and Steam Traps—Piston and Centrifugal Pumps

BY G. M. KOHLER

Before discussing this subject it may be well to consider the merits of the injector and the steam trap for use in feeding water into steam boilers. These two devices cannot be classed as pumps because they have no moving parts. Each has its own particular field and conditions under which it will operate most satisfactorily and efficiently as a boiler feeder.

Injectors

The injector is a contrivance by means of which live steam from a boiler flowing at high velocity through a nozzle gives sufficient momentum and velocity to a stream of water to enable it to enter the boiler. Fig. 1 shows the interior arrangement of the nozzles in an injector.

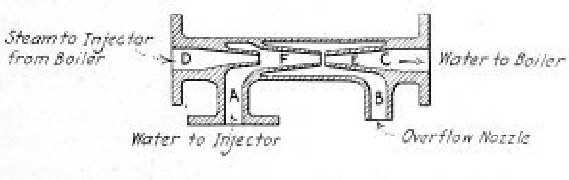


Fig. 1.—Section Through Injector

In operation steam from the boiler flows through nozzle *D*, which at first draws the air and then water from the suction pipe through inlet *A*. The steam and air, or steam and water, as the case may be, are mixed in nozzle *F*, and at first starting of the injector flow out through the annular orifice between nozzles *F* and *E* to the outlet *B*. The velocity of the stream of water through nozzles *D* and *F* gradually increases until such a velocity is attained as will be sufficient for it to pass into nozzle *E* and thence into the boiler through the feed line connected to the outlet of the injector.

In the operation of the injector the steam must be condensed by the entering feed water, and on this account an injector will not work with feed water at a temperature above 130 degrees F. Practically all the heat in the entering steam is returned to the boiler, hence the thermal efficiency of the injector is nearly 100 percent, but, on the other hand, feed water heaters cannot advantageously be used because the discharge water from the injector is very hot; for this reason, in large plants where there is considerable exhaust steam from various sources, feed pumps and heaters are always used.

Another disadvantage of the injector is its inability to maintain a continuous flow of water under varying steam pressures and capacities. When the feed water is lower than 130 degrees F. and no exhaust steam is available, an injector is the most efficient means of introducing the water into the boiler.

Steam Traps

Under suitable conditions a return steam trap is the most economical device yet invented for feeding boilers. As noted above, an injector cannot handle hot water and is not well adapted for varying conditions of load. A steam trap works best when the water is very hot and will discharge any amount of water up to its maximum capacity. The maintenance and repair expense of a return trap is much less than that of a pump. A trap does not require any lubrication and but very little packing around the small valve stems. Feed water heaters can be used and the feed water to boiler regulated by the stop valve in the feed line to boiler. The use of steam traps for boiler feeding seems to have been neglected, for there are a great many small power plants of 300 horsepower or less where small duplex feed pumps are used and exhaust steam allowed to go to the atmosphere; in such cases the installation of steam traps would mean a saving in fuel, which would soon pay for their expense of installation.

Fig. 2 shows the arrangement of a direct return trap for feeding a boiler. The trap must be placed at least 4 feet above the water level in the boiler. The trap shown is of the tilting type and operates as follows:

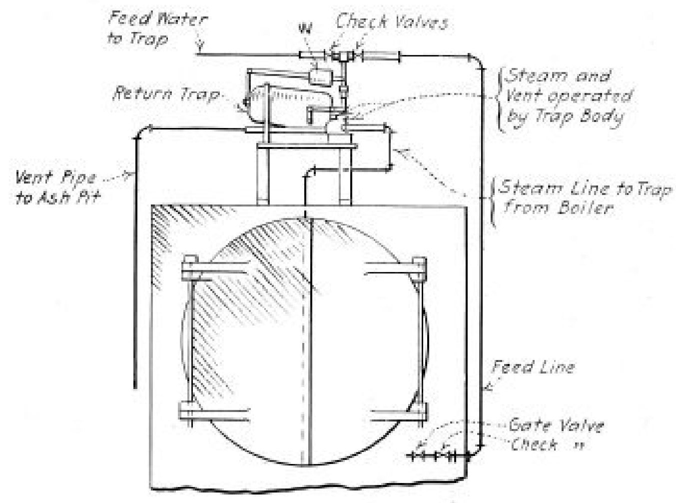


Fig. 2.—Arrangement of Trap for Feeding Boiler

The feed water flows into the trap by gravity until there is sufficient water in the body to overcome the weight of the counterweight *W*. This causes the bowl of the trap to drop down, or rather rotate, about its trunnions. This movement closes the vent valve and opens a live steam valve admitting steam at full boiler pressure to the trap and into the boiler. In the sketch it was assumed that the feed water flowed to the trap by gravity. Where this cannot be attained a second trap can be used to lift the water into the trap on top of the boiler. In some plants several different traps which drain various heating coils, vacuum pans, drying coils, etc., are so connected as to discharge into one main return trap located above the water level in the boiler. This makes an efficient method of feeding these drips into the boiler without loss of heat or energy expended for pumping.

Feed Pumps

There are two general classes of pumps—the piston type and the centrifugal. Under the former head are included pumps in which motion is imparted to the water by a reciprocating piston or plunger, such as the ordinary simplex and duplex direct acting pumps, crank and flywheel, and power-driven pumps either of the single acting or the double acting, duplex or triplex type. In a centrifugal pump motion and pressure are imparted to the water by a rapidly rotating impeller in a manner similar to which mud or water is thrown from the rim of a revolving wheel.

Direct Acting Duplex Pumps

By far the most common type of boiler feeder is the direct acting duplex pump, the packed piston type being used in small power plants and the plunger type in large

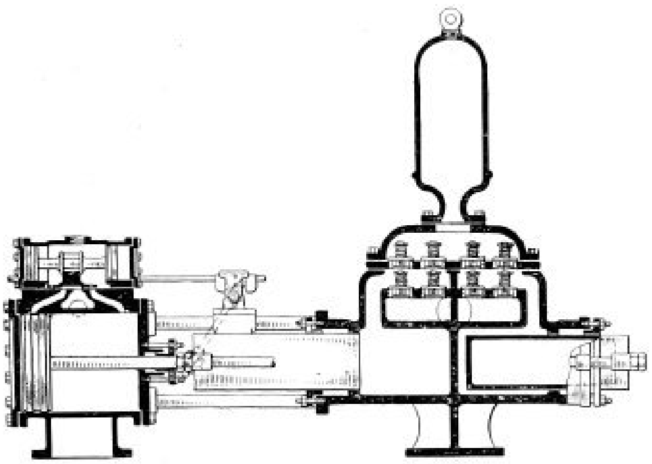


Fig. 3.—Outside End Packed Plunger Pump

plants. A duplex pump is so named because there are virtually two pumps side by side. The valve gear of the one is operated by the piston rod of the other in such manner that when one piston has finished its stroke the steam valve of the other pump is opened, admitting steam to its cylinder. The valve gear is simple and not liable to become deranged. The valves themselves are usually of the flat slide valve type and require considerable oil, especially with high steam pressures. The friction of the valves causes considerable wear on the valve gear, which in time permits more or less leakage of steam. The ordinary simple duplex pump is the cheapest type that can be purchased. It requires little floor space and head room and can very easily be automatically governed to maintain any pressure in the feed line. Its chief fault lies in its very high steam consumption.

Packed Piston Type Water Cylinders

The water end of a duplex pump may be either of the packed piston type or of the plunger type. The former type is most used in small plants, the water piston being packed with three or more rings of a linen duck packing, held in place by the follower plate. The packing is subjected to the high temperature of the boiler feed water and also to considerable friction, due to the motion of the piston. From these causes the packing quickly wears out, and as it is within the cylinder it is not definitely known just when the piston begins to leak and when it is necessary to repack, this operation requiring the removal of the cylinder heads and follower plate.

Plunger Type Water Cylinders

This type of water cylinder was invented to overcome the faults of the packed piston type, and it is in general use for feeding boilers. The displacement is obtained by use of plungers which, when worn, can be readily removed and trued up on a lathe without having to rebore the cylinder. All packing is adjustable from the outside and the amount of leakage seen at a glance, which is overcome by tightening up the gland nuts.

There are two types of steam-driven plunger pumps, the outside end packed and the outside center packed. In the former type two plungers are used for each pump, one entering each end of the water cylinder and connected by rods on the outside of the cylinders, which in turn are connected to the steam piston rod; this style of pump has no water piston rod and hence no rod packing on the water end of the pump.

The outside center packed type of pump has only one plunger for each pump, the water cylinder of which is virtually two single acting pumps. The plunger is connected to the steam piston by a piston rod, which passes through one end of the water cylinder. Hence this style of pump has one more stuffing box than the outside end packed pump. Both styles of pump are widely used and either will give good service and long life.

As far as mechanical efficiency is concerned there is practically no difference between piston and plunger type of water cylinders. This being true, the steam consumption of any pump must depend entirely upon the design of steam cylinders. The ordinary simple duplex cylinders give very low efficiency because the steam is not used expansively. The clearance spaces are large, and the pumps are apt to short stroke. The simplex type of pump, in which the piston rod operates its own valve gear, is a little more efficient than the duplex type, and in addition the valve gear is usually of a design that does not wear as much as the duplex type. The compound steam cylinders are much more economical than the simple type, since the steam is used expansively and the cylinder condensation is reduced because the range in temperature in each cylinder is very much less than in a single cylinder. If still greater economy in steam consumption is required, the cylinders can be arranged on the triple expansion type. This is not a common type of pump for boiler feeding. The extra expense is not justified, as the exhaust steam from the compound type of pump is usually used

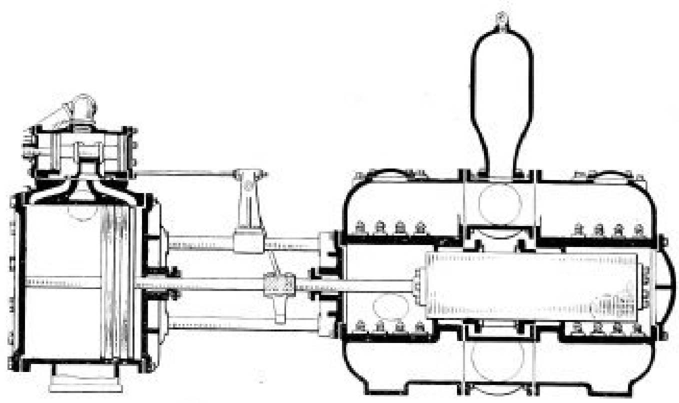


Fig. 4.—Outside Center Packed Plunger Pump

for heating the boiler feed water. The triple expansion type of pump, as well as the crank and flywheel type with Corliss engine, is used very widely in water works, mines, etc., where large quantities of water are pumped.

Power-Driven Pumps

Under this head are included all kinds of pumps which are operated by gearing or belting. The source of power may be an electric motor, steam engine, gas engine, etc. The pump may be of any type, such as piston or plunger, single or double acting, simple, duplex or triplex. For boiler feeding the single acting triplex plunger pump is most extensively used and is well adapted for this work. In many installations the pump is driven direct from the main engine, in which case the power for pumping is secured at the same cost as for other work about the factory. In some large power plants the boiler feed pumps are driven by direct current electric motors which make a flexible unit because the speed of the motor can easily be regulated. When the pump speed cannot be easily changed it is run continuously at such speed as will supply the maximum demand of the boilers. In case less water is required a bypass valve in the feed line is opened so that the excess amount of water can enter the suction pipe of the pump or into the open feed water heater or the hot well. All regulation of the boiler feed water is done by this bypass valve. In some installations a separate steam engine is used to operate the power feed pumps. The speed of the engine is then governed automatically so that a constant pressure is kept in the feed water main.

A triplex pump is very efficient in itself, and as it can be driven by the most economical Corliss engine, the cost of pumping can be reduced to a minimum when this style of pump is used. Its first cost is high, which, together with the large amount of space occupied, the more or less noisy gears and the vibration in pipe lines, are the principal reasons why it is not more widely used.

CENTRIFUGAL BOILER FEED PUMPS

There are only a very few large power plants built within the past five years that have not been equipped with centrifugal boiler feed pumps. This type of pump is well adapted to boiler feeding where the consumption of water is over 200 gallons per minute. It gives a continuous flow of water without shock or water hammer, thus insuring little trouble from leaky feed mains.

Another worthy feature is the absence of all pump valves, which in reciprocating types of pump cause considerable trouble. The speed of rotation ranges from 1,700 to 3,000 revolutions per minute, and on account of this high speed it can be driven direct from steam turbine or electric motor. With a centrifugal feed pump there is no danger of an excessive pressure on the feed mains, as is the case with a reciprocating pump. If all the valves leading from the feed mains be closed the pump will not build up any excessive pressure, as the impellers will simply maintain the impending head and will discharge no water, under which conditions the power consumed will fall to almost zero, but as soon as a valve in the line is opened the pump begins to discharge water at the required pressure. This is one of the most important characteristics of this type of pump in relation to its adaptability as a feed pump. Its further advantages are reliability, simplicity, small space occupied, inexpensive foundations, self-oiling arrangement and small amount of attendance required.

The steam consumption per horsepower of the various types of boiler feed pumps is given in the following table:

Style of Pump	Steam Consumption per Horsepower Hour Pounds	Mechanical Efficiency of Pump Percent
Small duplex	150 to 200	70
Large duplex	100 to 150	80
Small simplex	125 to 200	72
Large simplex	90 to 125	82
Compound direct acting	50 to 75	70
Triplex plunger pumps	....	85
Turbine-driven centrifugal pumps	35 to 40	60 to 65

A man had a boiler shop in which he built a boiler which was too big to get out the door by six inches, so he hired some masons to come and knock out some bricks in the arch of the door. This was dangerous, as he knew, and as he was talking over the job with the masons his ten-year-old boy came along. "Father," asked he, "why don't you dig down into the ground six inches instead of knocking out the bricks?" Sometimes we forget there are more ways than one to skin a cat. Look up and and hope, but also look down and be practical.

Design of Superheaters

BY WM. C. SHOTT

The writer has been asked on various occasions what formula he uses in figuring the amount of surface required for a superheater under varying conditions of service. The subject is one which has not received the attention it should have by writers on the subject. Their articles have mostly so far been only to give an exposition of the various types, their construction, application, etc.

Now, for the benefit of those who might be glad to add a good formula to their engineers' pocket-books, I offer the following, with an example to simplify its application:

$$X = \frac{10\,S}{2\,(T - t) - s}$$

Where X = square feet of superheating surface required per boiler-horsepower,
S = superheat required in degrees F.,
T = temperature of furnace gas at superheater,
t = temperature of saturated steam at boiler pressure.

It is not often that the value of T can be readily obtained. For practical purposes it may be calculated from the following equation:

$$\frac{1}{(T - t)^{.16}} = (.172\,H + .294)$$

where the values of T and t are the same as given above, and H is the percentage of boiler heating surface between the furnace and superheater. If there is 20 percent of the boiler heating surface between the grates and superheater, then call H = .20.

Now, take the following example:

It is desired to find how many square feet of superheating surface is required for a certain boiler, carrying steam at 175 pounds (gage). Let H, as given above, be .20. Now, from a steam table it is found that the temperature (t of our formula) of steam at 175 pounds pressure is 378 degrees F. Substituting in our formula for T we have:

$$\frac{1}{(T - 378)^{.16}} = .172 \times .20 + .294.$$

$$\frac{1}{(T - 378)^{.16}} = .3284, \text{ or } (T - 378)^{.16} = \frac{1}{.3284}, \text{ or } 3.084.$$

$$(T - 378) = \sqrt[.16]{3.084},$$

$\sqrt[.16]{3.084}$ must be solved by logarithms, which is as follows:

log. of 3.084 ÷ .16 = .489114 ÷ .16 = 3.056962; log. 3.056962 = 1140. Therefore, $T - 378 = 1140$, or transposing, we have $T = (1140 + 378) = 1518$ degrees F.

Let us suppose that we require 200 degrees of superheat, which means that the temperature of the steam on leaving the superheater is 200 degrees hotter than that corresponding to its pressure. We can now finish the problem.

$$X = \frac{10 \times 200}{2(1518 - 378) - 200} = \frac{2000}{2080},$$

or, let us say, that 1 square foot of superheating surface is required per boiler horsepower. If our boiler is a 200-horsepower unit, then we will require under the existing conditions approximately 200 square feet superheating surface.

Converter Hood Development

Layout of Conical Section with Warped Surface at the Base by Triangulation

BY C. B. LINSTROM

From the views represented in Fig. 1, it is required to make developments of patterns for the parts or segments of a convertor top or hood. The metal being of ⅝ inch thickness and butt joints used to join the parts together, the plate thickness must be duly considered.

One half of the hood at the bottom is curved, as for sections *A*, *B* and *F*, Fig. 2, which requires the formation of warped surfaces for these segments at this point. The elevation, Fig. 2, shows the degree of curvature in one direction and the plan shows it circumferentially, and which gradually decreases into the sections *C* and *E*.

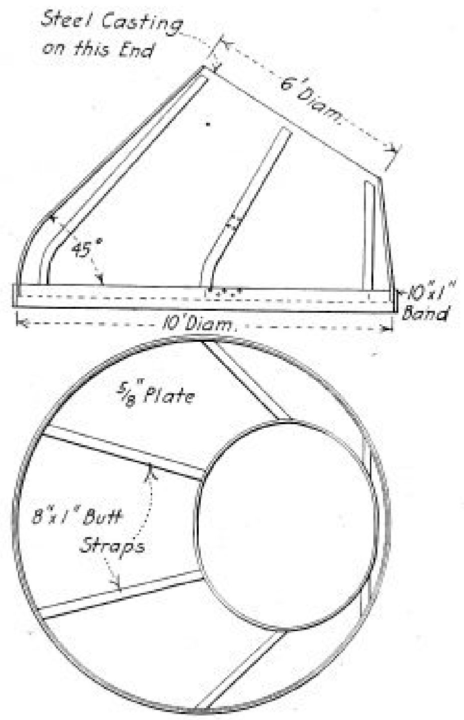


Fig. 1

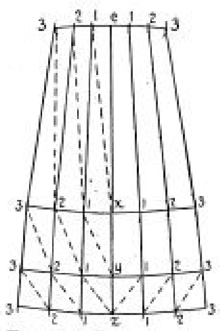


Fig. 3.—Pattern for Section A

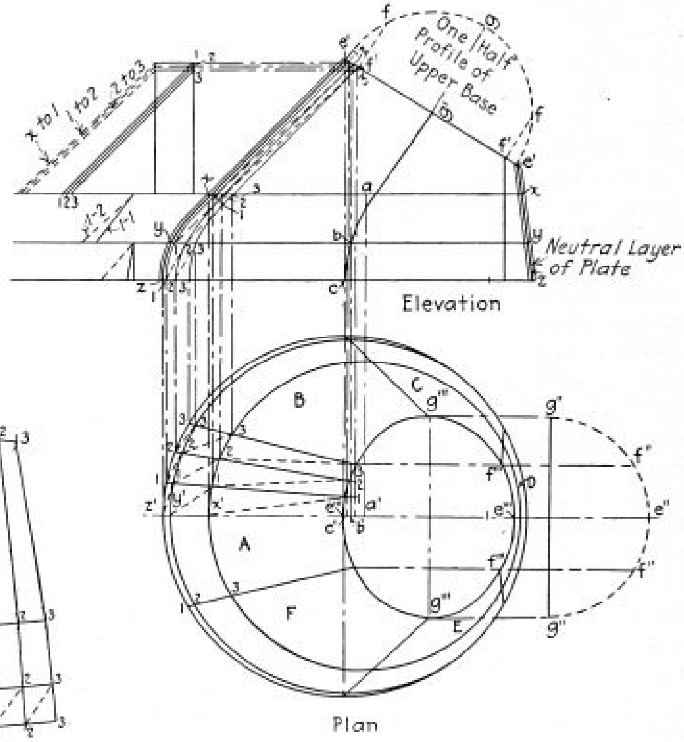


Fig. 2

The first step in the layout is to draw up a plan and elevation of the object to the dimensions of the object, but draw them to the neutral layer of the plate. The elevation can be readily drawn from the dimensions given, but to complete the plan requires a little additional work in developing the upper base of the hood, which is circular along the plane taken at right angles to *e'-e'*. Locate point *g'* and with *g' e'* as a radius draw the semicircle *e'-f-g-f-e'*. This semicircle represents a one-half profile of the upper base.

Next upon the horizontal axis of the plan *e'' z'* describe another semicircle of the same dimension and locate points *e''*, *f''*, *g''* in their relative positions with respect to the ones in the elevation. Then complete the ellipse *e'''-f'''-g'''* by development, as shown, and locate the position of the segments *A*, *B*, *C*, *D*, *E* and *F*.

For the development of patterns for *A*, *B* and *F*, the triangulation method can be applied, but to apply it in this case a number of planes must be passed through the object as shown in the elevation, as at *x-x* and *y-y*. Consider the shape of sections through these planes to be circular in form. Then locate their centers, as at *a*, for plane *x-x* and *b* for plane *y-y*. From *a* and *b* drop perpendiculars to the horizontal axis of the plan, thus locating points *a'* and *b'*. With these as centers describe the circles shown, using respectively the radii *a-x* and *b-y*. By this arrangement the segments can be divided into triangles and their true lengths found with which the patterns may be laid off.

For this example, one-half the plan of section *A* is prepared, the arcs along the bases *z-z*, *y-y* and *x-x* being divided into four equal parts and lines drawn in from 1 to 1, 2 to 2, 3 to 3, etc., and 1 to 2, 2 to 3, etc. Their vertical positions are indicated in the elevation. To find their true lengths draw right angle triangles, using for the bases the distances between points 1-2, 2-2, etc., of the plan. The corresponding heights are shown projected from the elevation to the vertical legs of the triangles. With the hypotenuses and spaces from the plan and profile of the upper base complete Fig. 3.

This problem is somewhat out of the ordinary in that it is of a conical form, having a warped surface at the base in a part of it. This condition complicates the layout somewhat, but in all cases of this kind a very close approximation of the required patterns may be secured by the triangulation system of development.

To further increase as nearly as possible accurate work with the triangulation method, it is always advisable to divide views of any form to be so developed into a great number of triangular sections, as the greater the number the nearer will be the form of the resulting patterns to their actual given dimensions.

One marked feature in this class of work where sections as of hemispherical heads and in work of the given example described here is that where the camber at the top and bottom of the patterns in the flat cannot be determined as in conical pattern problems, care must be used in getting the required degree of curvature so that the objects when assembled will lie in a straight plane across the bases.

Other layerouts no doubt have some good ideas on pattern layouts for the object shown in this article, and to bring out the different ideas on these practical problems why not express them in the columns of THE BOILER MAKER? While this problem is developed by triangulation, its patterns may be laid off by projection with satisfactory results.

Explosion of a Watertube Boiler

Rupture of Bumped Head in Watertube Boiler Causes Explosion in Lighting Plant in the Philippine Islands

BY AUG. SUZARA

It is not very common to hear of the explosion of a watertube boiler, but it may occur any time in a day as it happened recently at the electric lighting plant of the city of Iloilo, P. I., killing one baby and injuring the fireman on watch and a woman.

The plant was provided with three watertube boilers, two Stirlings rated at 150 horsepower each and one Babcock & Wilcox rated at 250 horsepower.

One evening, and while the plant was getting up ready to furnish light to the entire city, one of the Stirling boilers gave away, destroying itself and the other one also, and damaging the Babcock & Wilcox boiler as well. The plant boiler house was left a total wreckage, a mass of débris, as can be judged from Fig. 1.

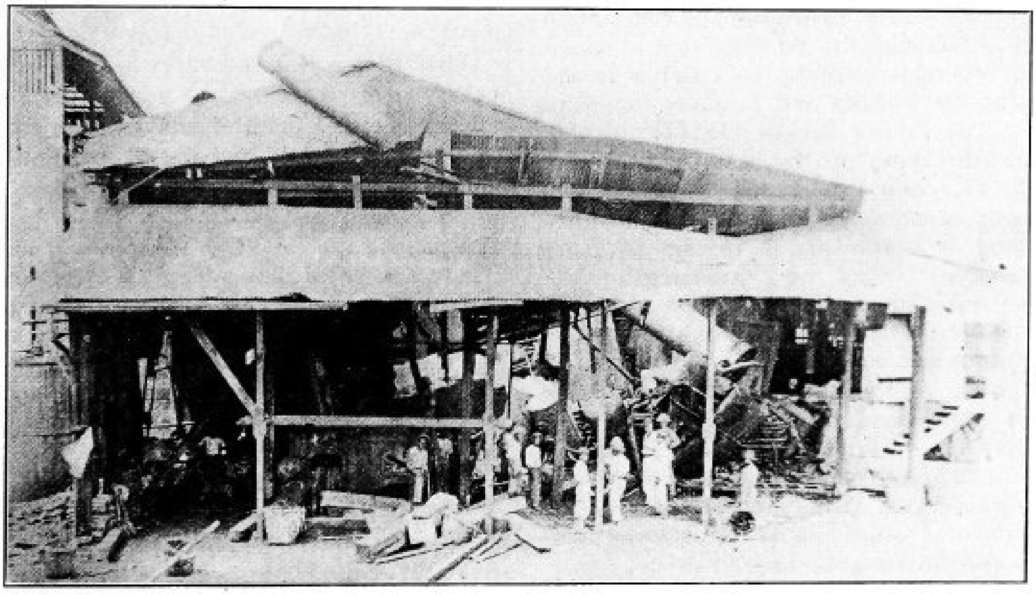


Fig. 1.—The Boiler House the Day After the Explosion

Upon investigation of the cause that led to the explosion, it was found to be due to the rupture of one of the bumped heads of one of the water drums (Fig. 2).

A closer examination of this fractured head revealed the following defects: (1) The thickness of the headplate around the turn of the bend was reduced by external corrosion to ¼ inch in some parts, while in others the thickness was found to be of 1/16 inch only (see Fig. 3, *c* and *d*). The original thickness of the plate was of about 7/16 inch, as may be estimated from the same Fig. 3 where is marked (*e*). (2) A crack about 4 inches long had developed in the bend of the flanging, which afterwards was oxyacetylene welded. This is plainly shown in Fig. 3 at (*a*). (3) The thickness of the shell in way of the girth seam was also reduced by external corrosion to 1/16 inch only, where it is marked with a (*b*) in Fig. 3 and where are also graphically shown the headless rivets. The original thickness of this shell is estimated to be the same as the thickness of the headplate.

According to the information received by the writer, the exploded boiler was built some thirteen years ago and was being worked at the time of the explosion at 130 pounds per square inch. Its tubes were renewed several times since it was installed at the plant and a periodical examination of the inner surfaces of the drums was made by the chief engineer of the plant, who tested the boilers every now and then to 140 pounds hydrostatic pressure.

From the above facts the following inferences may well be established: First, that the explosion could have been prevented had the boiler been subjected to a more critical examination of the inner and outer surfaces of the boiler, or its drums removing some, or all if necessary, of the brick setting, having in mind the age of the boiler and the crack developed on one of the water drums. This examination could have been conducted only by a competent person not connected with the plant in any way,* and not

* There is no boiler inspection law at the city of Iloilo.

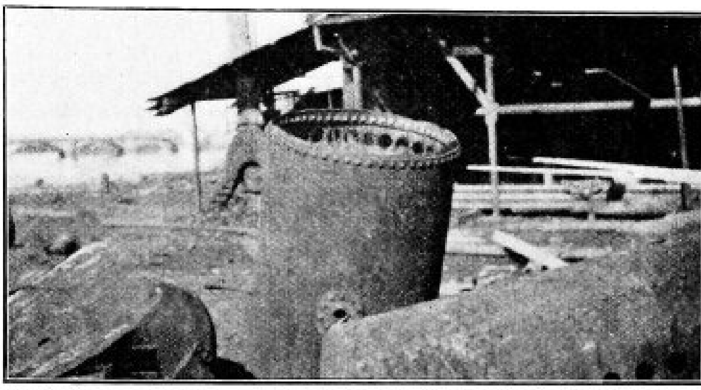


Fig. 2.—The Fractured Drum

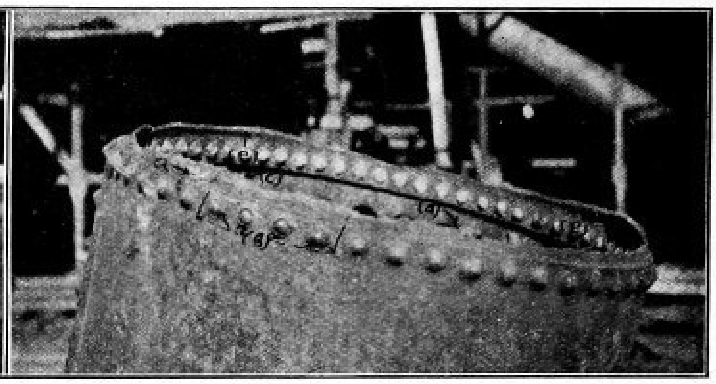


Fig. 3.—Closer View of Fractured Drum

by its chief engineer. Secondly, that had the boiler been subjected to twice the working pressure of the boiler as it ought to have been done when testing it with hydrostatic pressure, instead of subjecting it to 140 pounds only, as was the case, the defective head would undoubtedly have failed then and there. And last, but not the least, the repair done to the cracked head by building up its crack with the autogenous process was, in the opinion of the writer, a serious blunder which could not have been committed by a person not totally lacking in knowledge of the working conditions of a steam boiler. And this is so when it is taken into account the part of the boiler, the bumped head, and therefore "unstayed" of one of the drums where the repair above referred to was made, a part subjected to a frequent, no matter how little, change of temperature with consequent expansion and contraction of the plate. To this fact may also be added that of which a correct mention was made recently by a writer in the *Monthly Bulletin* of the Fidelity and Casualty Company of New York (see THE BOILER MAKER, October, 1915, p. 322), "id est," the "throbbing" of the head, or using the same words of the aforesaid writer, *"that small but perceptible inward and outward movement of the bumped head which is going on continually in rhythm with the pulsation of the engines."* And this "throbbing" of the head-plate and the tensile strain to which it was subjected tended to make ineffective if not dangerous the repair done with the oxyacetylene welding process.

This boiler explosion confirms again, in a certain way, the Colburn-Clark proposition or theory of boiler explosions, since we may infer by reasoning inductively that the weak head-plate started to burst in or near the welded crack, where the thinnest part of the head and shell plates are also located, when the boiler was at its working pressure, and immediately afterwards the entire head-plate blew off, shattering the whole structure and leaving the plant utterly useless for several days.

By using locomotive boilers of the Philippine Railway Company, the electric lighting plant was able to furnish light temporarily to the city, which was left in darkness during the nights that the plant was disabled.

A Handy Chart for Finding Areas, Loads and Stresses

This chart will be found useful by boiler designers, boiler makers or anybody who wants to save time in computing stresses in tension or compression.

The chart is so simple that explanation is practically unnecessary. To show how simple it is, take this example:

What load will a rod carry whose area is 2.25 square inches when stressed 5,000 pounds per square inch?

Find 2.25 in column *A* and 5,000 in column *D*. Lay a straight edge across and the intersection gives us 11,250 pounds in column *B*. It can also be done by just stretching a thread across from point to point. Anything straight will do. A little practice will make you perfect.

It will be noted that column *B* is to be used with column *D* only, and column *C* is used with column *E* only.

The chart is good for any stress between 1,000 pounds per square inch to 100,000 pounds per square inch. It is also good for any area, but when you go below 1 square inch or above 10 square inches be careful about the decimal point.

Results are not *absolutely accurate*, as in many cases figures must be judged with the eye, but it is as accurate as the slide rule, and we all know how universally the slide rule is adopted.

The chart can also be used "backwards" in solving for areas where the load is given and the allowable stress

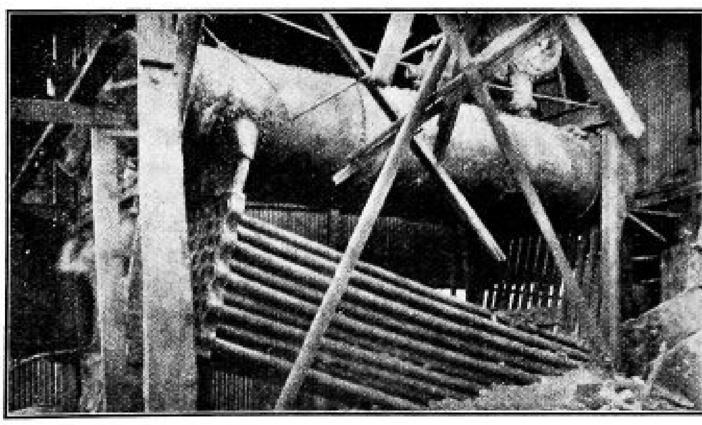


Fig. 4.—The Babcock & Wilcox Boiler

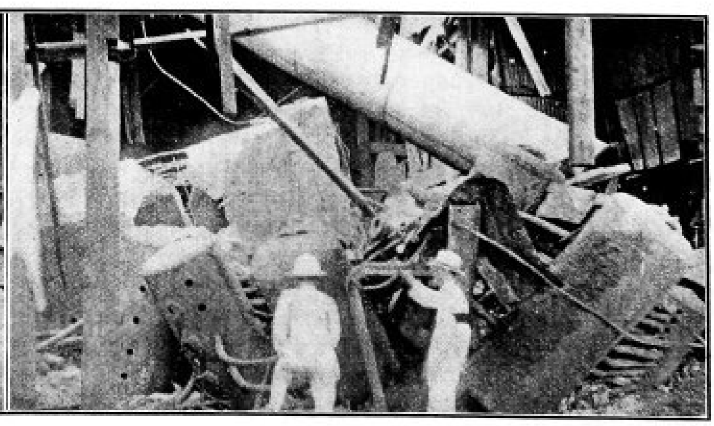


Fig. 5.—A Closer View of the Wreck

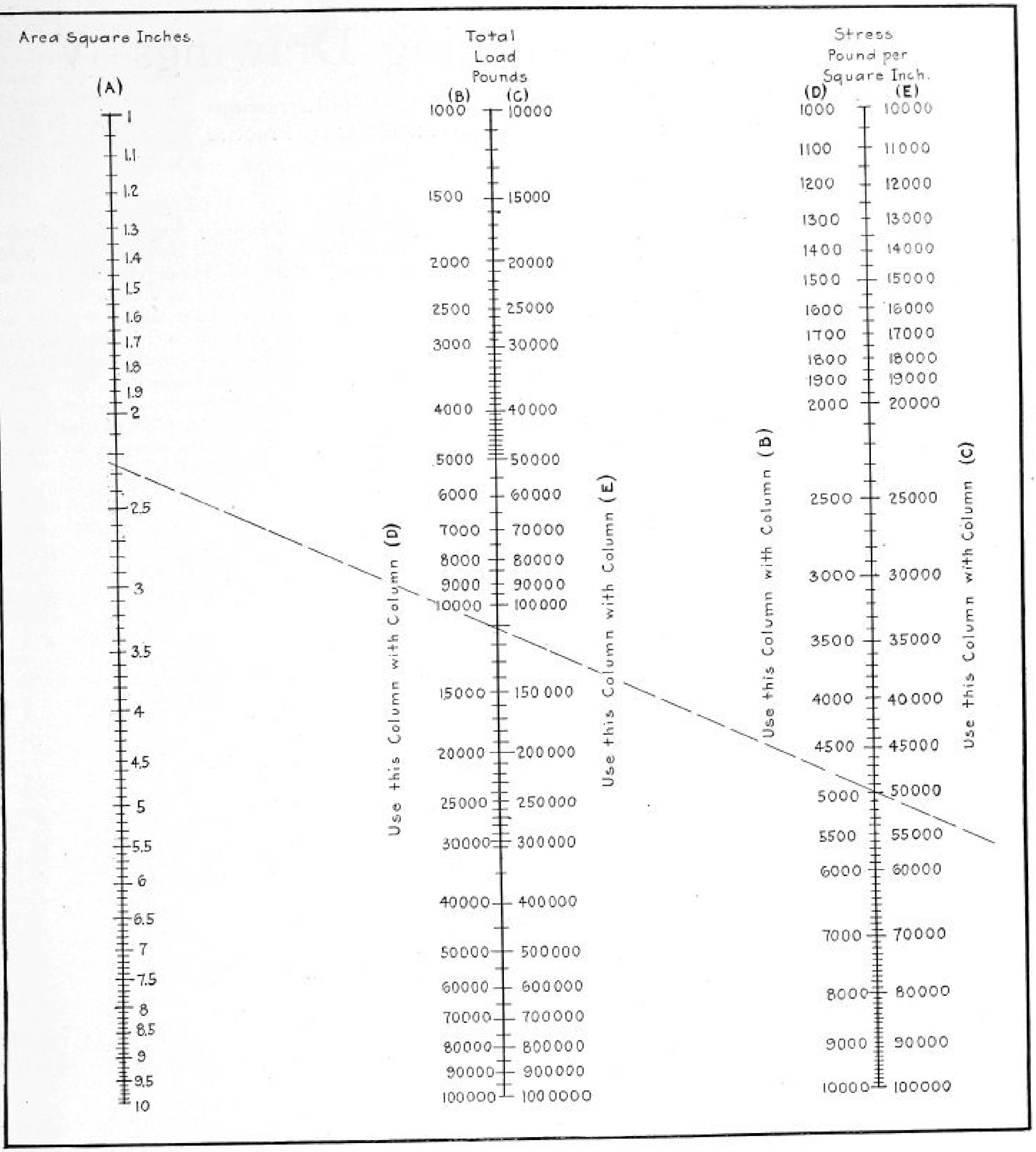


Chart for Use in Determining Areas, Loads and Stresses

per square inch. Or, it will find the stress per square inch where total load and area are known. Any two points determine the third.

New York. N. G. NEAR.

Boiler Explosions in Germany

In the entire Empire of Germany, not including those used in the military and naval service, there were in 1914, only eight explosions of steam boilers. One of these was built in 1873, one in 1874, one in 1880, one in 1881, one in 1892, one in 1902 and two in 1906. The dates are mentioned as showing that all the boilers were well along in years; the most were of the last century. Low water is given as a probable cause in five out of the eight cases. In three of the explosions no personal injuries were caused. The other five killed two, seriously injured two and slightly injured seven persons.

In the same period there occurred in the United States 575 accidents to boilers, by which 300 persons were killed and 476 more or less seriously injured; and yet there are those who protest with all the outraged righteousness of American citizenship imposed upon against any governmental control or supervision of the design and operation of boilers, or of the competency of the men that run them.—*Power.*

How to Read Working Drawings—V

Hidden Outlines and Cross-Sections—Detail Drawings Showing Construction of Tools—Examples for Practice

BY FRED WEST

When any part of an object is hidden from view, it may be shown in a working drawing by broken lines. The kind of lines was exhibited and explained under "A" in the alphabet in previous articles. An example of a hidden part shown by broken lines is illustrated in Fig. 19.

It will be seen that the scheme is a very simple one. The thickness of the spokes or web and the outlines of the hub and the flanges are clearly shown, and assuming that the reader knows that the pulley is round, a complete drawing is made in one view and on a very small space.

With a simple object as shown in Fig. 19, the broken line scheme of showing hidden parts does very well. But

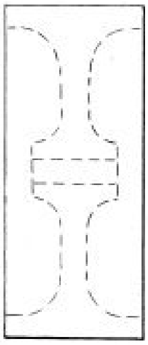


Fig. 19.—Hidden Outline Shown by Broken Lines

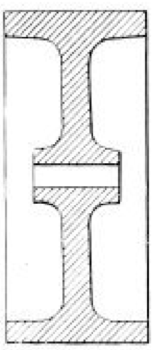


Fig. 20.—Hidden Outline Shown by Section

with objects having complicated surfaces, the scheme would be confusing and is not used. Instead, a section, or cross-section, as it is called, is made of the drawing. In this case full lines mark the boundaries of hidden surfaces and parallel lines equally spaced are drawn over the surfaces at an angle of 45 degrees. This is called cross-sectioning or cross-hatching, and Fig. 20 shows it applied to the same pulley as in Fig. 19. Both of these views show the same outlines, and neither of them shows the side view that would inform the reader that the object is round. Neither can he know whether the pulley has a solid web for a center or has spokes and how many.

The section supposes the object cut through so as to expose to view the surface that is cross-hatched. This imaginary cutting may be made at any location. It may pass clear across the object, or it may go into any partial depth. Also, it may cut some parts and leave others in the same surface uncut.

These points will be understood by the reader after considering Fig. 21. This is a standard pattern of the Jenkins globe valve. It will be seen that the body of the valve and the parts screwed directly to it are cut clear through lengthwise of the valve by a vertical cutting plane. The surfaces made by the cutting plane are either cross-hatched or colored, and each separate part is made different from the adjacent one. This difference may be shown by reversing the slope of the 45-degree lines, or by changing their form.

It will be noted that the valve wheel, its spindle, and its nut are not sectioned. The drawing is perfectly clear, showing the ten parts of the valve, without cutting through the wheel and spindle.

The valve has a composition disk, held in place on the spindle by means of a disk nut. The disk holder is held onto the end of the spindle by the lock nut. A packing or waste nut is used to enclose the packing that makes the spindle steam tight where it passes outside. The top of the lock nut is rounded and made true, so that when raised by the spindle against the flat surface on the bottom of the bonnet it will make a tight joint. This permits the waste nut to be removed without danger of a steam leak, while the packing is being replaced. The disk allows for the wear in service and may be replaced when the pressure is off.

Samples of sectioning are shown in Fig. 22. While all

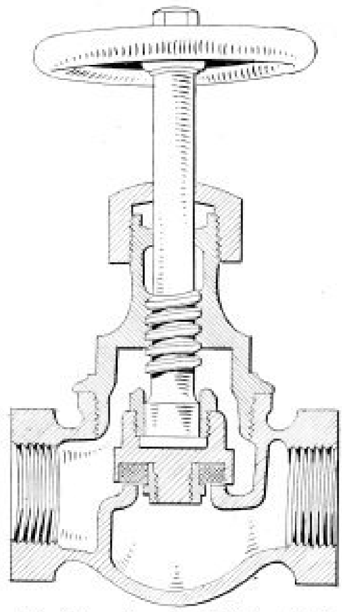


Fig. 21.—Standard Globe Valve Sectioned

working drawings are not sectioned alike for the same metals, yet most draftsmen use these forms. That at *A* is for steel, *B* is for wrought iron, *C* is for cast iron, *D* is for brass, and *E* is for babbitt and lead.

The reading of working drawings, like the reading of any style of printed information, is acquired by practice. Therefore, the mechanic should make it his practice to increase his ability in this respect at every opportunity. At first he will likely get no meaning whatever from a drawing, especially if it be of complicated construction. On this account he will make a big mistake by giving up trying. It is a wrong idea to expect to learn a system at a glance or by making a single mental dash into it. On the other hand, he should not swell up with conceit when he does understand one drawing, believing that he "knows it all." A good general rule to follow when starting to read a complicated drawing is to take up some small part first, beginning with the easiest. Continue with part after part until they can be assembled mentally and the whole construction learned in its true shape.

As a further example for reading, take that of a boiler joint, which is one that every boiler maker sees in practice in some form or other. Fig. 23 shows a triple-riveted butt joint. It is the standard pattern usually employed in the longitudinal seams of a high-pressure boiler shell. Two views are shown, an outside view as ordinarily observed, and a sectional view which gives certain details of construction that the outside view cannot show.

The two edges of the boiler plate butt square together and there is a wide cover plate or strap one-fourth inch thick laid over the joint on the inside of the shell, and a

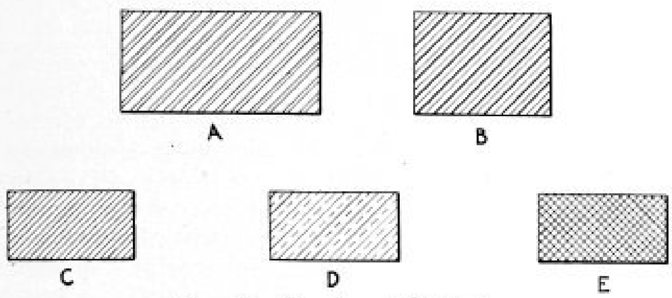


Fig. 22.—Samples of Sectioning

narrower strap on the outside. There are six rows of rivets and all dimensions are given. The only item of untruth in the drawing is that the joint is shown straight, while it should have the curve of the boiler shell. Note the two lines to form the edge of the outside plate. The necessity for these lines will be seen in the section, as the edge of the plate has been sheared at an angle of 45 degrees.

Something of the theory of the strength of riveted seams may be learned from this drawing. Thus, there are two rows of rivets equally spaced on each side of the butt. All these rivets go through the three plates and

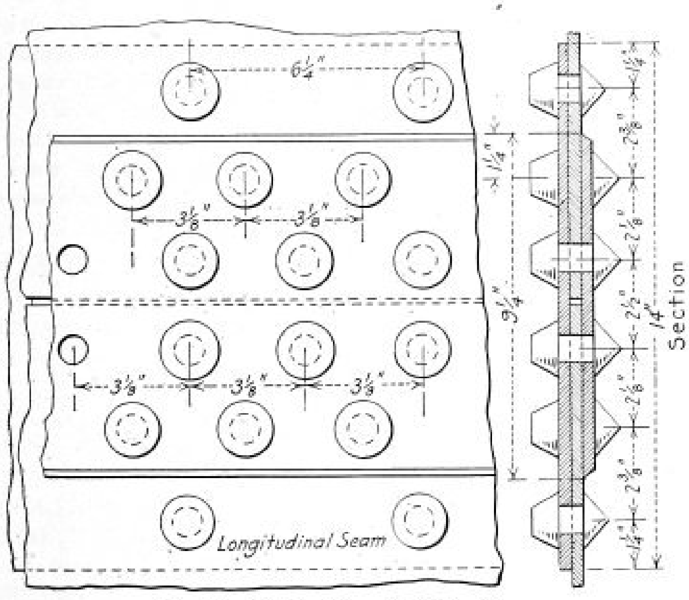


Fig. 23.—Triple-Riveted Boiler Seam

give tightness to the joint. The third and outer rows are double spaced and bind the boiler plate to the inside cover. The actual strength of the joint is really figured from the outer row of rivets. The greatest strength is in the solid plate. The weakest part is the section cut through the outer row of rivets. The strength of the shell for a length equal to the pitch of the rivets equals that of the solid plate less a length equal to the diameter of one rivet. Thus, in this example, the pitch is 6¼ inches. If the rivet hole is ¾ inch in diameter, then the net length of plate left to hold the pull is

$6\frac{1}{4} - \frac{3}{4} = 5\frac{1}{2}$ inches.

The estimated strength of the boiler shell along this line is

$(5\frac{1}{2} \div 6\frac{1}{4}) \times 100 = 11/2 \times 4/25 \times 100 = 22/25 \times 100 = 2{,}200/25 = 88$ percent.

Many interesting working drawings appear in THE BOILER MAKER. Two or three of these will be repeated here with special suggestions for reading them.

In Fig. 24 is shown a detail drawing of a beading tool made of ⅞-inch octagon steel. Four views are shown. It is designed with a round shank to fit into and be oper-

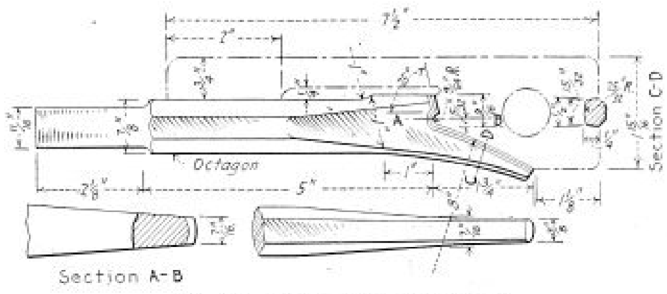


Fig. 24.—Standard Beading Tool

ated by an air hammer. When studying the sections, always note the reference line locating the section on the object. In this case sections are made at *A-B* and *C-D*. The section at *A-B* is but partial, as indicated by the ragged line at the left of the cross-hatched area. The inner face of the long prong has a curve drawn by an 8-inch radius.

As shown by the section *C-D*, the top of the prong is also curved and the radius is 25/32 inch. The radius of the beading curve is 9/64 inch. The angle of the heel is 75 degrees. A sheet metal gage 7½ inches long by 1 15/16 inches wide is shown in connection with the side view of the tool, this gage being used to test the tool outlines.

An eight-part sectional expander is shown in Fig. 25. It is made of hardened steel segments that, when assem-

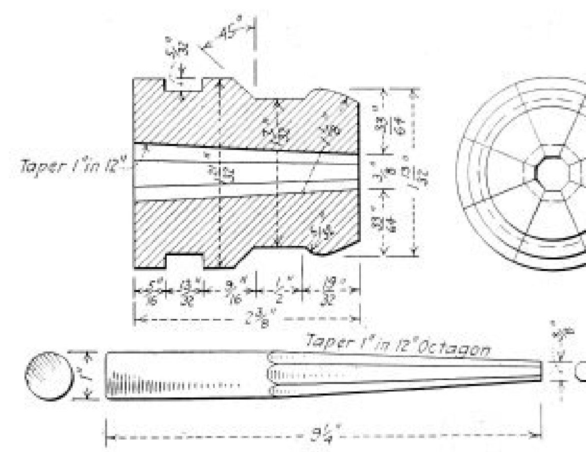


Fig. 25.—Details of Sectional Expander

bled, have a tapered octagonal hole through the center. A tapered steel plug made of 1 inch round steel, and having octagonal faces on the taper to fit into the segment ring, is driven into the holes to do the expanding. The various radii, angles, etc., of the parts are marked on the drawing. The use of broken lines on the end view illustrates the method of showing hidden parts. The sectional view is taken vertically through the middle of the segments, and the cut surfaces are wholly covered with cross-hatching.

The 13/32-inch by 5/32-inch groove around the segments at the large end is to receive a retaining ring of rubber, coil spring or of spring steel.

(*To be continued.*)

Electric Arc Welding*

Description of the Process—Its Application to Boiler Work in the Navy

BY LIEUTENANT C. S. M'DOWELL, U. S. N.

Welding is the joining of two pieces of metal of like or unlike characteristics by fusion, while in the plastic state. The old definition of welding was the process of uniting two pieces of metal by hammering them together while hot enough to be plastic. Modern methods, however, of obtaining high temperatures by means of gases and electricity has broadened the definition of welding and brought in use additional processes, to which the term "welding" has been applied. It is the purpose in this article to describe only the electric arc welding process, which it is predicted will rapidly become the standard method of joining sheet metals of all thicknesses, reclaiming castings, repairing broken machinery of all kinds, building up of worn parts, welding seams in new boilers, tanks, etc., making of high-speed tools, repairing boilers, etc., and an arc-welding equipment will be a necessary adjunct to every properly equipped machine shop.

Conditions for Successful Welding

The essential characteristics of a successful weld are: That the metal in the welded joint shall be free from impurities, slag and defects of all sorts; that it shall possess a sufficient amount of elongation, flexibility and tensile strength; and that the process of welding shall be such as to reduce to a minimum disturbances in the texture of the surrounding metal. In certain classes of work flexibility and elongation in the weld are of more importance than tensile strength.

The quality of the weld obtained with electric welding is dependent on the following: First, the furnishing of the correct amount of energy at the weld for obtaining of the proper working temperatures of the material to be welded; second, the quality of the metal electrodes (the welding wire); third, the skill of the operator.

Electrodes

There are two methods of electric are welding: One, the Bernardos process, in which a carbon electrode is used; and the other, the Slavinoff process, in which the metallic electrode is used. As a result of the tests which have been conducted, and from the experience of others in electric arc welding, it is believed that the carbon electrode process is not suited for general work, some of the reasons being that much greater difficulty is experienced in maintaining the proper temperature, and there are more chances of getting an excess of carbon in the weld. In the Slavinoff process, which is nearly universally used at present, it is necessary to have the metal electrodes of such material that the deposited metal in the weld shall have practically the same characteristics as the rest of the metal of the object worked on. As certain of the constituents of the electrode are partially lost in the arc, it is usually necessary to have the electrode contain an excess of certain materials over what is desired in the finished weld. The amount of the loss of these constituents depends upon the temperature, and it is necessary in order to obtain desired and consistent characteristics in the furnished weld to have a constant temperature at the weld. The steel companies will guarantee the results with the electrodes which they supply only if the system of arc welding with which they are used can maintain a constant temperature at the weld.

The Operator

A certain amount of skill and experience is required of the operator, no matter what system of electric welding may be used; but some types of outfits require much more skill and closer attention than others, and it is considered essential that the ideal system should require a minimum of experience and only normal mechanical skill. A system which depends primarily on the skill of the operator cannot turn out consistent work and is not suited to the navy's use.

Fluxes

Certain companies claim that a flux is necessary to obtain good results, but in the tests conducted all sorts of material and in all positions have been welded, and the best results have been obtained from systems in which no flux is used. The claims in favor of the flux are: that it blankets the weld by forming a gas around the material which prevents oxygen reaching it and thereby prevents oxidation; this has been proven not necessary by making similar welds first where oxygen was entireely excluded, and then under normal conditions in the air, and there was no difference in strength or structure of the weld. Another claim is that the flux acts as a scavenger to remove impurities from the weld; it cannot act in this way unless the metal actually boils, and this is a condition which, as previously shown, should be avoided. There are also certain users who believe a flux necessary for overhead work; but, in tests conducted, as good and consistent welds were obtained when welding overhead without a flux as in any other position. It is considered that in a good electrical welding system a flux is not necessary and is simply an added expense and complication.

Automatic Control

While it is recognized that it is desirable to have as simple an equipment as possible, it is considered necessary to have an automatic control of the input energy to the weld, the reasons for which have been previously mentioned, so that when the proper amount of energy has been determined for a particular job it will remain constant regardless of the varying of the arc length. A system with fixed resistances depends entirely on the skill of the operator in maintaining his arc length constant, and thereby the energy constant. This system gives good results at times, but our tests showed that even with a skilled operator, furnished by the manufacturer, tensile strengths varying as much as 50 percent on the same class of material were obtained. It should be possible for the operator to set the current controller at the desired amount, as well as at the panel board; the controller should automatically keep the current approximately at the fixed value. A variation of less than 5 percent can be obtained with a well-designed equipment.

Cutting

The electric arc has been found suitable for cutting, but a carbon electrode must be used; no automatic-current control is necessary, although a choke coil is advisable to prevent large inrushes of current. The amount of cur-

* *Journal of the American Society of Naval Engineers.*

rent varies with the size of the material to be cut; from 250 to 400 amperes are required for burning off rivet heads and light section plates, while from 500 to 800 amperes may be required on plates 4 inches thick. This is a momentary load, however, and a 300-ampere, continuous-duty machine is considered sufficient. It is necessary to cut away the edges of the cut and remove the burnt metal.

Preparation of Material to be Welded

The material to be welded should be cleaned with a scraper or wire brush to remove oxides and prevent forming of slag, and it is also necessary to bevel the edge sufficiently so that the distance from the electrode to bottom of the weld is less than that of the electrode to any other part of the article, so that the arc will not stray. In thick plates, where possible, and especially in castings, it is usual to weld from both sides, and in this case the original material is pointed by beveling on both sides.

Application of Arc Welding

During the past year the New York Navy Yard has had contract electric welding done on boilers of various ships. Certain defective castings have been welded, blow holes filled in others, and miscellaneous repair work has been done while the various machines were under test. Additional uses are being developed as the advantages of this method became better known. A large saving in cost over other methods of repair have been made on boiler jobs, in addition to a saving in time, notwithstanding the large profit which the outside contractors have made on the jobs. A specific application of arc welding is in the making of high-speed tools, a piece of the tool being made of ordinary steel, and high-speed tool steel is used for the cutting edge only.

Some of the various applications are as follows: Building up of worn wearing parts, pins, rollers, bearings, etc.; welding of plates in lieu of riveting, or where seams are leaking; building up of rivets, building up stripped gears, repair of cracked castings, making of high-speed tools, filling blow holes. In manufacturing work: Welding of heads on tanks, welding of tubes in tube sheets, welding of feet and end frames, etc.

Brass, bronzes and aluminium, as well as steel, cast steel, wrought iron and cast iron, can be welded, but none of the demonstrators has been able as yet to get very high tensile strength on naval brass.

Special Application for the Navy

Electric arc welding is considered especially applicable for use on shipboard for emergency repairs of all sorts. In this connection it may be noted that the British cruiser *Glasgow* put into Rio de Janeiro after the battle off Chile with several holes below or near the waterline, and was able, with an arc welding set which happened to be in Rio de Janeiro, to weld plates over the holes inside of twenty-four hours and put to sea, taking with them the arc welding set.

First Aid in the Shop

Emergency Relief to the Injured or Sick—The Training Required—First Aid Supplies

BY C. E. LESTER

The "safety first" propaganda inaugurated some few years ago is now a regular institution in most establishments, and is not now written of or discussed as much as has been usual in the past. Most of the new and novel practices and devices brought forth by the innovation are now staple and well known.

It seems, however, from perusal of mechanical journals and visits to a number of industrial plants, that an important adjunct to the safety-first movement is more or less neglected, in endeavoring to *prevent* accidents by preaching nothing but safety first and neglecting the care of the injured of *unprevented* accidents and unpreventable sicknesses.

The human element is the prime factor in a great many accidents. It generally requires very quick thinking to prevent an accident, and the quick thinker may not be there.

In spite of all the improved appliances and practices, accidents, trivial and serious, are bound to happen in industrial plants, and in order to preserve life and limb to the greatest degree possible, first aid, as well as safety first, should be taught to every employee.

The safety-first programme deals altogether with the prevention of accidents. First aid is all that the words imply, and may briefly be defined as giving emergency relief to the sick or injured.

Conservation of human life is the prime mover in both safety first and first aid. Though the objective is the same, the means to this end are entirely different.

Every employer, where the occupations are at all hazardous, and who has his employees' welfare at heart, should have a first-aid corps.

Selfish reasons, if no other, should prompt first-aid work. A perceptible disposition of the employer to mitigate the suffering of an injured employee would no doubt in many cases soften the injured person's attitude toward the employer, especially if he (the employer) were guilty of neglect and liable under the law for damages, and keep the injured person from instituting action for damages.

The selection of first-aid men to have an efficient corps should be made with a great deal of care and thought. They should be carefully selected, active men who have nerve, a steady hand, a good eye, and who are quick thinkers, resourceful and show—after training—an aptitude for the work.

There are very good reasons that all the corps possess these qualifications. The care of a badly mangled body first of all requires plenty of nerve, deft fingers, a steady hand and the training or natural resourcefulness to observe and apply quickly the necessary treatment to retain or prolong a life.

Accidents, such as cuts, bruises, contusions, sprains and minor accidents of all sorts are all too frequent, and seriously injured persons are not infrequent. An occasional accident will happen where whatever is done to help the injured must be done quickly. Again, it may not be an accident; heat prostration and cramps are more or less common in the summer months. The need of a person who knows the right thing to do is very great in a prostration case, as the lack of a little care here frequently means the loss of a life.

The one great point of distinction between the trained and the untrained is the ability to observe accurately and act intelligently. The average person knows as little of first aid as he does of calculus. It is a fact beyond dispute that many an injured person has died for the want of some simple emergency aid shortly after the accident.

There are many ways in which men may be given emergency aid training, and most of these are available in any town large enough to have a manufacturing plant. Practically all plants are so situated that men or women specially trained may be secured at various times to lecture and illustrate first-aid methods. Vicinity hospital corps and unattached local physicians can be always depended upon to assist in the training of men who will be of material benefit to them during and after training. By organizing the first-aid men into a corps and devising ways and means of securing small amounts of money, instructive literature, charts, mannikins and text-books may be secured. The American Red Cross furnishes any or all of these very nominally.

Emergency Aid Training

When a person is ill or injured to an appreciable degree the first-aid man in attendance should accompany the patient to the hospital or physician's office and assist in the further treatment. This part of the training is undoubtedly the most valuable that can be secured, as it is the practical experience that assists in making the novice a valuable and experienced person at all accidents where men are injured.

"How much to do in serious cases is difficult to say, as it depends entirely on the patient and the first-aid man." As little as the first-aid man may know, he, at least, knows more than the uninstructed bystander, and the application of his knowledge may prove of material benefit.

When forming a first-aid corps it is, of course, very essential that necessary supplies to carry on the work be secured as one of the first moves. A systematic way to handle the work and supplies is to have one central or head station in charge of the most proficient operator, where the most serious of the cases may be handled and from which point the supplies are furnished to the sub-stations, which are located throughout the plant, each in charge of an operator. There should be form blanks, which should be filled in by the operator after each accident and forwarded to the manager of the plant. It would seem advisable that the manager or some reliable subordinate be required to investigate every accident; by so doing dangerous practices or conditions would be brought before the proper person to have them eliminated.

List of Supplies

The following list of supplies may be depended upon to about fulfill all the requirements for successfully administering first aid to the sick or injured in the usual course of things. This list is for the head station only and should be kept in quantities to suit the requirements:

Adhesive plasters (1-inch), aromatic spirits of ammonia, absorbent cotton, arnica, army blankets.

Boric acid, saturated solution; bandages, 1-inch, 2-inch, 2½-inch, 3-inch.

Carbolated petroleum, sanitary drinking cups.

First-aid outfits in metal cases; first-aid text-books.

Sterile gauze; large first-aid dressings; medicine droppers; olive oil; safety-pins; soda mint tablets; nickel-plated scissors; wire splints; wood splints; stretchers; unguentine; tourniquets; triangular bandages; tweezers; eye probes; extract witch hazel; peroxide of hydrogen; tincture of iodine; essence peppermint.

There are some of these supplies that cannot be conveniently carried at the sub-stations.

However, the sub-stations, each in charge of an operator whose other duties should never take him far from his station, should have a conveniently arranged cabinet containing the following:

First Aid Outfits

Several first-aid outfits in metal cases containing: 1 long bandage with compress sewed in the center, 1 triangular bandage, 2 safety-pins, 1 card of instruction. Other than the encased outfits, the cabinet should contain: Sterilized gauze packages, absorbent cotton packages, 1 2-ounce bottle aromatic spirits of ammonia, assorted sizes gauze bandages, 1 pair tweezers, 1 eye probe, 1 pair shears, drinking cup, 1 tourniquet, 1 yard wire splints, several wooden splints, 1 Red Cross instruction book. The encased outfits are complete in themselves and always ready to be grabbed at short notice and hurried to some accident. An adjustable tungsten light should be erected at each station, to have a clear light for removing foreign bodies from the eye. The writer, as a layman, realizes fully his inability to even attempt any lesson on first-aid treatment, but a few hints as given by competent authorities may be of interest and assistance. If the first-aid man is not handy, do it yourself.

First of all, if the case appears to be serious, send for a physician or ambulance. Send a message, written, if possible, describing briefly the nature and urgency of the case, that the physician may come prepared. Keep cool. Try to get rid of everyone who cannot be used. If you can't get rid of them, keep them back from the patient—fresh air is very helpful in all cases. For injuries where removal of some of the clothing is required, try not to destroy any more than is necessary. The patient may not have the means to readily replace the destroyed articles. Rip open seams instead of cutting cloth.

Course of Action

If the injury be a bad cut in any of the limbs the action and color of the blood will determine the kind of hemorrhage it is. If the blood is bright and spurts out, it is arterial, and if dark and steady flowing it is venous. If a tourniquet is necessary to stop the flow of blood, one may be improvised from a piece of rope, belt or handkerchief knotted loosely above the wound if arterial hemorrhage, and below for venous, and twisted tight enough with a stick or bolt to stop or greatly retard the flow of blood. A tourniquet should not, however, remain in place over about one-half hour, as the part will die from loss of blood. The bleeding part should be elevated if possible. Stimulants should be given cautiously, to avoid exciting heart action.

Severe injury of most any sort may be followed by prostration or shock. Lay the patient on his back, with the head low, and give stimulant, if obtainable, to revive heart action. Loosen all clothing. Fainting and shock manifest many of the same symptoms and frequently the sprinkling of the face with cold water and fanning the patient will revive him.

For temporary splint for a broken bone any stiff material, such as cardboard, light board, or even a piece of 1/16-inch iron, may be used—anything to stiffen and control the spasmodic twitching of the muscles—until the physician arrives. In all serious cases where these conditions prevail, bind up the broken bones, dress wounds and control hemorrhages before attempting to revive the patient.

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An unusual opportunity to thoroughly test a typical consolidation locomotive of the type which forms about one-third of the total locomotives in service on American railways was recently given to the University of Illinois by the Illinois Central Railroad. These tests constituted the first work of the recently established locomotive laboratory at the university. The boiler of the locomotive was of the crown-bar type with straight top and wide firebox, built for a working pressure of 200 pounds per square inch. The outside diameter of the first ring of the boiler was 80 inches, the number of tubes 413 and their diameter 2 inches. The total heating surface was 3,283 square feet and the total grate area 49.55 square feet. The fuel used was run-of-mine coal from Mission Field mine, Vermilion county, Illinois, which varied in heat value from 11,835 to 12,848 British thermal units per pound of dry coal.

When the locomotive was received at the laboratory the engine had been in service three and one-half years, and had run 107,800 miles. Immediately preceding the tests, the locomotive had been in service only five weeks after receiving general repairs, and was in good condition when it arrived at the laboratory. The results of the first series of tests, which were made with the locomotive in this condition, were not quite so good as had been anticipated, and, in the endeavor to do whatever was possible to improve the performance, various changes and repairs were made to the valve gear and engines and the exhaust nozzle was enlarged from 5¼ inches to 5⅞ inches. Following this work the locomotive was run the equivalent of about 1,200 miles and, after this run, the locomotive was then subjected to a second series of tests. In general, the results showed what could be expected from this class of locomotive in ordinary service, and also when the locomotive had been put in first-class condition and various refinements made to improve its performance to the fullest extent.

The maximum amount of dry coal fired per square foot of grate per hour during any of the tests was 224.5 pounds, an amount much in excess of what is usual or desirable on hand-fired locomotives in service. The maximum quantity of cinders ejected into the front end and from the stack amounted to 27.4 percent of the dry coal fired. This cinder loss also is quite unusual, and it occurred under conditions which rarely prevail in service, the draft during this test being equivalent to 12.8 inches of water in front of the diaphragm. During the test, in which the heating surface was forced to its greatest activity, the total equivalent evaporation per square foot of heating surface per hour was 17.65 pounds. This rate of evaporation is altogether unusual in service and has been exceeded only rarely under test conditions.

During the second series of tests, when the locomotive was in first-class condition, the average boiler pressure varied from 191.5 to 199.2 pounds and the feed temperature ranged from 44.7 to 63.6 degrees. The rate of combustion varied between 39.9 and 224.5 pounds of dry coal per square foot of grate per hour. The equivalent evaporation per square foot of heating surface per hour varied from 5.26 pounds to 17.65 pounds.

Assuming the customary convention of 34.5 pounds of equivalent evaporation per hour per horsepower, the boiler of this locomotive developed a maximum horsepower of 1,680. This maximum equivalent to one horsepower of 1,680. This maximum is equivalent to one horse-each .295 square foot of grate area. The equivalent evaporation per pound of dry coal ranged from a minimum of 4.94 to a maximum of 8.75 pounds. This range represents as good a performance as would be expected from the grade of coal used. The efficiency of the boiler, which represents the combined efficiencies of the furnace and of the boiler proper in producing and utilizing the heat, varied from a maximum of 67.61 when the rate of combustion was 67.3 pounds of dry coal per square foot of grate per hour and a minimum of 38.77 percent when the highest rate of combustion prevailed; that is, of 224.5 pounds of dry coal per square foot of grate per hour.

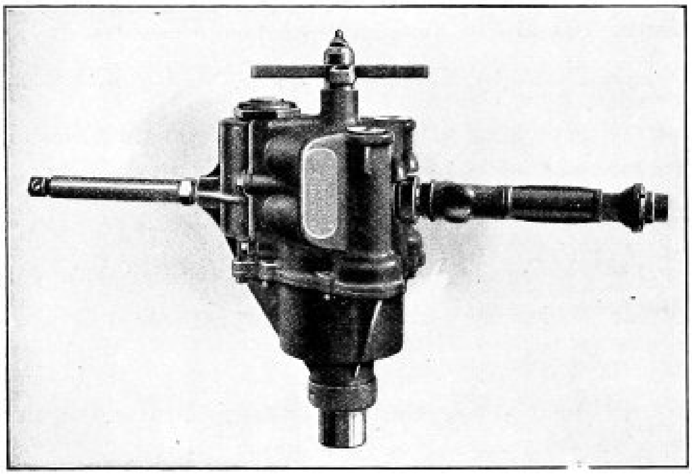
In attempting to draw from these results inferences concerning the performance of locomotives in service, it should be remembered that the boiler was forced somewhat beyond the limits which would ordinarily be maintained in service, so that the maximum test value of such measures of boiler activity as draft, the rate of combustion and rate of evaporation are somewhat greater than the values which would be maintained on the road, except for very short periods.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Portable Pneumatic Drill for Exceptionally Heavy Duty

The "Little David" line of pneumatic drills, manufactured for the Ingersoll-Rand Company, New York, has been increased by the addition of an exceptionally powerful compound geared model, No. 11 SE. This drill is reversible and is adapted to the heaviest flue rolling, drilling, reaming and tapping. It is particularly recommended by the manufacturer for tapping on flexible staybolt work, running in staybolt sleeves, locomotive valve setting and kindred heavy-duty operations. It is so constructed that



"Little David" Drill for Heavy Work

it develops full power on the reverse as well as the forward motion. This is pointed out to be of particular advantage in that, after running a flexible staybolt sleeve up tight, the No. 11 SE, due to its unusual power on the reverse motion, will unscrew the sleeve cap. This obviates the necessity for the usual cumbersome wrench.

This drill has the one-piece, gear-timed valves and ball and roller-bearing crankshaft and connecting rods and general simplicity of construction, which have been features of the pneumatic drills of this manufacturer. It is ordinarily furnished with a No. 5 Morse taper socket. It operates at a free spindle speed of 100 revolutions per minute.

Thomas-Langley Gage Cock

Several years ago Mr. T. J. Langley, Asst. S. M. P., and Mr. E. Thomas, M. M., of the Oregon-Washington Railroad & Navigation Company, conceived an idea of a self-grinding gage cock. After much experimentation the idea was worked out successfully and the gage cock was made. Service tests showed the necessity for some changes, but the idea, as incorporated in the first set, was shown to be most unusually good.

The purpose desired in the design of this device was a free opening to test water level, a tight closing to prevent leakage, easy operation, and a means whereby the valve can be ground free of obstruction without the use of any tools, and without the necessity of removing the valve from the boiler or removing the pressure from same.

The operation of the valve is very interesting indeed. If leaking develops, a slight twist left and right of the handle is all that is usually required to quickly grind the valve free, so that it will close tightly. In aggravating cases it is sometimes necessary to twist the handle back and forth several times. While this is being done the pressure in the boiler holds the valve tightly against the seat. When it is desired to open the valve the handle is turned in the usual way, except that the valve merely turns on the seat and does not open until one full turn has been completed, when the stem commences to force the valve proper off its seat. The construction of this

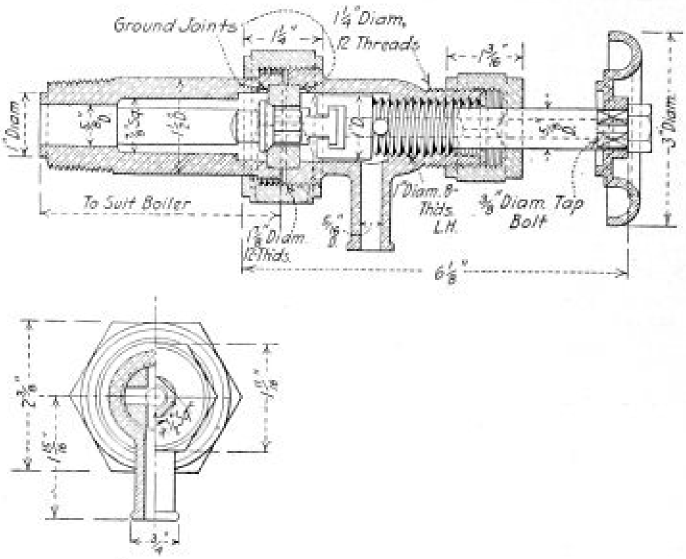


Fig. 1.—Details of Self-Grinding Gage Cock

valve is shown on the drawing (Fig. 1). A close study of this drawing will show its operation.

In explanation of the details we quote from Mr. Langley's description the following:

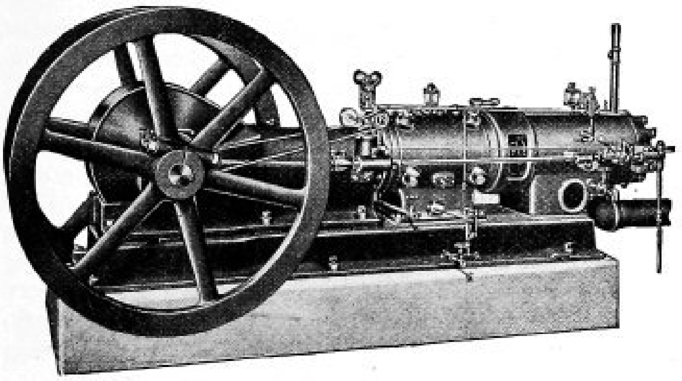
"The length of the slot at the end of the valve determines the amount that you can rotate the valve on its seat. We generally allow the slack to be equal to one thread on the stem, which will allow one complete turn on the seat. However, this full grinding effect is maintained when the valve is returned to seat by the screw. In ordinary practice the engineer will only turn this valve the same amount as an ordinary gage cock, which is gained by turning the stem until the stem just clears the end of the valve. Then, by turning the valve to the left, it opens, and by turning it to the right it closes by pressure. In case a little scale or foreign substance gets under the seat, by turning the valve to the right and left quickly it will be displaced or ground off.

"These gage cocks are made so they can be cleaned out under pressure by using a hollow stem. In real bad-water districts, would recommend the hollow stem so the gage cocks can be cleaned out and run the thirty days according to law.

"Never had any of these cocks leak. The only work done was to remove them and clean them, according to law. When any work is required the nipples can be placed at any angle without any undue turning of the nipple in the boiler."

"Chicago Pneumatic" Fuel Oil Driven Compressors

To produce air compressors with low operating costs and of low first cost, well suited to rough, heavy duty under all sorts of abnormal conditions, but with all the operating qualities of economy and simplicity necessary to high-grade stationary performance, has been the aim of the engineers of the Chicago Pneumatic Tool Company, Chicago, in the development of their Class N-SO fuel oil driven compressors, one of which is illustrated. The importance of these "Chicago Pneumatic" N-SO compressors lies in the fact that they operate on the lowest grades of fuel distillates. The compressors are guaranteed to run on any mineral oil of 28 degrees Beaumé scale or lighter, containing not over 1 percent sulphur. There are a number of oils well below 28 degrees Beaumé scale, on which they will operate satisfactorily, but this depends upon the characteristics of the particular oil, such as its asphaltum



"Chicago Pneumatic" Class N-SO Air Compressor

content, freedom from sand, etc., so that a general guarantee cannot be given, though recommendations for heavy oils can and will be made. Most of the common, crude oils, fuel oils and residuums are naturally included in the above guarantee. A few of the well-known oils particularly suited to the operation of the compressors are as follows: Star oil, Diesol, Calol, stove oil, Solar oil, gas oil, kerosene and all of the distillates between kerosene and lubricating oil. A number of the above fuels are obtainable for three cents per gallon, so that N-SO compressors are warranted to compress air to 100 pounds pressure at a cost not exceeding 56 cents per day of nine hours for each 100 cubic feet per minute of free air delivered to the receiver.

Class N-SO compressors are of the horizontal, straight line, single-stage type with compressing cylinder bolted to the main frames and closely connected in tandem to the power ends. The propulsive cylinders are of the valveless, two-cycle, low-compression design. Ignition is produced by a patented, positive-acting, hot-plate system that eliminates all electric apparatus, such as magnetos, timers, mixers and spark plugs.

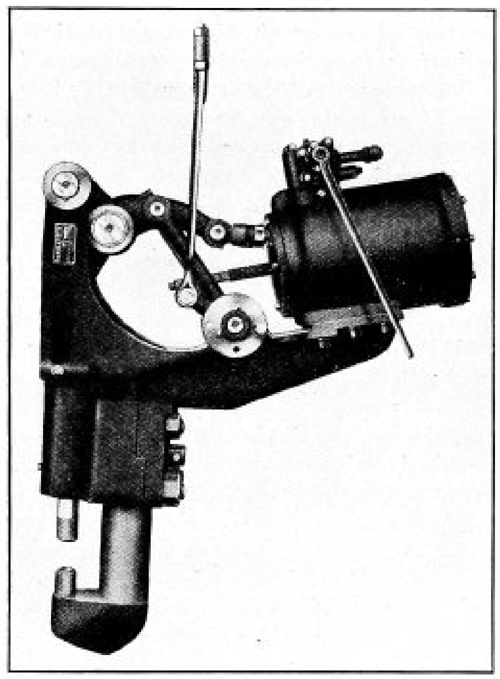
Just as in the Diesel engine, combustion takes place at the end of the compression stroke. The importance of this exclusive feature of design is immediately apparent. Air only is compressed in the cylinder of an N-SO, and combustion is so complete by the time the exhaust port is opened that the fuel loss is negligible. The result is attained through the medium of a small oil lamp which injects the fuel against the hot plate on the piston as it approaches the end of the compression stroke. Increased economy is obtained by the use of water with the fuel oil. The quality of both oil and water admitted to the combustion chamber is controlled by a fly-ball governor.

The outstanding features of the compressing cylinders are, of course, the patented "Chicago Pneumatic Simplate" flat disk air inlet and discharge valves, which make possible the highest compressor speeds and efficiencies. They are the only valves obtainable in American-made compressors of concentric plate construction. They are guaranteed for three years, and the company's records show that with 20,000 valves in constant use there has not been a serious complaint to adjust or cause indicated for any appreciable modification in design.

N-SO compressors are made in both single and duplex machines. Single compressors come in six standard strokes, 8, 10, 12, 14, 18 and 21 inches. The smaller size may be tank mounted and the larger types set on skids, so that their use is not confined to stationary requirements. The adaptability of these machines to severe service conditions renders them particularly attractive to mines and contractors, but they are equally desirable for railroad and industrial shops, for pumping oil and water by various systems, and for use wherever cheap compressed air can be utilized.

Hanna Riveter for Driving Boiler Door Ring Rivets

A specially designed Hanna type riveter manufactured by the Hanna Engineering Works, Chicago, for driving boiler door ring rivets, has been placed on the market by the Vulcan Engineering Sales Company, Chicago. The stake is of nickel steel; the frame, main lever, guide links, toggles, plunger and piston-rod head are all of steel castings; the main frame bushing and cylinder parts of cast iron; and the lower toggle, die screw, lower die holder,



Special Hanna Type Riveter

dies and piston rod of a specially selected high-carbon steel.

The usual Hanna mechanism is applied, in which there is combined, in a simple form, toggles, levers and guide links to give the large opening of the toggle joint movement with its gradually increasing pressure, until the desired pressure is reached, then a simple lever movement throughout a considerable space under approximately maximum pressure. This space is sufficient, so that there need be no uncertainty about the pressure applied on the rivet; and the machine, once adjusted for a certain length of rivet and thickness of plate, will require no further adjustment for ordinary variation in lengths of rivets, size of holes or thicknesses of plates, thus producing "hydraulic results" with a pneumatic riveter.

Sampling and Analyzing Flue Gases

As the analysis of flue gases tends to develop better methods of firing, which in turn reduces waste of fuel, the Bureau of Mines, Department of the Interior, in a Bulletin on "Sampling and Analyzing Flue Gases," by Henry Kreisinger, engineer, and F. K. Ovitz, assistant chemist, just issued, presents for the benefit of those in charge of boiler plants and all other persons interested detailed information on methods of sampling and analyzing flue gases, and on the utilization of the analyses in promoting boiler room economy.

This bulletin (No. 97) is intended to be a companion to Technical Paper 80, "Hand Firing Soft Coal Under Power Plant Boilers," and is written in plain and nontechnical language, as far as possible, so that it may be readily understood by persons who have not had the advantage of a technical education. Whenever possible, illustrations of apparatus and methods of handling have been used rather than elaborate descriptions.

The material presented in this report is arranged in two parts. The first part contains the description of the apparatus and the methods used in sampling and analyzing flue gases. The second part gives experimental results obtained with the different methods of sampling and collecting flue gas that are recommended in the first part of the report.

Only simple apparatus and methods are considered, as they are accurate enough to show the large heat losses due to the use of too much air, and are also accurate enough to indicate any incomplete combustion losses of economic importance. Without doubt the loss due to large excess of air is the greatest one in the boiler room, and can usually be greatly reduced by making proper use of gas analysis. Before engineers in the isolated industrial plants can be induced to analyze for small traces of combustible gases they must be first taught how to analyze for carbon dioxide, and they must learn to appreciate the great possibilities of reducing loss from large excess of air. Furthermore, in the face of the great difficulty of obtaining a fair average sample, it is doubtful whether more delicate apparatus for analysis and more refined methods would be of much advantage.

Those who wish to obtain information on the more accurate methods of analysis of gases are referred to Bureau of Mines Bulletin 12, "Apparatus and Methods for the Sampling and Analysis of Furnace Gases," and Technical Paper 31, "Apparatus for the Exact Analysis of Flue Gas," which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at a cost of five cents each. Bulletin 97 may be obtained by addressing the Director of the Bureau of Mines, Washington, D. C.

Questions for Readers to Answer

1. What is the weakest portion of the longitudinal seam, the net section of plate at the longest pitch of rivets or the net section of plate at the shortest pitch of rivets, and why?

2. What is meant by single and double shear of rivets? Explain with an illustration.

3. Can a slightly pitted boiler shell be brought back to its original thickness, so that its required factor of safety will be regained, by cleaning out the pitted cavities and welding or filling them up? Would it be advisable to reclaim pitted shells by the welding process if they are slightly pitted to the extent of four or five pitted spots?

INQUISITIVE.

Valves to Meet Requirements of A. S. M. E. Boiler Code

The following manufacturers have advised that they are prepared to supply valves built to meet the requirements of the A. S. M. E. Boiler Code: American Steam Gauge & Valve Manufacturing Company, Boston; the Ashton Valve Company, Boston; the Consolidated Safety Valve Company, New York; Crane Company, Chicago; Crosby Steam Gage & Valve Company, Boston; and the Lunkenheimer Company, Cincinnati, Ohio.

In ordering valves to meet these special requirements, it will be necessary to specify that they are to fulfill A. S. M. E. requirements.

Safety the Real Reason for Boiler Laws

On a recent visit to Maryland in the interests of boiler laws, the writer ran across a very striking illustration showing the necessity of legislation for boiler inspection.

The city of Baltimore has a boiler inspection law that does not apply outside of the city. The city inspectors condemned a boiler in a plant in Baltimore, and the man put in a new boiler, selling the old one as a second-hand boiler, and it was installed in a factory on the Eastern shore. About six months later the boiler blew up, killing six people outright and seriously injuring several others, and causing considerable property damage. The Workmen's Compensation Bureau of the State is now working on this loss.

The Results of Locomotive Boiler Inspection

The annual report of the chief inspector of locomotive boilers for the fiscal year ended June 30, 1915, has just appeared. In four years of service the annual number of accidents has been reduced from 856 to 91, the number of persons killed by such accidents from 91 to 13, and the number of persons injured from 1,005 to 467. Even during the past year 32,666 locomotive boilers and their appurtenances were found defective, and 2,027 were ordered out of service. In the face of facts like these there are those who oppose such inspection and supervision as an unwarranted interference.

Personal

J. N. Gallagher, foreman boiler maker of the Illinois Central Railroad Company, at Birmingham, Ala., has resigned to accept a position with the O'Malley-Beare Valve Company, Railway Exchange Building, Chicago, Ill.

D. W. Philips, formerly general foreman boiler maker for the R. D. Cole Manufacturing Company, Newnan, Ga., has accepted the same position with James G. Heggie & Sons, Joliet, Ill.

E. H. Tredinnick, formerly foreman boiler maker of the Erie Railroad at Buffalo, N. Y., has been appointed foreman boiler maker of the Lehigh Valley Railroad at Buffalo.

Harry Lutz has been appointed assistant foreman boiler maker of the Lehigh Valley Railroad at Sayre, Pa., vice Thomas Jones, resigned.

Robert Rumble and Thomas McCloskey have been appointed boiler inspectors.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Short Flues in Locomotive Boiler

In all of the articles that have appeared in THE BOILER MAKER I have failed to see any instances mentioned where the flues were short in the front flue sheet. Recently I saw a set of flues in a locomotive boiler carrying 200 pounds pressure in which about twenty flues in the center of the sheet extended only to within 1/8 or 1/16 inch of the outside of the sheet after they were rolled. Is there any danger of these flues pulling out of the sheet?

If there is, why is it that when in the back flue sheet there are about 25 flues without any bead on them they do not pull out of the back sheet? In the case mentioned the flues had good beads on the back end.

I have never seen anything like this before and have not seen any explanation of it. Can some of the readers of THE BOILER MAKER give me a few pointers on this?

L. H. K.

Which Type of Boiler is Safest for a Warship?

I am very much pleased with the discussion in the December BOILER MAKER regarding the different types of boilers. I note that the gentlemen boosting the watertube type are fluent talkers and seem well able to sway the jury to their way of thinking, while the poor Scot is "na hare aboot."

I would like to hear from some of THE BOILER MAKER'S "war horses" on the above suggestions. Those in mind are Messrs. N. G. Near, Francis and Hobart, also F. Ormer Boy. I have had a little experience with both types of boilers, and I remember having a fireman say once that the old Scot "nere got sa bad he could na mak poort wi' her." It seems to me we should be governed by actual war conditions instead of a few hours' or a few days' run; for instance, what type of boiler did the *Sharnhorst* and *Gneisenau* have? We know the type the *Lena* had when she came limping in through the Golden Gate some years ago, driven from the sea for lack of boiler power. I saw it stated that the *Sharnhorst* and her sister ship were nine months at sea before they were sunk. That was a hard test on her boilers, and that reminds me to ask if anyone will say that our "Old Bull Dog" could have arrived at Santiago "fit as a fiddle" had she been equipped with watertube boilers?

What kind of boilers has the *Minnesota*, the big ocean liner that broke down on the west coast a few weeks ago? Did anyone hear of German spies getting into the boilers of an Atlantic liner? These questions may lead some gentlemen to think that I favor one type more than the other—the facts are, my aim is to get (if I could) the most reliable boiler for war conditions that could use fuel oil economically. Any type of watertube boiler is a quick steamer, but the best of them will not stand a day's steaming on salt water without injury to it.

Now, let us imagine a ship at sea for three months, either looking for a fight or trying to keep out of one. Under those conditions she must keep her full power on hand, ready to call on in a few minutes' notice, either night or day—which type of boiler would be the safest for this ship? I hope our dear old Uncle will find that out before it is too late.

Wishing all your readers a happy new year, I am, respectfully yours. J. S. GRANT.

Vallejo, Cal.

Is He Right?

On reading over the January issue of THE BOILER MAKER I notice an artice by Mr. N. G. Near entitled "Is He Right?" His friend says that few boiler makers approach the work before them in a receptive, inquiring mind, and Mr. Near asserts that 90 percent do not approach their work in this frame of mind; therefore, he gives credit to only 10 percent of the boiler makers for ever carrying a "thinking cap" with them.

I don't quite agree with Mr. Near. I would like to ask him if he could tell me how many boiler maker foremen are willing to take, or even listen to, some suggestions made by a boiler maker that he hires? If he did, would he give the man credit for it? I often tried, where from practical experience I knew I was right, only being told to go and do the job the way I was told or let somebody else do it.

I agree with Mr. Near that there are exceptions to these men, but let's give the men credit that at least half try.

Chicago, Ill. J. CURTIS.

What Causes the Failure of Longitudinal Lap Seams

It is fairly safe to assume that if the question asked above were put to the persons interested in the use and construction of steam boilers, ninety percent of the answers could be summed up in the following phrase: "Departure from a true circle made necessary by lap seam construction and breathing of the boiler." The remaining ten percent would perhaps be divided between those having a different opinion, others non-committal, and a few, but unfortunately very few, who contend that lap seam construction is equally efficient from a standpoint of safety as other and more modern methods, notwithstanding the preponderance of evidence showing beyond any intelligent contradiction that lap seam construction, when used in longitudinal seams, is a positive menace where pressures higher than a few pounds are carried.

To answer the question by saying that "departure from a true circle and breathing of the boiler," is a great deal like a coroner's verdict in that "a man's death was caused by a bullet"; while the cases are hardly parallel, yet the coroner's decision covers the case to about the same extent that the other decision does, in that both decisions leave considerable evidence unearthed.

Assuming a boiler without longitudinal seams, but with the shell shaped to correspond exactly with the departure from a true circle as found in the lap seam construction, and further assuming that the opinion of the above-mentioned ninety percent is correct in relation to the cause of failure of lap seams, the writer has made some lengthy calculations in which an example of attempting to break a tough piece of wire with bare hands was used as a basis for the calculation; the result showed that it would take 11,489,362 years of boiler respiration to cause the plate to fracture, provided no other contributing causes were produced. It occurred to the writer to enlist the aid of two helpers in making the wire-breaking test, one to pour water on one side of the wire, the other to sprinkle soot on the opposite side, the idea being to enact conditions similar to the internal and external corrosive action frequently occurring at this point of the boiler. After several futile attempts in which the parties approached declared the writer had gone bugs, it was decided to omit this part of the test.

While the departure from a true circle and breathing of the boiler are partly responsible for the failure of longitudinal lap seams, there are other causes on which considerably more responsibility could be placed, but which are rarely mentioned, and in the opinion of the writer these causes are effected at the time the boiler is first constructed.

Reflect back to a period of a few years ago, when the construction of the type of boiler under discussion was common practice, then mentally rehearse the practice usually followed in the average shop, this is what you recall: First, the rivet holes were punched full size, frequently with too large dies and dull punches, then taken to the rolls, where a small portion of the lap was knocked down to the lower roll, regardless of the radius to which the plate was to be rolled; the plate was then brought through the rolls a little further and another session of the sledges enacted, the net result being that after rolling, instead of one nearly true circle there were really two, and sometimes four, separate and distinct curvatures and two flat spots at and adjacent to the lap. Then to the riveting machine, where in driving the rivets the pressure was brought to bear on that part of the plate at which the too sharp radii had been formed, this pressure tending to flatten the plate at the rivet line by reason of increasing the radius that had been made too small; also from the fact that the lapping portions of the plate were not formed metal to metal before riveting. In all of these operations—punching, knocking down, etc.—the plate is subject to about every abuse except mayhem, with the result that the joint is riveted up with the metal having first been subjected to severe and unnatural fiber strains, and these strains are still existent after riveting and when the boiler is installed for operation.

This theory can be readily proven by observing the peculiar discoloration and appearance of that part of the plate forming and adjacent to the joint, if the metal is allowed to rust slightly. It will be noticed that the metal at the point mentioned will have a decidedly different appearance than other parts of the plate similarly rusted—in fact, the rust will attack the first-mentioned parts considerably quicker and with more violence than the other parts. Further, if the rust be removed from the joint portion and a careful inspection made with a microscope, the small fractures resulting from the strained and distorted fibres are readily noticeable, and it is safe to assume that the method of construction outlined above has caused these fiber strains to exist through the entire thickness of the metal.

Assuming now that the boiler is installed for operation, the metal becomes rusted or corroded at the point where the metal fibers have been most strained. This rust or corroded metal is then flaked off by any or all of the following causes: the breathing action of the boiler, ebullition of the water, vibration due to engine pulsation, or in some cases by scale solvents in which the chemical constituents are such that the solids in the water are not affected previous to precipitation. After the initial corroded metal has flaked off a new surface is then exposed to the same conditions that affected the first surface, the innumerable repetitions of this action eventually waste away the metal to a point where it is unable to withstand the usual working pressure, and a fractured plate is the result. At other times the result is that the balance of the boiler is spread around promiscuously over the surrounding neighborhood.

This article is not written in defense of longitudinal lap seam construction, but for the purpose of venturing some opinion other than the inadequate and fossilized one usually advanced when the question outlined at the head of this article is asked, and also to get the opinion of some of the readers of this magazine concerning this subject, but for the love of Mike lay off the "breathing" stuff. Most concerns operating boilers of this type allow them to collect so much scale and muck that the boilers are unable to gasp, let alone breathe.

INSPECTOR.

Superheater Tube Testing Machine

The accompanying illustrations show a very handy testing machine for large tubes, such as are used in superheater locomotive boilers or large tubes for stationary boilers.

The tubes are clamped between heads carrying rubber plates, the heads being connected by rods, one on each side the entire length of the tube, plus the addition of the heads and apparatus, which is described as follows:

Fig. 1 and Fig. 2 are the end and side views of the general arrangement. A trough, made sufficiently long to contain your longest tube plus the rods and apparatus, must be made, and wide enough to contain the heads. The large section, Fig. 3, shows an end section of this trough with width marked 12 inches.

In the general plan are shown four posts and four hooks suspended by four ¼-inch standard chains from a line shaft, which is hung in hangers to the four bent angle bars, and extends the entire length of the machine. A brake-wheel and brake-ratchet are the raising and lowering mechanism, operated by hand.

The rods must be of such diameter as to withstand the tension to which they are subjected when a pressure is applied inside the tube. Two ⅝-inch rods will withstand a pull of 19,635 pounds when figuring the base of the thread to be ½-inch diameter. The pull they would have to hold when a 6-inch tube with a pressure of 100 pounds was being tested would be 2,827 pounds, the factor of safety then being nearly seven.

Fig. 3 shows the hook into which the tube is laid before clamping the rubber plates against the ends. The heads and rubber plates are shown plainly by Fig. 4. To hold the tube central between the rods a small, round plate of 3/16-inch steel is screwed on the face of the rubber plate and fits inside the tube. One head has a hole in the center to admit an air connection. A street elbow with a hose attached serves as a flexible air connection. A stop and waste cock, which will release the air when the tube has been submerged, is also needed.

In practice we put the first tube in the trough, clamped as stated before, then fill the trough with water until it covers an inch or so above the tube, always submerging the tube before applying the air pressure, as the load will continue to compress the rubber plates and will show more and more bubbling as the air has been turned on a longer length of time.

Fig. 5 shows the clamping screw and cross-head, which is fastened with two nuts on each side at the end opposite the air-applying end. As it takes two men to lay one of

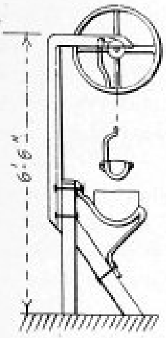


Fig. 1.

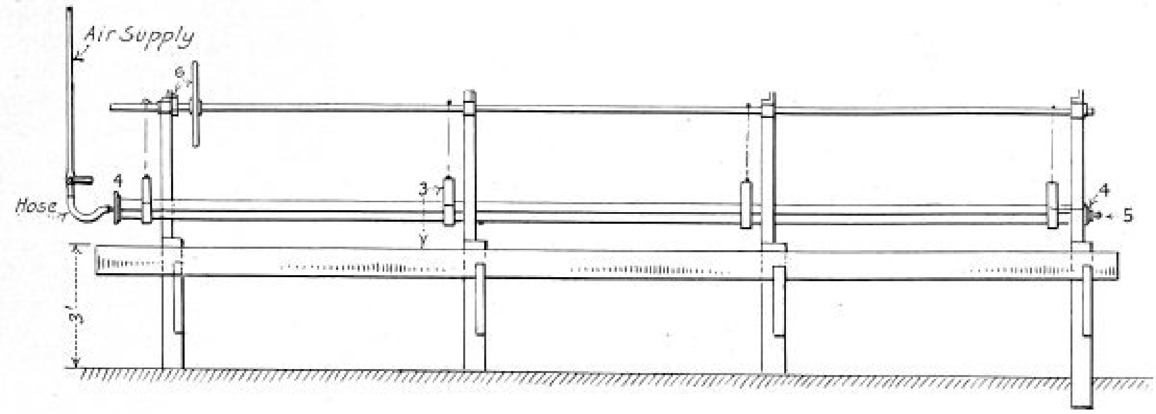


Fig. 2.

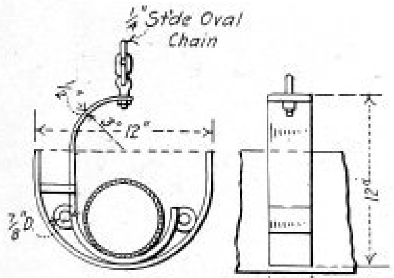


Fig. 3.

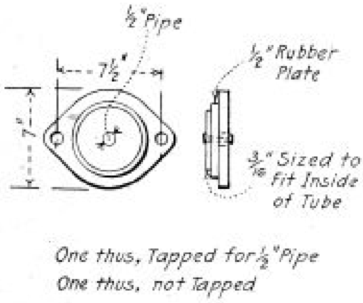


Fig. 4.

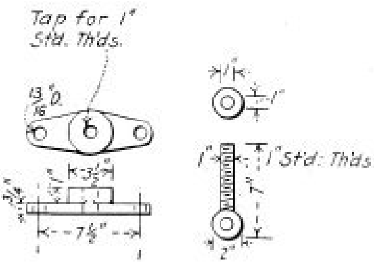


Fig. 5

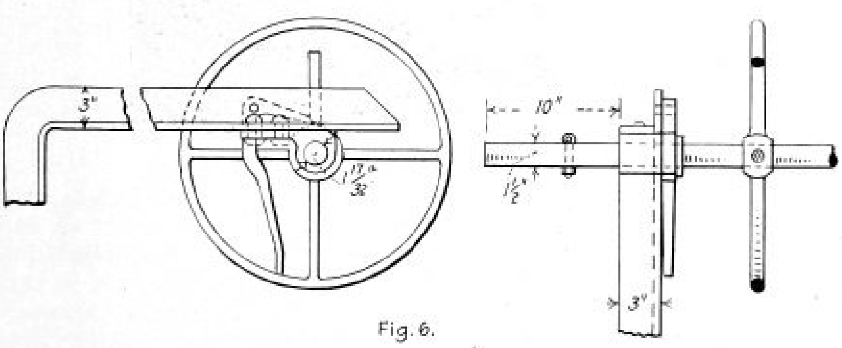


Fig. 6.

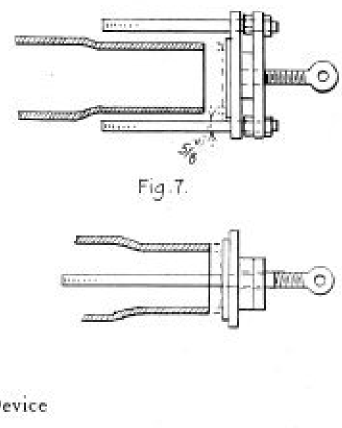


Fig. 7.

Arrangement and Details of Superheater Tube-Testing Device

the long tubes in the hooks, one man operates the wheel and applies the air while the other handles the clamping device.

Fig. 6 shows the lifting wheel and ratchet, which is simply an old brake-wheel from a freight car, and a ratchet fitted with a bent dog, also from a freight car, plainly shown in this figure.

Fig. 7 shows the assembly of the clamping screw cross-head and rubber plate bearing head, all of which have been described above. The ends of rods and the firebox end of a superheater tube are also shown in this figure.

It will require a different length of rods for each different length of tubes to be tested, and when the difference becomes very great one or more hooks can be disconnected from the shaft. The four hooks are necessary on the very long tubes, as they hold up the rods and keep them straight; otherwise the rods would sag down in the middle and the clamping would require much more time to take out the slack.

The angles used are 3-inch by 3-inch bent to a right angle, as shown, and extending slightly past the center of the trough. This can be seen by studying Fig. 6. The hangers for the shaft are made of forgings, and are also shown plainly in Fig. 6. Two ⅝-inch bolts extending up into the angle hold the hangers in place. (Fig. 6.)

The posts are wooden and are anchored in concrete, braced as shown, and carrying brackets into which the trough is hung, as shown in Fig. 1. The bent angles are also shown plainly in Fig. 1 bolted to the post at their lower end by two ¾-inch bolts.

A tube is shown in the general plan, hung in the hooks and raised above the trough. A short hammer handle, laid across the top of the trough at each end, holds the tube while it is being put in or taken out of the clamp.

The chains are made fast to the shaft by a 3/8-inch bolt through the shaft and through the end link of the chain and to the hook by an eye bolt. A hole drilled through the hook and a nut below are shown in Fig. 3.

The writer has made and has been using this machine, having tested about twenty-five or thirty sets of tubes of different kinds for stationary boilers, superheater locomotives, and so on.

Before making this machine we tested our tubes by elevating one end and filling with water after plugging one end with a wooden plug. We then would have to take out from two to six of the tubes after the high pressure was applied to them in the boiler. On the other hand, the machine described now holds a clean slate to date, as not a single tube that has been tested in the machine has had to be removed from the boilers.

This machine is set up in the shop, close to the welding machine, and spills very little water over the sides of the trough, so when the cold-weather season is on, the men can test these tubes without having to go out in the cold.

When testing tubes with water as before, very little pressure was obtained, and each time a tube was tested all the water which was in the tube had to be wasted, thus requiring the work to be done outside the shop and making it a very wet and cold job, exposing the men to the cold and thus making it a dangerous job as well as being a very poor test on the tubes.

Columbus, Ohio. PHIL NESSER.

Chips

Don't hurry when you have plenty of time; it is not expected of you.

Don't slight your work because the firebox is too hot. If you cannot finish it in the first heat in a workmanlike manner, get out of the firebox, cool off, get your breath, then go after it again and finish it in a manner that would do credit to a mechanic.

Don't drag a job because you know that you can, especially after you have been sitting around a couple of hours waiting for the engine to come in. Help the boss out of the hole every chance you get. He works for the same company that employs you. You may be boss some day and expect the same consideration.

Don't bawl out your helper. He gets as hot and tired as you do. He has his off days like yourself and perhaps he isn't well; we all get sick. Above all, don't expect the helper to read your mind, because mind-readers don't wear overalls—they don't have to. Don't expect too much from your helper, for the reason that if he knew as much as you do in regard to boiler making he would be getting your rate of pay.

Don't lay off the day after pay day. It might create a bad impression. I know that you don't drink and that you had to move, or your sister got married, or you went to a funeral, but so does the boss. If you have to lay off, just keep still about it and don't commit yourself. Possibly the boss told the same story when he was in the ranks.

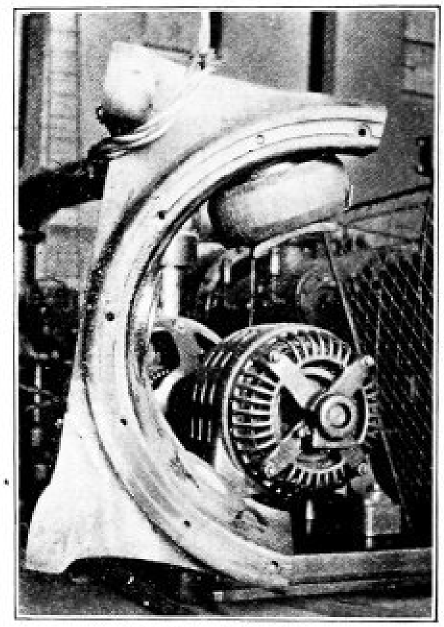
Always stop and take time to grind or dress a ragged tool, as there are at present about 80,000 blind and one-eyed men in the country, so don't be the 80,001 blind man. Protect your eyes with goggles, even if you have to buy them yourself, as protection against the loss of an eye should be considered a good investment. Who suffers the most when you lose an eye, you, your family or the company? Find out which will cost you the most, a glass eye or a pair of goggles, and be governed accordingly.

Don't work on a ladder unless you have a foot like a chicken. A ladder will do in emergency cases only, and when used in emergency cases they should be arranged with spurs on the bottom so they will not slip. When you build a scafford, make it strong enough to hold a mule—also include the boiler maker. Never try to operate a motor alone on a ladder, especially if you carry heavy life insurance, for in case of death by accident the insurance company may contest your claim.

Don't tie knots in a chain when putting a strain on the chain, as you cramp the links and they will break more readily. Have all your chains tested and use them accordingly. Don't tie fancy knots in ropes, as they won't do the business. G. L. PRICE.

Heavy Welding Job

The illustration shows a view of a heavy weld made by the American Iron Works, Louisville, Ky., in June, 1915, on a large motor base at Station A of the Louisville Gas & Electric Company. An oxy-acetylene welding out-



Welded Motor Base

fit was used and the actual time for welding was only five hours for one man, whereas if a new casting had been obtained there would have been time wasted waiting for the casting and the renewal would have cost 50 percent more than the cost of making the weld. This casting, or motor base, is in constant use and is still in perfect condition.

INFORMATION DESIRED REGARDING EFFECT OF VIBRATION OF STRUCTURES.—Recognizing that practically everyone is certain that higher speed, better work and greater human efficiency are possible in a stable as compared with a vibrating building, but that exact data proving this fact are difficult to obtain, the Aberthaw Construction Company, of Boston, Mass., is undertaking an exhaustive investigation in the effort to bring together conclusive evidence. They will greatly appreciate any suggestions or reports of experience that our readers may be able to send to them.

CORRECTION.—In the caption under the photograph on page 31 of our February issue depicting the cutting off of rivet heads with an oxy-acetylene torch, it was erroneously stated that the torch was of the Prest-O-Lite make. As a matter of fact, the torch shown was manufactured by the Davis-Bournonville Company, Jersey City, N. J.

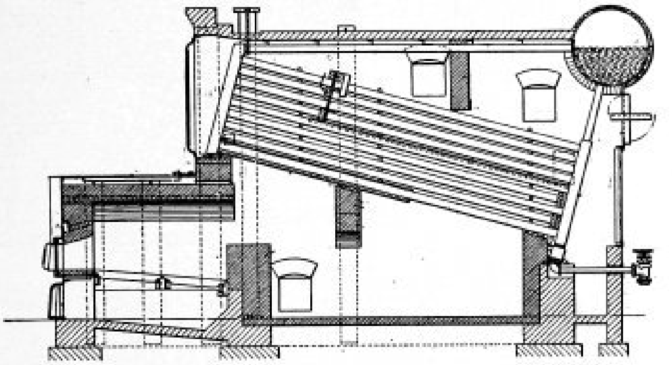
Selected Boiler Patents

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

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

1,161,133. FURNACE. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

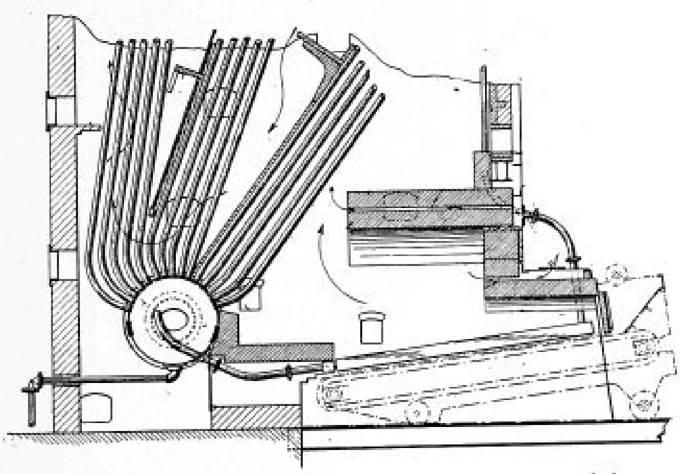
Claim 1.—A horizontal watertube boiler having a front external furnace and a primary combustion chamber, a horizontally extending baffle in the rear of the primary combustion chamber extending along the tubes to form a secondary combustion chamber below the tubes, an exit from



the rear of the secondary combustion chamber, leading to the tubes, baffling arranged along the tubes for directing the gases thereover, and means for admitting air above the level of the primary combustion chamber to the secondary combustion chamber. Four claims.

1,161,134. FURNACE. DAVID S. JACOBUS, OF JERSEY CITY, AND NATHAN E. LEWIS, OF PLAINFIELD, N. J., ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—A boiler furnace having a fuel support, a curtain wall over the support, an ignition arch extending outwardly from the curtain wall over the fuel support, an upper arch extending inwardly from the curtain wall toward the boiler tubes, said upper arch having a passage for



the admission of air to the furnace chamber, an air passage being provided above the lower external arch and separated from the air passage for the upper arch, and each of the said air passages having its outlet to the combustion chamber at the rear end of its respective arch.

1,158,865. WATERTUBE BOILER. JOSEPH ALVAH SCOTT, OF SEATTLE, WASH.

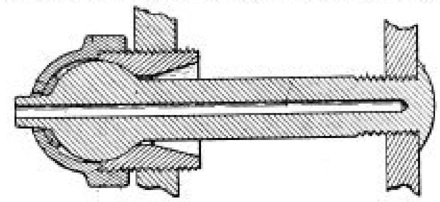
Claim 1.—In a boiler of the class described, in combination, a casing having a stack connection at its top, a furnace within the casing, a steam drum above said furnace, partitions extending downwardly at opposite sides of said drum and in spaced relations to the side walls of the casing to provide a flue between each partition and the adjacent side wall of the casing, said flues communicating from above with said stack connection and with the furnace at a distance below said drum, mud drums at each side of said furnace, banks of tubes respectively connecting said mud-drums with the steam drum and extending through the space between said partitions, each of said banks of tubes being arranged to afford alternate wide and narrow spaces between the rows of tubes thereof and bars removably connected to said partitions for closing the wide spaces between said rows of tubes for a distance below the adjacent partitions. Five claims.

1,157,472. FEED-WATER HEATER. CHARLIE V. WALLACE, OF TULSA, OKLAHOMA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO ECONOMY FEED WATER HEATER COMPANY, OF TULSA, OKLAHOMA, A CORPORATION.

Claim 1.—The combination, with a steam boiler including a smoke box, of a heater coil located within the smoke box and having an inlet end and an outlet end, said coil being arranged substantially below the level of the water in the boiler, a cold water supply pipe leading from a suitable source of supply and coupled to the inlet end of the coil, an outlet pipe coupled to the outlet end of the coil and leading back to and communicating with the boiler, a valved connection between the boiler and the supply pipe, and a check valve arranged directly in the supply pipe, and located between the valved connection to the boiler and the source of cold water supply. Two claims.

1,161,659. BOILER STAYBOLT. ANDREW S. GREENE, OF INDIANAPOLIS, IND.

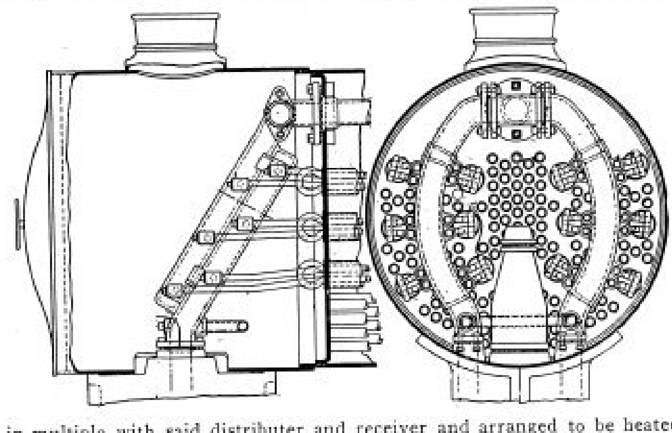
Claim 1.—A staybolt having a head provided on its top with a projection extending from the head on the axis of the body portion of the staybolt, the staybolt having a bore therein extending inward from the



end of the projection, and a guard for the head to cover the top thereof and having a central aperture to loosely receive the projection. Six claims.

1,161,976. STEAM SUPERHEATER. WILLIS L. RILEY, OF ST. PAUL, MINN., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, A CORPORATION OF DELAWARE.

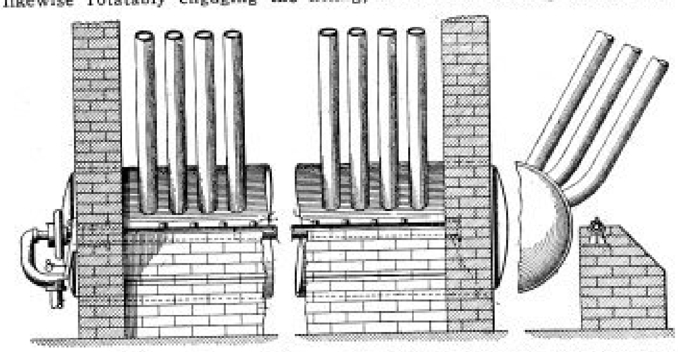
Claim 1.—A steam superheater, comprising, in combination with a boiler, boiler flues, smoke chamber and steam chest, a distributer connected with the steam space in the boiler, a receiver connected with said steam chest, said distributer and receiver being connected by an equalizing joint and a plurality of superheating steam tubes connected



in multiple with said distributer and receiver and arranged to be heated by heat egressing through the boiler tubes, said parts being so constructed and arranged that steam from the boiler passes in the shortest path to the superheating tubes and from said tubes to the steam chest; whereby a maximum heating exposure is produced upon said tubes with minimum heat loss. Eleven claims.

1,162,089. BLOWER FOR WATERTUBE BOILERS. JOHN MAGEE, OF DETROIT, MICH., ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

Claim 1.—A blower comprising detachably connected pipe sections having lateral jet producing means, a supply fitting to which the pipe sections are rotatably secured, casing sections encircling the pipe and likewise rotatably engaging the fitting, means for limiting the angular



movement of the casing and pipe on the fitting, expansion joints between the casing sections in staggered relation to the connected pipe section ends, and means between the extension joints for anchoring the casing sections to the pipe sections. Five claims.

1,160,514. METHOD OF REGULATING BOILER PRESSURE. PIERRE O. KEILHOLTZ, OF BALTIMORE, MD.

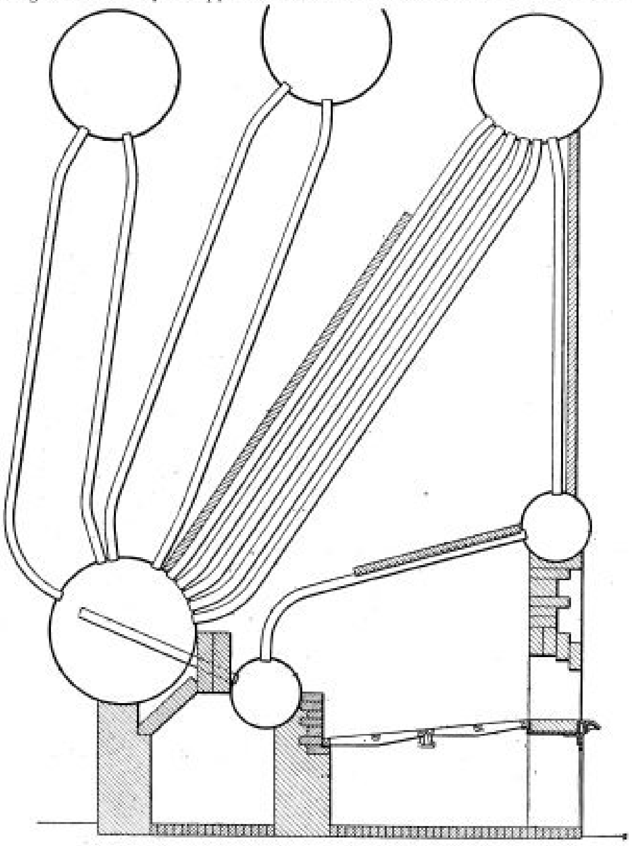
Claim 1.—A method of operating a mechanical apparatus including a steam boiler, a furnace and a pressure regulator, to control the boiler pressure, the method consisting in supplying varying quantities of fuel and air to the furnace in response to the variations in steam pressure in the boiler and causing the variation in air supply pressure to react directly upon the regulator determining the quantities of fuel and air, and preventing hunting of furnace conditions. Six claims.

1,160,729. FUEL-ECONOMIZER SOOT CLEANER. FREDERICK W. LINAKER, OF DUBOIS, PA., ASSIGNOR TO THE VULCAN SOOT CLEANER COMPANY OF PITTSBURG, PA., OF DUBOIS, PA., A CORPORATION OF NEW JERSEY.

Claim.—The combination with a fuel economizer system having rows of vertical water-circulating tubes and located in the path of travel of the products of combustion, the rows of tubes being in staggered relation, of fluid distributing pipes rotatably mounted in the casing of the economizer and disposed between the said tubes, nozzles carried by each pipe and disposed around the pipes to discharge cleaning fluid in jets or streams on lines or paths oblique to the axes of the pipes, said nozzles also disposed to project the fluid in the spaces between rows of tubes, the nozzles carried by one blow pipe being arranged to project the cleaning fluid on paths or lines which intersect and cross the paths or lines of streams of cleaning fluid issuing from another pipe, and means for rotating the pipes to vary the angularity of said jets or streams with respect to the vertical axes of water-circulating tubes.

1,161,985. STEAM BOILER. MINOTT W. SEWALL, DECEASED, LATE OF NEW YORK, N. Y., BY SUSANN E. SEWALL, EXECUTRIX, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

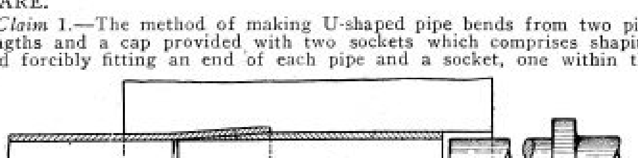
Claim 1.—A watertube boiler having upper transverse steam and water drums and a lower mud drum, banks of generating tubes connecting said drums, a supplemental drum located in front of said lower



drum, tubes directly connecting said lower and supplemental drums, a transverse water chamber intermediate the levels of the upper and lower drums, tubes connecting said supplemental drum and chamber, and tubes connecting said chamber with the front upper drum.

1,162,698. METHOD FOR WELDING PIPE ENDS. OSWALD KLINCK, OF MULHEIM-ON-THE-RUHR, GERMANY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

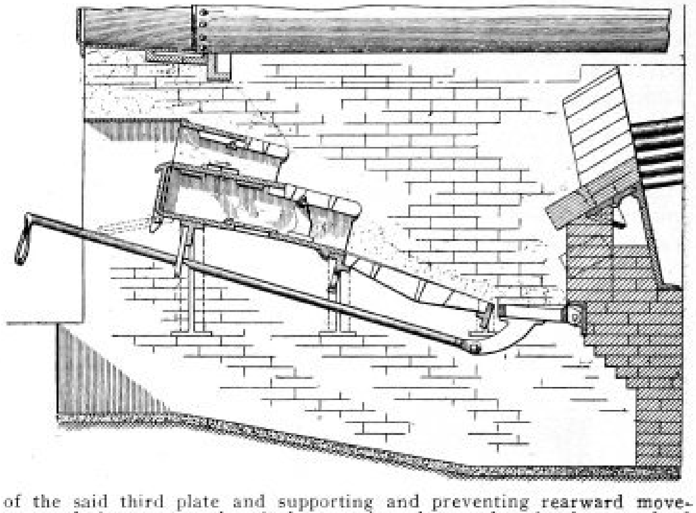
Claim 1.—The method of making U-shaped pipe bends from two pipe lengths and a cap provided with two sockets which comprises shaping and forcibly fitting an end of each pipe and a socket, one within the



other, heating the joints thus produced to welding heat, holding said joints in a die and simultaneously forcing a mandrel through each joint. Two claims.

1,165,982. SMOKE-CONSUMING FURNACE. EDWARD LANE, OF PITTSBURG, PA.

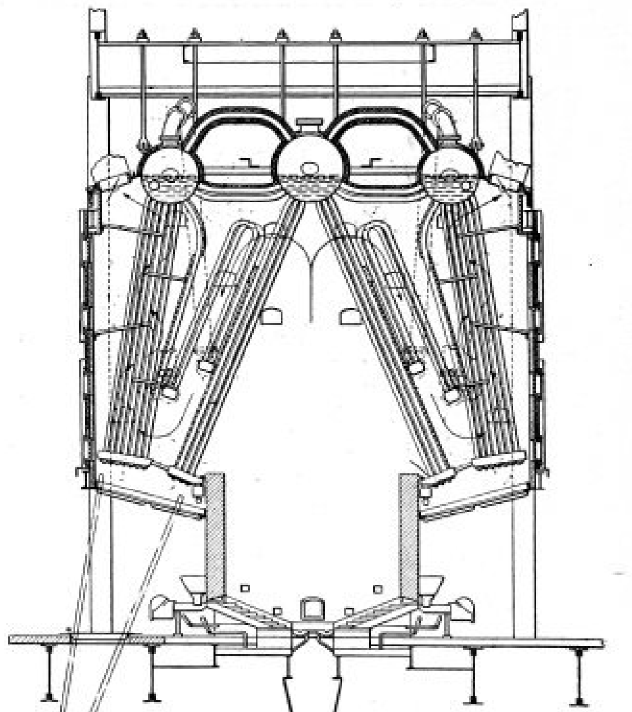
Claim 1.—In a furnace, a bridge wall, a boiler above the same, a pair of standards set in the side walls near the bridge wall, a cross bar connecting said standards, a second pair of standards set in the side walls forward of the first pair of standards with their lower ends in the same horizontal plane as said first pair of standards, a cross bar connecting the said second pair of standards, a third pair of standards of greater length than the second pair of standards and arranged forward thereof and set in the walls of the furnace and arranged with their base ends in the horizontal plane of the base ends of the first-named standards, a cross bar connecting the upper ends of the third pair of standards, a main grate bridging the space between the side walls and supported by the cross bars connecting the first and second pairs of standards, a pair of vertical side plates mounted upon the cross bars of the second and third pairs of standards, means to prevent rearward movement or creepage of said side plates, a plate mounted upon the cross bars of the second and third pairs of standards between said side bars, means to prevent rearward movement or creepage of said plate, a second plate above and substantially parallel with the first-named plate and supported by said side bars, a supplemental grate suitably supported between said side bars in the plane and at the rear edge of said second plate and preventing rearward movement or creepage of the latter, a door at the front end of the passage formed by and between said side plates and the plates between the same, a third plate substantially parallel with and above the front portion of the second plate and between the side plates, a second supplemental grate in the plane and rearward



of the said third plate and supporting and preventing rearward movement of the same, and a fuel-supporting plate under the front end of the boiler and extending from side wall to side wall and forwardly from the front end of the said third plate, and means whereby clinkers and dead fuel may be discharged into the ash-pit at a point rearward of said main grate. Eight claims.

1,162,065. WATERTUBE BOILER. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—In a watertube boiler, two inner banks of generating tubes inclined toward each other so as to form two sides of an A-shaped combustion chamber, a steam and water drum into which the upper ends of the tubes of both of said banks are expanded, headers into which



the lower ends of said tubes are expanded, two outer banks of tubes one on each side of the inner banks, steam and water drums and headers into which the tubes of the outer banks are expanded, and steam and water circulators connecting the intermediate steam and water drum with the outer steam and water drums. Six claims.

1,160,434. LOCOMOTIVE-BOILER FURNACE. CHARLES B. MOORE, OF EVANSTON, ILL., ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—A locomotive boiler firebox in combination with two longitudinally inclined water-circulating arch-tubes adjacent to opposite side sheets of the box, studs upon said side sheets substantially below respective tubes, and a row of downwardly and outwardly inclined refractory bricks between each tube and adjacent side sheet, each said brick having its inner end socketed upon the tube and its outer end supported by a said stud or studs and beveled for abutment with the side sheet. Four claims.

THE BOILER MAKER

APRIL, 1916

English Shop for Making Small Boilers

Description of an Unusual Boiler Shop in England Where Model Boilers Are Manufactured

BY A. L. HAAS

Gillingham, Kent, England, is an extension or division of the towns of Stroud, Rochester and Chatham, which are virtually the one city, strung along the valley of the Medway, where it empties into the Thames. The small shops whose staple manufacture consists in boilers of nearly every type. The working proprietor, for when the writer called he was busily engaged in closing rivets himself, is Mr. T. Goodhand, 149 Gillingham Road.

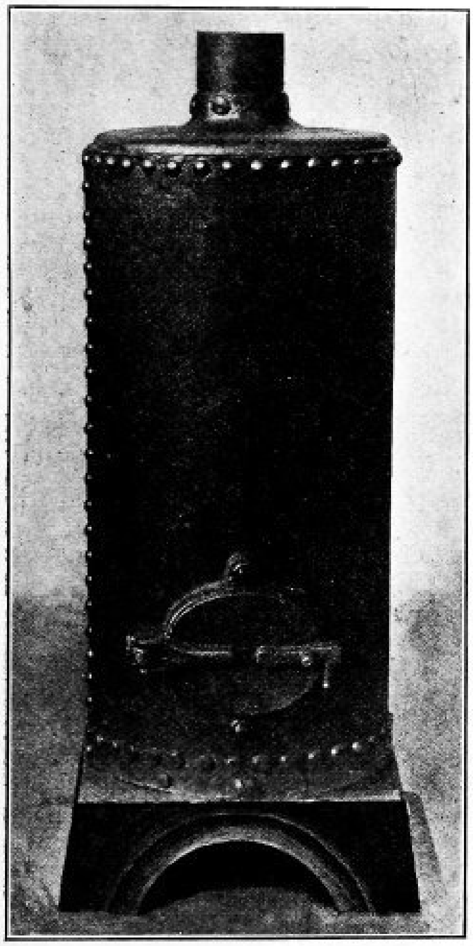


Fig. 1.—This Boiler is Built in Twenty Standard Sizes

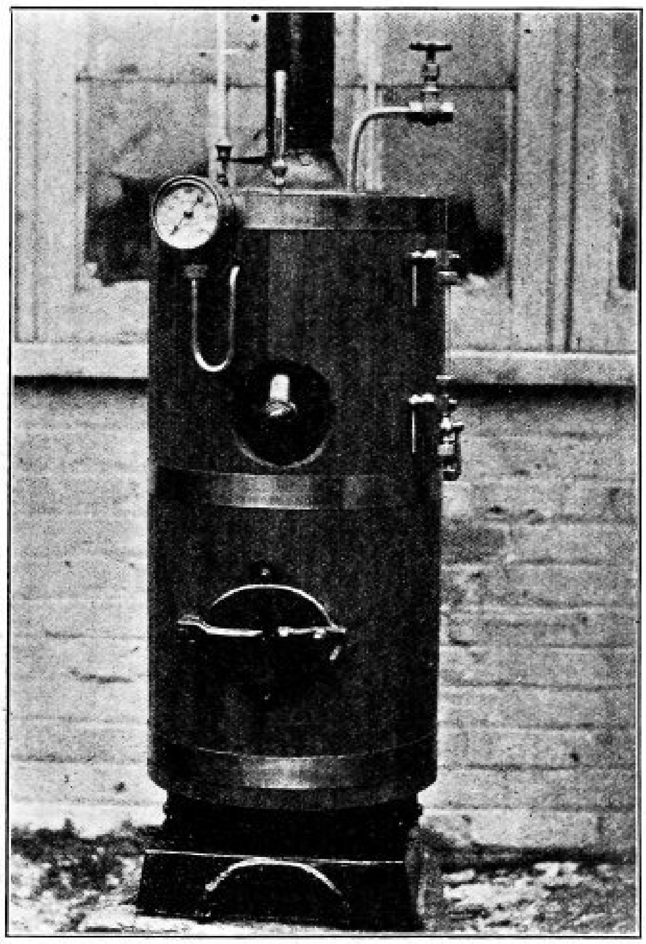


Fig. 2.—Cross Tube Vertical Boiler Complete with Attachments

principal industry is naval work, as the dockyard at Chatham is one of the principal naval stations of the United Kingdom. Beyond this the major portion of the Portland cement made in Great Britain is produced within a few miles, and at least one large engineering concern of world-wide reputation has its works at Stroud.

In Gillingham is situated one of the most interesting

In these days of huge enterprise and large capital, there is interest in the survival of the small master, as the conditions take the mind's eye back to when the circumstances were usual. The business was established by the present proprietor in 1889.

Part of the interest in the shop, apart altogether from its product, is the very full and generous equipment evi-

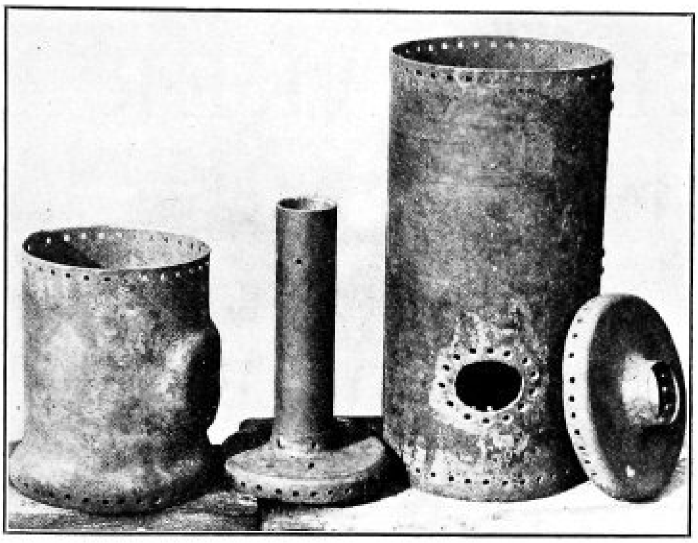


Fig. 3.—Details of the Vertical Boiler

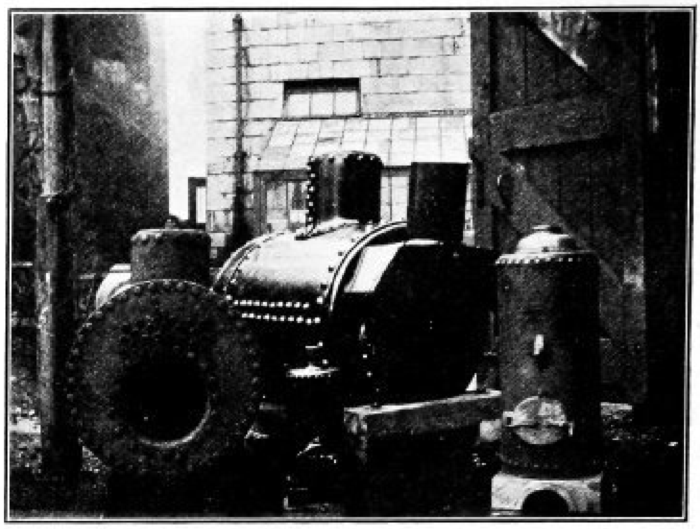


Fig. 5.—Dry and Wet Back Return Tube Boilers

dent. When the boss works the tools are abundant and well kept. It is the discriminating eye apparent in every first-rate mechanic which suffers no disability on the ground of tools and appliances where he can avoid being hampered by want of necessary gear. It would help materially in many modern shops if those responsible had to take an occasional day's work with the gear provided.

The Shop Equipment

The works at 44a Fox street employ twelve hands and the equipment consists, among other gear, of a 2 feet 6 inches by 2-foot 6-inch by 6-foot planing machine, an 8-inch stroke shaper, two good-sized column drills, one small radial drill, two sensitive drills, four lathes, the largest of which is 12 inches center, another 8 inches center by 8 feet bed, and two of smaller size; two punching and shearing machines, one taking up to 3/16 inch plate, the other ½ inch plate; two sets of rolls, one 4 inches by 3 feet 2 inches, the other 5 feet set, with bottom rolls 6 inches and the top roll 7 inches diameter.

In addition there are three smiths' hearths, a power hack saw, and gas engine. A new departure recently installed is a gas welding plant and a belt-driven power hammer, also quantities of miscellaneous gear.

Some of the above were home-made. The large plate-bending rolls, which are a creditable and first-class job, were entirely made in the shop. The bottom rolls are pieces of shafting from a wrecked paddle boat and are over fifty years old.

The equipment is detailed, as it is apparent this is the shop we all dreamt about as boys. Most of us in the trade built day dreams of owning such a plant, and the writer felt envious himself, although no longer a boy, of the full equipment and interest afforded by such an outfit.

Altogether it is the ideal existence for a practical man whose idea is more to make a living and have interest in his work rather than large commercial opportunities of a problematical fortune.

The Work Done

The interest in the equipment will no doubt be increased, especially to the apprentice boiler maker, when it is stated that the specialty of the shop is model boilers. All types are built and they range from 4 inches diameter

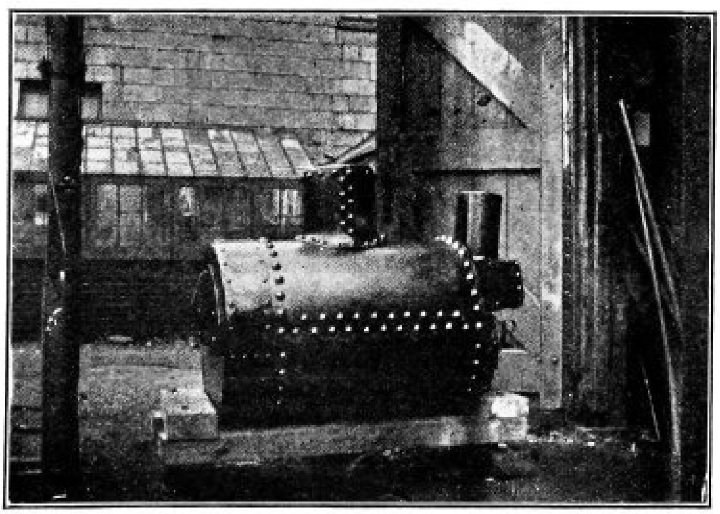


Fig. 4.—Dry Back Launch Boiler

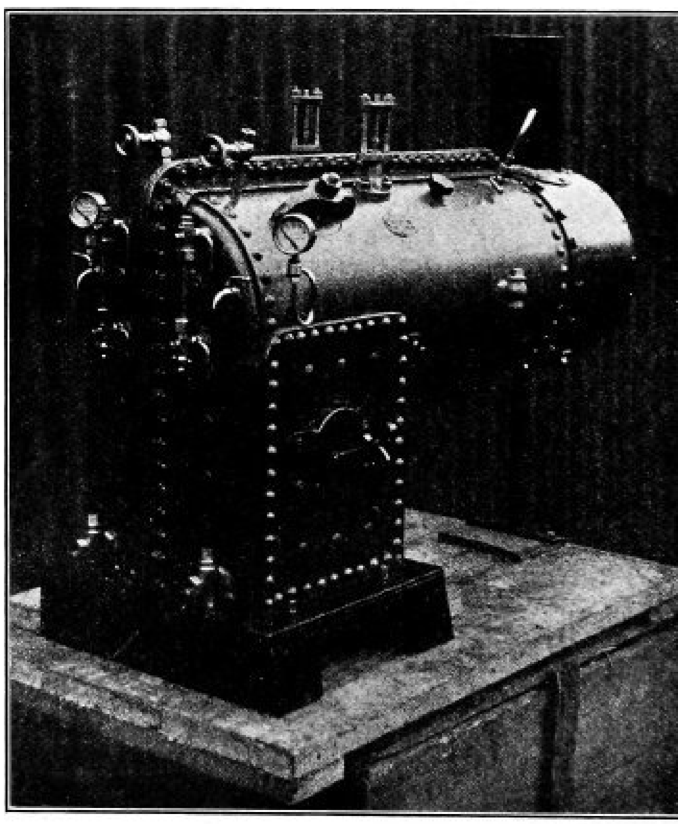


Fig. 6.—Experimental Boiler

by 8 inches high to 22½ inches diameter 48 inches high for the vertical type, either with central tube or with multiple vertical tubes. The locomotive type ranges from 8 inches diameter by 17 inches long to 26 inches diameter by 47 inches long; return tube launch boilers from 15 inches diameter by 22 inches long to 26 inches diameter by 36 inches long.

The thinnest gage plate used is 12 S. W. G. and the heaviest the shop deals with is ⅜ inch, so that where the usual run of boiler shop work begins, Mr. Goodhand finishes. While the average boiler shop regards ¼ inch plate as too thin to make a satisfactory job and 5/16 inch is the minimum usually permitted. ¼ inch plate is heavy work and ⅜ inch the maximum dealt with in this Gillingham shop.

There is interest in the question of steam tightness with gages of this character, as it demands exceptional workmanship and drilled holes to get a tight job. In some respects many a boiler maker who regards ¾-inch rivets and ½-inch plates as his minimum, could derive some benefit from a course of instruction in the workmanship needed for tight seams in 12 S. W. G. In spite of the scantling the factor of safety is high because of the small diameter. Every boiler without exception is tested hydraulically to twice the working pressure and under steam to the working pressure.

The Photographs

These illustrate the range of work done and are the normal standard products of the shop with one exception.

Figs. 1 and 3 show the type of boiler of which the greatest number have been made. They range from 5 inches diameter to 26 inches diameter and from 10 inches high to 60 inches high, there being twenty different regular sizes made.

Fig. 2 is a fully finished cross tube vertical having two cross tubes through the firebox, is 2 feet 6 inches high and 12 inches diameter and is lagged with mahogany and asbestos.

Fig. 4 is a photograph of a dry back horizontal return tube launch boiler. Its dimensions are 24 inches diameter by 36 inches overall in length, the furnace is 11 inches diameter and it has 18 tubes 2 inches diameter. The dome is 9 inches diameter and 10 inches high. Thickness of plate, ⅜ inch shell and 5/16 inch furnace and dome. Pressure tested, 200 pounds; working, 100 pounds.

Fig. 5 shows an interesting group of small boilers, the center being occupied with the same boiler shown in Fig. 4. On the left is a wet back return tube boiler which was oil fired. The diameter was 21 inches and the tubes 1⅛ inches The two smaller boilers shown are a 6 inch by 12 inch center flue vertical and a 12 inch by 24 inch multitubular vertical with twelve tubes each 1 inch diameter.

A Freak Locomotive Type Boiler

The photographs Figs. 6 and 7 illustrate what in design is surely one of the remarkable boilers on record. The dimensions are barrel 9 inches diameter, length overall 24 inches. There are twenty tubes in all. Thickness of shell, 3/16 inch.

How Mr. Goodhand came to build and design it is rather interesting. A firm of boiler fluid makers, wishing to demonstrate the benefit of their commodity, desired a boiler to take to pieces for exhibition purposes. As will be seen, the boiler is in two distinct halves separated by a ⅛ inch division plate through the water space. The firebox was not so divided, and owing to the construction the fire hole had to be in the side of the firebox and not in a normal position.

In operation one side of the boiler was fed with untreated water and the other with water treated with the boiler fluid. The same purpose would no doubt have been served by using two boilers, but the demonstration it was thought would be strengthened by the use of a single shell. This led to the construction shown. From one point of view the most interesting thing is the provision of two complete sets of fittings, everything had to be duplicated exactly as if two separate boilers were in question.

In testing, 30 pounds was applied to one-half with the manhole cover off to insure the partition joint being tight between the two halves, the test then being reversed to the other side. Subsequently 100 pounds per square inch

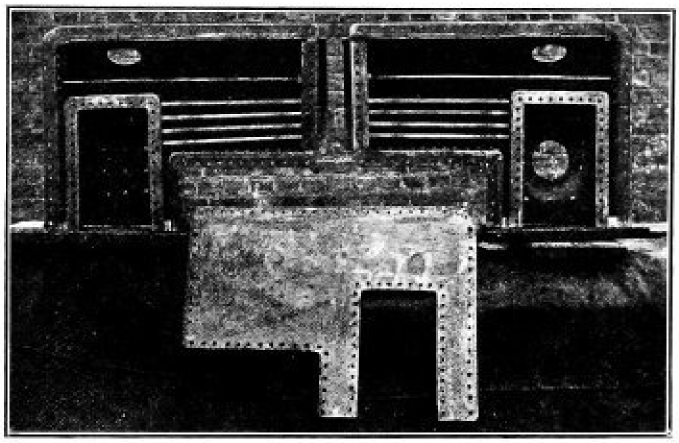


Fig. 7.—Sections of Experimental Boiler

was applied to both sides simultaneously to test the shell, firebox and seams.

The photograph shows a very creditable finished job and the purchasers were very pleased. History does not record any results from the boiler fluid point of view. A badly scaled half and a clean half, together with the unusual character of the boiler, would no doubt attract notice from any engineer. Certainly the idea of test implied is one worth imitation and extension where the merits of a process or method are debatable. Such a boiler could be used for many purposes for instruction and research.

For example, if fitted with an electric light inside and some glass hand holes, questions as to priming, connection currents and circulation generally could be directly compared side by side in a manner no other comparison would afford. The same firebox and exact duplication would cut out much judgment on the part of the experimenter, for if two distinct boilers were used it would be difficult, if not impossible, to insure exactly similar firing even with the best desire in the world. This, of course, leaves out the possibility open to bias the issue by the desire of the experimenter and that of open and flagrant fraud.

To my mind the boiler, as constructed would scarcely provide against deliberate fraud, and no customer of the fluid could be sure that the side shown as treated with the fluid and free from scale had utilized the same water as the scaled side. Perhaps, however, a further fitting was attached, a divided tank maybe, so that the operations were in full view and identical water insured.

Classes of Boilers Built.

Three distinct classes of boilers in the aspect of use are made—i. e., model, educational and commercial.

Model boilers, or sizes only applicable to model work, cover all types and a large variety in size. All are duly tested with water and steam, all are actual steam raisers, so that the work is not merely of a toy order. Boilers for scale locomotives, cranes and other pieces of mechanism fascinating alike to the amateur and professional engineer are represented.

Boilers supplied for instructional purposes cover all types, and up to the limit of the shop, all sizes. Engineering laboratories in universities, technical schools, colleges and elsewhere have been supplied with boilers from this Gillingham shop. In addition, research and experimental work of a definite and responsible character has formed a field where reliable small boilers are valuable.

The comparative cost is low, the steam supplied is, it is needless to say, exactly the same as that from a more imposing boiler. These small boilers answer just as well for the student as a bigger piece of apparatus, and their instructional value for most purposes is equal. Needless to say, quite a number of inventors who required for their purpose of demonstration in connection with heating or power a source of steam supply, have been customers for Mr. Goodhand.

By commercial boilers is meant boilers for definitely commercial purposes. Among these may be cited light railways for exhibition grounds and on large estates, steam launches and heating installations. Boilers for these purposes have been regularly made subject always to the limits in thickness and size. Quite a number have been made to fire with ordinary town gas. Given some type of thermostatic control in addition, such a steam raiser has endless possibilities for heating to predetermined temperature as a process of manufacture, for incubation and ordinary heating.

In work of the size and price done, prepayment of cost are the usual terms from the customers who are unknown. It is possible this is the only method of business possible under the circumstances.

The average boiler shop will scarcely undertake work of the character outlined except at an excessive cost. The demands are few and the amounts involved are trivial, while the trouble incurred in conjunction with work of any size is considerable. Those who, like the writer, have had to supervise small work of special character in its passage through the normal boiler shop know the troubles incident thereto. Without specialization and repetition such work is a nuisance unless at a prohibitive cost.

The interest in Mr. Goodhand's output to those familiar with larger work is the thin material demanding absolutely first-class workmanship to get tightness; the small character, confined as it is to a diameter of 26 inches as a limit; the variety in design and special character of many of his jobs. To run such a business successfully for twenty-six years is a certificate of competency as a boiler maker scarcely to be paralleled elsewhere.

Mr. Goodhand in this time has turned out many first-class men from his apprentices, their experience having been varied and it being no fault of the shop if the lad turned out a waster. Several are now engine room artificers in the British Navy. Actually it is more than likely that many readers of this article, like the writer, are frankly envious of the opportunities open in a shop of this character to any mechanically minded boy, who surely could wish for nothing better than to work all the week through on work of model caliber in such a well equipped shop.

It is, of course, well not to have too high a temperature in your smokestack, and there are instruments obtainable which will give you temperatures exactly, yet a crude indication of too high temperature is to note if the paint will stick on the stack.

Denney-Roberts Boiler Shop

A small shop for executing boiler repairs and getting out steel stacks, tank and all kinds of sheet metal work, has been established at Mt. Vernon, Ohio, under the name of the Denney-Roberts Company. The shop is splendidly equipped for the class of work which it is turning out, and it is conveniently located, only about five blocks from the central part of the city, with railway connections to the Baltimore & Ohio and Pennsylvania railroads.

The machine tool equipment of the shop includes a punch and shears made by the Cleveland Punch & Shear

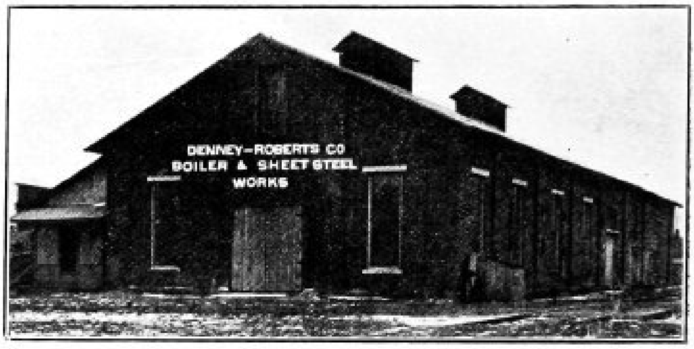


Fig. 1.—Exterior of Denney-Roberts Boiler Shop

Fig. 2.—Messrs. Denney and Roberts and Their Assistants

Works Company, two pairs of rolls made by the Hilles & Jones Company, Wilmington, Del., the smaller rolls being 6 inches diameter and 5 feet long, and the larger rolls 8 inches diameter and 7 feet long.

As flue welding is a specialty of the company, a special flue welding machine, made by the company, has been installed and for this work an oil-fired forge is used. In connection with the flue department there is a flue cutter and cleaner.

At the present time the company is installing a compressed air plant, with the expectation of operating three air hammers and a motor. The plans also provide for the installation of a Prest-O-Lite welding and cutting machine.

All of the machinery is operated by motors, and the shop is well lighted throughout by electricity supplied by the municipal plant.

The flanging department, not shown in the illustration, is equipped with a set of clamps, built and erected by the company, and also a flange fire and numerous blocks for various flanging operations. Power for this department is supplied by a Howe gas engine.

Near the punch and shears is a hoist for handling material, which also reaches the bending rolls. The company is contemplating the erection of a traveling crane in the main part of the shop and the floor of the shop is being cemented as rapidly as possible.

A feature of the shop which will meet the approval of experienced boiler makers is the tool room, which is well equipped with tools of all descriptions with everything systematically arranged. The management of the tool room is such that individual tools are kept in their proper place when not in use. A rivet room has also been provided, where all rivets are kept assorted according to size.

The office of the plant, though small, is neatly arranged and is well equipped in every particular. An invariable rule is strictly enforced in the office whereby everything is kept in its proper place, suitable files being provided for everything, not the least of which is a file for keeping such useful publications as The Boiler Maker. It is the policy of the management to keep everything where it belongs, and this rule is strictly enforced.

The largest orders which are being handled at present by the company are for foundry supplies, smokestacks, repair work and flue welding, as well as a variety of plate and sheet metal work and some structural work. Mr. Denney, shown at the extreme right in the photograph, Fig. 2, has been working at the trade for ten years, having served his apprenticeship with the C. A. & C. R. R. Company, now a part of the Pennsylvania Railroad system. Mr. Roberts, shown just to the left of Mr. Denney in the photograph, Fig. 2, also served his apprenticeship with the same company, and previous to his connection with the new boiler shop had sole charge of the boiler and structural iron work for the American Bottle Company, Newark, Ohio.

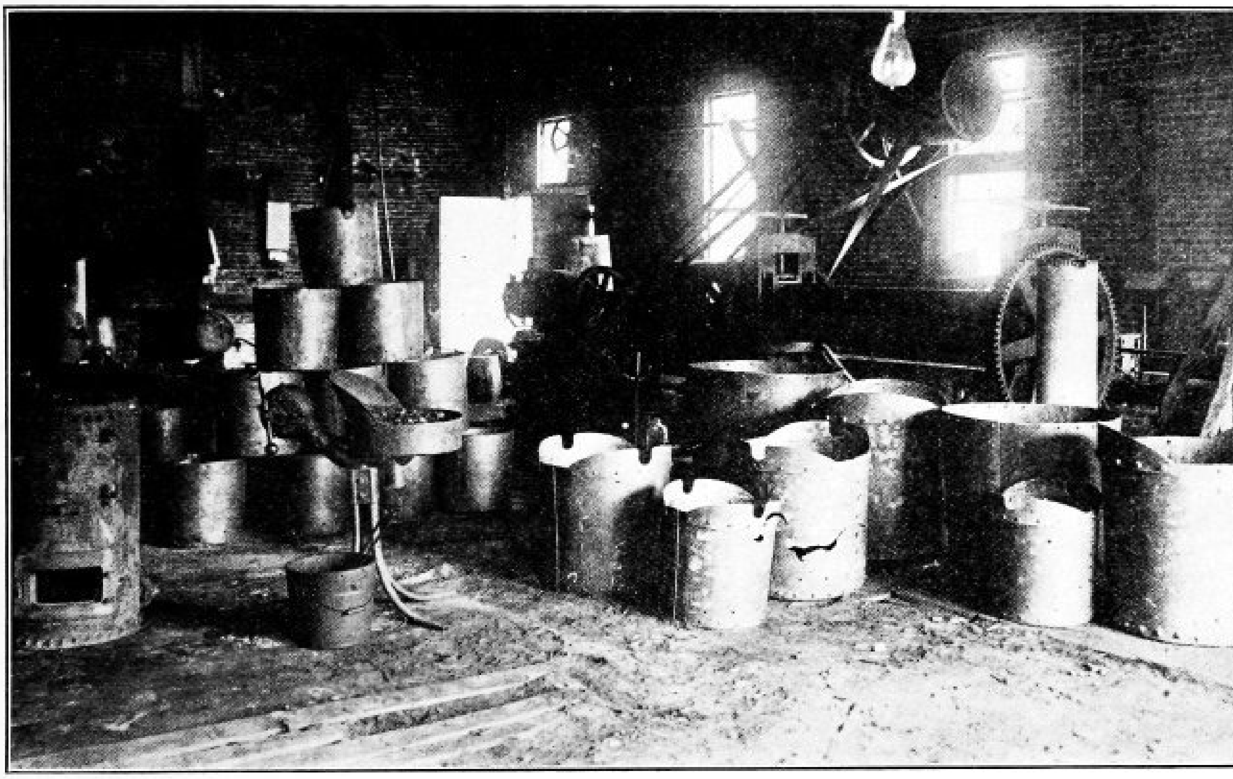


Fig. 3.—A Corner of the Denney-Roberts Shop

Safety-First Exhibit.—There was held in Washington during the week of February 21-26, inclusive, a "safety-first" exhibit in which all of the Government departments took an active part. This exhibit took on a national aspect, as manufacturers and operators from all over the country attended, in order to see what the Government of the United States is doing in "safety-first" work.

Welding a Broken Gear

In the course of its regular work the Searchlight Company, of Chicago, manufacturers of acetylene cylinders and compressed acetylene, received from the Harriman Hosiery Mills, Harriman, Tenn., a gear with two teeth broken out. The Searchlight Company was asked to repair the gear and the welding was done at the Searchlight factory with the following results:

Welders' time, at $.35 per hour, 20 minutes	$\$.11\frac{2}{3}$
Oxygen, at $.02 per foot, 10 feet	.20
Acetylene, at $.02 per foot, $6\frac{2}{3}$ feet	$.13\frac{1}{3}$
Material	.20
	.65
Machining, done by Western Machine Works	2.25
Total	$2.90

While the above cost may seem a high price for this particular job, it should be noted that the same work could be done on a very much larger wheel at approximately the same cost. For instance, the cost of a gear such as the one welded when new is only about $4.50. In this case, therefore, only $1.60 was saved by welding. However, a gear of this same type, whose diameter is 20 inches, costs about $23. The same job performed on such a gear would, therefore, effect a saving of $21.10. The cost of this work on the job described would not have been as great if the Searchlight Company had had facilities for machining the gear. As this work had to be done by an outside firm, this item alone accounts for the greater part of the cost of repair.

Development of an Ogee Corner

Method of Laying Out and Shaping the Ogee Corners of Flanged Firebox Heads

BY C. B. LINSTROM

Flanged firebox heads with ogee corners as door and firebox flue sheets are often made for light locomotive boilers, and by their use in such cases no mud-rings are required. Fig. 1 shows a perspective view of a part of the head with a section of the corner broken away to bring out its shape on the sides of the sheet at *A* and *B*. Sheet *C* is the outside door, or back head, and is riveted to the lower part of the inside door sheet, as shown.

The ogee flange on the inside firebox sheets provides a water and steam space between the sheets all around the

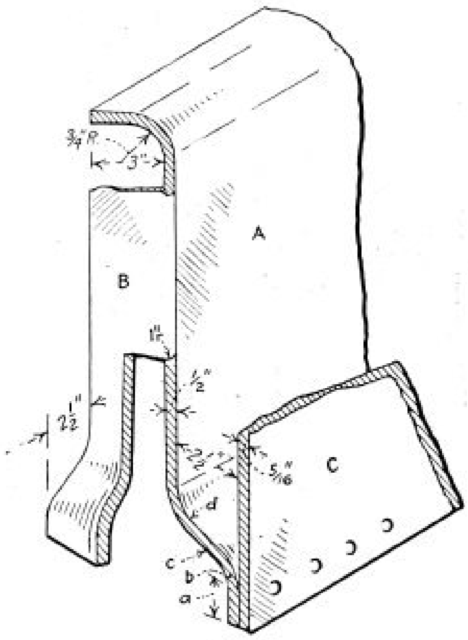


Fig. 1

firebox. In this case the distance is shown to be 2½ inches. The ogee flange is a double-curved flange with a straight section of plate *c* between the curved parts *b* and *d*. The bottom part *a* of the flange is straight, to which the outside head and wrapper sheets are riveted. Adjoining the side *B* of the head is placed the inside firebox wrapper sheet, which is also turned at the bottom with an ogee flange on both sides of the firebox. The two inside heads are riveted to it and the outside wrapper sheet.

By comparing the perspective Fig. 1 with the working drawing in Fig. 2 the method of developing the pattern may be more clearly understood. Its development can be only an approximation. Certain plate allowances must be made which are based upon experiments that have proved close enough for practical purposes.

The sectional elevation gives the length dimensions for laying out the head, the sectional plan those dimensions required for the width of the sheet. It is advisable before figuring on these lengths from the working drawings usually furnished that a profile elevation and plan view of the ogee corner be laid off to the full-size dimensions, as then there is not likely to arise any error in the pattern layout of the ogee flange and corner. Line *xx* in the plan is the center of the firebox. Lines *yy* and *rr* are lines from which measurements for the ogee flange are to be taken.

In laying off the pattern for the flanged head, first find the center of the flat sheet to be used, thus locating the line that corresponds with *xx*, Fig. 3. Set off from the center line *xx*, Fig. 3, the horizontal distance between the lines *yy* and *xx* of Fig. 2. Then locate the position of line *rr* on the pattern. About these center lines the ogee pattern is to be described.

From line *yy* lay off the distance equal to the arc length *f* taken along the neutral layer of the plate, as shown in the plan, Fig. 2. Make *e* of the pattern equal to the

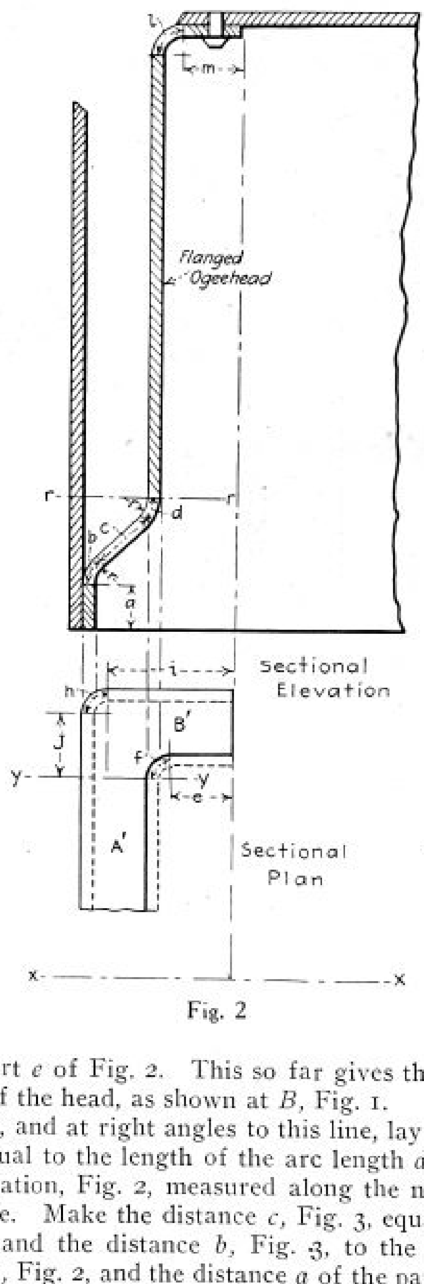


Fig. 2

straight part *e* of Fig. 2. This so far gives the flange for the sides of the head, as shown at *B*, Fig. 1.

From *rr*, and at right angles to this line, lay off the distance *d* equal to the length of the arc length *d* of the sectional elevation, Fig. 2, measured along the neutral layer of the plate. Make the distance *c*, Fig. 3, equal to that at *c*, Fig. 2, and the distance *b*, Fig. 3, to the neutral arc length of *b*, Fig. 2, and the distance *a* of the pattern to *a* of Fig. 2. Then from *y-y*, Fig. 3, measure off the distances *j*, *h* and *i* equal to their dimensions shown in the sectional plan, Fig. 2.

After the distance *i* of the pattern has been laid off, draw a perpendicular line *t-t* parallel with *y-y*, thus locating points *o* and *p*, and at the inersection between *j* and *h* draw line *s-s* parallel with *y-y*, also locating point *g*. By trial, find an arc that will pass through *o* and *g*, its center from which it is described lies on *s-s*. From point *p* set off on line *t-t* above *p* a distance equal to 7/8 or 1 inch, and to the right of line *t-t* lay off the same distance. Then draw the straight line parallel with *t-t* and connect point *o* and this line with an arc found by trial.

The upper part of the pattern from the point where the line *t-t* crosses the curved section is connected to the outer edge of the flange line with a large arc, the radius of which is also found by trial.

To be on the safe side and be sure that sufficient plate is in the pattern of the ogee corner it is customary to make an additional allowance, as at *w*, of about 3/4 inch all around the developed outside line of the pattern as shown. It is better to have a trifle too much of metal at the corner than not enough, as the surplus can be readily cut away to suit conditions.

The centers for rivet holes are spaced on the head after it is flanged to form, either by fitting up the inside firebox

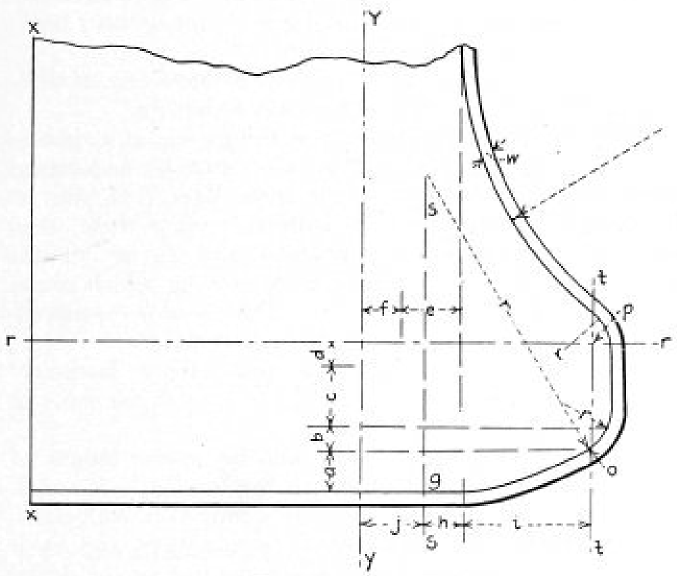


Fig. 3

with the door and flue sheet in position and marking off the position of the rivet holes on the heads from the wrapper sheeet, or by laying the heads on a surface block and with a describing gage locate the rivet line all around the head, and upon this line space off the rivet centers equal in number to those on the wrapper sheet.

How to Find the Camber or Versed Sine of a Taper Sheet

The taper sheet of Fig. 1 is in form the surface of the frustrum of a right cone—that is, a cone formed by the revolution of a right angled triangle about one of its legs as an axis. If the slant height or slope line of the taper sheet is prolonged, as in Fig. 2, it will eventually intersect the axis prolonged. If this intersection or apex is used as a center, the taper sheet may be "rolled out," as in Fig. 3, into the plane of the drawing or laid out flat. This all serves as a basis for calculating the camber of the taper sheet.

In the right triangle of Fig. 2 the difference between 39 and 32, or 7, squared plus 47 squared, gives us the square of the slant height or slope line of the taper sheet, viz., 47.52 inches

$$\sqrt{7^2 + 47^2} = 47.52.$$

Then to find the remainder of the hypotenuse of the full triangle we take the proportion from similar triangles

$$\frac{x}{47.52} = \frac{32}{7} \text{ or } x = \frac{32}{7} \times 47.52$$

from which

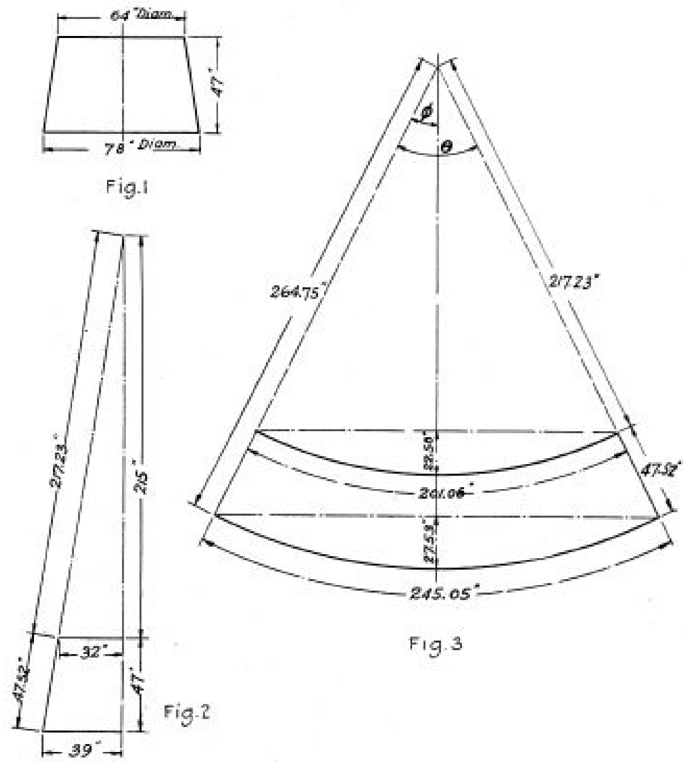
$$x = 217.23$$

also

$$47.52 + x = 264.75$$

giving us the radii for the top and bottom respectively for laying out the arcs of the taper sheet as shown in Fig. 3.

Next we calculate the respective lengths of these arcs



Taper Sheet and its Development

from the diameters of the top and bottom, Fig. 1, because these arcs will be just as long as the circumference in each case of the corresponding circle forming top or bottom of the sheet.

$$64 \times 3.1416 = 201.0624$$
$$78 \times 3.1416 = 245.045$$

Dividing one of these arcs by its radius and multiplying the quotient by 57.3 degrees, or one radian, gives us

$$\frac{201.0624}{217.23} = 0.92, \quad 0.92 \times 57.3 = 52.72 \text{ degrees} = \theta$$

from which

$$\phi = 26.36 \text{ degrees.}$$

Now the radius multiplied by the versed sine of the angle ϕ will give us the camber or distance from the chord to the arc in each case, viz.,

$$\text{versed sine } 26.36 \text{ degrees} = 0.10399$$

so that,

$$217.23 \times .10399 = 22.58 \text{ inches}$$

and

$$264.75 \times .10399 = 27.53 \text{ inches.}$$

After determining the camber of a large arc in this manner it is a simple matter to lay out the arc by any one of several methods, since the calculation for the lengths of the chords is quite apparent from an inspection of the triangles in Fig. 3. J. L. W.

John Works Out Some Ellipses

As Usual, John Finds that there is More than One Way of "Skinning a Cat"

BY JAMES F. HOBART

"Why, hello, John! Your last name is 'Stranger' all right. Haven't seen you for weeks. Where have you been?"

"I went over to New York to see THE BOILER MAKER folks. The editor put me under his desk and kept me there ever since. Said I talked too much with my mouth when I was out."

"Well, well! How did you get out? Hide in the waste basket?"

"No. One day the editor sent me to the printing office. Said there were so many 'blacksmiths' there I'd feel more at home. Then he told me that I asked so many questions it was weakening to his constitution. One day, in the printing office, I got a chance to slip into the paper, and here I am."

"Glad to see you again, John, but what are you trying to do with that string, the two nails and that old door?"

"I'm trying to set these nails and strings so I can draw an ellipse with them and a pencil, and the ends and sides of the ellipse must come just to these four marks in Fig. 1."

"Well, that's proper. Why don't you drive in the two nails, hang the string over them and draw the ellipse?"

"Why, I can't seem to get the nails set just right, and then something is wrong with the string. I can make it come just right for the two ends or for the two sides, but when I try to adjust nails and strings so both ends and sides will come exactly right, then something gets a strangle hold on my goat."

JOHN'S MISTAKE

"I see what your trouble is, John. You are all balled up trying to locate the two centers from which the string and pencil will describe an ellipse. Now, John, before we go any further, what is an ellipse, anyway?"

"Why, it's a sort of oblong circle, near as I can tell."

"Pretty good definition, John. About as good as the professor put up when he told a student to 'draw a round circle'! But—just remember this now—an ellipse is a figure—a curve—such that 'the sum of the distances from any point in the curve to two fixed points called the "foci," is constant and equal to the major diameter.' Just remember that a little later. Now to locate the 'foci' of the ellipse. From the points *A C D E*, sketch I, draw connecting lines between these points and determine the center *B*."

"Say, *B* isn't the center of the ellipse, is it?"

"Yes, John, it is the center of the ellipse, but it is not the point from which the circumference of the ellipse is drawn. We must now find the two points called the 'foci.' To do this, with a pair of big compasses, a rule or a stick, take the distance *A B*, and with *D* as a center, cut a couple of arcs on line *A C*, as shown by sketch II. Repeat the operation with *E* as a center, and the two points *F* and *G*, sketch II, are thus fully located. These points are where the two nails are to be driven, and are the 'foci' of the ellipse."

"Say, Mr. Hobart, what is the meaning of the word 'loci' as distinguished from foci?"

"Loci, John, is a combination of geometry and Latin. Loci is the plural of 'locus,' which means something like geometrical figure, only it has a broader meaning. Put your pencil on the paper. That is a point, isn't it, the mark the pencil made? Well, now move the pencil along and you have a line, don't you? And the line is the 'locus' of the point. Now, if we move a line sidewise and it could make a mark same as the pencil did, a surface would be swept over by the line, and that surface would be the 'locus' of the line. Loci means that two points are to generate lines and the points *F* and *G* are the starting points of no end of 'loci' (lines) which would reach from *F* and *G* to every portion of the ellipse circumference, as at *H* and *I*, sketch III. But we will leave that geometry business and you can dig it all out of your books if you want to get to the bottom of it."

"Say, I'll do just that. I don't like to have any of these things looking at me so I can't understand 'em."

"That's proper, John, take these things one at a time as they come up and you will be able then to understand other things which will surely come later. If you let these simple things slide by without nailing them, then some day you will have to go back and dig up all this detail before you can catch on to something which comes in the day's work. Dig 'em out. That is only 'preparedness,' so you'll be ready when the time comes."

"What do we do next with that ellipse business? We've got the 'foci' *F* and *G*, and I'll drive in the nails as in sketch III. Now, what next?"

"The next thing, John, is to find the proper length of string required. You have driven the two nails *K* and *L* in the foci *F* and *G*, now loop the string over both nails, place the pencil at *C* and pull the string tight and tie it as shown at *J*. Should it be troublesome to hold the pencil *M* firmly in place while the string is being tied, you had better drive a small nail at *C*, in place of pencil *M*, then stretch and tie the string as shown at *J*, and the apparatus is ready for use. Replace the pencil, removing the nail from *C*, then move the pencil along the limiting loop in the string and the curve *C I H A* will be described. And here is where the definition of 'ellipse' comes in. The length *I L* or *H L*, added to the length *I K* or *H K*, always equals the distance *A C*."

"Say, Mr. Hobart, that *A B-D F* business in sketch II is just what I wanted. It lets me out onto easy street so that it is all plain traveling now. But isn't there some way of drawing a pretty true ellipse without the string business?"

"Certainly there is, John. The string method is often used because it is so handy. But you can draw in many other ways almost any kind of an ellipse—yes, and any circle too. There are several ways of describing an ellipse and here is one method, shown by Fig. 2. To work this method, draw two circles, one within the other, and take as radii the distance *A B* and *B D*, sketch I, Fig. 1."

"Here it is, Mr. Hobart. Fig. 2 shows it. One circle with radius *B D*, the other circle with radius *B C*. And I take it that these two circles are the greater and less diameters of the ellipse?"

"Yes, John, that's right. Now draw a line from center *B* right to the outer circle, no matter where, say as at *O*. Next, drop a vertical line from where line *O* cuts the greater circumference. Draw a horizontal line from where B O cuts the inner circle and where these lines intersect will be a point in the circumference of the ellipse."

Oh ho! I see it now. I may draw any number of lines, N O P, etc., and put in verticals and horizontals for as many points in the ellipse as I want, then I sketch in the ellipse freehand, from one of these intersections to another? And I can, if I wish, put in so many of these lines that the intersections will practically form the circumference of the ellipse?"

"That's just the way, John. You may put as many or as few of the intersections as you choose, but the more of them the more accurate will be the work."

"That will be a very handy method to have up my sleeve and I can use it a whole lot. But I wish I knew of a way for sketching an ellipse where I didn't have to draw big circles, as in Fig. 2. Sometimes that is quite a task, when the ellipses are large ones."

"Oh, we can fix that all right, John. There is a way of sketching a circle which will meet your requirements, and the same method will work as well with an ellipse as it by Fig. 5 represents the ellipse, which is really a circle with the eye of the beholder moved around until the circle can be seen only from a pretty flat angle. If we keep on revolving the circle, the picture will change until we can see only a flat line, just the edge of the disk, instead of a full-moon view of the entire surface of the circle."

"Then we can make ellipses narrower and narrower, and all of the same length, by simply shortening the line D E?"

"That's it, John. No matter whether the line D E be long or short, the laying down of the diagonals and the lines through the first and sixth divisions of the side will intersect the diagonals in the circumference of the ellipse same as they did in the laying down of the circle."

"Then I can draw any kind of an ellipse in this manner, can I?"

"Yes, John, any size or shape of ellipse from a full circle down to a single straight line. And then there are some other ellipses which may be drawn in this manner, too."

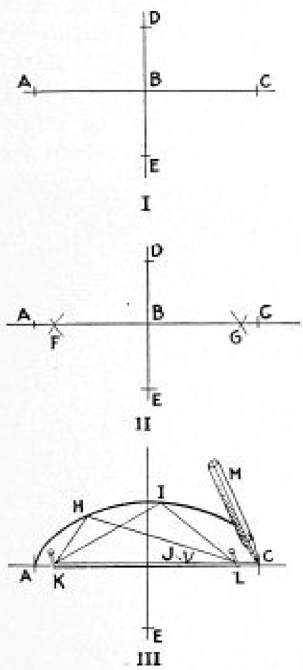


Fig. 1 - Drawing an Ellipse of Given Dimensions

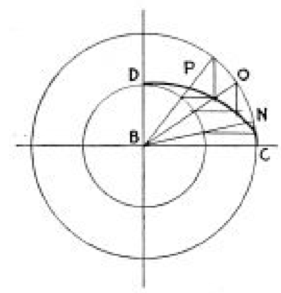


Fig. 2 - Sketching an Ellipse

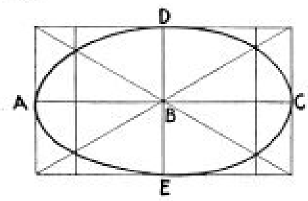


Fig. 5 - Sketching an Ellipse

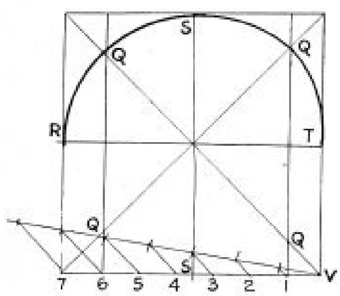


Fig. 4 - Sketching a Circle

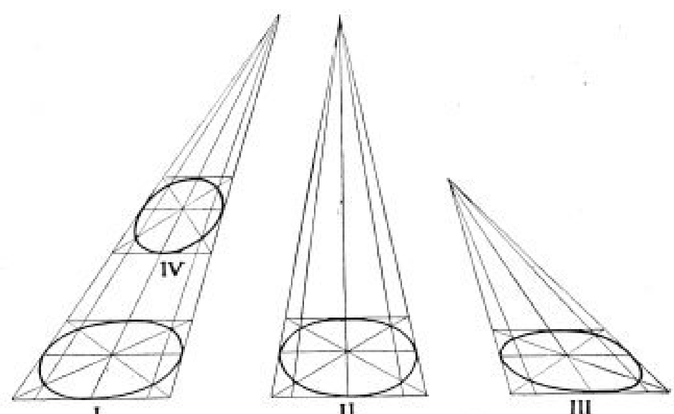


Fig. 6 - Sketching Ellipses in Perspective

Methods of Drawing an Ellipse

will with a circle. Fig. 4 shows how to do this stunt. Draw a square the size of the required circle and lay off one side into seven equal parts as at U 7. From the first and sixth point in the line draw verticals which cut the diagonals at Q Q Q Q. Through points Q R and S sketch a line which will be the circumference of the required circle."

"That sure is a handy way, Mr. Hobart, and there is not much work to it. Did you say this method could be used for sketching an ellipse, too?"

"Yes, John, Fig. 5 will show the way it can be done. Just lay out the long and short diameters same as in Fig. 1, draw the diagonals and divide one side into seven equal spaces and draw the lines through the first and sixth, cutting the diagonals of the figure exactly the same as shown in Fig. 4. Indeed, the entire operation is about the same as in Fig. 4, and the result is the development of a flatted circle, known as the ellipse."

"Say, Mr. Hobart, an ellipse seems just like a circle tipped up so you can see more length than you do breadth."

"That is exactly what happens, John; the view shown

"What are they, Mr. Hobart?"

"Perspective ellipses, John. Something which you always see when you look at a circle, although you don't realize it when you are thus looking. Any circle, John, takes the form of an ellipse when you view it from any point except a full front view. Stand directly in front of a boiler with your eyes level with the middle of the boiler head and you see the head as a perfect circle. Now move ever so slightly from that position and you see the boiler head as an ellipse. And the further you move from the front position, the flatter becomes the ellipse which you see. Finally, you move sidewise until you are exactly in line with the boiler head, and although you know it is a circle it appears to you just as one straight line. Do you get me?"

"Yes, sir, I get that all right. When I look at circles from any other direction than square out from them, the circles appear to me as ellipses, and the more to one side is my point of view, the flatter the ellipse; until seen from a point at right angles to the circle it appears to be only a straight line."

"That's right, John. You have got the idea. Now place several boiler heads on the shop floor, the heads all in a line with each other and a few inches apart. Now when you look at these heads, what do you see? You can't get exactly in front of all those heads. It is dollars to doughnuts that you are not squarely in front of even one of the heads, but are viewing them all from a very considerable angle. These heads, as you look at them, appear to be round, but if you look closely you will see that they appear as ellipses and that the ones nearest seem larger than the heads farther away."

A Practical Lesson

"Say, that is so, isn't it? Queer how things look differently from what they really are. I never thought of that before, but it's so. If there were a long row of boilers side by side they would grow smaller in the distance and vanish, same as a railroad track does when you look at it along a couple of miles of straight track."

"You would find things different from what they seem to be, John, should you try to draw a picture of that row of boiler heads as they lay on the ground. Just try it once. Try drawing each head as it appears, each more distant head being smaller and smaller. And if you don't have the time of your life trying to draw those boiler heads in perspective—well, than I'll lose my guess!"

"Say, that is some stunt. I have tried a half-a-dozen sketches and something is wrong with each one. I can draw one head all right and make it look right, but just as soon as I draw in the second or the third head, then the first one goes wrong, the second one looks worse, and I can't get that row of heads to look right, try as I may. The heads farther away seem bigger than the head nearest me and don't any of the heads look round."

"Perspective, John. That's where perspective gets its grip on you and you can't get a grip on perspective. But you can do it with this last method of sketching an ellipse. Just take a look at Fig. 6 and you will see what I mean. In sketch I the vanishing point lies off to the right, and in the picture all lines seem to vanish in a direction as shown by the converging lines. In a picture of a railroad track the fact is quite apparent, but if we are looking into a forest the perspective is not as evident, but it is there all the same."

"Say, those shapes look exactly like boiler heads, and they aren't round, either. What makes them seem round when they aren't?"

Perspective Sketches

"Perspective again, John. Perspective, the thing which makes pictures look right, and the lack of perspective is what makes Chinese and Japanese pictures seem so funny and so jumbled. Now, we may stand with the row of boiler heads vanishing to the right, as shown by sketch I, or we may stand dead in front of the heads, as in sketch II. Sketch III shows the vanishing point leading to the left, and very much nearer than in the other sketches, yet for all of that the figures seem right, and while they are all ellipses there is not the same shape to either. Even in sketch IV, where the long dimension of the ellipse is from you—something which cannot possibly be so except in a section—the ellipse in question seems to be all right and in good proportion."

"And are all these ellipses drawn or sketched by the method shown in Fig. 4?"

"Yes, John, the side is divided into seven equal spaces, lines drawn thence through the several diagonals, and the ellipse sketched in through the intersection points, as stated elsewhere, and that's all there is to sketching perspective ellipses—shapes which look right, but which perhaps never existed save on paper. Yes, if we photograph the row of boiler heads the picture will look about the same as the sketches. So if you ever find it necessary to make a perspective sketch of several boiler heads or boilers, the method here given will enable you to make some 'perspective ellipses' which look right when you get them on paper."

"I have noticed that, Mr. Hobart. When I have to make a sketch, I get into no end of trouble to get the several things to look right, but after I do succeed in getting them in as they should be, then the sketch looks all right. But it's pretty hard, changing a sketch a dozen times when you don't know just what the matter is, and have to keep changing until you finally hit the right combination; then the thing looks right, because it is right."

"John, just study out on the geometry of circles and ellipses. It will help you a whole lot in more ways than one. You can get the books out and read up a bit, then put in your spare time studying the matter."

"I'm just going to have a lot of that stuff in the back of my head, Mr. Hobart; then if I ever get shoved under the editor's desk again for a month or two, I'll have something to think about besides waste baskets and office boys in the sanctum, and a type louse in the printing office. Gee! Type lice are fierce things. A printer showed me one one day in the printing office. He found the type louse in a galley of type and showed it to me, and by thunder! that type louse hit me right in the eye! Phew, but it hurt!"

Welding Sheet Iron

A recent series of tests of welding 20 and 24 gage sheet iron demonstrated very clearly the utility of the oxy-acetylene torch in manufacture of light steel and sheet iron products, such as carbide cans, sheet iron vats, stills, etc.

It was found that without difficulty and without any special apparatus for holding the sheet iron in place, 24-gage metal can be welded at the rate of 45 feet per hour, with a consumption of 3 feet of acetylene and 4 feet of oxygen. The total cost, including labor, is approximately 1 cent per lineal foot. Twenty-gage metal can be welded at the rate of 35 feet per hour with a consumption of 4½ feet of acetylene and 6 feet of oxygen. The total cost of this operation is approximately 1¼ cents per foot.

Furthermore, manufacturing sheet metal products by the oxy-acetylene method produces very much more satisfactory results than are possible either by riveting or by spot welding. Not only is the finished product stronger and more uniform, but the seams are absolutely air and liquid tight. The manufacturing cost is less than the cost of punching holes and riveting, and is practically the same as the cost of spot welding.

The Elyria Enameled Products Company, of Elyria, Ohio, uses this method of welding in manufacturing its stills and vats. After the welding is completed, and the entire product is glass-enameled, the finish is so smooth that it is impossible to tell where the welding has been done. This firm reports that by no other method were they able to secure results so satisfactory in every respect.

The figures on the cost of welding the sheet iron were obtained from a series of tests recently made at the plant of the Searchlight Company, Chicago, Ill.

Fittings up to 2½ inches and including that size should screw 4½ turns on to a piece of pipe of standard thread by hand.

Savings Effected by Welding Battery Plant Steam Pipe Installation and Headers

Cost of 6-inch Header Reduced 26 percent by Welding — 36 percent Saving by Welding 3-inch Headers

The steam pipe installation illustrated consisted of three lines of pipe, each about 400 feet long. One line consisted of about 250 feet of 10-inch pipe and about 150 feet of 8-inch pipe for low-pressure steam for heating purposes. Another line was 4-inch pipe for carrying the vacuum return and another 4-inch line is for carrying high-pressure steam at about 100 pounds pressure for power purposes.

The three lines extend from the present boiler room to the new battery plant. Fig. 1 shows a welded bend in the 10-inch line at the point where it enters the boiler room. Fig. 2 shows two bends, in each of the three lines just outside of the boiler room. The sections of pipe containing these bends were welded on the ground at the side of the trench and were later lowered into the trench. Just beyond the bend shown in the background of the picture it will be noted that a flange is screwed to the pipe. Another flange is attached to the other end of each of these sections not shown in the photograph. These flanges are attached to short threaded sections of pipe which were welded to each end for the purpose. These flanges were inserted at each bend to permit turning the pipe during the welding.

Fig. 3 shows a trench containing one 8-inch line and two 4-inch lines looking toward the new battery plant. The background of this picture shows flanges attached and standard elbows for making the turn into the battery plant. Fig. 5 shows a weld being made inside of the battery plant. It will be noted that there is a coupler shown on the 8-inch pipe at the side of this weld. There is no particular reason for this, as this joint should have been welded very easily, but it happened that the pipe

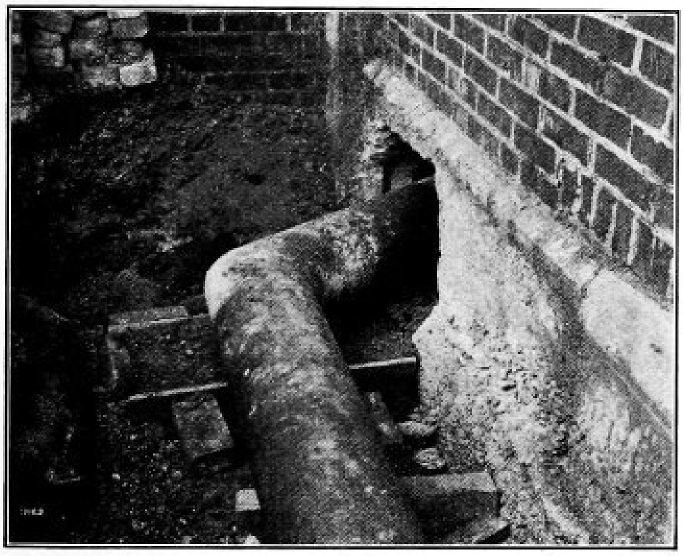


Fig. 1.—Welded Bend in 10-Inch Pipe

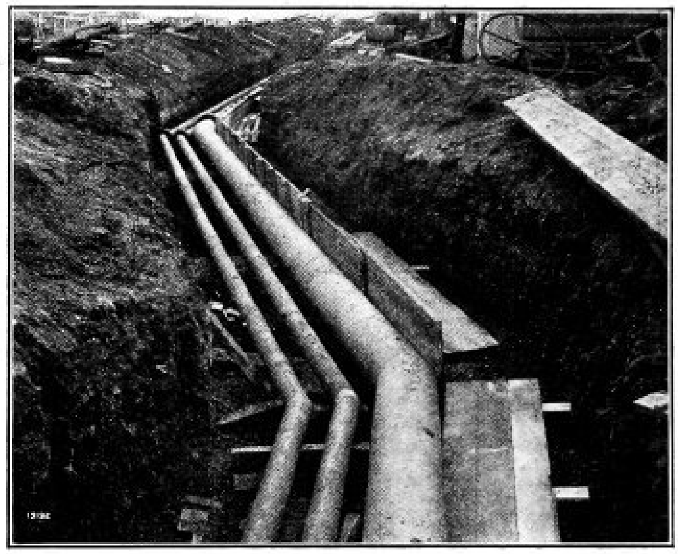


Fig. 2.—Bends in Steam Pipe Lines

Fig. 3.—8-Inch and 4-Inch Pipe Lines

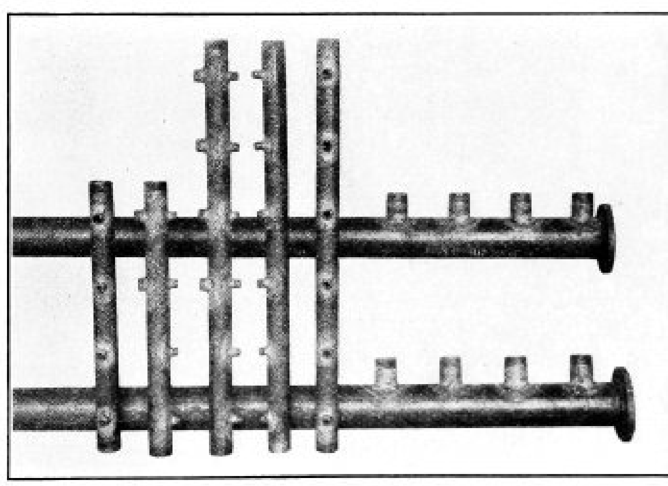


Fig. 4.—Welded Headers or Manifolds. The Two Larger Headers are 6-Inch Pipe with 3-Inch Nipples; the Smaller Ones are 3-Inch Pipe with 1- and 1½-Inch Nipples. In all ten of these manifolds were welded

used at this point was already threaded and the coupler was at hand, so it was connected in this manner. The weld is being made in 4-inch pipe.

Fig. 4 shows some welded manifolds or headers for the new battery plant. The two larger headers are 6-inch pipe with 3-inch nipples, while the smaller ones are 3-inch pipe with 1-inch and 1½-inch nipples. In all there were ten of these manifolds, two of the 6-inch ones and eight of the 3-inch ones. Some of the 3-inch manifolds are not shown in the picture. The costs and rating on these manifolds are shown in the following tables.

In the whole steam pipe installation, there were approximately 44 welded joints in 4-inch pipe, 11 in 8-inch pipe and 15 in 10-inch pipe.

The 4-inch high-pressure line of this installation was tested out and no leaks were found. The 8-inch and 10-

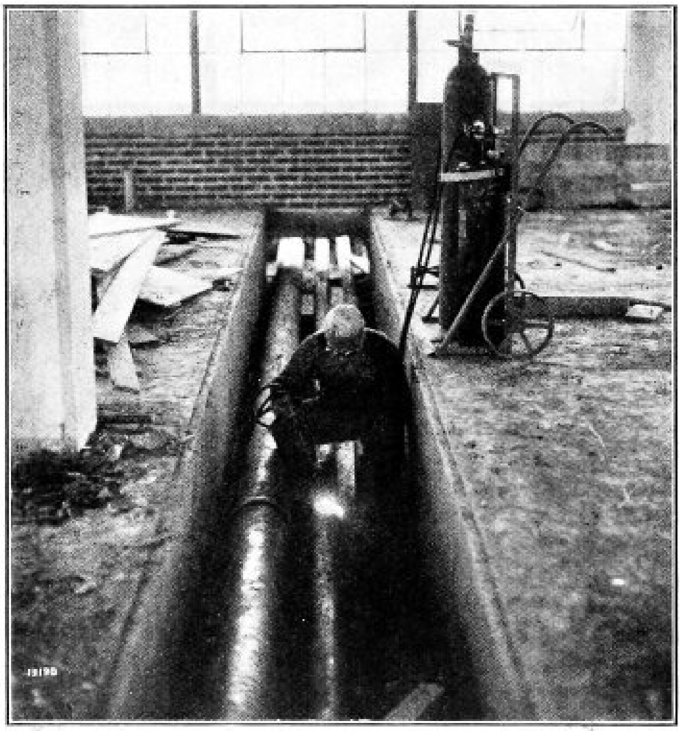


Fig. 5.—The Welding Operation

The weld here is being made on a 4-inch pipe. The coupling on the 8-inch pipe alongside this weld was unnecessary.

inch low-pressure lines were tested out and two pinhole leaks were found in the entire length. The 4-inch vacuum return has not been tested out, but of course no test is necessary on this line.

TABLE 1.—ESTIMATED COST OF STEAM HEADERS FOR BATTERY PLANT MADE UP WITH FITTINGS

Two 6" Headers	
2 pcs. 6" black pipe 8' 2¾" cut to lengths	$12.20
4 6" threads	2.10
8 6" x 6" nipples	7.40
2 6" x 4" nipples	1.18
2 6" x 3¾" nipples (special)	1.41
12 6" x 6" x 3" C. I. tees	20.20
12 3" x 2" nipples	1.84
2 6" companion flanges	2.00
Labor	4.20
	$52.53
Eight 3" Headers	
32 3" x 8" nipples	$12.30
16 3" x 3" nipples	2.46
40 1" x 2" nipples	.70
12 1½" x 2" nipples	.34
12 3" x 3" x 1½" x 1" C. I. crosses	9.76
28 3" x 3" x 1" C. I. tees	11.65
Labor	7.30
	$44.51

Total estimated cost of all headers, $97.04.

TABLE 2.—COST OF WELDED STEAM HEADERS FOR BATTERY PLANT

Two 6" Headers	
2 pcs. 6" black pipe 17' 2½" cut to length	$24.74
4 6" threads	2.10
1 pc. 3" black pipe 4' 6" long	1.13
2 6" companion flanges	2.00
12 3" threads at 12c	1.44
125 cu. ft. oxygen (for cutting and welding) at 2c	2.50
106 cu. ft. acetylene (for cutting and welding) at 2c	2.12
5 lbs. Norway iron filler rod at 10c	.50
Labor—setting up	1.20
Cutting and welding	1.00
	$38.73
Eight 3" Headers	
1 pc. 3" black pipe 26' 8" long	$6.67
1 pc. 1½" black pipe 1' 9" long	.12
1 pc. 1" black pipe 5' 10" long	.27
16 3" threads	1.92
12 1½" threads	.60
40 1" threads	1.40
303 ft. oxygen (for cutting and welding) at 2c	6.06
261 ft. acetylene (for cutting and welding) at 2c	5.22
10 lbs. Norway iron filler at 10c	1.00
Labor—setting up	2.60
Cutting and welding	2.45
	$28.25

Total cost of all welded headers, $66.98.
Saving on 6" headers, $13.80 or 26 percent.
Saving on 3" headers, $16.26 or 36 percent.

How to Find What Thickness of Material is Required to Carry 150 Pounds of Steam

The thickness of a boiler shell to carry a given pressure is generally calculated from the formula for the safe strength of thin cylinders.

$$P = 2\,t\,T\,f \div d\,F$$

$$\text{or } t = P\,d\,F \div 2\,T\,f$$

where P = safe working load or pressure in pounds per square inch
T = tensile strength of plate in pounds per square inch
t = thickness of plate in inches
f = ratio of the strength of the riveted joint used to that of the solid plate
F = factor of safety allowed
and d = diameter of shell in inches

The value of T is usually specified by the manufacturer, a good value being 55,000 or 60,000 pounds per square inch, f is taken from tables of strength of riveted joints or is computed, and F may be taken at a figure not less than is prescribed by local or State laws. The Massachusetts Boiler Rules state:

"The lowest factor of safety to be used for boilers, the shells or drums of which are exposed to the products of combustion, and the longitudinal joints of which are lap riveted, shall be as follows: 5 for boilers not over ten years old; 5.5 for boilers over ten and not over fifteen years old; 5.75 for boilers over fifteen and not over twenty years old; 6 for boilers over twenty years old. The lowest factor of safety to be used for boilers, the longitudinal joints of which are of butt and double strap construction, is 4.5."

For the efficiencies of the various types of riveted joints reference is made to the Massachusetts Boiler Rules, 1910, or the A. S. M. E. Boiler Code of 1914.

Let us assume for the case in hand that our longitudinal seam has an efficiency of riveted joint to solid plate of 85 percent, then

$$t = \frac{150 \times d \times 5}{2 \times 55{,}000 \times 0.85}$$

which is an expression for the thickness in inches of material required to stand 150 pounds of steam.

J. L. W.

Commercializing "Used" Boilers

An Order for Second-Hand Boilers Leads to Some Surprising Disclosures

BY JAMES FRANCIS

"I wish," tinkled the telephone, "you would look around and find for me about 200 or 250 horsepower of good second-hand boilers which I can place in a large saw mill. We are sending an entire outfit of used machinery and want some boilers which must be good for 125 pounds of steam pressure, moderate price and fairly good-looking. And we want all the attachments and appliances belonging thereto, including the piping necessary for connecting the boiler and the other steam appliances. And we are in a hurry, too—had a couple of boilers which we intended to send with the outfit, but when we commenced to get these boilers ready for shipment we found they would not answer. Look around and find a bargain. We don't want any cheap-skate of a boiler and we can't pay very much for it, either. Get two boilers if you can find them; if not, find one large one, but we would rather have two of smaller size."

It looks like a rather small matter to go out and pick up a couple of 16-foot steam boilers, but to meet all the conditions imposed by the man behind the telephone proved something of an undertaking. Two solid hours of telephoning simmered all available boilers in town down to half a dozen, and visits were made to these as soon as possible.

The Search for a Second-Hand Boiler Begins

The first boilers looked at were in the back lot connected with a dealer in used machinery of all kinds. The boilers were lying on the ground, packed with loose snow, and one shell was lying with one end in a hole and water had frozen inside and out, covering the front head about 6 inches and developing an ice field among the tubes, the open manhole permitting the puddle of water free ingress.

With a boiler frozen fast in the ice, one end in 6 inches of water and the thermometer 20 degrees above zero, what was to be done? The telephone talker was in a rush for these boilers, too. The ice was chipped out around the shell as much as possible with well-sharpened crowbars, but there was no ice underneath the boiler, which was frozen solid to the ground.

The ice was chipped out inside the boiler as far as possible through the manhole, a sharp tattoo sounded on the shell with sledges failed to break the frost, and a gallon of gasoline thrown a quart at a time into the boiler and cautiously set on fire failed to loosen the shell from its cradle of ice.

Meanwhile that portion of the shell above the ice was inspected as well as possible. The upper portion of the shell developed a coating of red oxide of iron more than one-sixteenth of an inch thick. "Where could this scale have come from?" was the question which arose when the scale was found. The front head seemed good, but the rear head looked wasted. Closer work with hammer showed a considerable wasting away of the heads, and the front head, even though it appeared good to a casual inspection, developed several places around tube ends where the metal had been reduced more than one-half in thickness from its original 9/16 inch of metal!

Finally the shell was loosened from its icy bed. A five-ton chain tackle had been rigged to a chain placed over the top of the boiler, the pull of the tackle, attached to a convenient railroad track nearby, was to roll the shell over. Several jacks had been placed underneath one side of the shell, holes having been chipped in the ice at an angle, so the upper end of each jack could bear fair against the boiler shell.

With all the jacks well screwed up, a heavy pull on the chain tackle and in addition a vigorous tattoo upon the shell with sledges, the frost finally let go and the shell was rolled out of its hole in the ice. And then the inspection closed suddenly. Across the middle of one of the sheets, about 30 inches long, was a fine crack, well developed and full grown. The boiler had been through a fire, heated hot, and water had reached the shell when it was evidently very hot. This closed the work upon this boiler, which was scrapped, upon the recommendation of the writer.

Corrosion Discovered

Another pair of boilers were then hunted up, the result of the same 'phonefest. These boilers seemed pretty good, save that the tubes were bad and would have to be replaced. The owner of the boilers agreed to do this, and the old tubes were removed and sent to a shop, where they were cut off at both ends and pieces welded on to make up the necessary length.

While the tubes were in the shop I took occasion to slip inside the boiler shells and give them the "once-over." To my surprise I found the tube sheets so wasted away that they were utterly unfit for retubing. In some places the metal had been grooved and corroded away to less than a quarter of an inch thick. A visit to the owner of the shells and a "song and dance" therewith, led to "diplomatic relations being severed" and the trade called off. He would not stand for putting a new head in each of the shells and I would not accept the boilers unless new heads in each were provided. He finally scrapped these boilers and sold the rewelded tubes to go into another boiler.

The two remaining boilers discovered by 'phone were then looked up and found to be in the custody of a dealer evidently two-thirds fox and the rest monkey, for he had given both the shells a liberal application of very thick and very black asphaltum paint, and had even daubed over a goodly share of the sheets and tube-sheets, on the inside!

Fresh Paint Arouses Suspicion

But a gasoline blow-torch applied around the tube ends and along the seams and against the rivet heads soon exposed enough metal in such condition that I became decidedly suspicious and lost all interest in the boilers. This set the dealer into a panic, and he began to sing all sorts of songs to complete the sale. But I would have nothing more to do with the boilers until he agreed to fill the boilers with water, heat the water to 212 degrees by means of a small boiler, which he was to place nearby and connect up; then, after the boilers and their contents showed a temperature of 212 degrees, he was to apply hydrostatic pressure up to 150 pounds per square inch.

He filled one boiler—was going to run the water into the other boiler after testing the first one—and heated it to the required degree, but he never pumped up 150 pounds pressure, or even half of that, for the old shell leaked like a sieve when pressure was applied. This I was afraid of, and also fearsome that the heavy coats of thick paint might make the leaks temporarily tight, hence the specification for heating the shells and their contents to 212 degrees before the pressure was applied. He did not heat the other boiler, and I set out to hunt some more shells.

Chicago seemed a good place to find second-hand—no, not "second-hand," but "used" boilers, if you please; so I visited several wrecking companies and saw boilers enough to load Noah's Ark three times over, and some of the boilers might have been originally in the old ark, judging by their very venerable appearance. Of the hundreds of boilers looked over in the premises of the wrecking companies, none would fill the bill. "You're too blamed particular" was the manner in which one dealer summed up my requirements.

Then I heard of a certain electric company which had all kinds of boilers and engines to sell. "Yes," these people told me, "they had exactly what I wanted. They had electrified a small manufacturing plant about three years since and took over the steam plant as part paymeent for the electric apparatus, and had left the boilers and engine in their original location until they found a customer for the machines.

Renewing an Old Acquaintance

I visited the plant at once and found the boilers just as they had been set five years before, and had run only two years. Apparently the boilers were in excellent condition. They had been well cleaned off and fairly taken care of. Finally I purchased the boilers subject to a final examination and acceptance after the shells had been removed from their setting, the present owners of the boilers to remove them from the setting and place them free on board cars.

I never had seen this manufacturing plant before, but something seemed vaguely familiar about the placing of the boilers and engine and the manner of its setting and the arrangement of the several rooms in the factory. After doing a bit of questioning among those familiar with the plant, the reason of its familiar appearance became apparent, for I found that five years before the plant in question had been erected and equipped from my own plans, drawn expressly for that manufacturing plant; also that the boilers had been bought according to my own specifications.

"Here now," I thought, "is a pair of boilers which should be O. K., and if they look all right after they are out of the setting I'll buy them!" And they did look all right when loaded on the cars, and I passed them and they were sent to the wood worker who was to use them. When the wreckers removed the boilers and the piping they did very little pipe-wrench work. And pipes which were unscrewed were backed out by turning upon the end of a pipe, not by any "fool pipe-tongs." Any hammering which was done to loosen a pipe was done with a sledge in a very effective manner, which left no doubts whatever whether that particular pipe was loose or not!

The boilers and piping and the boiler appliances were duly shipped, set up and operated, and I heard nothing of them for nearly two years, when in came a subpœna to attend a court of deposition to make statement under oath of the condition of those boilers, and particularly of the fittings that were sent with the boilers. It appeared that some time after the boilers had been erected in their new location,and had driven the engine for several months, the throttle valve "exploded," the law papers stated, and injured the engineer, who had brought suit against the new owners of the boilers, who in turn came back against the party who sold them the boilers and the fittings, for whom I had purchased and inspected the boilers, fittings and the alleged defective throttle valve.

But that was about all I ever heard from the case. My deposition was that the apparatus was apparently in perfect, usable condition when I saw it loaded upon the car in Chicago, and, as the valve in question had been operated safely for a period of two years, it was reasonable to presume that the valve, as well as the rest of the apparatus, was in good working condition when placed upon the cars, it was so when unloaded at destination by the purchaser, and furthermore, that the valve, if defective at all, had probably been cracked or otherwise injured by the mechanics employed by the purchaser when they piped the engine and placed said throttle in its new position.

That was the last I heard of the result of commercializing this used boiler and its fittings, but no one knows what kind of a surprise party will next be sprung upon the writer by the parties who purchased the boilers in question.

Ohio's Stand Against "Used" Boilers

I believe the State of Ohio has taken a grand, good stand in regard to the use of second-hand—"used"—steam boilers. I notice that there are no dealers in second-hand boilers in that State and that the installation and use of used boilers is conspicuous by its absence. Would that it were so in all States of the Union, and that when a boiler was removed and sold by any party it should go to the scrap heap at once. The rolling mill is the best place for old boilers. There is never any doubt regarding their safety after they have passed through the rolling mill, and such disposal of used boilers is a pretty good thing for the boiler maker, as well as for the would-be purchaser of used steam vessels!

But the owner of a steam boiler has some rights as well as the boiler maker, and it requires careful consideration to arrive at the value of a steam boiler to its user. When a man purchases a steam boiler he should at once begin to charge off at least 20 percent of its cost for "depreciation." Some concerns charge off 20 percent of the cost each year, and at the end of five years the boiler, as far as its first cost is concerned, has gone—vanished—and if the boiler lasts any longer than five years, the owner should charge himself with something from nothing, for he is using a steam boiler which he has sold to "depreciation" and for which he has been paid in full. Here is a fine question for the "efficiency sharps" to argue, but to the writer it appears that the boiler should not be charged off, full cost, in five years.

Depreciation

Why should a boiler cost be thus charged off? At the end of one year the owner of a $300 boiler charges off 20 percent of its cost, and $60 is promptly cut off the value of the boiler. Next year he starts to clip off another $60, but here is where he is in error. Why should he charge off $60 from a boiler which only stands him for $240? That's what the boiler is being carried for on his books, and by what proper means of figuring can depreciation be charged against something which the factory does not own?

At the end of the first year let the boiler be charged off for depreciation at the rate of 20 percent on $240, not of $300. This brings the depreciation charge-off at the end of the second year to $48, instead of $60, and the depreciation charges for the next three years are $38.40, $30.72 and $24.57, respectively, bringing the book-carried cost of the boiler down to $98.31 at the beginning of the sixth year. Thus, instead of the cost of the boiler being entirely wiped out in five years, it has been reduced to $98.31, and if the boiler be disposed of at this time for scrap it will probably bring about that figure, or may be sold as "used" for a goodly proportion of that amount.

Boilers, with good care, last considerably more than five years. I have inspected steam boilers which had been in daily service—under the most favorable conditions, of course—continuously for thirty years, and I had to give clean bills of health to the boilers in question. Now then, would the owner of these boilers be justified in charging off 20 percent, or any other percent, of the original cost of the boilers each year? Or would he not be justified in charging off 20 percent, or some other percentage, of the remaining valuation of the boiler after the yearly depreciation had been deducted?

Taking, for example, the boiler which cost $300. At the end of five years the owner finds himself charged with a boiler which was worth $98.31 to him, the balance of the $300 having been charged off as noted. Should this boiler last for ten years it should stand on the books as representing an investment of $32.22, the balance of the $300 having been charged off by the yearly increments of depreciation.

The owner can now afford to sell the old boiler at a very low figure, but it is still worth something, and the books show that it is, whereas had 20 percent been charged off each year for ten years, $600, or twice the cost of the boiler, would thus have been charged to the depreciation of a $300 boiler!

When this manner of charging depreciation is carried out on all the shop tools and machines it should certainly prove a very interesting matter to determine the disposal of this amount of money—where it came from, who got it, and if really and truly there ever was more than a paper charge of the sum of money in question. And if this be the fact, where was the balancing charge or credit placed to balance the $300 paid on paper to replace with new something which the shop never had?

Talk about "high finance!" What is higher than charging off twice the cost of a boiler for ten years' use of that piece of steam machinery? And where did that $300 go to? Who got it?

How to Read Working Drawings—VI

Explanation of Semi-Detail Drawing of High-Pressure Ammonia Valve—Outside and Sectional Views Are Fully Dimensioned

BY FRED WEST

While those engaged in boiler making should take a special pride in reading the working drawings pertaining to this important work, yet any man who is the least bit ambitious will learn some of the other lines also. He will study drawings relating to buildings, power stations, machinery, sheet metal layouts, water supply sewage disposal, railway construction, shipbuilding, electrical drafting, pattern making, and such like.

The fact is pretty well established that the man who can read working drawings and work from them is the

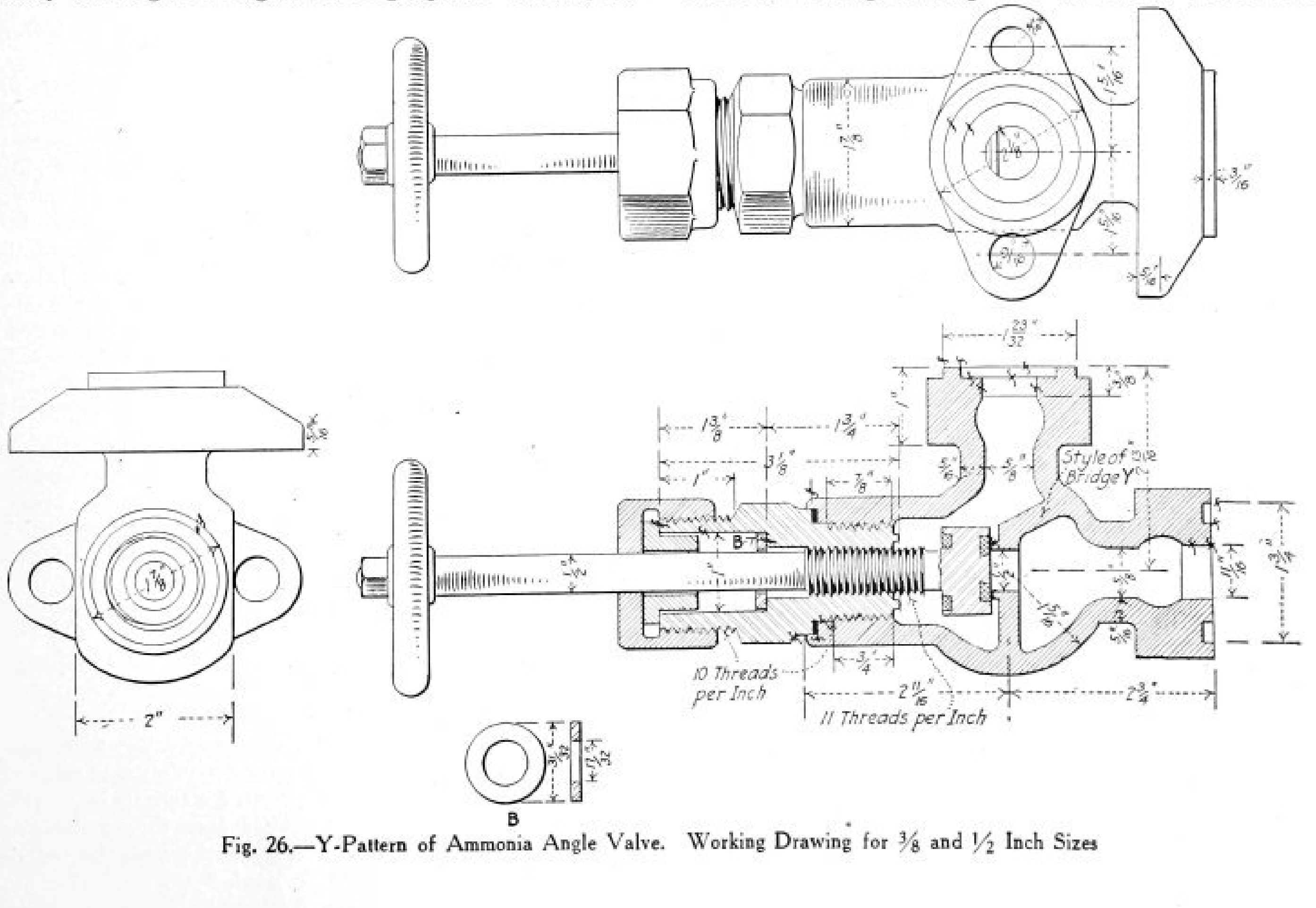


Fig. 26.—Y-Pattern of Ammonia Angle Valve. Working Drawing for 3/8 and 1/2 Inch Sizes

one who is most likely to get into the best positions in any branch of the trade. In many of the large manufacturing plants it is required to conduct what are known as tool-room operations. These require the services of the best trained employees. And it is a fact that to get into a tool room requires that the mechanic know how to read working drawings as the first consideration.

When one is not practiced in reading working drawings, the first appearance of some complicated design gives him considerable fright. The reader should remember, however, that sometimes even old hunters get frightened when they first see the game that they started out to find. Then after it is too late to get a shot the hunter "kicks himself" for his fool timidity. The following semi-detail drawing of a high-pressure ammonia valve is given here as a preparation for reading complete detail drawings. In this case the reader should not wait for the chance to kick himself, but he should follow out every detail of the explanations with as much care as he would when reading the most fascinating tale of fiction.

The first thing to note when reading this drawing is the title, which states that this is a Y pattern of an ammonia angle valve, and that this pattern serves for both the 3/8 and the 1/2 inch sizes. The dimensions on the drawing are for the 1/2 inch valve, and they are full size. The name of "Y" is applied owing to the form of the bridge, as shown by the note and the arrow on the section near the bottom. Then the "angle" name is given because the two openings are not in line with each other as in the ordinary valve, but in this case they are square with each other. The liquid or gas passes through a square turn when going up from the bottom opening to the side opening.

The general outside view shows this valve on the face of the side opening, and enough dimensions and notes are given to introduce the greater detail in the sectional view. It should be noted that the bolt holes through the connecting flange are "cored" out. This means that these holes are to be molded in the casting and not made by drilling. The center hole through which the gas flows is also cored, but this is finished by machining, as indicated by the letter "f" that is put on. This letter is used in quite a number of places, and the reader should note these carefully.

The view of the left-hand end shows the arrangement of the parts as viewed from the top of the spindle and with the hand-wheel removed. Certain dimensions relating to the circular parts are given on this view, as they cannot be shown clearly elsewhere.

The most important of all the views is, of course, the sectional one. This is full of interest to anyone that has a knack for mechanics. First, the body of the valve is cast of gray iron, the high grade kind classed as "air furnace" being specified. The stem and the hexagonal nut, that holds the stem and also which is double-ended and forms the stuffing box, are made of machine steel. A steel washer, *B*, that forms the bottom of the packing box is shown in detail. The foot of the stem forms the valve disk, and this has a ring of babbitt on the bottom to fit the seat when closing the opening. It also has a ring on the top to form a seat under the packing box and prevents any blowing through in case the valve stem must be packed while the ammonia pressure is on. The nut has ten threads per inch, and the stem has eleven threads.

The notes show that there are some specification sheets that go with this drawing, and the complete story is not told without the entire set. Give special attention to all the dimensions, the finishes and the allowances. Count the number of parts and follow out in ,imagination the processes of manufacture that are used in producing such valves.

How to Find the Capacity of a Locomotive Boiler

The measure of the capacity of a boiler is the amount of "boiler horsepower" developed, a horsepower being defined as the evaporation of 34.5 pounds of water per hour from and at 212 degrees F. The term horsepower is not generally use, however, in connection with boilers in marine practice or with locomotives, and such boilers are designed to suit the engines and are rated by the extent of grate and heating surface only.

The unit of evaporation—i. e., the evaporation of 34.5 pounds of water per hour from and at 212 degrees F.—is an arbitrary unit originally adopted (1876) because it was considered to be the steam requirement per indicated horsepower of an average engine. It means the evaporation of 34.5 pounds of water per hour from a feed water temperature of 212 degrees F. to steam at the same temperature.

Unless a particular boiler is tested for the actual amount of evaporation per hour from and at 212 degrees the nearest approximation we can make to its capacity is done by multiplying the total heating surface in square feet by 3 and dividing the result by 34.5 to reduce the result to "boiler horsepower" units—i. e.,

$$\text{Boiler horsepower} = \frac{\text{Square feet heating surface} \times 3}{34.5}.$$

The factor 3 in the numerator of this expression is an average value for the number of pounds of water evaporated from and at 212 degrees per square foot of heating surface.

For the measurement of heating surface the usual rule is to consider as heating surface all the surfaces surrounded by water on one side and by flame or heated gases on the other, using the external instead of internal diameter of tubes for greater convenience in calculation. This method is somewhat inaccurate, for the true heating surface of a tube is the side exposed to the hot gases—i. e., the inner surface in fire tube and the outer surface in watertube boilers.

Let us state right here that with such a calculation for horsepower without test data refinement of accuracy is unwarranted. A rough rule for finding the heating surface of horizontal tubular boilers, as given in Kent's "Mechanical Engineer's Handbook," follows: Take the dimensions in inches. Multiply two-thirds of the circumference of the shell by its length; multiply the sum of the circumference of all the tubes by their common length; to the sum of these products add two-thirds of the area of both tube sheets; from this sum subtract twice the combined area of all the tubes; divide the remainder by 144 to obtain the result in square feet.

In running a line of pipe in new work it is a wise thing to cut in a tee now and then and plug the outlet instead of using a coupling, as very likely a branch line will be wanted sooner or later. The extra expense is not great.

It should be remembered that the areas of pipes vary as the squares of their diameters—that is, a 2-inch pipe has four times the area of a 1-inch pipe.

Trouble has arisen from not remembering that heavy and extra heavy pipe does not vary on its outside diameter by being enlarged, but that the extra strength is obtained in making the hole smaller. Therefore to get the same area for the flow of gas or liquids the next larger size of extra heavy pipe should be used.

Layout of a Right Angle Connection to a Cylindrical Pipe

Subdivision of the Surface of the Connection—Development of the Patterns by Triangulation

BY J. L. WILSON

The working drawing of the pipe connection, Fig. 1, shows the joint made up of two triangular sheets and two sheets bent to very nearly a cylindrical form. If all openings were circles of the same diameter these curved sheets would be exactly cylindrical. It will be noticed that the flanges are designed so that the inside edge of the sloping flange from C_1 ends at the level of the axis of the pipe A_1-B_1. This point is shown to better advantage in Fig. 5 at points A and B. The purpose in doing this is to make the curved ends of the sheet exclusive of flanges a full semicircle for convenience in laying out.

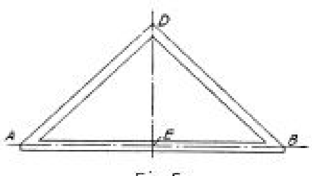


Fig.5
Pattern

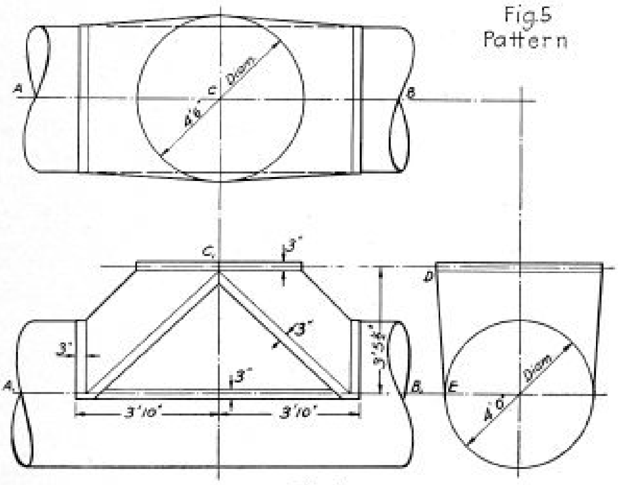


Fig.1
Working Drawing

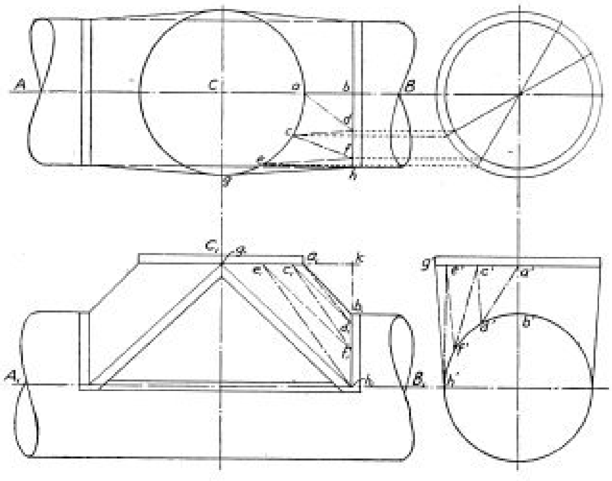


Fig2-Plans for Development

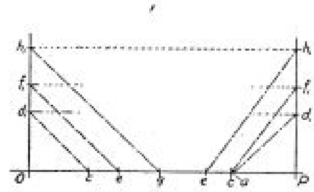


Fig.3
Diagram of Triangles

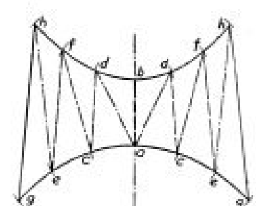


Fig.4
Pattern

The pattern for the triangular piece should give no trouble; care should be exercised, however, in laying out the height of this sheet, D-E, Fig. 5, making it equal to D-E in the end view of Fig. 1, because of its slope in each other view.

Now the surface of the curved sheets should be subdivided by elements (dashed) and diagonals (dash and dot), as shown in Fig. 2, and it is only necessary to lay these off for one-half of each curved sheet, because the sheets are symmetrical about a line, as a-b, Fig. 2. The method of division consists of the usual laying off of the same number of equal spaces around corresponding quadrants of the circular ends and joining the points thus found by their respective elements and diagonals.

If all the elements were parallel to a-b the sheet would be cylindrical and we could do without the diagram of triangles, but here we have a case in which the elements are very nearly parallel, and consequently almost shown in their true length in the elevation. Naturally we must be careful in such a case.

In Fig. 2 we extend g_1-a_1 to k and pick off from k the lengths k-d_1, k-f_1 and k-h_1 and lay them off on the verticals, both right and left, as shown in Fig. 3. Next we transfer the lengths of elements c-d, e-f and g-h from the plan Fig. 2 and lay them off from O, Fig. 3, giving points c, e and g. From P, Fig. 3, we lay off points a, c and e in the same manner by transferring the lengths of the diagonals d-a, f-c and h-e from the plan in Fig. 2. These points on the line O-P are joined to the corresponding points on the verticals to give the true lengths of the elements at O and the diagonals at P.

From here we proceed by the usual method of triangulation and form successively by using the true lengths as arcs the various triangles which make up the curved surface under discussion. This is shown in Fig. 4, and as the lettering and type of lines remain the same here as in the other views, it is quite apparent to the reader how the various parts of the surface are laid out.

For convenience and to eliminate confusion, Fig. 4 shows the pattern of the curved sheet without flanges, but these are hardly necessary to carry out the purpose of this article, and it is a simple problem to add a strip 3 inches wide around a plate already patterned.

In this problem the writer has assumed that a pipe or reinforcing ring would fit over the flange at C_1 so that the two curved sheets may simply butt at that point on both sides; if such is not the case, allow for the lap.

Progress in the Adoption of the A. S. M. E. Boiler Code in the United States

Results from the Campaigns Inaugurated in Several States by the American Uniform Boiler Law Society

The American Uniform Boiler Law Society, which is engaged in securing the legal adoption of the A. S. M. E. boiler code throughout the United States, has been carrying on campaigns in the interest of this movement in the States of Georgia, Kentucky, Louisiana, Maryland, Massachusetts, Mississippi, New Jersey, New York, Rhode Island, South Carolina and Virginia. The work in this direction has met with varying degrees of success, and, owing to the fact that in almost every case it becomes solely a question of politics, numerous obstacles have been encountered.

The Situation in Indiana

In Indiana, for instance, where the State legislature has already enacted a law which plainly states that the A. S. M. E. code boilers will be acceptable in the State, the Indiana Industrial Commission has made a ruling that where there is a conflict between the A. S. M. E. code and the Indiana law, the Indiana law must govern. This, of course, practically made the A. S. M. E. code obsolete in Indiana. In spite of the fact that there is no disposition on the part of the Industrial Board of Indiana to antagonize the enforcement of the A. S. M. E. code, it has been found that the Industrial Board itself has no power to change the law. The law can be changed only by legislative enactment, but it is encouraging to learn that the Administrative Council of the American Uniform Boiler Law Society has received assurance that there will be no difficulty in amending the Indiana law at the next session of the legislature so as to cover the A. S. M. E. code in its entirety.

A discrepancy has been found in the Indiana law in that it makes no provision whatever for plate boilers for heating purposes, with the result that there is no section in the Indiana code covering heating boilers, and a plate boiler that is used for heating must correspond to the code just as much as a plate boiler that is used for power purposes. As a matter of fact, the A. S. M. E. code permits steel of lower tensile strength than 55,000 pounds per square inch being used for heating boilers if desired. They could not be used, however, under the Indiana law. It is to be hoped that at the next session of the Indiana legislature these differences will be overcome.

Some of the provisions in the Indiana law which are not found in the A. S. M. E. code are that diagonal braces shall not be welded; the tensile strength of plate shall not be less than 55,000 nor more than 65,000 pounds; longitudinal seams are not to exceed 12 feet in length on horizontal tubular boilers of the fire-tube type; manholes on horizontal tubular boilers must be located as provided in section 8 of the Indiana law; fusible plugs must be installed in all boilers, as provided in section 13 of the Indiana law. This same construction is required on all steel boilers regardless of the pressure carried. The installation of fittings and appliances must also be in accordance with the Indiana law.

Favorable Action in New York

Favorable action has been secured in the State of New York, according to a report issued on March 25 by Mr. Thomas E. Durban, chairman of the Admiinistrative Council of the American Uniform Boiler Law Society. A bill making the A. S. M. E. code the standard in New York State and carrying the endorsement of the State Industrial Commission, the Associated Manufacturers and Merchants of New York State and the New York branch of the American Federation of Labor has been reported out of committee, and it seems quite probable that it will be passed by the legislature without further opposition. The campaign in New York State was brought to a successful issue by Mr. Mark Daly, secretary of the Associated Manufacturers and Merchants of New York State, and too much cannot be said for the very able manner in which he handled the situation.

Delays in Maryland and Virginia

The campaign was vigorously pushed in Maryland and the proposed bill for enactment in this State has received favorable attention from President Goodnow, of Johns Hopkins University, who is chairman of the Commission of Efficiency appointed by the legislature of Maryland. Although it will be impossible to introduce an independent boiler inspection bill this year, it is expected that such a bill will be enacted at the next session of the legislature.

The boiler inspection bill proposed in Virginia was killed in committee, due to unexepected opposition by the labor interests. It is believed, however, that the bill will receive a more favorable reception at the next session of the Virginia legislature.

The Results in New Jersey and Rhode Island

An unusual difficulty was encountered in New Jersey in that, after numerous delays, it was found that the only way the A. S. M. E. code could be incorporated in the laws of the State was to have the code itself incorporated in the Boiler Inspection Bill. Owing to the lack of time and the fact that the law of New Jersey requires the printing of 800 copies of every bill, and also the fact that the printing appropriation for bills was inefficient to print 800 copies of a bill in which the entire code was incorporated, it became necessary to hold the matter over until the next meeting of the New Jersey legislature.

In Rhode Island the attempt to introduce a bill in the legislature was given up after a consultation with leading manufacturers, attorneys and insurance men in the State, due to the fact that an Engineer's License Law and Inspection Bill had been introduced under the auspices of Union labor, and that if the Boiler Inspection Bill was introduced it would have to be tacked on to the other bill, which did not provide for the construction of boilers, but only for their inspection. This course of action would have doomed the bill to defeat, and so the campaign in Rhode Island will have to be renewed at the next session of the legislature.

In the city of St. Louis, through the excellent work of two members of the American Uniform Boiler Law Society, an ordinance has been introduced in the City Council making the A. S. M. E. code the official specification for boilers in the city. As the ordinance has been indorsed by all interested parties, its enactment seems assured, and it is believed that this action will finally dominate the State of Missouri.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

The record of one boiler insurance company shows that in their boiler inspection work during the past year 25,000 serious defects were found in boilers in operation in the United States. About 800 of these boilers were condemned as unfit for use.

If this is the condition of boilers that are under regular inspection by insurance companies, what must be the condition of those that have no inspection at all? The response to this argument would be, of course, that boiler users are looking after their own interests and would not run a boiler that was in a dangerous condition.

This argument could be applied to any "safety-first" movement, and yet in the most efficiently managed factories the factory inspectors have found innumerable opportunities to improve the conditions with but very little expense to the manufacturer, and generally the suggestions of the inspectors have been very well received.

For years the United States Government has recognized the necessity of having boilers built and inspected in accordance with rules which will guarantee so far as possible the safe operation of the boilers. Marine boilers and locomotive boilers in interstate trade are under the jurisdiction of Government rules and regulations; why should not all citizens be entitled to the same protection under the law and all property receive the same protection, whether it is under Federal or State jurisdiction?

On the twenty-first of this month the offices of the Aldrich Publishing Company, publishers of The Boiler Maker and Marine Engineering, will be moved from 17 Battery Place to the new Printing Crafts Building, 461 Eighth avenue, New York city. After this date all communications to The Boiler Maker should be directed to the new address.

The Printing Crafts Building, which is to be the future home of The Boiler Maker, is a new twenty-two-story structure especially designed to meet the needs of the printing and publishing trades. It occupies the block between Thirty-third and Thirty-fourth streets, facing Eighth avenue, adjacent to the Pennsylvania Railroad Terminal and directly across the street from the main New York Post Office. Every facility for the prompt and rapid execution of printing and publishing contracts has been incorporated in the new building and a cordial invitation is extended to all of our patrons to visit and inspect our new quarters.

The annual convention of the Master Boiler Makers' Association will be opened at the Hollenden Hotel, Cleveland, Ohio, on Tuesday, May 23, and will continue until the 26th. Aside from the regular business of the convention, addresses will be delivered by the following: Hon. H. L. Davis, mayor of Cleveland; Mr. B. R. MacBain, superintendent of motive power of the New York Central Railroad; Mr. Frank McNamany, chief inspector of the Federal Locomotive Boiler Inspection Service, and Mr. J. T. Carroll, assistant superintendent of motive power of the Baltimore & Ohio Railroad. Other special features of the convention will include an instructive series of moving pictures showing the manufacture of boiler tubes from the mining of the ore to the shipment of the finished product, as carried out by the National Tube Company, and also a similar series of moving pictures exhibited by the Carnegie Steel Company, showing the manufacture of boiler plate at the Carnegie plant.

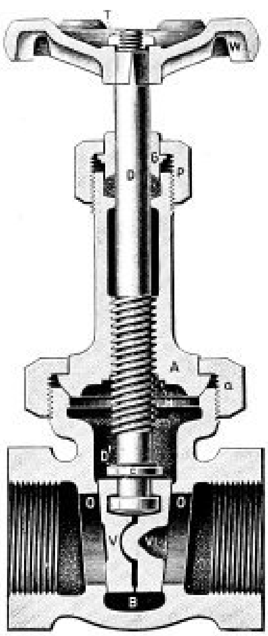
The regular programme of the convention consists of the discussion of fifteen topical questions on which comprehensive reports will be presented by the various committees which have had these topics under investigation during the year. Thirteen of these reports have already been printed and mailed to the members of the association, and each member should come to the convention fully prepared to discuss these subjects and give the others the benefit of his experience in work relating to them. Of special interest among the committee reports are those which deal with the subject of flexible stays, oxy-acetylene and electric welding and the cleaning and maintenance of superheater tubes. The work of the individual committees during the year has been most thoroughly and carefully carried out, and the discussion of these reports will be found most instructive and valuable to every master boiler maker.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Powell "White Star" Double-Disk Gate Valve

The Powell "White Star" double disk gate valves, manufactured by the Wm. Powell Company, Cincinnati, Ohio, are made with and without inserted renewable seat rings in two styles with rising and non-rising stems. These valves are well proportioned, the metal being distributed to give uniform strength throughout, and are cast of the best steam bronze composition. However, they are also cast in iron body from 2 inches to 12 inches, inclusive, with bronze trimmings. The disks are counterbalanced and constructed with a ball and socket back, making them smooth working and self-adjusting. The improvements in the double disk gate valve illustrated will be readily appreciated by engineers and boiler manufacturers.

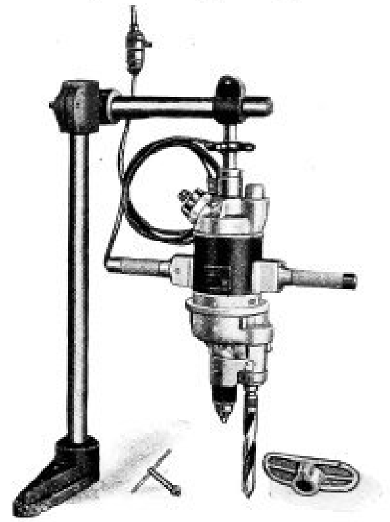


Section of Gate Valve

Stow Two-Speed, Two-Spindle Drill

A very useful tool for work in boiler shops and for general repair work is the two-speed, two-spindle portable electric drill made by the Stow Manufacturing Company, Binghamton, N. Y., which is particularly adapted to heavy work, having a maximum capacity of 1 inch in cast iron. One spindle is fitted with a Jacobs chuck taking S.S. drills up to one-half inch, running at a speed of 450 revolutions per minute. The second spindle is equipped for M. T. drills up to three-fourths inch, with a speed of 225 revolutions per minute. The maximum capacity of this spindle is 1 inch. The tool is furnished complete with breast plate and screw feed, making it adaptable for portable and bench work. It is also adaptable to tapping and reaming and is furnished for either alternating or direct current and operates direct from a standard connection.

There is a certain ideal speed at which a drill should be driven in order to secure maximum efficiency. Drill presses are equipped with special fittings to change the speed. This portable tool carries with it the feature of a drill press and can be taken to the work, thus saving time and eliminating expense. The Morse taper attachment on one spindle furnishes quick change for large drills. This tool has been designed to give extra power from a motor of portable weight, the latter being assembled in an aluminum frame. The heads, gear case and handles are also of aluminum, giving a maximum efficiency tool at minimum weight. The controlling switch is fitted into one of the handles, in a thumb's reach of the operator at all times; the reverse switch being on the front of frame in an instant's reach, enabling the spindle to be reversed instantly. Planetary gearing, which has proved most adaptable to drill work, due to the equal distribution of pressure, has been provided in the construction of this tool. Each piece of material used in the tool is thoroughly tested before assembling, which insures perfect mechanical construction. The motors are of special design and are of high duty type, enabling the tool to stand momentary overloads required of a portable electric drill.



Stow Portable Drill

DeLaval Turbine Driven Compressor

The construction of the DeLaval multi-stage compressor, manufactured by the DeLaval Steam Turbine Company, Trenton, N. J., is such that the casing is split horizontally, permitting of the top half or cover being lifted off, so that internal parts may be inspected and lifted out after removal of the bearing caps. The impellers are mounted upon a large-diameter and stiff shaft, the critical speed of which is far above the running speed, and which is made from hammer-forged, open-hearth steel, suitably heat treated and ground and polished over the entire surface on dead-center grinders. The hubs of the wheels and impellers are attached to the shaft by keys and separated from one another by shaft-tightening rings, which run inside the split packing rings attached to the diaphragms separating the stages. The diaphragms between stages are separate from the casing and are divided on a horizontal plane so that they may be removed without removing the shaft and impellers. When cooling is employed, the diaphragms are hollow, the water entering through the bottom of the casing and escaping at the top.

The impellers are of the single-suction, shrouded type, and are built up on heat-treated, forged, chrome-nickel steel disks, the blades or vanes being riveted to the disks and to side plates, turned tapering to give strength and lightness. That part of the disk which is within the circle of the suction opening is subjected on the inlet side to the suction pressure and on the back to the discharge pressure of the individual stage, which gives a resultant thrust equal to the area of the suction opening multiplied by the pressure generated. The accumulated thrust of all the stages is overcome by a balancing disk at the discharge end, so arranged that one side receives the total discharge pressure in a direction opposite to that acting upon the impeller disk, while the chamber upon the opposite side of the balancing disk is connected to the suction inlet, thus completely neutralizing the unbalanced pressure on all of the wheels. The head delivery characteristic can be varied considerably to meet different requirements.

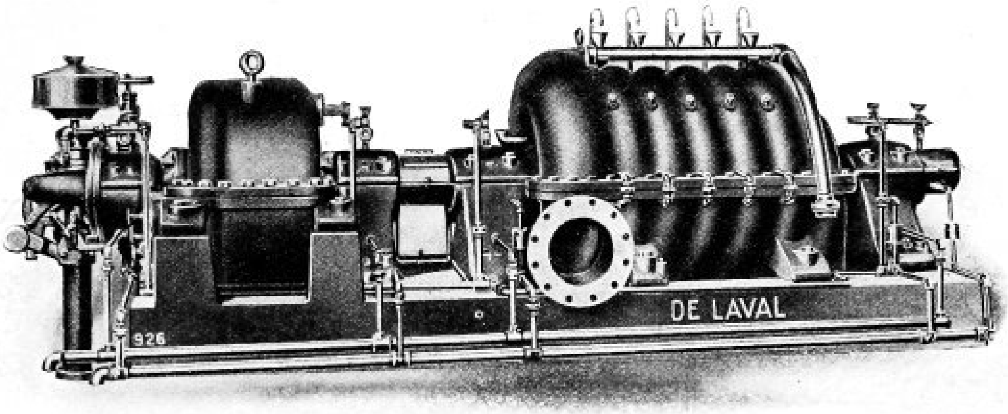


Fig. 1.—DeLaval Turbine-Driven Multi-Stage Air Compressor

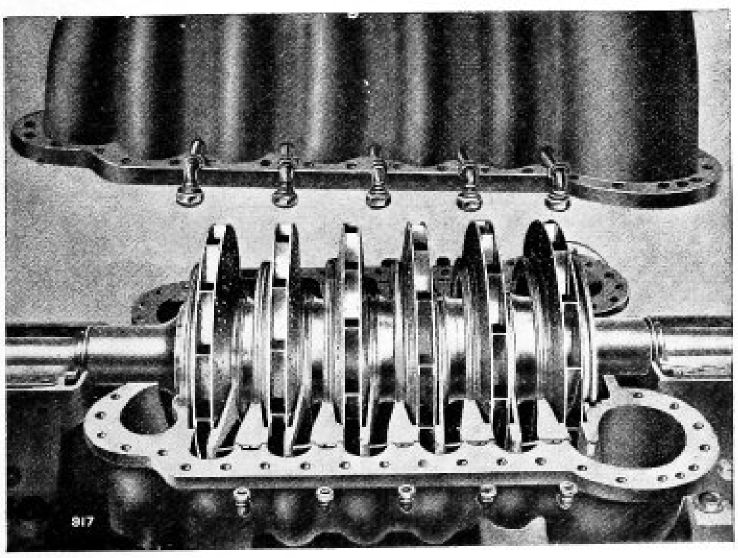


Fig. 2.—Multi-Stage Compressor with Cover Lifted

Generally where compressed air is used in tools, as around machine shops, shipyards, etc., a fairly constant pressure over a wide range of delivery is desired. The capacities in such cases range between 2,000 aand 10,000 cubic feet per minute and the pressures from 75 to 120 pounds per square inch. Less than 2,000 cubic feet per minute is usually not practicable. The larger machines, or machines which must run at motor speeds, are usually built in two sections; that is, with two shafts and two housings, the speeds available with electric motors of these sizes requiring either a compressor with a large number of stages and several housings, or the use of a step-up gear, by means of which the compressor can be operated at 4,000 to 5,000 revolutions per minute. It may be noted that in shipyards it is frequently desirable to centralize the power generated in large turbo electric units and to operate compressors and blowers, pumps, hoists, etc., by motor, the 10 percent or so loss in electrical transmission not being so great as the loss from widely separated steam using units, and the compressor load of 1,000 or 2,000 horsepower forming a good foundation for the turbo-generator load.

A. S. M. E. Boiler Code in Technical Schools

That the work of the A. S. M. E. boiler code committee is meeting with increasing recognition is indicated by its use in technical schools as a text or reference book. The A. S. M. E. boiler code is being used as a reference book at Stevens Institute of Technology at Hoboken, N. J., at Sheffield Scientific School of Yale University, and in the course in boiler design at the Rensselaer Polytechnic Institute at Troy, N. Y. At Rensselaer the code supplements the text and lecture notes; in the actual design work the requirements of the code are examined and the design made to meet the requirements.

NEW BOOKS FOR BOILER MAKERS

MECHANICAL ENGINEERS' POCKETBOOK. Ninth Edition. By Wm. Kent, M. E., Sc. D. Size, 4 by 6¾ inches. Pages, 1,526. Illustrations, over 250. New York, 1916: John Wiley & Sons, Inc. Price, $5 net.

Since the eighth edition of this book was published, five years ago, there have been notable advances in many branches of engineering rendering obsolete portions of the book which at that time were in accord with practice. In addition, many engineering standards have been changed during the five-year period, necessitating a thorough revision of many sections of the book. The absolutely necessary revisions to bring the book up to date have involved changes in over 400 pages of the eighth edition and the addition of over 150 pages of new matter. The treatment of many of the subjects in the earlier edition has been condensed into smaller space to enable the insertion of the new matter without increasing the size of the book to unwieldy proportions, with the result that the new edition actually contains only 64 more pages than the previous edition.

Extensive revisions have been made in the subjects of materials, mechanics, fans and blowers, heating and ventilation, fuel, steam boilers and engines and steam turbines. The chapter on machine shop practice has been rewritten and practically doubled in size. The new matter includes additional data on planing, milling, drilling and grinding, together with an elaborate treatment of the subject of machine tool driving. The subject of electrical engineering has been completely rewritten. A valuable feature of the new edition is the addition of numerous tables, giving the latest standards for various engineering materials. Indispensable as this book has become, a copy of the new edition should find a place in every engineer's library on account of the value of the new matter which it contains.

Oxy-Acetylene Welding and Cutting: Electric, Forge and Thermit Welding. By Harold P. Manly. Size, 4¼ by 6½ inches. Pages, 215. Illustrations, 56. Chicago, 1916: Frederick J. Drake & Co. Price, leather, $1.50; cloth bound, $1.

In learning the process of welding, the workman who wishes to handle his trade from start to finish finds that it is necessary to become familiar with certain other operations besides the actual welding of the metal parts. For this reason this book has been prepared with the object of covering not only the several processes of welding, but also those other processes, such as annealing, tempering, hardening, heat treatment and the restoration of steel, all of which are closely allied in method and results so as to make them part of the whole subject of welding. In order that the workman may understand the underlying principles and the materials employed in this work, much practical information is given on the uses and characteristics of the various metals; on the production, handling and use of the gases and other materials which are a part of the equipment, and on the tools and accessories for the production and handling of these materials.

As it was the object of the author to present the information in as concise form as possible, all matter which is not of direct usefulness in practical work has been eliminated, and to this end the descriptions have been limited to those methods and accessories which are found in actual use to-day. For the same reason, the work includes the application of the rules laid down by the insurance underwriters which govern this work, as well as the instructions for the proper care and handling of the generators, torches and materials found in the shop.

Special attention has been given to definite directions for handling the different metals and alloys which must be used. The instructions have been arranged in the form of rules which are placed in the order of their use during the work described, and the work has been subdivided in such a way that it will be found possible to secure information on any one point desired without spending time in reading a lot of irrelevant matter. The facts which the expert welder and metal worker find it most necessary to have readily available have been secured and prepared especially for this work, and those in most general use have been combined with the chapter on welding practice to which they apply.

The practical mechanic fully realizes the value of definite instructions in the form of rules in attempting to learn the intricacies of a new process, and, for this reason, the reader wiill be well repaid for having a copy of this little volume at hand when taking up the study of the various methods of welding which are now coming into such general use in boiler shops.

Information Wanted

One of the readers of The Boiler Maker, who is employed in a bad water district on one of the transcontinental railroads, has requested the views of other readers of this magazine on the following questions:

(1) Does soda ash cause excessive pitting of sheets and tubes when used as a water treatment?

(2) Will it effect savings in the cost of maintaining the boiler between shoppings?

As many of our readers have undoubtedly had considerable experience with the use of soda ash in the treatment of feed water, we would urge them to send their views on this subject to our office at once so that these questions can be fully answered in our next issue. All replies to these questions which are found available for publication will be paid for at our regular rates when published.

Meeting of New York Boiler Inspectors

At a regular meeting of the New York branch of the American Institute of Steam Boiler Inspectors, held in the Engineering Societies Building, 29 West Thirty-ninth street, New York city, on March 31, Mr. Joseph McNeill, chief inspector of the Hartford Steam Boiler Inspection and Insurance Company, addressed the members of the institute on the educational features of boiler-inspection work. Through his work in connection with the formulating of the Massachusetts Boiler Rules, Mr. McNeill has had exceptional opportunities to accumulate a vast amount of information of great value to boiler inspectors, and his talk was of exceptional interest to the men who are carrying out the actual work of boiler inspection.

PERSONAL

Thomas W. Reeves, formerly layerout for the McNaull Boiler Manufacturing Company, Toledo, Ohio, was appointed on March 1 superintendent of this company.

Ralph G. Coburn, formerly Eastern sales manager of the Franklin Railway Supply Company at New York, has been appointed sales manager of the electrical department of this company, with headquarters in New York.

Samuel Hooper, foreman boiler maker of the Union Iron Works, Cleveland, Ohio, has retired from the boilermaking trade. Mr. Hooper has been employed by the Union Iron Works since that company first started the manufacture of boilers, twenty-seven years ago, and for the past sixteen years has held the position of foreman boiler maker. Mr. Hooper will be succeeded in the shop by P. Yonser, formerly employed on the test blocks.

Correction.—In the article entitled "What Causes the Failure of Longitudinal Lap Seams," published on page 83 of our March issue, the ninth line, which reads "and a few but unfortunately very few," etc., should read, "and a few but fortunately very few," etc.

Correction.—Several slight errors were noticed too late for correction in the sectional drawing of the standard globe valve manufactured by Jenkins Bros., New York, which was published on page 74 of our March issue. This valve as manufactured is a brass valve, but the style of cross sectioning shown in the illustration would indicate that it is of cast iron. It should also be noted that the renewable disk of the valve is sectioned in the drawing in a manner which would indicate that it is of babbitt or lead, whereas, as boiler makers are aware, the disks of the Jenkins' valves are of rubber composition.

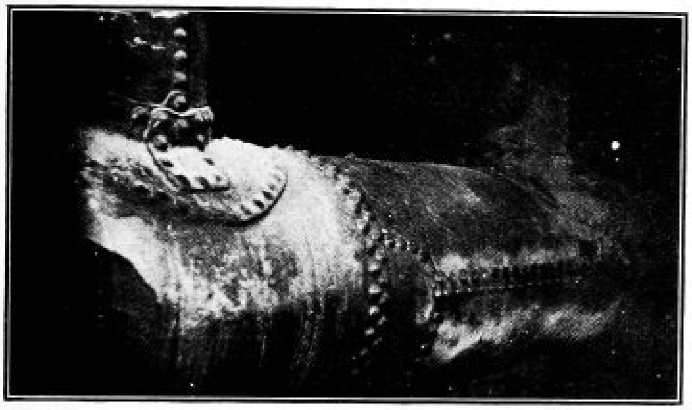
Letters from Practical Boiler Makers

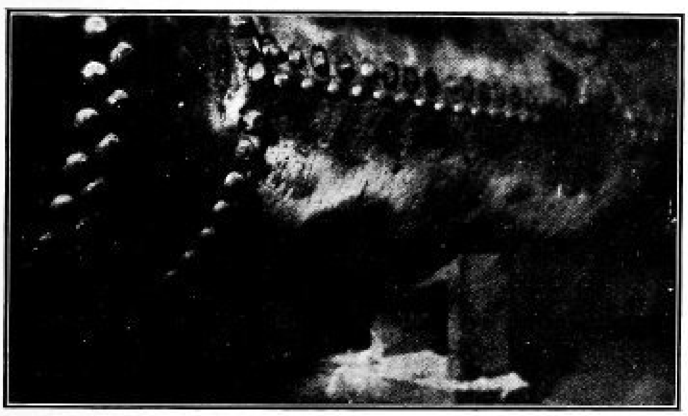
This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Repairing Old Boilers with Oxy-Acetylene Apparatus

The illustrations show a welding job which the writer carried out with oxy-acetylene apparatus on a mud-drum connecting a battery of four return tubular boilers. On removing the brick work for interior inspection, the boiler shell was found badly corroded and eaten away from seep leakage along the calking edge of the longitudinal seam for a length of 60 inches. Several spots were hardly more than one-eighth inch thick.

By a close inspection of the drum, it was found in good condition and it was decided to build up the shell to the





Corroded Parts Welded Up on Mud Drum

original thickness with the oxy-acetylene torch. In order to do this it was found necessary to weld on to the calking edge, as the corrosion had penetrated into and under the calking edge. By building this up and tapering it off gradually to where the corrosion stopped, a width of about 3 inches, it made the plate much stronger than it was originally at that point. Also it eliminated the possibility of further leakage from the calking edge.

In welding along this seam care had to be taken to keep the heat away from the rivets and loosening them. I also took the precaution of starting at the bottom of the corroded part and working a strip about 1½ inches wide up and well on to the calking edge. By doing this, much heat was kept away from the rivets. By building up the plate in narrow strips it lessened the chance of developing a flaw of any length. Although this should not happen in new work it is quite a different matter on old corroded plates, which are covered with oxides.

After the welding was done the rivets were calked and the boilers tested, giving entire satisfaction. The welding of boilers should never be attempted except by welders having a thorough knowledge of iron and steel and the responsibility involved.

Manistee, Mich. G. Dohm.

Strength of a Riveted Joint

In answer to "Inquisitive," page 82, March issue of The Boiler Maker, I offer the following:

1. In a properly designed riveted joint, where the rivets at the outer row are double spaced, the weakest part of the joint will be at the net section of plate at the outer row of rivets. The strength of the net section of plate

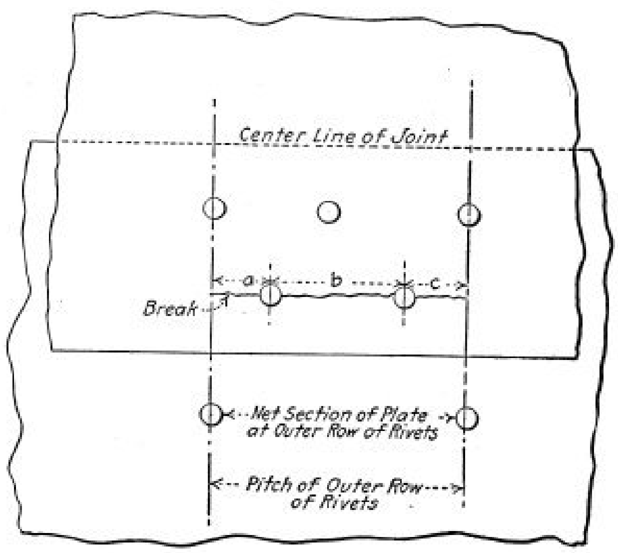


Fig. 1.—Diagram of Joint

at the outer row of rivets represents the strength of the joint as a whole, and it is expressed as a percentage of the strength of the solid plate.

The reason that the net section of the plate at the outer row of rivets is weaker than the net section of plate at the inner row of rivets, where the pitch of the rivets is less than at the outer row, is because if, in pulling a given strip of the joint apart, the plate were to break at the net section at the inner row, and thus not disturb the rivets in that row, it would have to shear off one rivet in the outer row. In a properly designed joint the combined strength of the net section of plate at the inner row, and the shearing resistance of the one rivet in the outer row, is greater than the strength of the net section of plate at the outer row.

In the last analysis, the strength of such a joint as a whole depends upon the strength of the net section of plate at the outer row. It is because of this that the outer row is made with a double spacing of rivets, so that a higher efficiency may be obtained than is possible with a lesser pitch of rivets. A careful and close study of a triple and quadruple riveted joint respectively will bring out the truth of the foregoing statements relative to the matter.

2. With regard to single and double shear of rivets, the words "single" and "double" really explain the situation. When two pieces of plate are secured together with rivets, and then placed in a machine and pulled apart, if the

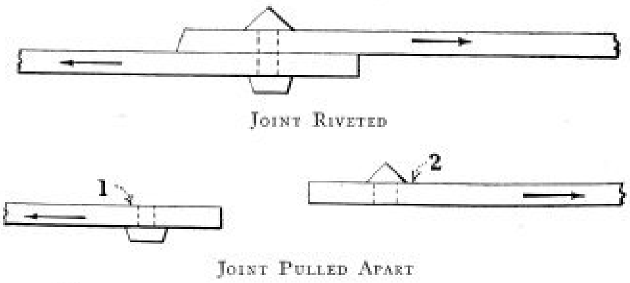


Fig. 2.—Rivets in Single Shear

rivets are weaker than the plates the rivets will "shear" off. Each rivet will be cut in *two pieces*—one cut. This is *single* shear.

Now imagine three pieces of plate secured together—as in the case of a boiler joint with inside and outside butt straps—with rivets, and subject them to a destructive pull. Assume the rivets to be weaker than the plates as

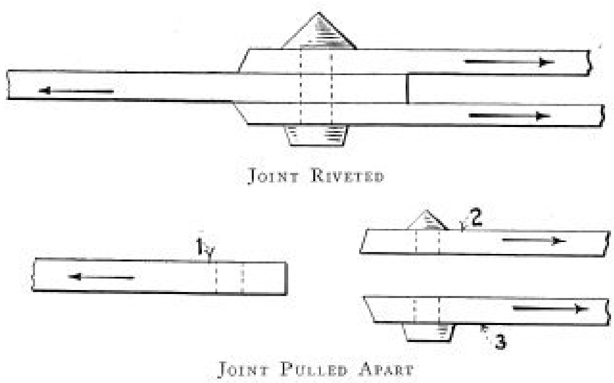


Fig. 3.—Rivets in Double Shear

before. Then, in pulling out the center plate from between the other two plates, a piece of each rivet, equal in length to the thickness of the center plate, would also pull out, and in this case the rivets would be cut into *three* pieces, *two cuts*. This is *double shear*.

3. I would prefer that some one, well informed on the subject of welding, answer this question. But, in passing, I might venture an opinion that I think the pitted surface may be reclaimed if not too far gone, and possibly even then if skillfully handled. However, let us hear what the "welders" have to say about it.

Scranton, Pa. Charles J. Mason.

Analysis of a Triple-Riveted, Double Butt Strapped Joint

The formulæ for calculating the strength of riveted seams can be found in most any text-book containing boiler calculations, and while these formulæ are readily understood by some authorities on steam boilers, it is possible for the average boiler maker to calculate the strength of a riveted seam by the use of the formula and still be unable to grasp the proper meaning of the various parts of the formula. I distinctly recall the fact of using these formulæ in laying out work for some time before being able to understand the necessity of using all the calculations, and while I do not pretend to be an expert at analyzing riveted seams, I trust the following explanation will be of some benefit to the readers who have not been able to grasp the intent of the formulæ.

First consider the elements of the joint necessary to make the calculation, and assume the following dimensions:

Tensile strength of plate, in pounds per square inch, or $T. S. = 55{,}000$.

Thickness of plate, in inches, or $t = 3/8 = .375$.

Thickness of butt straps, in inches, or $b = 5/16 = .3125$.

Pitch of rivets, in inches, in row having greatest pitch, or $P = 6\frac{1}{2} = 6.5$.

Diameter of rivet after driving, in inches, or $d = 13/16 = .8125$.

Cross sectional area of rivet after driving, in inches, or $a = .5185$.

Strength of rivet in single shear $= s = 42{,}000$ pounds per square inch of cross-sectional area.

Strength of rivets in double shear $= S = 78{,}000$ pounds per square inch of cross-sectional area.

Number of rivets in single shear in a unit of length of joint $= n$.

Number of rivets in double shear in a unit of length of joint $= N$.

Fig. 1 is divided into six equal units of length, in order to show the necessity of each calculation and to show graphically wherein it is possible for the joint to fail in so many different ways.

As a basis on which to complete the calculation it is necessary to determine the strength of the solid plate in a given unit of length, as compared with the strength of the other elements of the joint in a unit of equal length; the ratio that these other elements bear to the strength of the solid plate is the efficiency of the joint, and for this reason P, or the greatest pitch, represents a distance, or unit of length that embraces all the other elements to be considered. This is readily seen by a glance at Fig. 1; the layout of the unit represented by P is exactly the same as that of the remaining units.

According to the formula, strength of solid plate $= P \times t \times T. S.$, or $6.5 \times .375 \times 55{,}000$, which means that in a section of the plate 6.5 inches long and .375 inch thick the total area of the plate is $6.5 \times .375$, or 2.4375 square inches, and as the tensile strength, or $T. S.$, is 55,000 pounds per square inch, then $2.4375 \times 55{,}000 = 134{,}062$, which is the strength of the solid plate in the unit of length indicated by P. Call this unit A.

The next calculation to be made embraces this same section, and in the formula is $(P - d)\ t \times T. S.$, or $(6.5 - .8125)\ .375 \times 55{,}000 = 117{,}304$. The relation that this calculation bears to the first one is readily observed and is simply the tensile strength of the plate in the length indicated by P, minus the diameter of the rivet hole d, or rather, one-half d on each side of the unit of length, making a total of d. It is hardly necessary to explain that if the solid plate 6.5 inches long and .375 thick has a certain strength, to punch out part of the metal, as indicated by d, will certainly reduce the total area of the plate and consequently lessen the total strength in proportion to the diameter of the hole punched; therefore, if $P \times t \times$ T. S. = strength of solid plate, then $(P - d)\ t \times T. S. =$ strength of solid plate minus the amount of strength lost by punching away part of the plate. Call this unit B.

The next calculation is $N \times S \times a + n \times s \times a$, or $4 \times 78{,}000 \times .5185 + 1 \times 42{,}000 \times .5185 = 183{,}549$. This is the shearing strength of four rivets in double shear plus the shearing strength of one rivet in single shear. Referring to unit C in Fig. 1 it is seen that there are 4 rivets in the two inner rows and that these rivets are in double shear (see Fig. 3); also that there are two one-half rivets and 1 whole rivet in single shear (see Fig. 2). The formula allows 78,000 pounds per square inch of cross-sectional area as the ultimate shearing strength of rivets in double shear, so that by multiplying 4 × 78 × .5185 we get the total shearing strength of 4 rivets in double shear; the decimal .5185 represents the cross-sectional area of one rivet after driving, the idea being that the rivet will fill the hole after driving, so that instead of figuring on a ¾-inch rivet, which would be the size used in a 13/16-inch hole, we figure on the full diameter of the

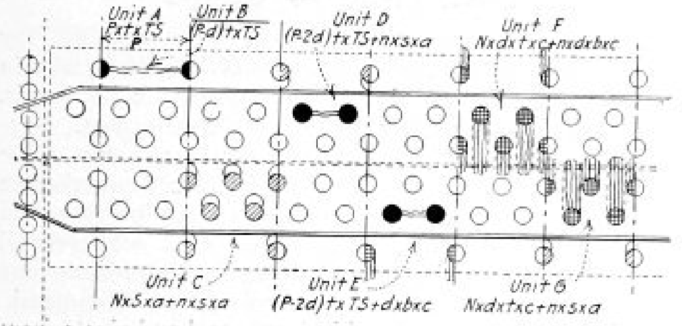


Fig. 1

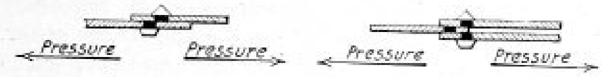


Fig. 2
Rivet In Single Shear

Fig. 3
Rivet In Double Shear

Section of Triple Riveted, Double Butt Strapped Joint, Showing Methods of Failure

hole as representing the diameter of the rivet. Adding the strength of the rivets in double shear to that of the rivets in single shear, we then have the total shearing strength of all the rivets in this unit. Call this unit *C*.

Next we have $(P - 2d)\ t \times T.S. + n \times s \times a$, or (6.5 — 2 × .8125) .375 × 55,000 + 1 × 42,000 × .5185 = 122,-323; this is the strength of plate between rivet holes in the second row plus the shearing strength of one rivet in single shear in the outer row. Remembering the explanation of unit *B*, showing the relation between $P \times t \times T.S.$, and $(P - d) t \times T.S.$, it will be easy to understand the necessity of using $(P - 2d)\ t \times T.S.$, as there are two holes punched out in the second row instead of one, consequently $(P - d)$, representing the outer row, becomes $(P - 2d)$ when representing the inner row. The shearing strength of the rivet has been explained, and a study of Fig. 1 will show why these two elements are combined and why the strength or failure of one is dependent on the strength or failure of the other. Call this unit *D*.

We now have $(P - 2d)\ t \times T.S. + d \times b \times c$, or (6.5 — 2 × .8125) .375 × 55,000 + .8125 × .3125 × 95,000 = 124,667. This is the strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of one rivet in the outer row. The strength of plate between rivet holes in the second row has been explained, and need not be dealt with further. The formula allows 95,000 pounds per square inch of cross-sectional area as the crushing strength of the material, and the area of metal subject to a crushing strain is that immediately in front of the rivet; so, in order to find the total area subject to crushing, we multiply the diameter of the rivet hole by the thickness of the material (in this case the butt-strap), or .8125 × .3125, and this result, multiplied by 95,000, gives the total crushing strength of the strap in front of one rivet. The combination of the elements in this unit is explaiined by reference to unit *E*.

Now consider $N \times d \times t \times c + n \times d \times b \times c$, or 4 × .8125 × .375 × 95,000 + 1 × .8125 × .3125 × 95,000 = 139,902. This is a combination of the crushing strength of the plate in front of the four inner rivets, plus the crushing strength of the butt-strap in front of one rivet in the outer row, and the explanation of unit *E* will make this clear. Call this unit *F*.

Finally we have $N \times d \times t \times c + n \times s \times a$, or 4 × .8125 × .375 × 95,000 + 1 × 42,000 × .5185 = 137,-558. This is the crushing strength of plate in front of four rivets in the inner rows, plus the shearing strength of one rivet in single shear in the outer row, and need not be explained except to refer to Fig. 1 for the graphic illustration. Call this unit *G*.

The least sum resulting from these several calculations represents the weakest part of the seam, and this sum, divided by the sum of unit *A*, will give the efficiency of the seam.

The first question asked by "Inquisitive," in which he asks to know what portion of a longitudinal seam is weakest, the net section between the holes in the outer row, or the net section between holes in the inner row, is answered by the explanation of units *B*, *D* and *E*, provided he has in view any of the usual types of double butt-strap joints, in which the inner rows of rivets are in double or quadruple pitch and double shear, and the outer row is in single pitch, and the rivets in single shear. While the net section of plate between holes in the short pitch or inner rows is, of course, weaker than that of the long pitch, on account of the greater reduction in net section, Fig. 1 will show that the efficiency of the joint is not entirely dependent on the remaining net section of plate in the short pitch, but is afforded strength by the shearing strength of the rivets in the outer row; thus, $(P - d)\ t \times T.S. + n \times s \times a$; while in the long pitch the efficiency of the joint *is* entirely dependent on the net section of plate remaining between the rivet holes; thus $(P - d)\ t \times T.S.$, and is not afforded any strength by any other elements of the joint. So the ultimate efficiency of the joint, if found to be contained in either the long pitch or the short pitch, would depend on the pitch of rivets, thickness of material, shearing strength of rivets, etc., and not on the net section alone.

An illustration of the single and double shear of rivets, as requested by "Inquisitive," is found in Figs. 2 and 3. A rivet may be said to be in single shear when it is used to hold two plates together, the contact of the two plates at the rivet tending to form a single shearing effect on the rivet, it being understood, of course, that the pressure applied is to produce a shearing strain on the rivets and not a tension strain. Likewise, a double shearing effect is produced when the rivet is used to hold three plates together, the contact of the inner surface of the upper plate with the upper surface of the middle plate forming one shearing effect; the lower surface of the middle plate and the inner surface of the bottom plate forming the other shearing effect.

An answer to the third question asked by "Inquisitive," concerning the reclaiming of pitted boiler shells and the advisability of reclaiming by means of welding, would of necessity be the personal opinion of the one answering the question, and personal opinions frequently differ; so I will suggest the following as an answer: A slightly pitted boiler shell can be brought back to its original thickness by cleaning out the pitted cavities and filling them up by welding, although there are other methods equally efficient, if not more so, than the welding one, these methods depending on the type of boiler and the location of the pitted places. As "Inquisitive" specifies a slightly pitted shell in his question, I believe he has overlooked the fact that it is not absolutely necessary to raise the factor of safety on account of slight pitting, for this reason: the safe working pressure is invariably governed by the efficiency of a riveted joint or by the strength of the stayed surfaces, and these are invariably less than the strength of the solid plate, and may be said to represent an approximate ratio of 75 to 100, the 100 representing the solid plate, consequently the solid plate could be pitted to a depth equal to 25 percent of its original thickness and still be as strong as the joint or stayed surface.* Of course, pitted shells should be closely watched and not allowed to become sufficiently pitted to weaken the plate to a point that would endanger the safety of the boiler.

Regarding the advisability of reclaiming pitted shells by welding, I will say that I would certainly try some other method in preference to welding, particularly if welding by acetylene gas is referred to and the parts to be welded are subject to a tensile strain, although the welding of four or five pitted spots could no doubt be efficiently done. I have yet to learn of any advocate of welding by acetylene gas who will guarantee to weld a piece of boiler plate so that it will stand the physical tests prescribed by the rules governing boiler construction now in force in some States of the Union. INSPECTOR.

Dangers Due to Construction of Locomotive Boilers

The development of the locomotive boiler to its present size and capacity on all the great railway systems of the United States certainly should merit the consideration of all thoughtful men. We have become so familiar with its use that we have forgotten the powers of destruction and death which lurk in them and the great desire to eliminate as much as possible the danger should be considered a commendable effort on the part of all connected with its construction.

The ponderous construction of the locomotive boiler nowadays is largely held together with movable flexible stays. Any group of these stays through unequal tension may be caused to bear more than its equal share of pressure, and the excess pressure might readily be the cause for rupture resulting in an explosion. Taking the recent New Haven wreck, in which the boiler exploded, the collision itself might be the cause of this kind of stays releasing their hold and causing an explosion. Undoubtedly the boiler had the usual quantity of movable stays in it. Had it had instead a flexible boiler with non-movable stays the chances are 100 to 1 that it would never have exploded. We have in recent years had a number of locomotive boilers explode, all of which had their usual number of movable stays, all going to show the effect of inertia even on an engine drawing a heavy train coming to a sudden stop, as in the case at Rahway, N. J., or at San Antonio, Texas, where the engine had just been overhauled and fired up and standing in the shops waiting for the engineer to take it out. Again the large Mallet boiler which exploded out West, a photograph of which actually showed the explosion to have taken place in the firebox. Numerous others might be quoted, but it would be trespassing on your valuable space.

If any reader who can explain how or where the use of movable stays has prevented the fireboxes in locomotive boilers from cracking or mud rings from leaking and crowns from being raised over tube sheets, I would be glad to read his explanation. I have read a large number of letters in THE BOILER MAKER appealing for information on the subject, but no such information or explanation of the how and why and where of this subject has been given.

I am merely putting the question again before thoughtful readers with the hope that it will enable us to hear from those who have heretofore been silent, I am,

WM. H. WOOD,
Mechanical and Constructing Engineer.
Media, Pa.

* The figures 75 and 100, given as the ratio between the strength of joints and solid plate, are merely for the purpose of explanation, and would not, of course, represent true conditions in a boiler having a high efficiency percentage in relation to seams or stayed surfaces.

Lost Time in Shops

In reading the statement on "Lost Time in Shops," by Mr. James Francis, there are numerous things to take in view, and he will find out he has some job on his hands. The work must be placed in condition to gain time. Suppose there should be a number of boilers or tanks to be built of certain sizes, these should be placed together to work on, and not put one in one corner of the shop and another off in the back yard. With work scattered all over like that the riveter must drag his hose from one place to the other, disconnect it and connect it up again. The rivet heater must carry his forge, coal and rivets from one place to the other. This all takes extra time, whereas, if the work were in one spot, all that would be necessary would be just to toss the tools from one job to the other, slide the scaffolding from one to the other, and then go to work again in a very short time.

A boiler maker should not let his helpers lag on him, and should have the privilege of sending such a helper out of the gang to the foreman and let the foreman put him at some other kind of work where he will work. There are always certain helpers that do not like certain boiler makers, and the minute they are sent to help such a fellow they will start to lag, also start to visit with the other helpers and get them under his influence and help hold a job up. The boiler maker should have the privilege of chasing such a fellow out of the gang.

You will find these fellows in every shop. They brag of what they will do and won't do. Perhaps the boiler maker has to go to the foreman on some business and leaves his helper to do some part of the work. When he comes back he finds one of these fellows telling a story or doing something else to keep the others from working. There are a great many cases where boiler makers have been jacked up for slow work just on this account, whereas if the boiler makers had a chance to choose their helpers they would do faster work. If the foreman should stand and watch some of these fellows he will notice how busy they seem to be. Then let him go to some other part of the shop and watch them and not let them know it, and he will see the change they make and the hold up on the job.

There are boiler makers as well as helpers that are drawbacks to the company. There seem to be certain ones that are always talking about the others and complaining of so and so doing too much work and spoiling the time on jobs so that the rest of them will have to do more to keep up their end. These fellows should get a lay-off to learn to mind their own business and let the other fellows work to suit themselves.

The foreman should not jump on a man and call him down too sudden over a mistake; for the only man that does not make a mistake is the one that never does anything. Nevertheless, it is not necessary to make too many mistakes, or the same mistake twice. The foreman must remember that some days the men will accomplish much more than on others; it seems as though they have good and bad days. The foreman should try to talk to his men just as he would like to be spoken to if he made a mistake; for he might have men working for him that know as much as he does. Everyone can't be a foreman; someone has to do the work. I have worked for foremen that would reason with their men in case their work was not going right, and notice their men were always on the bound and trying to do what was right. I have worked for others that would just as soon call a man down as look at him. This foreman looked at his men as though he wanted to scare them, but after his back was turned they would stop and talk about it and laugh. In this case the foreman was the drawback. Glenn Lacey.

Bay City, Mich.

Punching Versus Drilling

The question drawn to the attention of the readers of The Boiler Maker by Mr. Glenn Lacey in the August, 1915, issue, is of great importance to all in any way connected with the making of a steam boiler, and the lack of data bearing on this subject is very much to be regretted. I have been anxiously waiting to see this subject taken up by some of the subscribers of this magazine who are mechanical engineers, and in a better position to deal with it than the ordinary boiler maker. In searching various text-books for something bearing upon this question, I find that there is nothing very authentic later than the years 1875-76, which can be found on pages 95-105 of "The Theoretical and Practical Boiler Maker," but on account of the time that has elapsed since that date it would be very interesting to all concerned to know that there was a new set of rules in use derived from experiments of a later date, so that they could be compared with those made in England so many years ago.

My own experience with drilled holes has been quite extensive. Some years ago I worked in a large marine shop in the East where every hole in the boiler was drilled; in fact, there was not a power punch in the works (the only device for punching was a screw punch used for outside repairs) and when the various plates were assembled together, should there be a bad hole, it had to be reamed out. The writer has cause to remember that all holes that were bad were to be reamed. Finding a bad lap hole (four thickness of plate), and while the inspector's back was turned, he undertook to gouge the hole. The handle of the gouge was broken so the gouge was held in the rivet tongs, and when the blow was struck the gouge flew out of the tongs, striking the writer on the forehead just above the right eye, slightly injuring the eye but not impairing the sight. Thus two lessons were learned: first, if a hole is to be reamed, ream it; second, never hold a punch or gouge in a pair of tongs, and I have always made an effort to stop others doing so when I have seen them.

Another shop that I worked in punched small holes and reamed out to size; for instance, building tanks of 13/16-inch steel for compressed air to withstand a test pressure of 1,150 pounds, holes were punched 1 inch and reamed out to 1 5/16 inches. In several cases after punching, and during the process of bending, some of the sheets failed through the rivet holes. The appearance of the material was that of common cast iron, yet those plates had come from the mills of one of the greatest plate makers in this country, fully stamped with the usual test marks. There is no doubt that punching injures the sheet and forms cracks that cannot be seen with the naked eye, but which will show up while being worked, especially when a driftpin is freely used. For many years we punched all holes in boiler sheets ⅛ inch small, so that they could be reamed out to full size, thus removing the rough, uneven edges left by the punch. This was carried out with staybolt holes the same as rivet holes. All of this work was done on new boilers and the writer has been unable to follow them up and know the result.

One of the advertisers in the January, 1916, Boiler Maker, asks the question, What is a test? and answers it by saying it has been proven beyond the shadow of a doubt that laboratory tests for staybolt iron, while of great value, are *not conclusive tests*, and the same can be applied to steel plates, for during some four years' connection with a large steel works I found that there were no two casts from the same ladle alike; part would be hard enough to make a boiler maker's riveting hammer and some quite soft and easily welded.

Again, many of the plate failures that are blamed on punching are caused by the plate being sheared at the mill too close to the crop end; that is, there is not enough margin allowed so that the plate can be cut out of what ought to be solid material, thus insuring the sheet being free from blemishes caused by rolling. This was the cause of many failures of plates when iron was first used for shipbuilding purposes, and the failures puzzled the engineers until they realized that the plate makers were putting one over on them; then they, when ordering plates, specified that there should be so many inches crop end all around the sheet. When this was done, many of their troubles ended.

It appears from the tests made by S. Nicholls that there was very little, if any, difference shown on the testing machine between punched and drilled holes. In one case, where the test pieces had been annealed after punching, the punched piece stood rather more than the drilled piece. Therefore, I take it that if all plates were annealed after punching, the plate would be restored to the original condition. About the punching of flue holes on stationary and oil well boilers, I have seen them punched to within ⅛ inch of full size, and the reamer applied, and I have seen flue sheets for oil well boilers drilled out of the solid sheet, after a ¾ inch hole had been punched for a lead for the cutter.

There are shops in England that drill all the holes in their boilers after they are rolled. How they do it I am unable to say, but I am sure they have tools adapted to that purpose, so that they are able to make good time with multiple drills like those in use in locomotive works; from 12 to 24 holes can be drilled at one time, according to the capacity of the machine. A punched and reamed hole is not as good as a drilled hole, for, although it is quite possible when riveting to fill the hole and make a tight job, on an equal with the drilled hole, yet when put into service everything is in favor of the drilled hole; for, being cut out of the solid sheet there can be no cracks, which cannot be said of the punched or the punched and reamed hole. As long as there are boilers to be made, however, there will be a difference of opinion among manufacturers. I have before me while I write useful information which allows 20 percent in favor of drilled holes for marine boilers, and Mr. W. H. Maynard's records, which allow 19 percent in favor of drilled holes in stationary boilers; but, as mentioned before, I should like to see some institution or some reliable boiler making firm make an experimental boiler, or boilers, one with drilled, the other with punched, holes; subject it to the severest test possible up to the bursting of the boiler, and all data carefully tabulated and a set of rules, stripped of all mathematical formulæ, so that the common, everyday boiler maker and boiler makers' apprentices may be able to understand this very important question.

Pittsburg, Pa. Flex Ible.

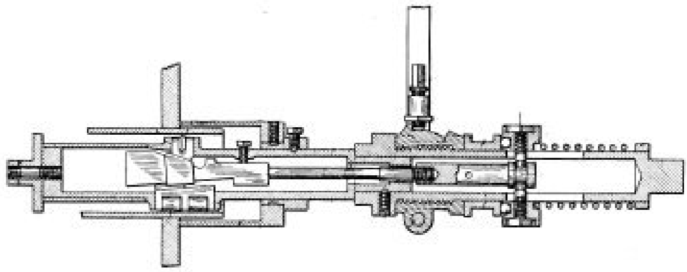
Selected Boiler Patents

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

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

1,162,893. TUBE CUTTER. OTTO WIEDEKE, OF DAYTON, OHIO.

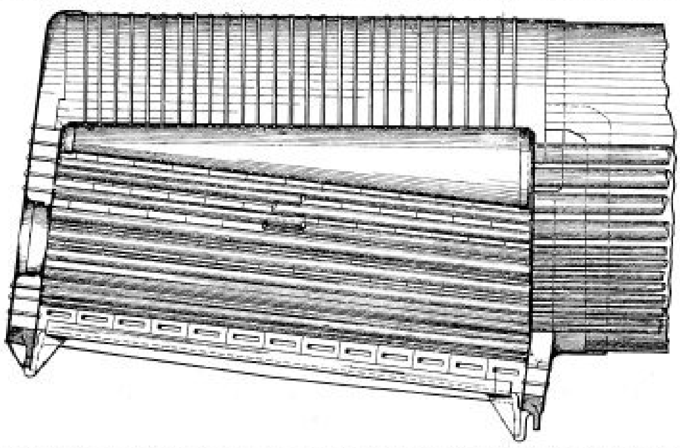
Claim 1.—In a device of the type specified, a rotating member, cutting means mounted in said rotating member having screw threads, split nut members operatively connected to said cutting means, means for placing



said nut members in engagement with said screw-threads, including a cam on one of said nut members and a lever, and a means adapted to return said nut members to a normal position and to release said cutting means. Eight claims.

1,162,295. STEAM BOILER FIREBOX. DAVID M. LIGHT, OF SPRINGFIELD, MO.

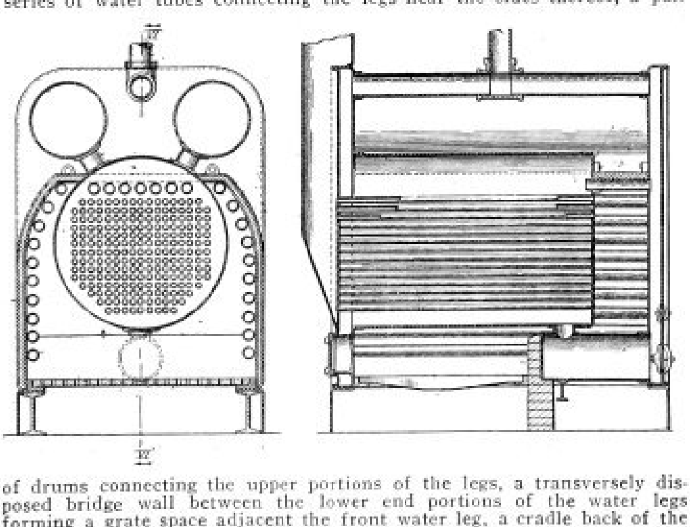
Claim 1.—The combination, in a steam boiler firebox, of a top header of substantially crescent-shaped transverse section, composed of a roof sheet and a connected crown sheet, and having a downwardly depending



water chamber on each of its sides; a front transverse water leg composed of a tube sheet and a connected throat sheet; a back transverse water leg composed of a back head sheet and a connected door sheet; and a plurality of watertubes located below each of the lateral water chambers of the top header and connecting the front and back transverse water legs. Four claims.

1,164,884. BOILER. HENRY A. SPRENGER, OF DETROIT, MICH., ASSIGNOR TO JOSEPH SPRENGER AND SONS, A CO-PARTNERSHIP DOING BUSINESS IN DETROIT, MICH.

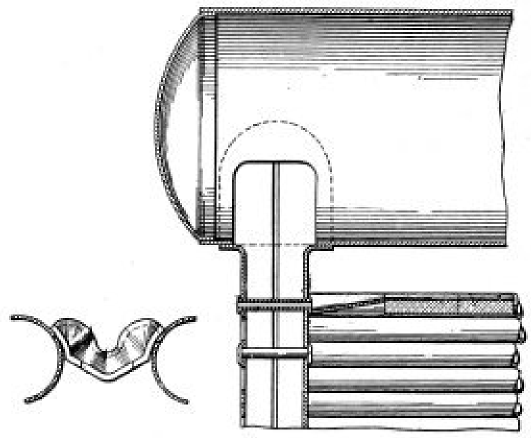
Claim 1.—A boiler comprising a front water leg, a rear water leg, series of water tubes connecting the legs near the sides thereof, a pair



of drums connecting the upper portions of the legs, a transversely disposed bridge wall between the lower end portions of the water legs forming a grate space adjacent the front water leg, a cradle back of the bridge wall, a mud drum extending forward from the rear water leg and resting on the cradle, a flue shell extending inwardly from the rear wall of the front water leg and having communication with the mud drum on which it is supported, flues in the shell extending through the front wall of the front water leg, a smoke breeching on the front water leg in communication with the flues, a steam pipe in communication with the water legs above the normal level of the contents of the steam drums and a jacket extending between the water legs and inclosing the water tubes and flue shell. Three claims.

1,164,952. FURNACE TILE. EDWARD C. MEIER, OF PHŒNIXVILLE, PA.

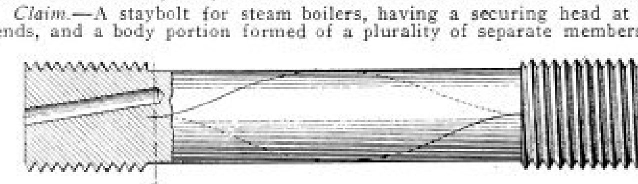
Claim 1.—The combination with a boiler having a box header, stay-tubes in the header, and boiler tubes secured to the header, of baffling tile supported on the boiler tubes and having longitudinal grooves in



their upper faces, and a metal tile supported on the boiler tubes and having an inclined groove in its upper face, the lower end of said groove located in a plane below the stay-tube, and the upper end of said groove registering with the groove in the first-mentioned tile, substantially as described. Two claims.

1,165,456. STAYBOLT. CHARLES A. SELEY, OF CHICAGO, ILL., ASSIGNOR TO KERNER MANUFACTURING COMPANY, OF PITTSBURG, PA., A CORPORATIOIN OF PENNSYLVANIA.

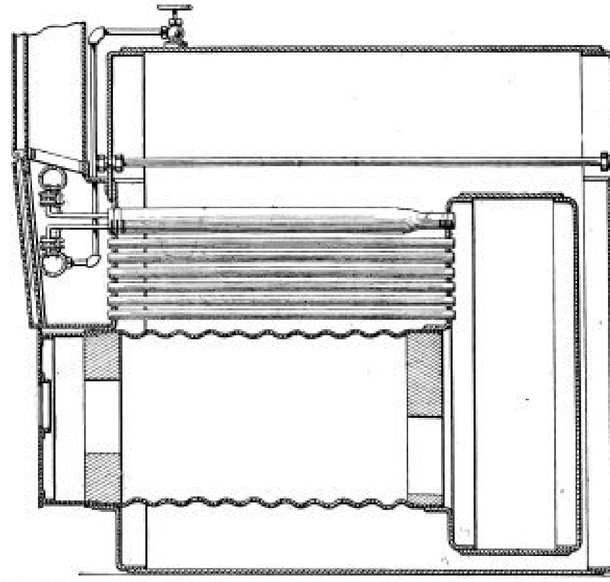
Claim.—A staybolt for steam boilers, having a securing head at both ends, and a body portion formed of a plurality of separate members ex-



tending from head to head, there being a tell-tale hole through one of said heads extending from the center of the outer face thereof into one end of one of the body members and at an angle to the longitudinal axis of the bolt.

1,163,357. STEAM SUPERHEATER FOR BOILERS. JAMES S. MILNE, OF SAN FRANCISCO, CAL.

Claim 1.—In a steam superheater, the combination of an inlet header, an outlet header, an integral superheater unit having its outer ends de-



flected in opposite directions, a coupling flange secured to each of said outer deflected ends, nipple flanges secured to said headers, and fastening devices common to said coupling flanges and said nipple flanges. Eleven claims.

1,171,353. STEAM SUPERHEATER. JOHN PRIMROSE, OF DONGAN HILLS, NEW YORK.

Claim.—The combination with a furnace having a passage or chamber for connecting the firebox and chimney, of a superheater located in said passage and adapted to receive the gases immediately issuing from the firebox, and a duct for conveying air to the fire extending through a chamber in said furnace and located between the superheater and the chimney whereby the heat of the gases after leaving the superheater will be transferred directly to the air which supports combustion.

THE BOILER MAKER

MAY, 1916

Diagnostics of Steam Boiler Ailments*

Causes and Conditions which Tend to Produce Failure and Minor Troubles in the Use of Steam Boilers

BY J. C. MC CABE †

IT is the purpose of this paper to deal in a general way with some of the causes and conditions which tend to induce failure and minor troubles in the use of steam boilers.

The engineer dealing with boiler matters labors with some disadvantages not found in branches of engineering more recently developed and standardized. The American Society of Mechanical Engineers has only recently completed a code which, it is hoped, will standardize boiler materials and methods of construction and design. This work occupied some four years of time. The American Boiler Manufacturers' Association gave over 20 years' time to the promotion of standard laws and methods. The latter organization has arranged to raise $12,000 per year to promote this work, the accomplishment of which means much to the steam user and engineer. Our boiler accidents are only a hundred times as great as those of Germany and other European countries. This condition will cease when the people awake to the facts.

The steam boiler is afflicted with troubles of its own, which, however, have not been catalogued with an "itis" suffix, although the engineer may have his mind somewhat inflamed, because of the character and multiplicity of such troubles. It is the function of the boiler inspector to feel the pulse of the steam plant and diagnose its ailments. The horizontal tubular boiler for stationary work is the most common in use for units not exceeding 150 horsepower. This type of boiler has been a prolific cause of death and disaster in this country. It is only within the last ten years that steps have been taken to legislate against the use of lap joints, particularly in this type of boiler.

Before discussing the features of construction from which trouble may eventuate, attention should be given to the difficulties encountered in the production of a soft steel suitable for the exacting service it is subjected to in a steam boiler. Dr. Chas. L. Huston made very careful experiments on the segregation of steel ingots in its relation to the plate specifications. The usual range of tensile strength is limited, in boiler rules, at 45,000 to 55,000 pounds in extra soft steel, 52,000 to 62,000 pounds in firebox steel and 55,000 to 65,000 pounds for flange steel. Fig. 1 shows an ingot 16 by 18 inches and weighing 2,800 pounds, from which was rolled a plate 5/16 inch thick, 370 inches long and 76 inches wide. It will be seen that the highest carbon content was at the middle of the top end, having .27 C with a tensile strength of 67,050 pounds, while the edges show .13 C and tensile strength as low as 55,490 pounds, a variation of over 11,000 pounds. Fig. 2 shows the customary gas holes and variation of the carbon content, which usually causes a variation of about 800 pounds tensile strength for each .01 of 1 percent.

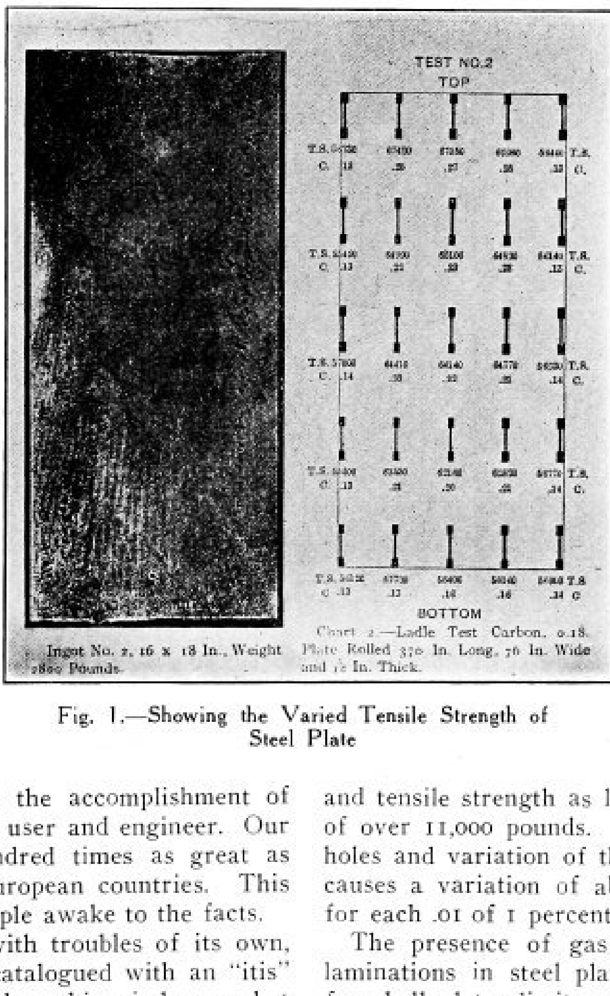


Fig. 1.—Showing the Varied Tensile Strength of Steel Plate

The presence of gas pockets no doubt accounts for laminations in steel plate. The customary specification for shell plates limits sulphur to .04, phosphorus to .03, manganese to .5. Plates over these limits are rejected.

In the old practice of lap joint construction the shell could not be made truly cylindrical, with the result that bending at the joint often resulted in cracks, which, if not discovered, resulted in disastrous explosions. In addition to the bending due to internal pressure, a horizontal tubular boiler 6 feet in diameter, 18 feet long, would expand about 3/8 inch longitudinally girthwise from the temperature due to 100 pounds of steam. Further stress was set up from the internal strain due to increased temperature of shell over the fire. If the holes were punched, as was usually the case, it was a question as to what percent of rivets was actually supporting the load. Holes were usually punched full size and a sledge used to make

* Paper read before the Detroit Engineering Society, November 5, 1915.

† Chief Boiler Inspector, Detroit, Mich.

plate ends approximate a circle. The drift pin was the first aid in such work.

It is instructive to consider what happens to the shell plate in rolling it up for a boiler. In the case of a ½-inch plate rolled for a shell 72 inches in diameter, we would find that the plate remained the same length measured along the neutral axis, but that it had lengthened over 1½ inches on the outer surface and shortened the same amount on the inner surface. This would mean a change

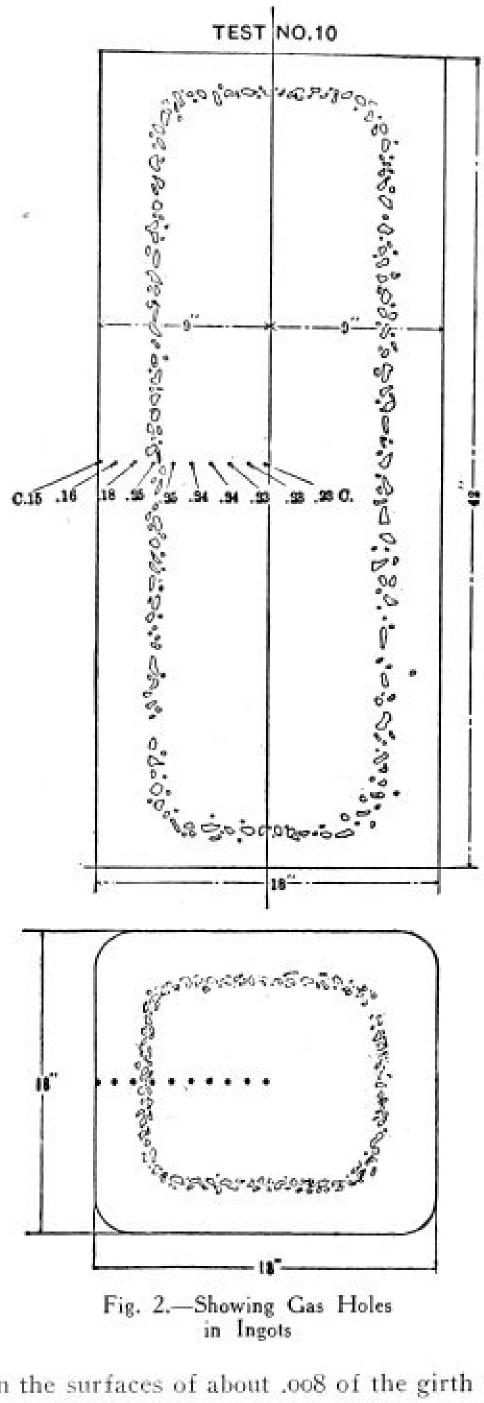


Fig. 2.—Showing Gas Holes in Ingots

or set on the surfaces of about .008 of the girth measurement at plate center.

It will be well to remember that the amount of fiber change will be the same for a given thickness of plate regardless of the shell diameter, but that the percent relation of extreme fiber change to diameter will be inversely proportional to the diameters of shells, and directly proportional to the thickness of the plates for same diameters.

In the case of a shell formed to 40 inches diameter with plate 1 inch thick, the extreme fiber change would be about 3⅛ inches for each side of plate and would be about .023 of plate length girthwise. It is apparent that in cases of segregated carbon or other metalloids, serious distress may occur when plates are formed cold to small diameters with plate of thicknesses of 1 inch or thereabouts.

I am informed that in the near future a decided change will occur in this country in the preparation of boiler materials and their fabrication. There seems to be no doubt that within a few years seamless courses will be rolled for boiler shells and drums which will dispense with riveting and the stresses just spoken of in the shell.

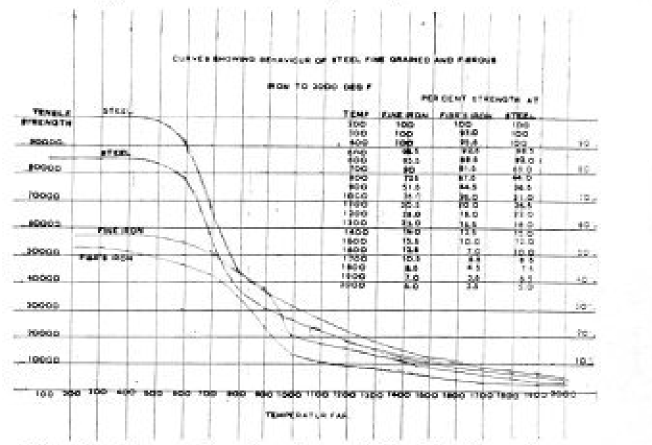


Fig. 3.—Curves Showing Loss of Tensile Strength up to 2,000 pounds

A source of much trouble in the horizontal tubular boiler is the design and workmanship on girth joints. In so far as strength is concerned from the internal pressure, if the shell was 100 percent strong the girth might reasonably be 50 percent if the tubes were not concerned. As usually designed, these joints go about 42 percent of plate. This is due to desire to use the same size rivet hole throughout on boiler. Failure and trouble come from inability to draw such a joint tight enough together to prevent overheating of the outer lap. An instance of overheating of such a joint came under my observation wherein flange steel utterly failed, breaking into eight separate pieces in a space of about 1 square foot. This joint had excessive lap and was overcalked and the rivets were too small for good design.

Another trouble common to the horizontal tubular boiler is bagging or bulging. It is, of course, possible to concentrate a fire on the shell or tubes of a steam boiler and heat it to deformation even though the surfaces are clean and the water pure. It is merely a question of delivering more heat than can be taken up. If the surfaces are not clean, then the deformation will occur with less intensity of heat. It is of interest to know approximately to what temperature a shell or tube has been heated when a bulging has occurred. The curve shown in Fig. 3, although the result of tests on Bessemer steel, will be found practically correct for open hearth steel. The following formula, taken in conjunction with the curve showing tensile strength as related to temperature, will give the proximate temperature at which the bulging occurred.

$$\frac{R \times P}{t \times E.L.} = \text{percent of original strength of plate when bulging occurred.}$$

R = radius of shell or tube.
P = operating pressure when bulged.
t = thickness of shell plate or tube.
$E.L.$ = elastic strength of plate.

Example.—A boiler 72 inches diameter with ½-inch plate and operating under 150 pounds of steam is bulged. Normal E. L. = 50,000 pounds. What was the temperature of the plate when bulging occurred?

$$\frac{36 \times 150}{.5 \times 50{,}000} = 21.6 \text{ percent}$$

of the original strength of the shell plate. From the curve we find this to be 1,225 degrees F. If the operating pressure was 200 pounds we would have:

$$\frac{36 \times 200}{.5 \times 50{,}000} = 28.8 \text{ percent}$$

of original strength, and by the curve we find the temperature to be 1,050 degrees.

If the operating pressure was 100 pounds, we would have:

$$\frac{36 \times 100}{.5 \times 50{,}000} = 14 \text{ percent}$$

or original strength of plate required to hold up to yield point. The curve indicates a temperature of 1,425 degrees.

The same reasoning applies to elastic boiler tubes.

In tension tests under low temperatures beyond the yield point the metal is in a sense compressed, and its ultimate strength is expressed in terms of original area rather than area at break. Under high temperature the metal does not increase its tensile strength, but actually takes the heat more readily because of increasing reduction in thickness.

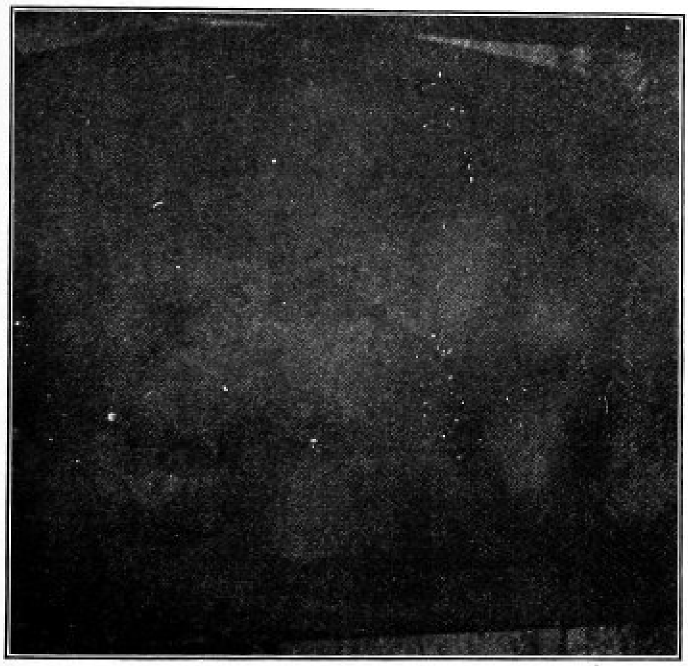


Fig. 4.—Sheet Bulged from Heat

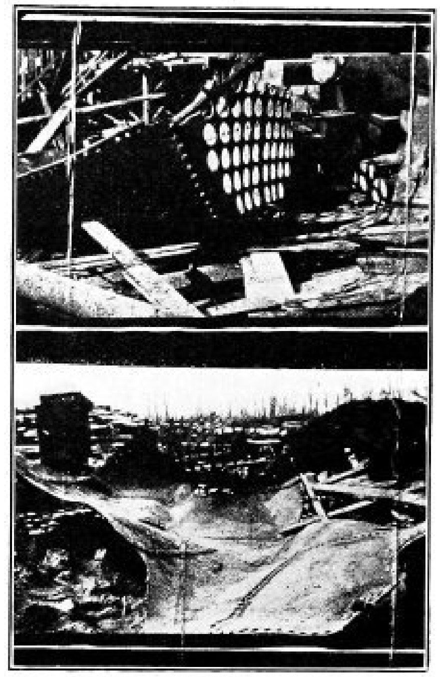


Fig. 5.—Views of the Crump Explosion

A case of failure of the front course of a horizontal tubular boiler that occurred just west of the city about five years ago, indicates the necessity for great care in dealing with steam boilers. This boiler was 60 inches by 16 feet, of the horizontal tubular type, and had been cleaned on Sunday and was apparently in fair condition. The boiler was fired up slowly, but towards morning a crack three feet long occurred at the right-hand side of front course over the fire, which was on plain flat grates. It developed that the blow-off valve was of gate type and some of the brittle scale from the tubes lodged under the disks. As the steam pressure was raised the water was forced from the boiler, and as the tubes became bare the slight scale dropped off and was carried with the circulation and lodged over the fire. The metal was reduced to about one-fourth its original thickness at the break. No great damage was done.

Fig. 4 was taken from a horizontal tubular boiler 54 inches diameter by 14 feet long; the plate was 5/6 inch thick. The picture shows the plate bulged throughout to the shape of a barrel. The increase in radius was 3½ inches and clearly shows that the boiler had only enough water in it to generate steam to fill the boiler at some given pressure. It will be seen that at the girth seams little change occurred. Assuming that a pressure of 100 pounds was on this boiler at the time of overheating, it would be necessary to have the sheet heated to a degree that would reduce it to about 15 percent its original strength. This would indicate a temperature of about 1,450 degrees F. The girth retained its original shape for the reason that at that point the plates lapped.

Fig. 5 shows the wreck after an explosion at Crump, Mich., which occurred on February 10, 1910. The boiler was 54 inches diameter, 14 feet long, and was made with three courses, using two plates to the course. The shell plates were iron. The boiler had a steam dome 24 inches in diameter by 36 inches high, with the shell plate cut out below it to full size. The dome was located on the first course and only a few inches from the girth seam. A cast iron manhole ring was riveted to the shell on the second course. Inspection disclosed that the shell of this boiler was about forty years old, but had in recent years had new steel heads and tubes. There had been ample warning given of its dangerous condition. Previous to the explosion the front course had been patched because of failure due to the fact that a pressure had been used that strained the plates well beyond the yield point. A patch near steam dome had cracked again because of this and the leak was stopped by a row of screw plugs. This explosion resulted in the death of seven men and was due to using a pressure which strained the plates far beyond the yield point along the top centerline of the boiler. The shell plates shown, opened along the top and lay flat where the boiler was used. The perforation at the back was caused by the piercing of the plate by a cast iron pedestal which supported the back end. The piercing was due to the force of the boiler contents expanding against atmosphere. The dome was thrown about 200 yards forward, carrying with it the upper half of the front course and tube sheet. The lower half of the tube sheet was thrown forward about 10 feet and was the part which killed the seven men.

Under present regulations cast iron cannot be used for manholes or other reinforcements. Such reinforcements must be of steel or wrought iron and must provide as much strength at least as the longitudinal joint, which, of course, must be of butt type and should have at least about 80 percent value of plate.

Flat surfaces are a source of much trouble, both to the designer and operator. Figs. 6 and 7 show the construction of a watertube boiler at the Detroit Soap Works. A crack occurred at the curve of the outer sheet. Inspection disclosed that a crack about 24 inches long at each corner

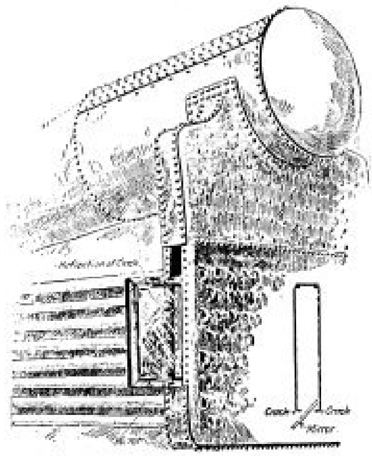


Fig. 6.—Locating Crack with a Mirror in Detroit Soap Works Boiler

had occurred. The tube and outer sheet were each 7/16-inch thick, while the wrapper plate was ⅜-inch thick. The distance between rows of rivets was 6¼ inches, the diameter of rivet holes 13/16 inch.

The boiler was built in 1902 and is known as a Geary boiler. This boiler carried a pressure of 185 pounds and was used in processing glycerine.

A deflection test gave .039 at 250 pounds and .026 at the working pressure. The metal was of good quality. The repeated bendings finally caused failure after a period of about twelve years. The usual formula for such design indicated a pressure about 100 pounds. Aside from this

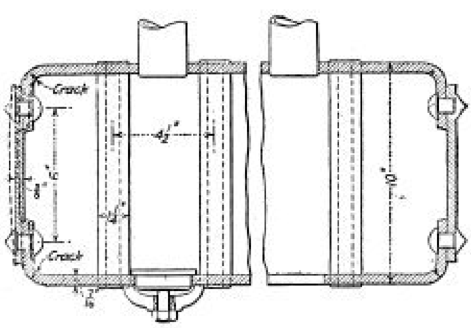


Fig. 7.—Showing Location of Crack and Curvature Assumed by Wrapper Plate

wrapper plate the boiler was well designed and constructed.

Staybolted Surfaces

A few years ago the writer was consulted in regard to the failure of a Scotch boiler (Fig. 8). The boiler was 11 feet in diameter by 13½ feet long and had two Morison corrugated furnaces 42 inches in diameter made from 7/16-inch plate. These furnaces connected with a combustion chamber, technically called a wet back.

The rear stay plate which failed was 15/32-inch thick. This plate was supported by 178 staybolts 1⅛ inches outside diameter, pitched 7¼ by 7¼ inches. The stay plate in many places showed bulges of as much as ⅜ inch, while the staybolts had the customary heads broken off. The safety valves were set at 105 pounds. Failure occurred from stripping of the staybolts which held the rear stay plate in position by connecting it to the rear head by means of the 178 staybolts. The initial failure appeared to be at the second horizontal row of stays from the top, which was incidentally the point of much of the bulging between stays.

A series of tests were made with staybolts in plates shaped similar to parts of the stay plate where bulged. One test made with staybolt and plate with thread and

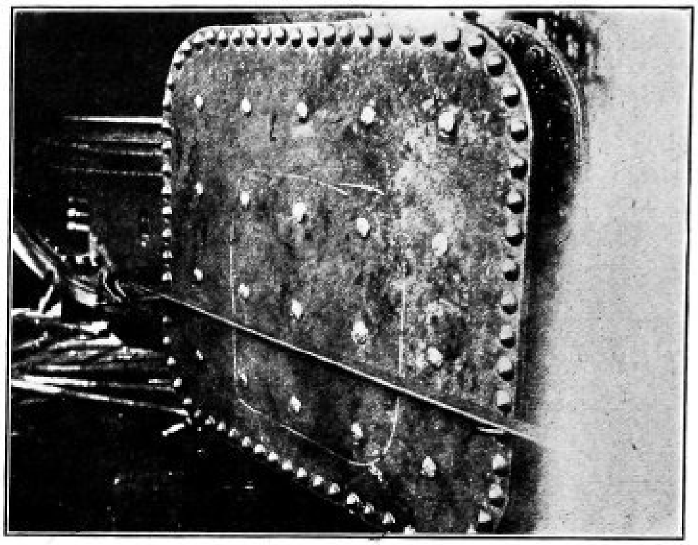


Fig. 8.—Stayed Flat Surface

head made as usual, took a load of 29,100 pounds at the elastic limit and failed at 46,140 pounds, by stripping the staybolt. The equivalent gage pressure was 564 at the elastic limit and 893 at point of failure.

A second test with a plate bulged ⅜ inch. The stay was headed as in the first test. The threads began to yield at 26,000 pounds and failed at 28,800 pounds. The equivalent gage pressure was 522 pounds when yield commenced and 557 at failure.

A third test with a staybolt in a plate buckled ⅜ inch, but with no head, was made. This bolt stripped at 24,800 pounds and was the equivalent of 407 pounds gage pressure.

The values 893, 552 and 407 show the decreasing strength as thread contact and staybolt head was lost.

In order to check the conclusions arrived at from the inspection a series of tests were made to determine the reasonableness of the conclusions reached.

The formula used in such cases being:

$$\text{Pressure to induce yield} = \frac{E \times t^2 \times 1.5}{(P - h)^2}$$

E = elastic strength of metal.
t = thickness in inches.
P = pitch of staybolts.
h = diameter of bolt heads.

Tests were made to observe how close actual tests would agree with the formula (Fig. 9). It will be understood that the diameter of stay decreases after yield begins and load is put on the outer part of the threads and stay head.

For the purpose of determining the behavior of a flat stayed surface under varying conditions of heat and pressure, a steel ring was made up having a plate .447 inch thick on one side and .517 inch thick on the other side, the distance between plates being 4 inches. The spacing of staybolts was 7¼ inches by 7¼ inches, and the staybolts were 1⅛ inches in diameter with 12 threads per inch.

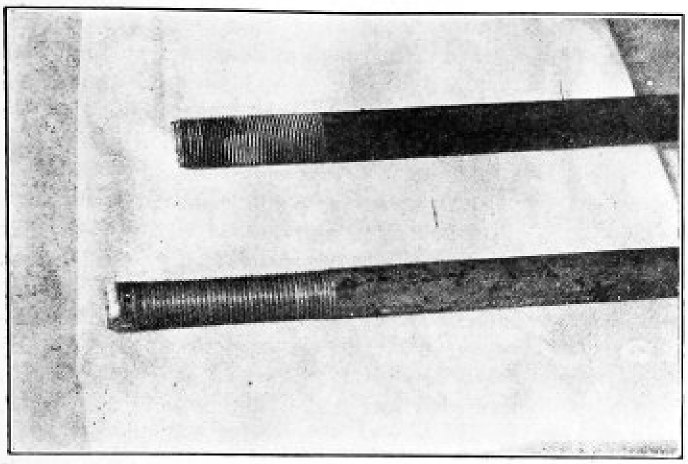


Fig. 9.—Staybolts

A physical test of the .447-inch plate gave the elastic limit 42,846 pounds and the ultimate strength 52,539 pounds.

To determine the ultimate strength of this plate a hydrostatic pressure was applied. A straight edge applied to the sheet .447 inch thick disclosed that it was flat and true, excepting at the outside of the outer row of stays, leaving the central portion slightly prominent.

A pressure of 370 pounds was applied and an elastic bulging between 1/16 inch and 1/8 inch was noted, which on release of pressure disappeared. The pressure was again applied to 400 pounds gage, and on release a set of 2/100 inch was noted. Pressure was again applied to 455 pounds and a set of 1/4 inch was found between stays upon release of pressure.

The actual bulging pressure was between 372 and 400 pounds, at which pressure a set of .02 inch was found.

In order to determine the effect of heat on a flat stayed surface similar in design to the defective boiler, a pressure of air was maintained on the sample at 95 pounds pressure and a flame was made to impinge against the surface. On the plate .447 inch thick, under an internal pressure of 95 pounds, the plate took a set at 1,075 degrees F. The plate .517 inch thick took a set at 1,275 degrees F.

Staybolt No. A.—This stay was used in the test sample

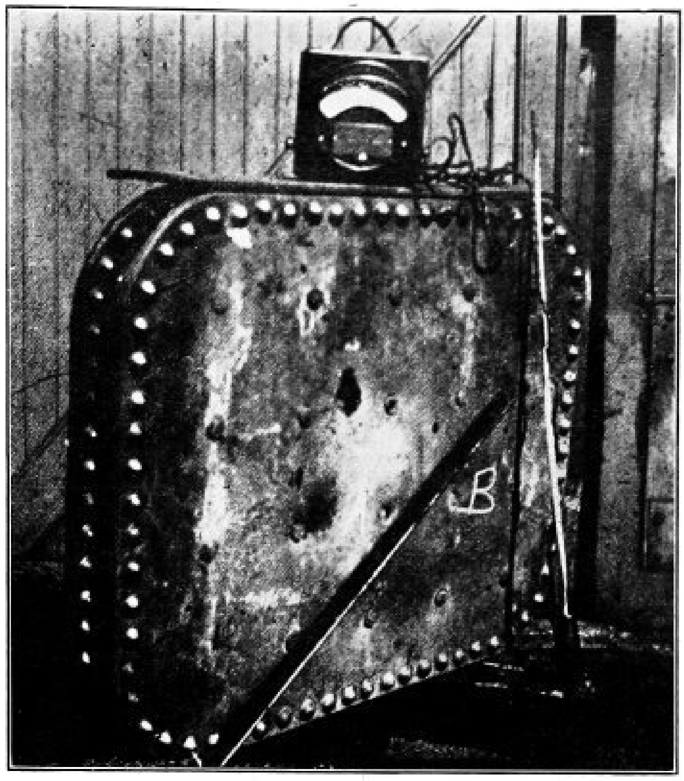


Fig. 11.—"B" Staybolt

of stayed surface and stripped on threads at 95 pounds internal pressure at 800 degrees F. when the head was cut off (Fig. 10). The inside threads show that at the time of failure the inside threads had but small contact when failure occurred.

Staybolt No. B.—This staybolt was used in test sample and stripped under 95 pounds internal pressure with full head when the plate was at 1,275 degrees F. (Fig. 11).

A very vital factor in this problem lies in the destructive stresses induced in the staybolts by the overheating of the rear stay plate and the destructive movement on the threads. This plate had at times an expansion of about 5/8 inch and the effect would be cumulative from the bottom towards the top. The sheet is held at the bottom by

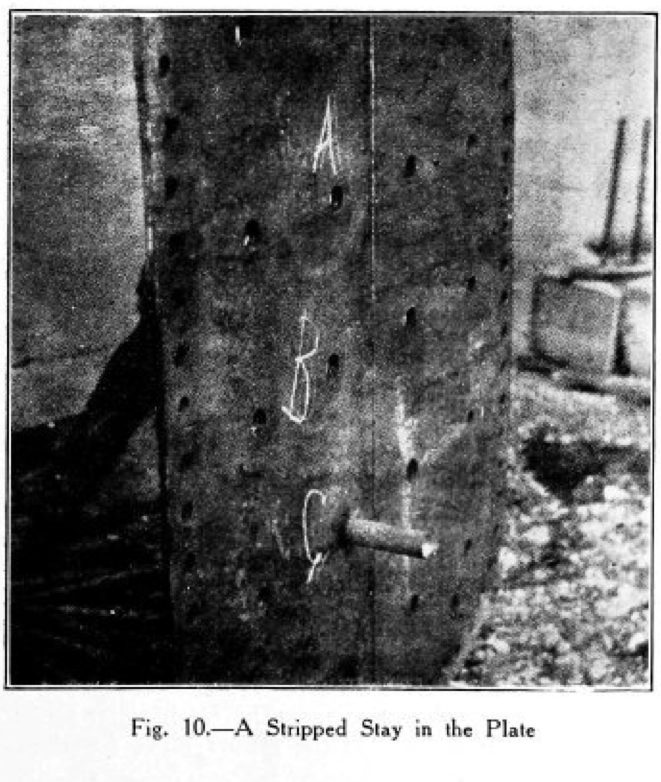


Fig. 10.—A Stripped Stay in the Plate

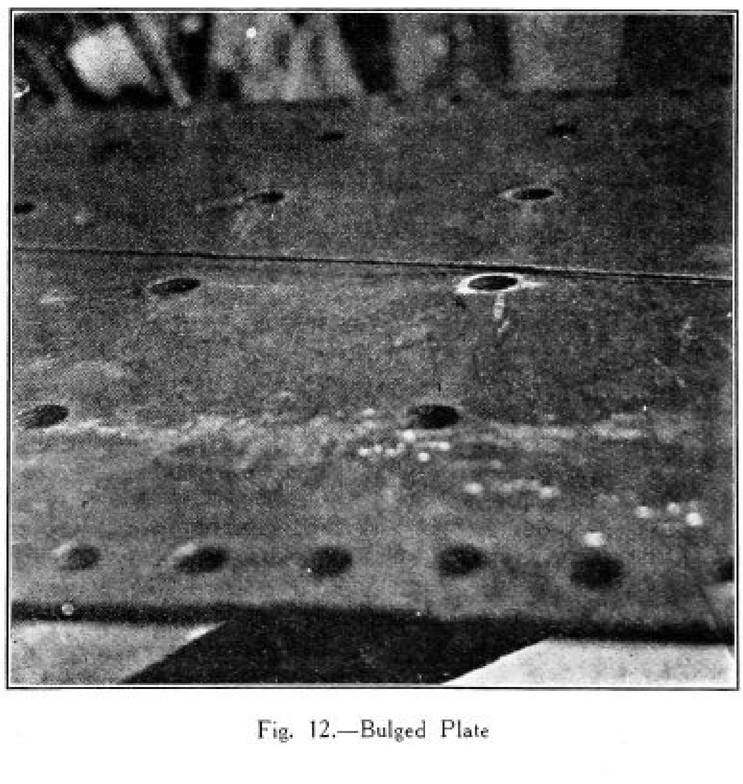


Fig. 12.—Bulged Plate

straps to the shell, but is free to expand in an upward direction.

The foregoing tests show clearly the necessity of renewing stays in a flat surface when bulging occurs. To convince yourself of this necessity, take a piece of plate ½ inch thick with the edge squared. Bend the piece to conform to the shape of a bulge. By measurement you will find the least amount of bulging draws the threads of the bolt and hole apart inside and tightens on outer threads. It will be seen in such a case that the system is no stronger than the value of thread contact plus the strength of head of stay (Fig. 12).

The necessity for a high factor of safety on stays is clearly indicated. Staybolts and rivets should be considered from and at their elastic limit as against the ultimate strength of the plate.

Fig. 13.—Munoz Boiler After Explosion

On October 25, 1909, a Munoz boiler exploded in the brewery of the Pabst Company, Milwaukee, Wis.

Fig. 13 shows a ruptured drum. The boiler is a type of watertube boiler having 36-inch drums longitudinally at the top. These drums were made from ⅜-inch plate. The shell was reinforced by a ⅝-inch plate riveted to the outside of the shell by a single row of rivets at each side of the ligament strip. The boiler was calculated to carry 150 pounds with a factor of safety of 5. It was shown that considerable trouble was experienced from leakage at the rivets and tubes due to stresses set up by the differences in temperature in the plates. In this case we would have steam at 150 pounds, or water at 365 degrees F., with a furnace temperature upwards of 2,500 F. and the known fact that water leaked through this strip, with scale formation as a result of such leakage. It can be readily seen that a rather high temperature difference would be set up with the ⅝-inch or outer strip in compression and the ⅜-inch or shell plate in tension as a result of such overheating.

Theoretically a difference of 300 degrees F. should reach the ultimate strength of the shell plate in this case, but more or less yield at rivets and an inclination to bulge out, and pull on the tubes would modify the destructive effect in a measure. The significant fact is that in this case the normal load on the shell was about 20 percent of the ultimate plate strength. This reinforcing strip which was used to increase the plate value between tube holes was, in my opinion, the actual inciting cause of the disastrous failure of this boiler. Pyrometer measurements would disclose swinging temperatures in such cases, setting up very serious stresses and strains.

In an experimental observation made recently to ascertain the temperature differences in construction somewhat similar to that in the Munoz boiler, but used under conditions where there was little chance for trouble, the temperature differences were found instructive.

Three pieces of plate 6 inches square and ½ inch thick were used. These plates were riveted together with seven 13/16 rivets. A copper rim was soldered around the one side to provide a pan. The device was filled with water. A temperature of 600 degrees F. was maintained on one side and the water was kept at 210 degrees F. The temperature difference between the centers of the outside plates under above conditions remained at 40 degrees F. It will be understood that the rivets, seven in number, were exposed to fire on one side and water on the other. Cases have come under my observation where I found evidence of rather high temperature on girth joints of horizontal tubular boilers. In one case observed last March the heat ran above 1,500 at the rear girth seam on the lap of the joint. A fire crack, so called, is the result of repeated heatings which, while heated, takes a set finally in compression while hot, and on cooling it cannot resume its original position or shape, but cracks opposite a rivet hole. In extreme cases it may crack or break elsewhere. This is not evidence of poor material.

(*To be concluded.*)

How Feed Water Should be Discharged Into a Scotch Boiler

There are several fundamental principles which govern the location of the feed outlet in a Scotch boiler, and the designer must bear in mind the conditions under which the boiler is to be used.

1. As a general rule, feed water heaters are installed in all first-class plants, either stationary or marine, and the feed water enters the boiler at about 200 degrees F., and the customary practice is to discharge the water above the tubes just below the water level, not from the open end of the pipe, but through two or more branches led over the tubes with the ends closed and the sides perforated with small holes, the combined area to be 1½ times the area of the feed pipe; in this manner the water will be uniformly sprayed over the surface.

When water enters the boiler at 200 degrees F. in the manner described it has its best advantage and is rapidly evaporated into steam. Due to this high temperature, it has an advantage of 2 pounds per horsepower per hour.

If this discharge were led to the bottom of the boiler, where the water is fairly cold (and it is seldom any other way unless a system of perfect circulation is provided) the effect of the heater would be entirely destroyed.

To bear me out in this I will cite a recent instance of a small tug boat with a compound engine non-condensing one Scotch boiler with 1,200 square feet heating surface and 40 square feet of grate surface and no heater. At the suggestion of the owner, a good feed water heater was installed. After several weeks there was no noticeable difference in the consumption of fuel, and it was then that the writer discovered that the internal feed pipe discharged its water near the bottom of the boiler. This was immediately changed and placed above the tubes in the manner previously described, and better results were noticeable from the start. The exact extent of economy was not recorded, but was about 140 pounds of coal per hour, enough to prove that the change was very desirable.

2. If there is no feed water heater installed and the feed is made up with cold water from the fresh water tanks, it is the writer's opinion that the proper place for the dis-

charge is near the bottom of the boiler, using a tee fitting on the internal pipe with an open end branch in each direction. This, of course, should not be so close to the bottom as to stir up sediment.

When water enters the boiler thoroughly cold it is advantageous to have the discharge as far away from the water level as possible. Cold water entered at the water level prevents proper evaporation.

3. The United States Steamboat Inspection rules require all boilers to have two feed connections, main and auxiliary; sometimes the auxiliary feed is connected only with the injectors and is seldom used except for supplying the boilers sufficiently to keep auxiliary machinery running when the main units are shut down; the discharge then should be placed over the furnaces and sprayed over the surface, as in case No. 1.

When the auxiliary feed is supplied with an independent feed pump, using cold water, the same case applies, and the discharge should be placed over the furnaces, this being the most effective part of the boiler when the fires are banked.

4. In some plants the auxiliary feed pump is used in case of an emergency, and is connected to the main feed line and heater, and should discharge over the tubes just below the water level, as in case No. 1.

5. The feed valves can be located in any convenient place on the boiler; shell, backhead or front head, if sufficient space can be found, but in no case should the discharge terminate above the water level in the steam space, for the reason that it produces excessive priming and also excessive air hammer in the feed line. Great quantities of air pass into the boiler with the water at all times, which produces a certain amount of hammer in the line. To overcome this an air chamber of ample capacity should be placed on the discharge side of the feed pump or in some convenient place in the feed line.

R. R. ROANE.

If you have a wooden peg stuck in a beam and suspend a weight from it by a rope, and the pressure comes one inch from the beam on the peg, it will break if the amount of weight is greater than the strength of the peg. The peg tends to bend as the weight is increased and the top fibers of the wooden peg are drawn apart while the fibers on the underside of the peg between the rope and the beam are compressed. If now the rope is put out two inches from the beam, the peg will not hold up as much weight as if it was only one inch from the beam. Should there be two beams one inch apart and the peg passes through both beams, the peg will sustain a very much greater weight than if the peg is stuck in only one beam. From this it can be understood why a boiler seam made with the plates butted together and the seam faced with plates on both sides and rivets passed through all three thicknesses is stronger than when two plates are lapped and riveted.

Fish and lard are animal oils. Either one is good to use on a pipe thread when making up a joint, but fish oil seems to have a little the better of the other, although it is generally not so pleasant to use.

Left-hand threads always look steeper in pitch than right-hand threads do. From this optical illusion arises the idea that left-hand threads do not make as tight a joint as do the right hand.

Bearings give trouble because they are too small, are out of line or improperly lubricated. Find out which of these is the cause before you start to correct matters.

Monthly Report of Broken Staybolts, Radial Stays, Defective Arch Tubes and Flues Renewed

The illustration shows a sample of our monthly report sheet, which is filled out at all roundhouses on the system. The report shows the total number of staybolt tests made and the total number of broken staybolts and radial stays renewed. It also shows if the boiler is equipped with flexible staybolts or not, the condition of the flues and number renewed, the condition of washout plugs, telltale holes and firebox sheets. This report is filled out at the end of each month by the boiler maker and round-

M. P. 105

Chicago, Milwaukee & St. Paul Railway Co.

GREEN BAY SHOPS Station APR 4th 1916

To Mr. W H HART

District Master Mechanic GREEN BAY SHOPS

REPORT OF BROKEN STAYBOLTS, RADIAL STAYS, DEFECTIVE ARCH TUBES AND FLUES RENEWED

For the month of MARCH 1916 19

Total number of engines tested during month 49

Engine No.	Staybolts M	Staybolts N	Staybolts O	Staybolts R	Staybolts CC	Crown Sheet Radial Stays Row 1	2	3	4	State if Boiler has Flexible Bolts	Flues Size	Flues Cond.	Flues No. Ren.	Arch Tubes R	L	M	MM	LM	Cond. Wash-out Plugs	Cond. Tell Tale Holes	Cond. Fire-box Sheets
15.9				1						No	2"	Fair	167			1			Good	Good	Good
2003	1	1								"		Good							"	"	"
2025										"		Fair							"	"	"
2027										"		Godd							"	"	"
2028										"	2"	"	25						"	"	"
2031	1	2	2							"		Fair							"	"	"
2067										"		Good							"	"	"
2068										"		"							"	"	"
2077										"		"							"	"	"
2091		1								"		"							"	"	Fair
2103										"		"							"	"	Good
2210										"		"							"	"	"
2317										Yes		"							"	"	"
2329				1						"		"							"	"	"
2417	3						1			No		"							"	"	"
2440								1		"		"							"	"	Fair
3108										Yes		Fair							"	"	Good
3109	2									No		"							"	"	"
Total	7	4	2	2			1	1					192			1					
Grand Total	18					2							192			1					

F. BAENFN Inspector. A. WOODRUFF R. H. F.

M—Right Side Sheet; N—Left Side Sheet; O—Door Sheet; R—Flue Sheet or Throat Sheet; CC—Combustion Chamber.
Radial Stays: In renewing broken radials show number of broken radials renewed, each row from seam up. If breakage show large may want to apply a number of flexible bolts.
State if boiler has been equipped with flexible staybolts so that proper report can be made.
Flues: Show size; number of flues removed, 2"—2¼" or 5⅜" Superheat and condition.
Arch Tubes: Show location and number of arch tubes applied. Also show condition of washout plugs, telltale holes and firebox sheets.
All defects to be made good and all broken staybolts must be renewed. R. H. F. to send report to D. M. M. who will forward same to S. M. P.

Sample of Monthly Report Sheet

house foremen. The sample shown, it will be noted, was filled out at the Green Bay shops, Superior Division.

The reports are sent to the district master mechanic from all points under his jurisdiction, who in turn sends them to the superintendent of motive power, who has same delivered to the general foreman of boiler work, who looks them over thoroughly and makes up a report showing each district separate with the number of broken staybolts, radial stays and arch tubes being renewed. If the amount of broken bolts is shown to be excessive in any one class, arrangements are made to have flexible staybolts applied in the breaking zone. If the number of arch tubes applied is excessive, conditions are looked into.

This report is only to show the broken staybolts or radial stays renewed. It is not intended to show staybolts renewed on account of poor condition.

By looking over the report it will be noted that each firebox sheet is designated by a letter so that we can locate where staybolts are breaking most frequently.

The broken radial stays are also designated by rows No. 1, 2, 3 and 4. These are the short rows on each side of the eight rows through the center. In these rows the majority of radials are found broken. If the breakage is shown to be excessive at all, flexible staybolts are applied; and by looking over the reports monthly, we can readily see the engines that are equipped with flexible staybolts and the difference in breakage, or the results obtained.

A report of this kind made out and sent in monthly keeps one in touch as to conditions at all points, and shows if staybolts break in one locality more than another, or if more arch tubes are used. It also shows where firebox sheets give most trouble and the life of same.

At the end of the year an annual report is made up showing each district separately, the total number of tests made, the total number of broken staybolts and radial stays and the total number of arch flues renewed. From this we get the average number of broken bolts per engine per test and the average number of broken bolts per engine per year. We believe a report of this kind keeps one in touch with the outside points and cannot help to give one a better line-up as to general conditions.

A. N. LUCAS,
General Foreman Boiler Work.
Chicago, Milwaukee & St. Paul Railway, Milwaukee, Wis.

A Supplementary Boiler Water Gage

BY CHARLES J. MASON

In modern watertube boilers of the vertical type, the water column and gage glass are located at such a height above the eye of the observer, that unless great care is taken mistakes may occur with regard to the water level. Of course it is obligatory in most places to locate the water column and gage glass in the usual place on the top drum of such boilers, even though in some cases the water glass is twenty-two feet above the level of the boiler room floor. This is correct, and no exception is taken to it, but an additional or supplementary water gage may be installed as well as the regular prescribed-by-law gage, and so make it convenient for those whose duty it is to watch the water, and as well as that, to use the supplementary glass as a check on the other, and vice versa.

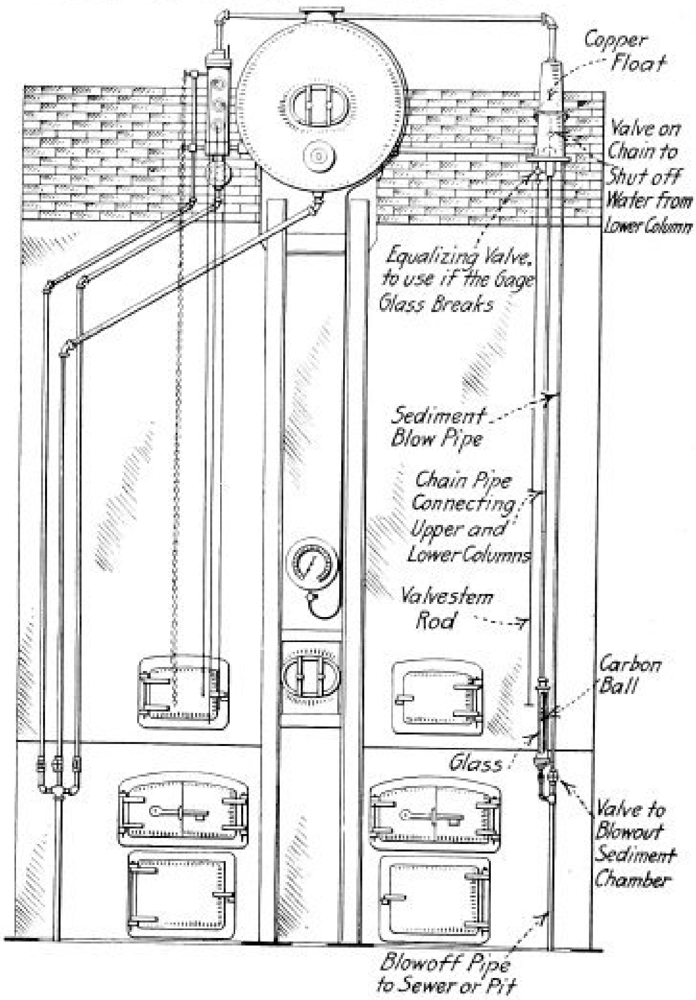
The accompanying illustration shows the idea referred to and its application.

The boiler in question is known as "the Lackawanna," made by the Lackawanna Grate Bar Company of Scranton, Pa. The illustration shows the attached supplementary water gage as well as the regular water column and gage glass connections.

A brief description of the supplementary will, I believe, suffice. Inside the attachment shown at the righthand side of the steam drum is a copper ball float, sufficiently stout for its needs. Secured to the bottom of the float is an aluminum chain, to the lower end of which is attached a carbon ball. The carbon ball is free to move up and down in the supplementary gage glass, shown at the bottom of the illustration. The connection between the supplementary gage glass and the column in which is the copper float is made by a straight length of pipe, and it is in this pipe the aluminum chain is placed. The length of the chain is such that when the water level in the upper drum is central, the copper ball float will be central and also the carbon ball in the lower glass. The lower glass is placed at a height of about five feet from the boiler room floor, and thus easily within the range of vision of the boiler attendant.

The upper column in which the copper float is located is so made that any sediment that may be in the boiler water will settle at the base of the column, but it cannot get down into the lower glass where the carbon ball is. The illustration shows an internal raised part which prevents the sediment from going down the pipe. There is a small blow-off valve, also shown at the bottom of the pipe, at the righthand side.

In case the lower glass should break, as sometimes happens, the flow of water is stopped as follows: The top of the internal raised part near the sediment chamber is also a valve seat for a small valve attached to the chain, just below the copper float. Upon the bottom glass breaking, the water rushes down the pipe, carrying chain, valve and float with it, and thus the valve closes the connection until a new glass is put in. When the new glass is ready for the water, the small valve shown at the bottom of the upper column, at the lefthand side, is opened, thus admitting water to the under side of the valve, and to the connecting pipe, and thus establishing an equilibrium of forces again in the system.



Supplementary Water Gage Operated by Copper Float with Aluminum Chain, at the Bottom End of Which is Attached a Piece of Carbon

The various parts described are marked in the illustration, and will enable the reader to understand the working of this ingenious contrivance, which has proved to be reliable and satisfactory.

An unusual use of a plumber's blow lamp or torch is to employ it to cut out bolt holes in gaskets. The gasket is cut to size and two bolt holes cut and the gasket placed in position and held by the two bolts. The flame of the lamp is then thrown against the gasket through the other bolt holes and the material is almost instantly burned, leaving a nice clean hole.

Placing the Shop Tools

Plans for Rearrangement of Machine Tools to Improve Shop Efficiency

BY JAMES FRANCIS

"Do you remember that talk which you gave me last December (1915), Mr. Francis? Well, I do if you don't. I didn't like it a bit then. Your telling me that I would have to 'get out of the rut or get out of the shop'! Now tell me if you find any change for the better? Is the work coming through more to suit you and has the change made any difference in the cost sheets?"

"It surely has made a marked change, Henry, and as to the present way being more to my liking than as things were last December, why, you are still in the shop, aren't you, Henry? Well, the very fact that you are still here should answer your question about how the work is coming through. But, Henry, there are several troubles still afflicting the shop which you can't cure, no matter how much you are 'on the job.'"

"What are they, Mr. Francis? Seems to me that we have tackled about every problem that could be thought of, and while we couldn't cure all the ills, we have rooted out a good many of the time-killing stunts which we used to do?"

"That is so, Henry. You have done well. The men now seem to be working as though they really intended to accomplish something. You don't see three or four of them waiting for one to do something and get out of the way. They seem to make more 'team work' nowadays, and that means that a whole lot more is being accomplished."

"Then what is it that isn't being done right and which I cannot change for the better?"

A Chance for Further Improvement

"It is the men and the machines, Henry. Your men walk around the shop far too much and the machines are not where they ought to be. That is where unnecessary cost is added to the work and that is the something which you can't help unless the office takes hold with you."

"Then I wish the office would take right hold, for I want this shop to be the latest thing in boiler shop efficiency. Meanwhile, as we are waiting for the office to 'take hold,' suppose you let me in on the proposition, Mr. Francis, and tell me what the real trouble is?"

"It is in the arrangement of the machines, Henry. As the shop machines are now placed, your men have to walk back and forth many times in order to pass the work from one machine to another. Just see what happens when sheets come into the shop. They are dropped as close to the layerout corner as possible, then they are sheared, carried to the edge planer and then punched or drilled."

"Sure, that's the way it's done. And what is the matter with that arrangement, anyway? Isn't that the way they do it in all shops?"

"Yes, Henry, in all too many shops that is just how they do it, and there is where lies the defect which causes as much loss of efficiency as did the 'you keep still while I stir' policy your men were working under last winter."

"Then, Mr. Francis, it seems to me that it is up to the office to cut out that loss right by the roots. They got after me all right, and passed the word to 'get out of the rut or out of the shop.' Now, why don't the office do their share?"

"They will do it, Henry, and that is what I want to talk with you about to-day. Last winter I put the matter squarely up to the directors, or 'the office,' as you call it. I told them just how they were losing money through bad arrangement of the shop tools and they came back at me with a tale of idle men in every direction, no 'team work,' and told me that the men might as well pass the time walking from one machine to another as to stand on one foot and hold the other one up, half the time. The office had me dead to rights and I told them I would meet them half way; that you would put in team work if they would fix the shop so that efficient work could be done. They agreed to that, and such was the cause of the hard 'call' which you got last December about 'getting out of the rut or out of the shop!'"

"Well, I did it! Now, let's see the office do their part?"

"They will do it, Henry, and that is what I want your help on, right now."

"What can I do about that? Seems as though it was the business of the 'man higher up.'"

"Yes, so it is. But, Henry, he wants your advice and co-operation as to exactly what it is best to do in regard to rearranging the shop."

"What can I do about that, Mr. Francis?"

Rearrangement of Machine Tools

"You can do a whole lot, Henry, and here is how I would like you to go about it. Have the draftsman make up a floor plan of the shop at least one-quarter of an inch to the foot—not any smaller scale, at any rate, and one-half inch might be better. Then have him draw to the same scale floor plans of each and every tool in the shop—forges, drills, sheet edge-planer, riveting tower and everything else, power plant included."

"Draw all these on the floor plan? Then where should he put the machines in the plan? They are not right now and it is quite a piece of work to decide exactly where each tool should be placed to work to its best advantage and with the greatest possible efficiency as regards all the other tools, the rivet tower and the erecting floor."

"That is true, Henry, and furthermore that is just the point which you are to help me work out to the best advantage possible. See? Then have the machines drawn upon separate sheets—upon thick paper or cardboard; then cut out each one, leaving only its ground area, with the working face duly marked thereon in order that the machine might be rightly placed when put in any position upon the floor plan."

"Oh, yes, I get you now, Mr. Francis! Say, that is some scheme! We are to take the 'cut-out' machines and place them on the plan in positions where we think the machines might be located to the best advantage."

"Yes, that's the scheme. And once the machines are located, proceed to study the plan, following the material from machine to machine and try to get it through the shop as straightforward as possible without having to move either men or material oftener or further than is absolutely necessary. And we *never* want to move material backward in the shop, but to keep it going as straight ahead as possible, from stock pile to shipping platform. It costs money to zigzag any product whatever around the factory, and the closer we can keep work moving ahead in a straight line during process of manufacture, no matter whether it be wheelbarrows, boilers or flying machines, the less will be the cost of production. And the more zigzags, comebacks and crossovers there are in the route of the work through the factory, the greater will be the cost of production."

"Then you want me to juggle those machine cut-outs around on the plan until I get a layout which will send the work through the shop in straight lines?"

"That's just it, Henry. The closer you can keep the route of each article manufactured to a straight line, the less will be its cost of production."

"Well, there are several things which will handicap us in getting the best possible results. First, there is the power plant. We have to arrange the power tools in such a manner that we can get the belts to them, and furthermore, we have to keep the tools pretty much under the balconies in order that the crane have fair sailing overhead and not run foul of belts or shafting."

"Never mind belts or shafting, Henry! Just put the tools where they will be the most convenient and efficient and we will connect each with an electric motor. Then the power plant may be placed anywhere you wish. Perhaps dispensed with altogether and power obtained from the electric company. Therefore, just go ahead, free lance, and locate the machines independent of the power plant."

Change to Electric Drive

"That's the best I have heard yet, Mr. Francis. We now have a whole power plant, engine, boilers, piping, belts and pulleys and shafting, all open in the shop, placed where it occupies valuable room and handicaps the work a good deal."

"Clean it all out, Henry. Put the power plant just where you want it, or leave it out altogether."

"Say, I think I'll have the draftsman make up half a dozen sets of plans and machinery cut-outs, then I can make up several layouts and compare one with another."

"That's a very good idea, Henry, and, better yet, after you get each machine placed as you think it should go, pin its plan to the plan of the shop, then the whole layout can be moved around and handled as you please without any tool or machine getting out of place."

"That's what I'll do. I will make up the best layout I can, then try to better it on another, and so on until we can't improve matters in any way."

"Do so, Henry. And when you get a plan to suit you, connect the machines with a line, showing the course of the several parts, from stock pile to shipping platform. Then make another line, in another color, showing the movements of the layerout—how he progresses from one part of the shop to another on a certain job, taking one which is stock and frequently put through the shop. Then, with another color of line, follow the riveting gang through the job, and likewise with the other kinds of work which have to be provided for.

"By using individual motors at each machine you can place each and any tool exactly where it is most needed, and will not have to bother about how power may be gotten to that machine without belts and shafting coming in the way of something else."

"Mr. Francis, if we are to do 'intensive farming' or manufacturing in this shop, there are two more things which should be attended to, then, with the men on team work and the machines just where they ought to be, why, we will have a shop that can't be beat by anything in the United States."

"What are these two other things, Henry?"

"They are light and heat. There is mighty poor light in this shop, and a man with a chisel in one hand ought to have an incandescent lamp in the other hand in order to see what he is doing, about half of the time. Then in cold weather—why, this shop is a fright. We have several stoves standing around, and the crane will pick one up and place it near where a gang may be working, but the shop isn't heated. There isn't even an apology for heating, and when the mercury is flirting with the zero mark, as it does in this latitude for two or three months out of twelve, why, efficiency is simply out of the question. Men can't be efficient with half frozen fingers and with feet like ice. While they are flapping their arms to keep warm, they aren't making any money for the stockholders."

Heating and Lighting

"That's true, too, Henry. The efficient shop is certainly well lighted and heated. We will have big electric lights placed where they will light the whole shop, and we will have the shop "coopered' tight enough so you can't run a wheelbarrow in or out without opening a door. Then we will have several thousand feet of steam pipe run where it will do the most good and see if we can't have one shop where a boiler maker can work in winter time with his coat off."

"If you do that, Mr. Francis, you will have to do something towards ventilation. With all the openings there are now in the shop walls and roofs, it is about all a man can do to stay in the shop when all the fires are going, the rivet heaters hard at work, and all discharging the products of combustion right into the air of the shop in which the men must work and breathe."

"Yes, Henry, the shop must have some system of ventilation. But when those stoves and salamanders are dispensed with, it won't be as bad and a fan in the roof will take care of most of the gases which do get into the shop."

Ventilation

"Mr. Francis, why wouldn't it pay to put in a system of indirect heating? Put the steam heating pipes all in a bunch, then pass the shop air over or between the pipes by means of a fan. Then there could be two inlet or suction pipes to the fan, one pipe taking air from the interior of the shop, the other pipe taking air from out of doors. Then by adjusting a damper in either pipe, the required quantity of fresh air could be admitted at any and all times and the shop air heated and sent back again, as far as possible to do so, and not let the shop air become too foul. Seems to me that a heating system of this kind would keep the shop comfortable and give all the fresh air needed without driving a fan in the roof."

"Well, wouldn't it be necessary to draw out the foul air?"

"I don't see why it would with the duplex air supply business for the heating fan. The shop is not air-tight, by all means; that you'll admit?"

"Reckon I'll have to, Henry, even after we stop up the 'wheelbarrow' holes!"

"All right, then. Now, if we draw in 1,000 cubic feet of fresh air each minute, and send it into the shop through the distributing pipes in addition to the amount of shop air which is warmed and sent back, then it will be necessary for 1,000 cubic feet of air to leak out of the shop each minute, will it not?"

"Looks that way, Henry, or else the old shop would be a Zeppelin inside of a few hours."

"Well, then, won't that give all the ventilation necessary without using a fan? You can draw in all the outside air necessary, even if you take all from outside and none from inside of the shop. And, furthermore, you can run the blower in the summer time and change the air in the shop, omitting steam through the coils, of course, and if you want to go farther and make the shop a genuine socialist's paradise, then you can run cold brine through the steam coils and keep the shop at just the temperature which makes each man work the hardest!"

"Well, Henry, I hardly think we will get as far along as that, but I believe I can promise you a rearrangement of the shop tools to any plan which can be demonstrated to be the best we can think of. So go to it and make up your plans with the cut-out machines pinned in place. In the office we will get up a plan or two also, then we will all get together and pick out the plan which figures out to be the best all around arrangement of shop tools."

"I'll do it, Mr. Francis, and I will get right after it. But, say! I'll tell you one thing right here and now—that riveting tower will be found 'right in the wrong place.' I can see that now and I believe you can see it too."

"Well, Henry, I fear we can hardly move the riveting tower. That's a pretty expensive proposition!"

"Then let's dispense with the riveting tower! We can arrange matters so we can rivet anywhere in the shop that we wish that work done!"

"How's that, Henry? Isn't that a rather radical idea?"

"Yes, but we can do it easy. We will lay the tower riveter down flat and place it on a car. Then we will rig another car to carry the shell to be riveted and do the whole business with the shell lying down level!"

"Henry, that's some big idea. I'll have to think about that and take it up with you again when I have more time to go into it thoroughly."

Tests of Oxy-Acetylene Welded Pipe Connections and Screwed Pipe Connections

Results of Experiments Conducted at the University of Kansas to Determine Strength of Welded Pipe Connections

BY F. H. SIBLEY*

The rapid extension of the use of the oxy-acetylene blowpipe for welding pipe connections and the possibilities of still further adaptations in the future give at this time particular interest to figures on the cost and efficiency of connections made by this process as compared to those of screwed connections.

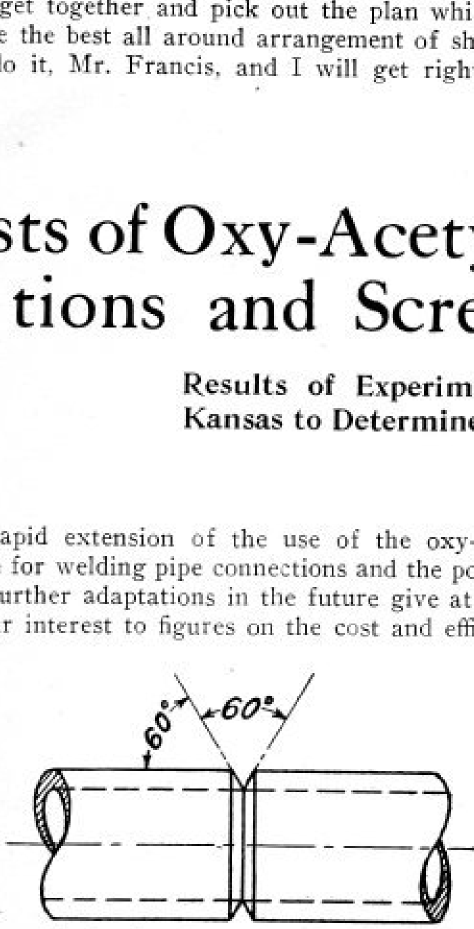


Fig. 1.—Pipe Beveled for Welding

During the spring of 1915 a series of experiments were conducted at the University of Kansas which had for their purpose the determination of the strength of welded pipe connections. The pipe welds were compared with screwed connections of equal size and with the original pipe material. The detail work of these experiments was performed by three senior students in mechanical engineering, under the direction and supervision of the author.

The specimens were furnished by the Oxweld Acetylene Company, Chicago. The samples were cut from standard weight "National" black steel pipe, were from the same stock, and hence probably of uniform quality. The specimens included two pieces of the original pipe, four butt welds, two connections made with malleable iron screwed couplings, three welded tees and two tees made up with malleable iron screwed fittings.

The length of the straight samples was 18 inches. The pieces for the butt welds were cut at an angle of about 60 degrees (Fig. 1) in a pipe-cutting machine to give the necessary "V" groove for welding.

The tees were made with an 18-inch run and a 15-inch outlet, the tee welds being made by cutting a hole in the run and butting the outlet against the outside of the run. All the connections were made by the company's operators.

The straight samples of ½-, ¾-, 1- and 1½-inch pipe were fitted with plugs in the ends to prevent crushing in by the jaws of the testing machine, and were then tested in

* Director, Fowler Shops, University of Kansas.

Fig. 2

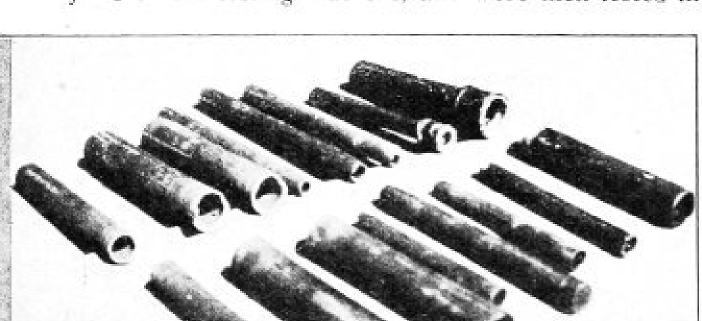


Fig. 3

Specimens Tested in Tension

tension by the usual method. The 2-inch straight samples were cut off square to lengths of 5 inches and tested in compression. For the tee welds a holder was made to fit the run of the tee at either side of the joint. The end of the holder was then placed in the upper jaws of the testing machine, the outlet of the tee was held in the lower jaws and the sample was tested in tension.

The behavior of the welded connections under tension was very much like that of the original pipe specimens. Some of the specimens broke outside of the weld and

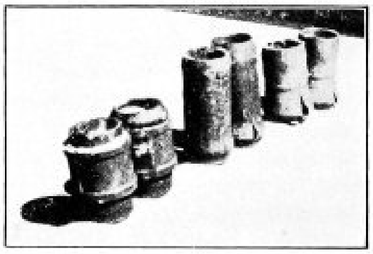


Fig. 4.—Specimens Tested in Compression

some broke in the weld. All of the screwed connections broke right at the last thread in the fitting. The characteristics of these failures are shown in Fig. 2 and 3. The arrows indicate the location of the weld in the smaller samples.

The 2-inch pipe samples tested in compression bulged out on either side of the weld, split along the seam in the pipe as far as the butt weld, which held without spliting.

TABLE 1.—RELATIVE STRENGTH OF WELDED AND SCREWED PIPE CONNECTIONS.

Pipe Size (Inches)	Average Maximum Load. Welded Connection (Pounds)	Average Maximum Load. Screwed Connection (Pounds)	Relative Strength Welded / Screwed (Percent)
Tension Tests of	Butt Welds and	Couplings:	
½	10,222	9,040	113
¾	21,367	13,835	154
1	28,330	17,230	164
1½	43,975	31,270	140
Compression Test	s of Butt Welds a	nd Couplings:	
2	72,500	58,150	125
Tension Tests of	Welded and Scre	wed Tees:	
½	12,903	8,723	148
¾	19,763	12,303	160
1	30,007	17,550	171

One of the screwed fittings sheared the threads and telescoped, and the other bulged outside of the fitting. The characteristics of these failures are shown in Fig. 4.

In most cases the welded tee connections broke in the outlet and at some distance from the weld. All of the screwed tee fittings broke in the casting. The characteristics of these breaks are shown in Fig. 5.

In the tension and compression tests of the specimens of butt welded pipe, unwelded pipe and malleable iron screwed pipe couplings, the elastic limit of the welded specimens

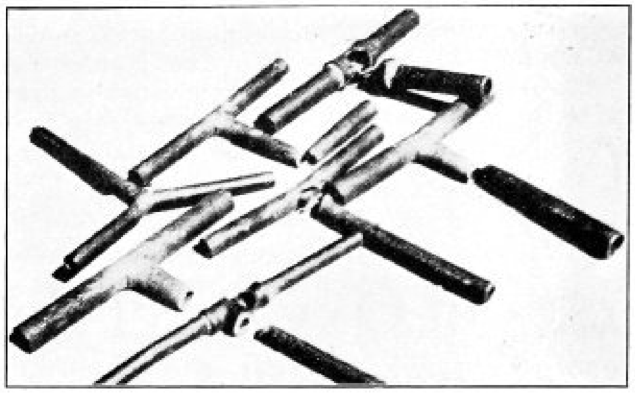


Fig. 5.—Specimens of Tees Tested in Tension

was practically the same as the unwelded pipe, showing that the elasticity is not much affected by welding. The screwed coupling specimens broke without elongating because of the reduced cross-sectional area at the threads, and so has no elastic limit. The elongation of the 6-inch test sections was less for the welded than the unwelded pipe. But this was even better than the screwed couplings, which broke with no elongation.

Table 1 is a summary of the average maximum loads of the welded and screwed specimens. From these average loads, the relative strength of the welded and screwed connections have been computed. These figures (see last column, Table 1) show the strength of the welded connections to be from 113 to 171 percent of the strength of the malleable iron screwed connections.

The higher strength of the welded connections is at once appreciated when the curves in Fig. 6 and 7 are examined. These curves are taken from the data given in Table 1.

Those who are concerned with the comparative cost of making pipe connections by the two methods will be in-

TABLE 2.—COST OF PIPE CONNECTIONS

Pipe Size.		1/2″	3/4″	1″	1 1/2″	2″	3″	4″
Welded Butt Joints.								
Cost of labor	@ 30 cents	$0.0150	$0.0175	$0.0200	$0.0250	$0.0300	$0.0500	$0.0750
" " oxygen	@ 2 cents	.0056	.0086	.0152	.0190	.0302	.0502	.0952
" " acetylene	@ 2 cents	.0046	.0082	.0148	.0184	.0294	.0488	.0886
" " welding wire	@ 12 cents	.0006	.0011	.0015	.0023	.0038	.0120	.0300
Total cost		$0.0258	$0.0354	$0.0515	$0.0647	$0.0934	$0.1610	$0.2888
Screwed Couplings.								
Cost of fitting		$0.02	$0.03	$0.04	$0.08	$0.11	$0.27	$0.45
" " making up joint		0.02	0.02	0.03	0.03	0.04	0.05	0.07
Total cost		$0.04	$0.05	$0.07	$0.11	$0.15	$0.32	$0.52
Welded Tee Joints.								
Cost of labor	@ 30 cents	$0.0225	$0.0250	$0.0275	$0.0350	$0.0450	$0.0800	$0.1100
" " oxygen	@ 2 cents	.0082	.0122	.0210	.0268	.0452	.0804	.1396
" " acetylene	@ 2 cents	.0070	.0118	.0202	.0258	.0440	.0776	.1300
" " welding wire	@ 12 cents	.0015	.0030	.0045	.0075	.0105	.0405	.0713
Total cost		$0.0392	$0.0520	$0.0732	$0.0951	$0.1447	$0.2785	$0.4509
Screwed Tees.								
Cost of fittings		$0.04	$0.05	$0.08	$0.14	$0.18	$0.51	$1.02
" " making of joint		0.03	0.03	0.04	0.04	0.05	0.06	0.09
Total cost		$0.07	$0.08	$0.12	$0.18	$0.23	$0.57	$1.11

terested in Table 2 and the curves in Fig. 8 and 9, which are plotted from the data in this table. The cost of oxygen at the present time varies from 1½ to 2 cents per cubic foot in different parts of the country. The price of 2 cents, which has been used in computing these tables, is therefore very conservative. The cost of acetylene at 2 cents per cubic foot is the price if supplied in tanks. If the acetylene were generated as used, the cost would be reduced to a little less than 1 cent per cubic foot.

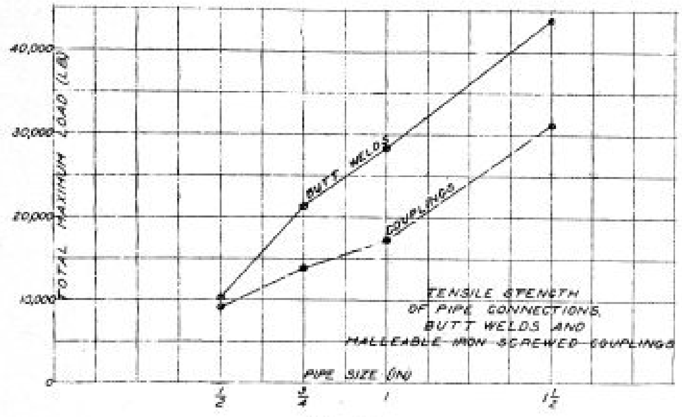


Fig. 6

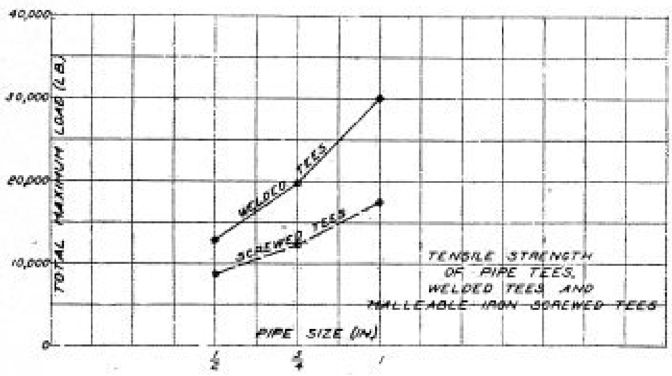


Fig. 7

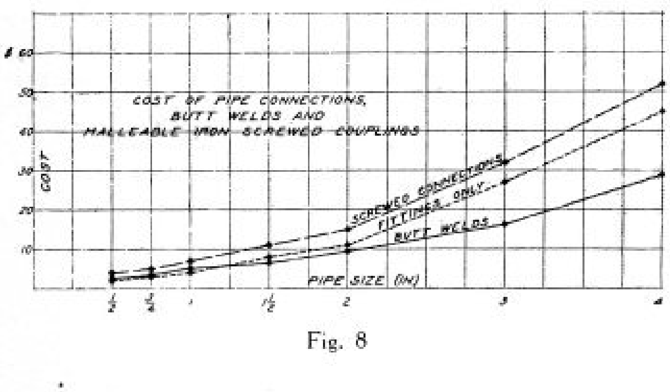


Fig. 8

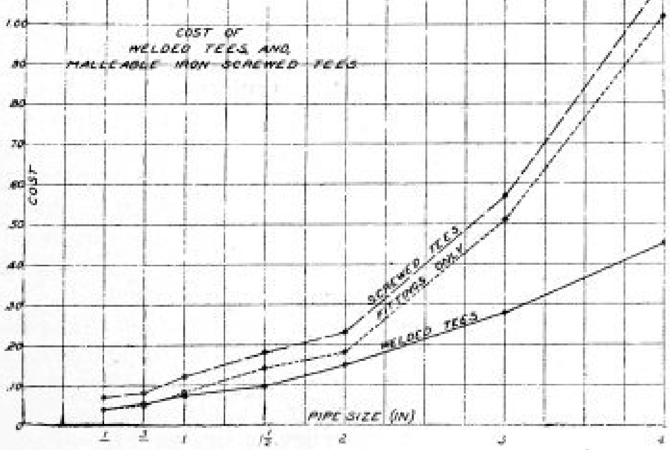


Fig. 9

The curves in Figs. 8 and 9 give the total cost of welded and screwed connections and the cost of the fittings alone. From these curves it is seen that the cost of the fitting is the principal item in the screwed connections. In most cases, the cost of the welded joint is less than the cost of the fitting. As the pipe sizes increase, the lower cost of the welded joint is even more marked.

The conclusions that may be drawn of these tests point to the following facts:

a—The cost of the welded connections is less than the cost of the screwed connections. The larger the pipe size the greater is the difference.

b—The time required to make up the screwed connections is about the same as that required to make up the welded connections.

c—The strength of a welded pipe connection is practically the same as that of an unwelded pipe. By building up the weld it can be made as strong, or even stronger, than the rest of the pipe.

d—The elasticity of the pipe is not much affected by welding.

e—The strength of the welded pipe connections is greater than that of malleable iron screwed fittings. The strength of the welded specimens was from 113 to 171 percent of that of the screwed connections.

The "Excessive" Safety Valve Formula

In the A. S. M. E. Boiler Code, page 1059 of the Transactions, Vol. XXXVI, is the formula

$$A = \frac{W \times 70}{P} \times 11.$$

This formula is to be used "when the conditions exceed those on Table 9." It is applicable to bevel and flat-seated valves.

For simplification of computations I have constructed this little alinement chart, from which A can be determined quickly with a straight edge.

Here I call W the weight of water evaporated per square foot of grate surface per hour (not per second, as in the Transactions). I do this because the table gives evaporations per hour, and it seems to me that both should be the same to avoid confusion.

Otherwise A and P are the same, i. e.:

A = area of direct spring-loaded safety valve per square foot of grate surface, square inches.

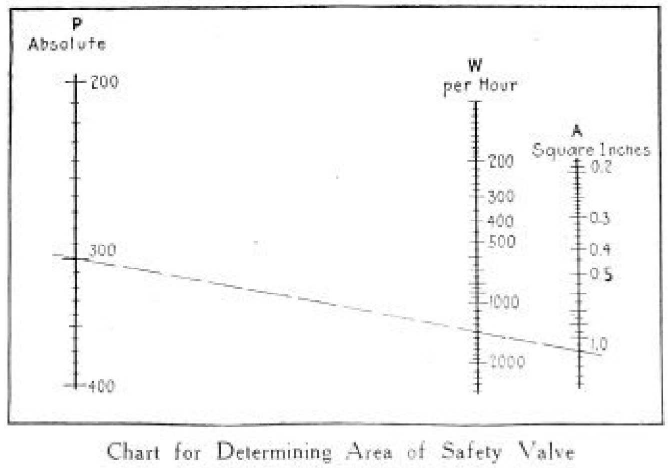


Chart for Determining Area of Safety Valve

P = pressure (absolute) at which the safety valve is set to blow, pounds per square inch.

For example, let us assume a case where the rate of evaporation is as high as 1,402 pounds per hour (see the middle column). The absolute pressure is 300 pounds per square inch. (See the left-hand column.) Lay a straight edge on the two points and the intersection will fall on 1, whence we get the result and use a valve having 1 square inch of area to each square foot of grate area. I have indicated the solution here with a dotted line.

Layout of Branch Pipe

Two Practical Methods of Laying Out a Y Connection

BY R. J. HETTENBAUGH

The pipe illustrated is designed in general practice so that the area of the base is equal to the area of the two outlets. By reading the following instructions carefully it will be surprising how simple this problem is to work out:

FIRST METHOD

First draw the plan and side elevation in accordance with the plate. Space off the base and top circles into equal parts, and from the dotted base circle on the lower half of the centerline project points to the centerline *A-B* as shown. This line represents the arch of the pipe, and in this case the base and arch are of the same radius. The base circle represents a quarter plan of the arch.

Connect the points in the small circle with those on the arch with dotted and full lines as shown. Also connect the points on the base circle with those in the small circle on the opposite side of the centerline. These points are shown on the opposite side of the centerline for convenience, and this arrangement causes less confusion in the lines.

The same thing will be done with the side elevation. From point *X* scribe a circle representing the quarter plan of the base and arch. Space these off equally with the same number of points as was used in the plan and project them at right angles to the object shown. Next draw the half circle or half plan of the top. Space this off equally and project the points to the object. Connect all points in accordance with their numbers with broken and full lines as shown.

The construction triangles must now be formed as in Figs. 1, 2, 3 and 4, and from these triangles the pattern is formed.

Take the distance 1-16 on the centerline of the plan with a pair of dividers, and place this on the horizontal line of Fig. 1. This is the base line of the first construction triangle. Next take the distance from point *A* to point 16 on the centerline of the side elevation, and place this on the perpendicular line of Fig. 1, this being the height of the first construction triangle. Connect these points with a diagonal line, which is the hypotenuse or true length of line 1-16. This can be proved by placing the dividers set at this length on line 1-16 of the side elevation. If they check, the work is correct. Lines 1-16 and 30-15 are the only two lines that can be checked in this manner, as the true lengths of the other lines are not shown in this position. All other triangles will be found in like manner, and, as all triangles from points 23-8 to 30-15 are the same height, only one point need be taken on the perpendicular line of Figs. 3 and 4.

The pattern now remains to be formed. Proceed by taking the length of line 16-1 in Fig. 1 and place it at any convenient place on the sheet, and from point 16 scribe an arc equal to one of the spaces in the base circle. Next take the length of line 1-17 in Fig. 2, and with point 1 as a center, scribe an arc to cross the one taken from point 16. The point of intersection will form point 17. With point 17 as a center, scribe an arc equal to the length of line 17-2 in Fig. 1, and, with point 1 as a center, scribe an arc equal to one of the spaces in the small ciricle to cross the arc taken from point 17. This forms point 2. Find all other points in like manner until the half pattern is completed.

When the pattern is completed fold it on line 1-16 and cut it out. Lay it out flat and scribe another pattern from it. This will make both branches of the pipe.

SECOND METHOD

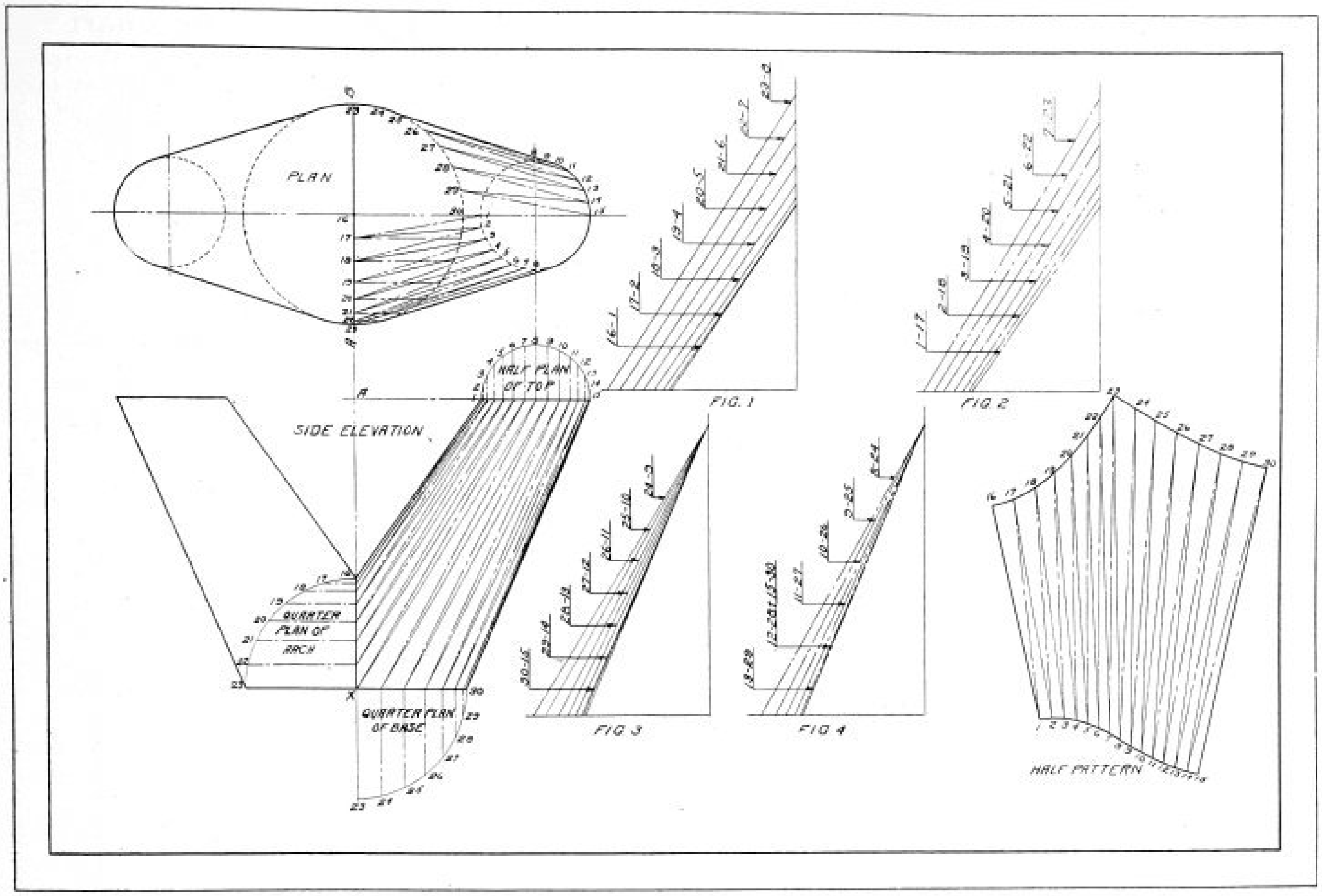
This may look like a difficult pattern to lay out by this method, but if carefully studied it will prove very simple. This is not the simplest method of laying out this pattern, but is the most accurate, and is very little more work than by the first method.

First draw centerline *AB*, and on this line form the side elevation of the pipe. The base and arch both being the same, set dividers on point *X*, and scribe two quarter circles representing the quarter plan of the base and arch. Space these circles in any number of points desired, eight being used on this drawing. Project these points at right angles to the side elevation, and from this to the centerline as shown. In the same manner scribe the half circle or half plan from point V. Space off equally and project these points to the side elevation, and thence to the centerline as shown.

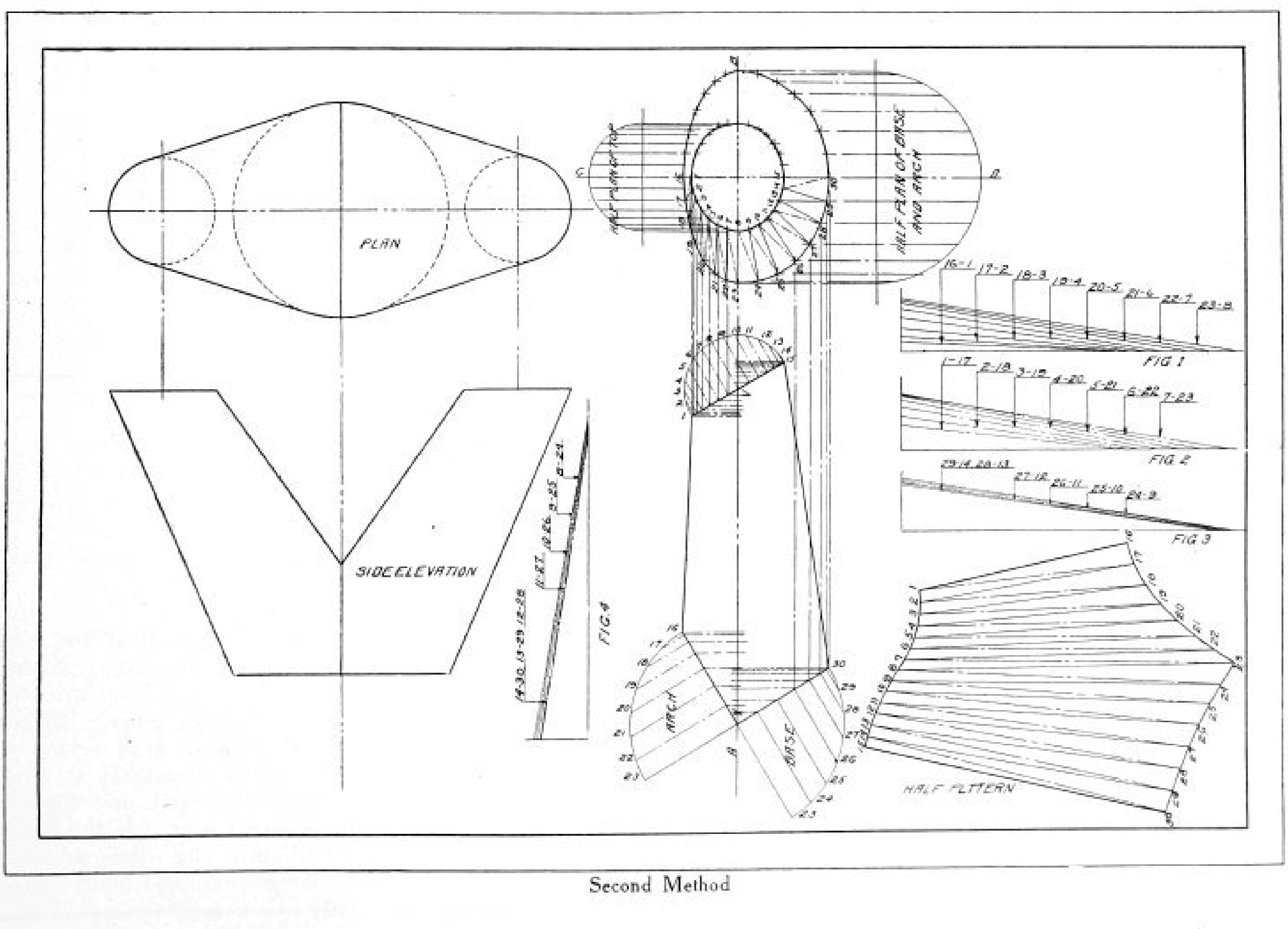
At right angles to the centerline *AB* draw the centerline *CD*, and on this line draw the half plan of the arch and base on one side of the centerline *A-B* and the half plan of the top on the opposite side. As the base and arc are the same, only one circle is necessary, as they come directly opposite each other. Space these circles in the same number of points as was used on the side elevation. There must also be the same number of points in the top as there are in the bottom, including the arch and base.

Project all points in the half plans of the top base and arch to the end view parallel to the centerline *C-D*, and in like manner project the points in the side elevation to the end view parallel to the centerline *A-B*. The points of intersection will form the end view. Connect these points with an irregular curve. The crosses shown represent the points of intersection, but care must be taken so that the numbered points in the half plans check those in the side elevation, as point 1 shown on the centerline in the end view must cross point 1 from the side elevation.

The next step will be to find the construction triangles in Figs. 1, 2, 3 and 4. This requires much care and accuracy so that the points are not confused. Set dividers equal to the distance between points 1 and 16 in the end view. Place this distance on the perpendicular line in Fig. 1. Next take the distance between points 1 and 16 on the centerline



First Method



Second Method

of the side elevation, and place this on the horizontal line of Fig. 1. Having the base and height, draw a line diagonally across, connecting the two points just found. This will be the hypotenuse or true length of line 1-16, and forms the first construction triangle. This can be proved by placing the dividers on line 1-16 of the side elevation, and if they check, the work is correct. This line is shown as 16-1 in Fig. 1. In like manner get lines 1-17, 17-2, etc.

After all the triangles have been formed they must be pieced together to form the half pattern. Take the line 1-16 in Fig. 1 and place it at any convenient place on the sheet. From point 16 scribe an arc equal to one of the spaces in the half plan of the arch and base. Next take the line 1-17 in Fig. 2, and with point 1 as a center, scribe an arc to cross the one taken from point 16. The point of intersection will form point 17. Now take the length of line 17-2 in Fig. 1, and with point 17 as a center, scribe an arc, and from point 1 scribe an arc to cross it equal to one of the spaces in the half plan of the top. The point of intersection will form point 2. Lines 2-18, 18-3, 3-19, 19-4, etc., will be found in the same manner until the half pattern is formed.

Fold the pattern on line 1-16 and double it to form one branch of the pipe. Lay this out on the sheet and scribe around it to form the other branch.

Orders for 83 locomotives were placed the first week in April, with inquiries for 29 others.

A Handy Boiler Power Chart

I send herewith a chart that will tell you the approximate horsepower of ordinary horizontal return tubular boilers. You don't have to do any figuring at all. Just lay a straight edge across the chart and you've got it roughly and in accordance with the formula

$$\text{Horsepower} = \frac{D^2L}{5}$$

where D = diameter of boiler in feet,
L = length of boiler in feet.

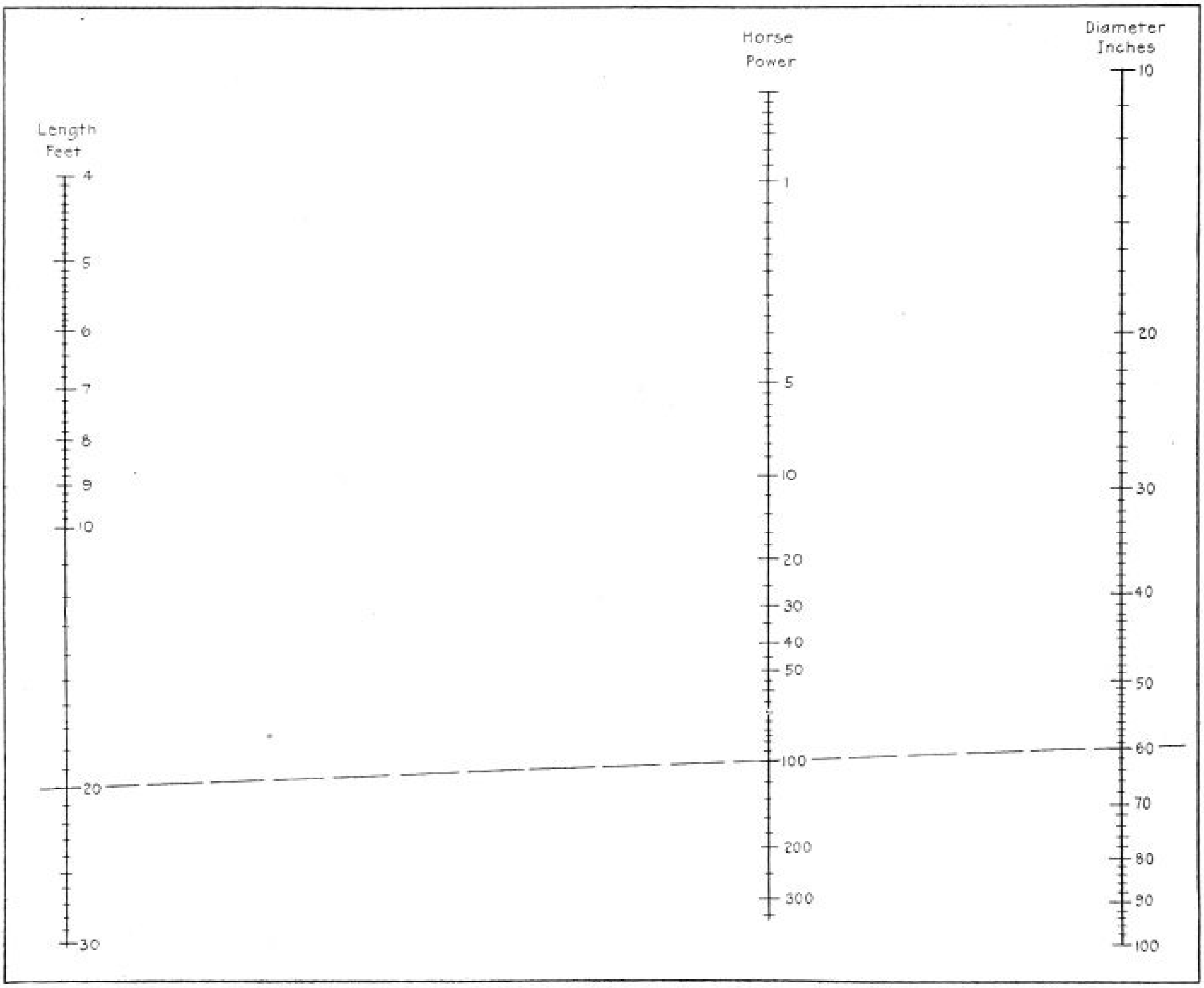


Chart for Finding Approximate Horsepower of Horizontal Return Tubular Boilers

The dotted line I have shown on the chart tells us that a boiler 20 feet long and 60 inches in diameter would be, roughly, a 100 horsepower boiler.

New York. N. G. NEAR.

The strain on a rivet is both longitudinal and transverse, and these last are what is known as shearing strains—that is, the rivet is inclined to be cut in two by the two plates being forced past each other. There is also a bending effect. In horizontal head seams this shearing effect is less and there is a tendency to stretch the rivet lengthwise, forcing off its head, and this same condition exists in the longitudinal seams; in the vertical seams this tendency is very light. The whole subject of strains on rivets is most interesting, and boiler makers should study them carefully.

Programme of Master Boiler Makers' Convention to be Held in Cleveland May 23—26

The tenth annual convention of the Master Boiler Makers' Association will be held at the Hollenden Hotel, Cleveland, Ohio, on May 23, 24, 25 and 26. Registration will begin at 9 A. M. Monday, May 22. Each member should report promptly after his arrival for himself, ladies and guests, and receive convention badges with such instructions as may be of value during the progress of the convention. The official programme is as follows:

TUESDAY, MAY 23 (BUSINESS SESSION)

Convention called to order at 10 A. M.

Invocation—Past president, John H. Smythe.

Addresses—Hon. Harry L. Davis, Mayor of Cleveland; Mr. D. R. MacBain, S. M. P., N. Y. C. R. R., Cleveland.

Responses—Mr. P. J. Conrath, past president; Mr. John A. Doarnberger, past president.

Annual Address—Mr. Andrew S. Greene, president of the association.

Routine Business—Annual report of the secretary, Mr. Harry D. Vought; annual report of the treasurer, Mr. Frank Gray.

Miscellaneous business.

WEDNESDAY, MAY 24 (MORNING SESSION)

Convention called to order at 9 A. M.

Address—Mr. Frank McManamy, chief boiler inspector I. C. C.

Response—Mr. M. O'Connor, past president.

Commitee reports:

"Oxy-Acetylene and Its Advantage in Boiler Repair." John Harthill, chairman.

"Electric Welding and Its Advantage in Boiler Repair." P. F. Gallagher, chairman.

"Do Long Flues, Which Are of Such Length and Thickness That They Sag on Being Applied to Boiler, Vibrate with the Momentum of the Locomotive When in Service?" C. L. Hempel, chairman.

"Why Do Front Flue Sheets Bulge and How Can It Be Eliminated?" John B. Tate, chairman.

"Best Method of Cleaning and Maintaining Superheated Tubes." T. F. Powers, chairman.

THURSDAY, MAY 25 (MORNING SESSION)

Convention called to order at 9 A. M.

Address—Mr. J. T. Carroll, assistant general S. M. P., B. & O. R. R.

Response—Mr. T. W. Lowe, past president.

Committee reports.

"To Obtain Extension of Time Limit for Removal of Caps with Flexible Staybolts." C. N. Nau, chairman.

"What Is the Most Economical Method of Removing and Replacing Wide Fireboxes in Locomotive Boilers." B. F. Sarver, chairman.

"What is the Advantage of Cutting Off Stay Ends with the Oxy-Acetylene Over the Old Method of Nippers and Chisel?" Thomas Lewis, chairman.

"Which Firebox Steel Gives Best Result in Locomotive Service—the Basic or the Acid?" James C. Clark, chairman.

"Cracking of Barrel Sheets, Where They Crack as Well as the Shape of Crack?" C. R. Bennett, chairman.

"What Are the Best Rules to Follow in Arriving at the Maximum Heating Surface of a Locomotive Boiler?" Charles P. Patrick, chairman.

(AFTERNOON SESSION)

Convention called to order at 2 P. M.

Committee reports:

"What Are the Advantages and the Disadvantages of Fusible Plugs in Crown Sheets of Locomotive Boilers?" A. R. Hodges, chairman.

"What Are the Advantages or Disadvantages in the Use of Standard Thickness of Copper Ferrules for Both Good and Bad Water Districts or Territories? Is It Better to Use Light Copper in One District and Heavier Thickness in Another, or Is Any Difference Experienced?" W. H. Laughridge, chairman.

"Cleaning Boilers in Back Shop or Round House When All Flues Have Been Removed and the Most Economical Way of Doing It?" George Austin, chairman.

"What Is the Proper Thickness and Best Mud Ring to Use in a Locomotive Boiler to Keep Side Sheets from Cracking?" T. P. Madden, chairman.

FRIDAY, MAY 26 (MORNING SESSION)

Convention called to order at 9 A. M.

Commitee reports:

"Law."

"Topics for Convention of 1916-1917."

Unfinished business.

Election of officers.

Good of the association.

Announcements and closing exercises of the convention.

Boiler Manufacturers' Convention

The twenty-eighth annual convention of the American Boiler Manufacturers' Association of the United States and Canada will be held at the Hollenden Hotel, Cleveland, Ohio, on June 19 and 20. Prominent among the subjects to be discussed are the progress towards adoption by various States of the Boiler Code compiled by the American Society of Mechanical Engineers, data on uniform cost systems and many other matters of interest to all boiler manufacturers. In addition, the executive committee of the organization is planning to have delegates to the convention visit one or two of the manufacturing plants in Cleveland of special interest to boiler manufacturers.

The last convention of the association, held in Erie, Pa., in June, 1915, brought out a large attendance and proved to be a profitable and interesting meeting. All of the time during the convention at Erie was given over to business and no time was consumed with social features. This rule will be adhered to at Cleveland, with the result that the meeting will last only two days.

Further information regarding the programme of the convention, hotel accommodations, etc., can be obtained from Mr. W. C. Connelly, president, Cleveland, Ohio, and Mr. H. N. Covell, treasurer, care of the Lidgerwood Manufacturing Company, Brooklyn, N. Y.

When you screw a nut down tight the strain comes on the top of the threads in the nut and on the underside of the bolt. If you put on a thin lock nut on top of the nut and tighten it you tend to draw the bolt up and force the nut down, thus throwing the stress of holding on to the thin lock nut. Put your thin lock nut in front. It does not look to most people as good, but a little thought will convince anyone that the place for a thin lock nut is not at the top of the nut.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

One of the first steps inaugurated by manufacturers in the "safety first" movement was the protection of the eyes of employees. As long ago as 1897 the Crane Company, Chicago, began to provide eye protectors for its workmen, and in 1898 the company established the custom of giving glasses to the men free of charge, and requiring operators as far as possible to wear the glasses constantly when they were exposed to flying bits of metal, emery, dust, glare and hot metal. The originator of this plan was Dr. A. M. Harvey, who was at that time and is still the company's chief surgeon. The success of his work in this direction is shown by the fact that eye injuries among the workmen have been cut down to an extremely low point. Signs conspicuously posted at various points in the works serve to draw the attention of the men to the necessity of using the glasses and also to the fact that the glasses can be obtained free of charge from the company. To-day the Crane Company is one of the best known industrial companies in the "safety first" movement, and much of their success is due to the activity and thoroughness of the surgeon who originated and carried out this plan. The value of having workmen protect their eyes in the shops is no longer open to doubt, and every manufacturer should at least provide protection to this extent for his employees.

"On to Cleveland" will be the marching orders for all master boiler makers this month and for all boiler manufacturers next month.

If you believe in preparedness, prepare to go.

If you are one of the stay-at-homes, do not look for sympathy from those who are spending time, money and energy to keep the wheels of progress turning.

Your place is at the front! Mobilize!

When the master boiler makers assemble at the Hollenden Hotel in Cleveland on May 23 they will be welcomed by the mayor of the city and other distinguished guests. During their stay in Cleveland they will be royally entertained. A glance at the official programme of the convention, printed on the opposite page, will show that the topics and committee reports to be discussed on the convention floor will cover a wide range of boiler shop work; and it should be remembered that the committee reports on these subjects are the result of a year's careful investigation by the best qualified men in the country. In addition to the regular proceedings of the convention, the boiler makers will find on exhibition at convention headquarters all of the latest tools and appliances for use in the boiler shop, and, moreover, they will have an opportunity to meet and become personally acquainted with the men who manufacture or supply these tools and learn at first hand what kind of service the new devices are capable of giving. Every minute of the four-day convention will be profitably and pleasantly spent, and no master boiler maker can afford to miss it, whether he be a railway, marine or contract man.

The boiler manufacturers' convention, which will also be held at the Hollenden Hotel in Cleveland, will be the twenty-eighth annual meeting of the association which has been the guiding spirit in the development of the boiler trade in this country for over a quarter of a century. The convention will last only two days, but every session will be a business session, and special attention will be given to the work that has been carried on during the past year in promoting the adoption of a uniform boiler code in the United States. Favorable reports have been sent out from month to month by the Uniform Boiler Law Society that was organized at the last meeting of the American Boiler Manufacturers' Association, and, with a year's work behind it, this movement should speedily be brought to a successful issue.

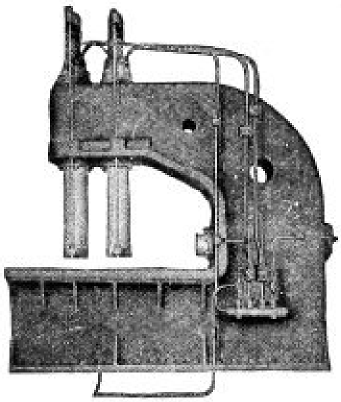
The encouraging news has just been given out that the boiler code bill which was introduced in the New York legislature has passed the House unanimously and will probably soon become a law. Favorable action on similar legislation is also predicted in the States of Louisiana and Texas.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Southwark Standard 200-Ton Sectional Flanging Press

The Southwark standard 200-ton sectional flanging press, illustrated, which is used in boiler shops for flanging boiler heads and for other miscellaneous work, has two vertical rams of 100 tons capacity, one horizontal ram and one supplementary ram. The housing is cast of open hearth steel and all of the cylinders are open hearth steel castings inserted in the housing.

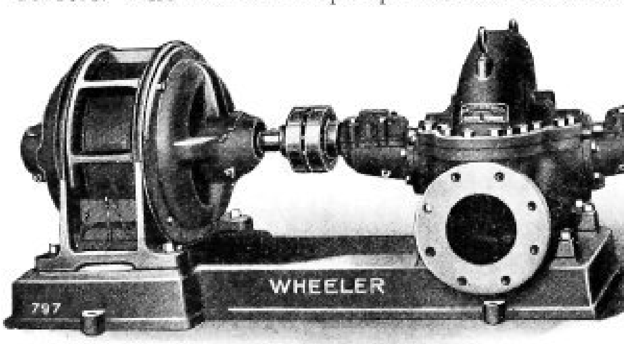


Southwark Flanging Press

The operation of the machine is accomplished by using the outer vertical ram for clamping; the inner vertical ram for flanging and the horizontal ram for squaring up the flange, or for holding the backing-up bracket, while the inner vertical ram is doing the flanging work. There is also a lower ram located between the two vertical rams, which is used for clamping and stripping.

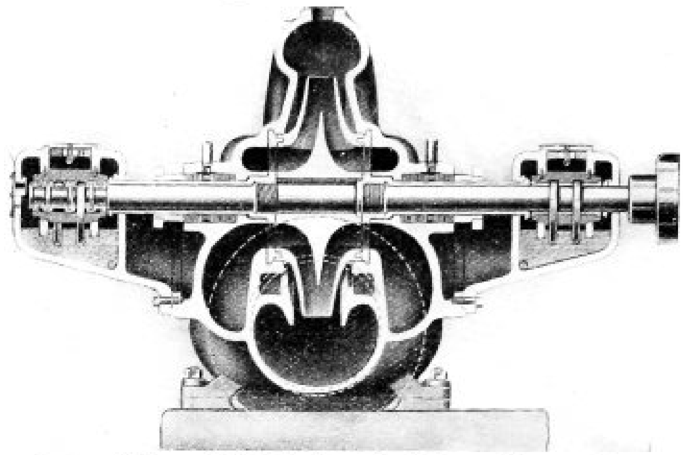
Wheeler Centrifugal Pumps

The Wheeler Condenser & Engineering Company of Carteret, N. J., is now building a line of horizontal and vertical shatt centrifugal pumps for general services as well as for condenser work. This company has been building centrifugal pumps for over twenty years, most of them being used, however, in connection with condensers. The new line of pumps is suited for all services.



Typical Small Motor-Driven Pump for Tank or Stand Pipe Service. Capacity 1000 Gallons per Minute

A small motor-driven unit for tank or stand pipe operation is shown in Fig. 1. Referring to Fig. 2, it will be seen that this pump conforms to the most recent advances in centrifugal pump construction, having a two-part divided casing, with the suction and discharge nozzles in the lower half. The impeller is of the closed double suction type, protected by labyrinth wearing rings. The shaft is protected from the water by bronze sleeves, which screw onto the shaft and extend clear through into the bearing bracket boxes. Bearings are of the ring-oiled type, and in the outboard bracket there is located a ring-oiled thrust bearing, which is a refinement not usually found in double-suction single-stage pumps. A feature of these pumps is the large size of the bearing brackets and the fact that they are bolted to the pump casing instead of being cast integral with them.

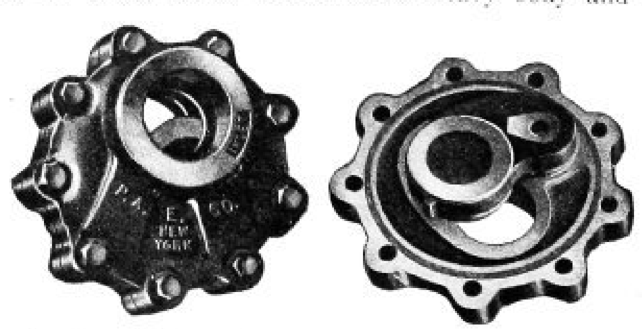


Sectional View of Wheeler Centrifugal Pump, Showing Water Passages in Casing and Impeller, Also Shaft Protecting Sleeves

In manufacturing, particular attention is given to the casting of impellers, since the work of the designer in selecting the correct impeller dimensions may be entirely defeated by crude or careless shop work. The impellers are cast in dry sand or skin dry molds, and the cores are made from a core "sand" which is in reality a fine powder, which when properly mixed and weathered and baked into a core, gives a surface to which the metal adheres perfectly. The result is that the finished impeller is a perfect casting, true to pattern.

Everlasting Blow-off Valve

The Scully Steel & Iron Company, Chicago, Ill., has placed on the market a marine type of the "Everlasting" blow-off valve, which has an extra heavy body and is guaranteed to pass government inspection. The valve is especially designed to meet marine requirements and is composed of a top and bottom bonnet bolted together with an approved high-pressure gasket between them. The



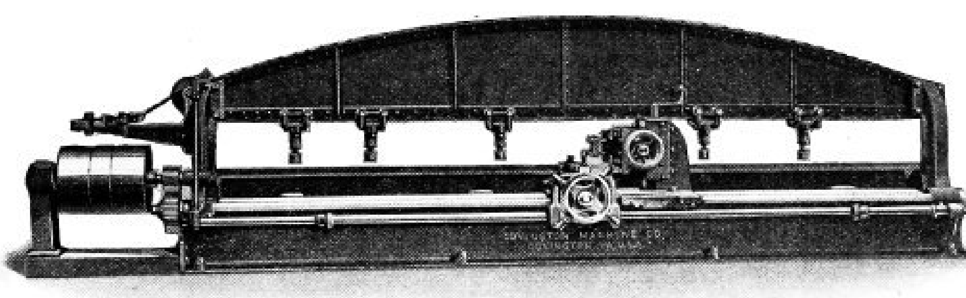
Exterior and Interior Views of Everlasting Blow-off Valve

valve has no stuffing box, and, for this reason, requires no packing or repairing. After it is once installed it requires no attention from the engineer outside of operating it. The valve has a straight-through blow, thus eliminating the deposit of sediment in any part of the valve. The disk has a rotating movement over the valve seat, which makes it self-grinding and keeps the surface true. The inlet orifice is slightly choked, which increases the velocity of the blast at that point and insures its delivery into the discharge pipe without impairing the seat. This also has the effect of syphoning the valve clean at each operation.

The valve can be used anywhere where a quick opening or closing valve is required, and many large steamship companies on the Atlantic and Pacific coasts, as well as on the Great Lakes, are using the valve, not only in blow-off service, but also on purifiers. It is made with screwed or flanged ends, or with one end screwed and the other flanged, and also with angled ends. If a slow-opening valve is required it can be furnished with a rack and pinion device.

Covington Plate Planer

A tool of special interest to boiler makers is the plate planer shown in the illustration, which is manufactured by the Covington Machine Company, Covington, Va. The laws are becoming more stringent in every State requiring the planing of all plates instead of bevel shearing where any pressure is to be maintained. The plate planer illustrated is of small capacity with hand-operated jacks for holding the plate. Air jacks may be substituted for the screw jacks on larger machines. The planer is equipped with two tools, one for cutting in the hight-hand direction or motion of the carriage and the other for cutting in the left-hand direction. In other words, it cuts going and coming, and there is consequently no loss of time. Two cuts are usually all that are necessary to straighten the edge of a plate and this may be cut square or at a bevel.



Covington Plate Planer

The planer bed is made of semi-steel of box construction designed for rigidity. The housings are also of semi-steel of box construction. The girder which is attached to the housing is a steel plate girder in all cases. The machines are supplied for both belt and motor drive and are designed to cut at the rate of 20 feet per minute.

PERSONAL

William F. Brady, of Buffalo, N. Y., has been appointed superintendent of the Wholey Boiler Works, Providence, R. I.

Henry Cave, president Cave Welding & Manufacturing Company, will hereafter be directly associated with the Davis-Bournonville Company in active charge of its research department at the general office in Jersey City, N. J.

B. A. Clements has been elected vice-president of the Rome Merchant Iron Mills, Rome, New York, a position for which he is eminently fitted by his personality, training and experience in the railway field, and his knowledge of the metallurgy of iron. Mr. Clements was born in Indianapolis, Ind., on October 3, 1877, and was educated in the public schools of Centralia, Ill. He entered the service of the Illinois Central Railroad as a messenger boy and after 1891 served successively as clerk and stenographer to the roadmaster and superintendent of the Chicago and St. Louis division until July, 1898, when he became secretary to the general passenger agent of the Michigan Central Railroad at Chicago. During the next year he returned to the Illinois Central as secretary to the general superintendent of transportation and from 1902 to 1904 was chief clerk to the general manager. From 1906 to 1909 Mr. Clements was chief clerk to the vice-president in charge of operation, when he was appointed general agent, operating department, reporting to the president. Mr. Clements left the Illinois Central in 1910 to accept the position as the Western representative of Worth Bros. in the railway field, with headquarters at Chicago, a position which he held when elected to the new position announced above. Mr. Clements' headquarters will be at 30 Church street, New York.

B. A. Clements

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.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, *461 Eighth avenue, New York city.*

Introduction

The average journeyman boiler maker is usually able to construct or repair a *stationary, marine* or *locomotive* boiler without knowing what the requirements are to insure safety. There are certain laws or principles underlying the important science of boiler construction that must be understood and intelligently applied in order to design, construct and repair properly the different types of boilers. Certain principles are applicable to some types of boilers and entirely unsuited for other types. In general the following subjects should be understood by competent boiler makers, viz.:

Practical Mathematics, Properties of Metals, Strength of Materials, Mechanics, Boiler Design, Construction and *Inspection* and *Boiler Repairing.*

It is not expected that the apprentice or boiler maker can remember all that he studies on such subjects, as that condition is unnatural with all who are good students. The study habit, however, if rightly directed will develop a person to be competent to handle questions entirely out of the reach of the undeveloped mind. It is this kind of development that enables mechanical, electrical and civil engineers to handle the valuable rules, formulas, tables of reference and other data found in handbooks and apply such information correctly to engineering work. It may be said that the purpose of technical colleges is to prepare men to be able to produce from text and hand books practical methods and solutions applicable to engineering problems that arise in the engineering world. Mechanics and arts are changing in practice from day to day, but the underlying principles remain the same.

To present new ideas and changes in boiler practice, magazines such as THE BOILER MAKER keep in touch with the prevailing conditions and present information direct from the men who are factors in this readjustment of conditions. Years ago the journeyman boiler maker was in a class by himself. What he knew was a vital secret to him, for he considered that if someone else knew his trade as well as he did it would work directly against his best interests. Fortunately time usually changes such conditions for the better, and so to-day we have schools and periodicals championing the cause of anyone who desires to make a success of his best efforts.

The aim of this department is to give complete and direct information on subjects in which the readers are interested. However, bear in mind that there always arise in giving directions for doing certain classes of work, the answering of questions involving mathematics, the laying out of a boiler part or sheet metal job, differences of opinion as to what is considered best practice.

Apprentice boiler makers are advised that this department is for them as well as the older mechanics. We especially desire to hear of the difficulties which they encounter in the study of any branch of the boiler making industry.

Calculating Strength of Lap Seams

Q.—How is the strength of a single-riveted lap joint, as shown on accompanying sketch, figured? E. C.

A.—The strength of seams depends upon their arrangement on the boiler, the thickness of boiler plate, pitch arrangement and size of rivets, number of rows of rivets and whether the seams are *butt* or *lap* joints. The physical properties of boiler plate and rivets have an important bearing in calculating the strength of seams commonly termed *efficiency of joint.* The United States Government rules specify that the *tensile strength* for *iron plate* shall not be less than 45,000 pounds per square inch and 50,000 pounds per square inch for *steel plate.* The efficiency of the longitudinal or horizontal joint in Fig. 1

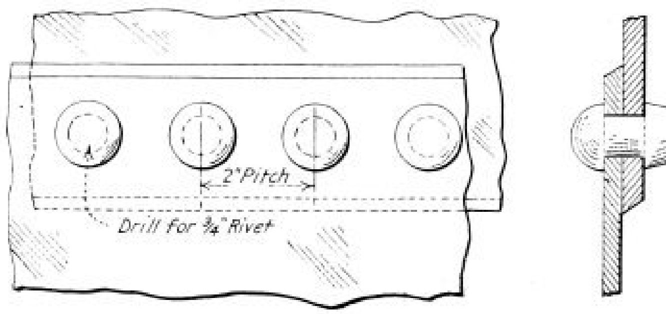


Fig. 1.—Single-Riveted Lap Joint

is found by first determining the strength of the net section of plate between the rivets, then find the strength of the rivets which are shown in single shear.

Efficiency of net section of plate equals:

$$\frac{2 - \frac{3}{4}}{2} = 62\frac{1}{2} \text{ percent.}$$

Strength of rivets, as compared to strength of solid plate when the shearing resistance of rivets equals 42,000 pounds per square inch and tensile strength of plate equals 60,000 pounds per square inch, is determined as follows:

$$\frac{\frac{3}{4} \times .7854 \times 42{,}000}{60{,}000 \times .375 \times 2} = 55 \text{ percent.}$$

In calculating the strength of joints, the practice is to work from one unit of length as the pitch. The efficiency of the unit is the joint efficiency. The strength of rivets is figured from the number in one unit of length or pitch. In this case, one rivet is in a 2-inch pitch. Comparing the plate efficiency of 62½ percent with the rivet efficiency of 55 percent shows that the rivet section of the joint is the weakest. The allowable working pressure on the boiler is always figured from the lowest efficiency or its weakest part.

Construction of a Transition Object

Q.—Will you kindly show how to develop the pattern of a transition piece, which tapers from a circular opening at the top to a rectangular opening at the bottom, as shown in the sketch enclosed herewith? F. L.

A.—The method of development involves the triangulation system, which consists in dividing the views of the object into a number of triangular sections, and then to find the true length of the sides of these triangles that are not shown in their true length in either of the views, plan or elevation.

Construction of Fig. 2

First lay off the horizontal axis *am* in the plan, about it draw the circular outline representing the upper base, then in its proper position draw the rectangular opening. Next

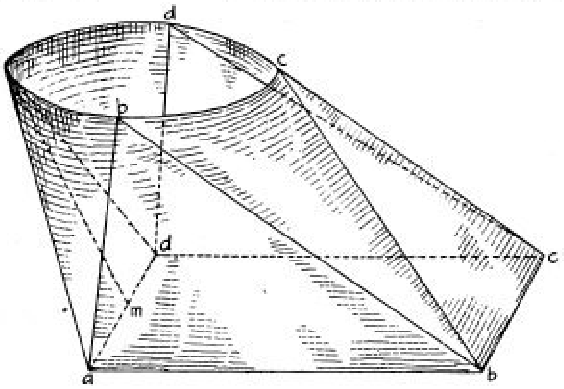


Fig. 1.—Sketch of Connection Piece

lay off an elevation to the required dimensions, indicating the relative positions of the upper base *ac* and lower base *ab*. The next step is to divide the views into a series of triangles as follows: Step off on the arc *abc* of the plan a number of points spaced equally apart as 1-2-3-*b*-4-5-6. Connect the points *a*-1-2-3 and *b* to *a'* with radial lines, and points *b*-4-5-6 and *c* with points *b'*.

It will be noted that there are four triangular flat sides on the object shown in the perspective, and that between them run circular surfaces from the top to a V at the bottom. After the plan and elevation are completed, proceed to find the true lengths of the lines *a-a'*, *a'-1'*, *a-2'*, *a-3'*, *a-b*, etc., as follows: To the right of elevation is shown a right angle triangle *xb2* its vertical height or leg *bx* is equal to the altitude of the transition piece, and as the bases of the object are parallel, this height is the same for all of the triangles assumed to be on its surface. Upon the base *b2* lay off the distances between *a-a'*, 1-*a'*, 2-*a'* 3-*a'*, *b-a'*, etc., of the plan. Connect the bases for the triangles with point *x*, thus establishing the true lengths. These are to be used in developing the pattern in Fig. 3.

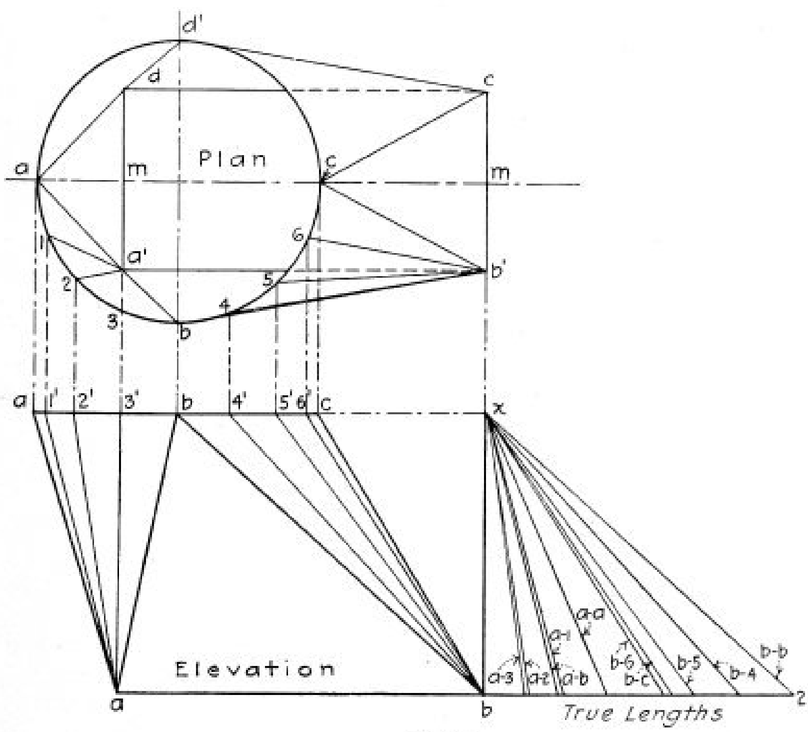


Fig. 2.

Layout of Pattern

In this case the seam line is brought to lie in the plane of line *am* as illustrated in Fig. 1. It may be placed any desired place. Draw *am*, Fig. 3, equal to *aa* of the elevation, Fig. 2. From point *m* set off a distance equal to *m-a'* of the plan, then with the dividers or trammels set to distance *aa* of true lengths, and with *a* at the top of the pattern as a center, draw an arc to intersect at *a''*. Assemble the true lengths to correspond with their positions shown in Fig. 2, until the pattern is completed. The arc lengths in pattern should equal arc lengths of circle plan view; *ab* at bottom of pattern is equal in length to bottom edge *ab*, Fig. 2; *bm* of pattern equals *b'm*, Fig. 2.

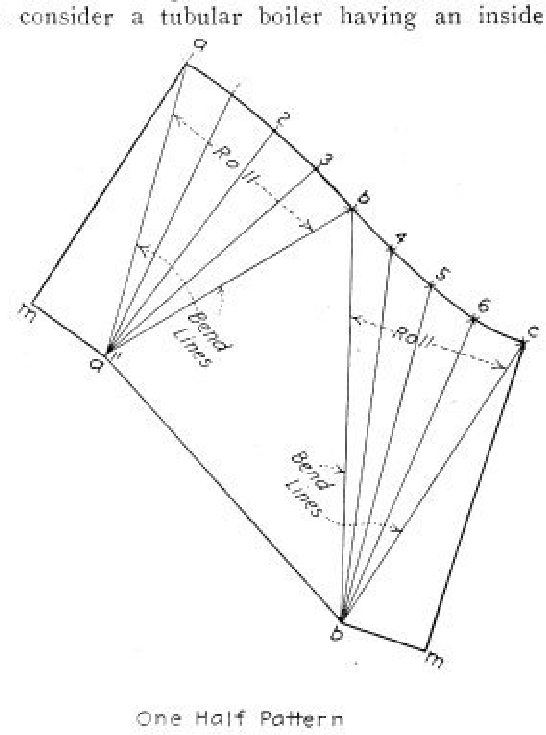


Fig. 3.

Thin Spot on a Boiler

Q.—What is the usual practice followed, when a thin spot has been located in a boiler? A. R.

A.—First reduce the pressure, providing the defective part is in a fair condition and will warrant the operation of the boiler after the pressure is reduced. Otherwise, the boiler should be taken out of service at once and proper repairs made.

Allowable Working Pressure

Q.—Please explain what is meant by the allowable working pressure of a boiler? H. S. J.

A.—The allowable pressure is the safe working steam pressure at which the boiler may be safely operated.

As an example, showing how the allowable pressure is determined, consider a tubular boiler having an inside diameter of 60 inches, plate thickness equal to ½ inch, tensile strength of plate equals 60,000 pounds per square inch, efficiency of longitudinal joint equals 80 percent and factor of safety is 5.

Then according to the following:

$$\frac{\text{Tensile strength} \times \text{efficiency of joint} \times 2 \text{ thickness of plate}}{\text{Inside diameter of boiler} \times \text{factor of safety}} =$$

allowable pressure.

This equation is often written or expressed in this form:

$$\frac{T \times E \times 2T}{D \times F} = P.$$

When P = pressure
T = tensile strength of plate in pounds per square inch.
E = lowest efficiency of joint.
D = inside diameter of boiler.
F = factor of safety.
$2T$ = two thickness of plate in inches.

Using the values in the example given, we have:

$$\frac{60{,}000 \times .80 \times 1}{60 \times 5} = 160 \text{ pounds safe working pressure.}$$

Elastic Limit and Yield Point

Q.—Is there any difference between the elastic limit and yield point in testing a specimen by tension? M. T. L.

A.—Properly the elastic limit is the point where the specimen *begins* to distort at a greater rate than the load increases—i. e., when the ratio of stress to strain departs from a constant value. The yield point is commonly considered as the point at which the weighing beam of the testing machine rather abruptly drops and the specimen

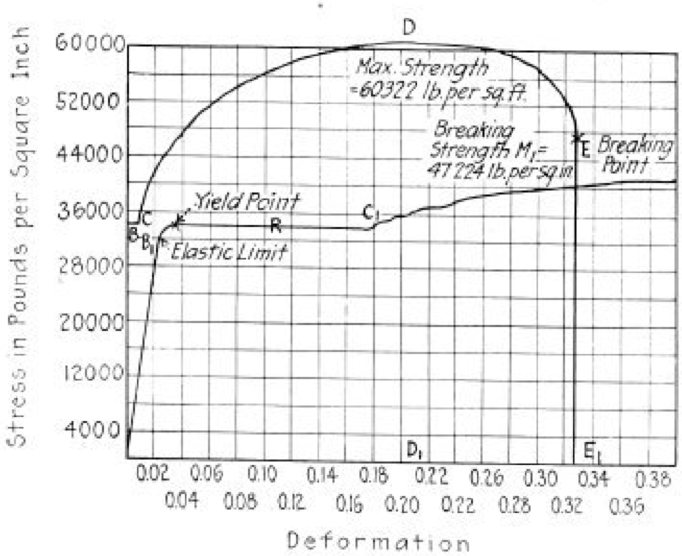


Diagram Showing Elastic Limit and Yield Point as Determined by Test

elongates appreciably at constant load. In some materials the points are very close together, but usually the yield point is a bit higher than the elastic limit (see diagram). Curve $B\ C\ D$ shows entire test, B-C being the yield point. Curve B_1-C_1 is the early part of the same curve plotted to a much larger horizontal scale, and shows the difference between the elastic limit at B_1 and the yield point much more clearly.

Outside or Inside Patches

Q.—Should a patch be placed on the outside or inside of a boiler shell? O. R.

A.—Boiler patches directly in contact with the furnace fire should be placed on the outside. It is the practice to remove the damaged part of the sheet first and afterward apply the patch, as this method of construction provides the patch with the cooling effects of the water. When patches are applied to the outside shell without removing the affected plate, such patches soon burn off, thereby requiring additional time and expense in making new repairs. If the patch is placed on the inside of the shell, or firebox, the edges or lap of the opening will soon burn away, thus requiring a new and larger patch.

Crown Sheet Design

Q.—I notice that the crown sheets of locomotive boilers are usually made higher at the firebox flue sheet than at the firebox door sheet, why is this done? L. H. K.

A.—This design in firebox construction was made principally to gain more heating surface in the firebox, and to permit of the installation of one or more rows of tubes, thus materially increasing the heating surface of boilers so constructed.

Rivet Holes

Q.—Where I am employed, the rivet holes are punched smaller than the size of rivet and afterwards reamed out. Why is this done? I. B. B.

A.—In punching plate, the metal is distorted and small cracks extend into the plate surrounding the rivet holes. To insure good work, the holes should be drilled; or it is good practice to punch them 1/4 inch under the size of rivet and afterward ream them out in place, which practically removes the damage due to punching.

Chunks of Wisdom

Frequent cleaning of boiler tubes is of great value from the point of economy, as is illustrated by the fact that 1/16 inch of soot offers the same resistance to heat as a tube 4 inches thick.

There are two knots that all boiler makers ought to learn to tie, one is a bowline and the other is a half hitch. If you do not know these, get some one teach you how to tie the one and "throw" the other, as they say.

Sometimes an engine fitted with an automatic governor will kick up for no apparent cause and an adjustment of weight and springs is undertaken. Before this is done find out whether or not the boiler pressure is at its normal, as either too low or too high steam pressure will cause governor troubles.

The Empty Growler

The scene was in a boiler shop, a girl was working there,
Her hands were rough and calloused, but her face was sweet and fair.
She pounded rivets all day long and she was very dry;
"I wish I had a good long drink," the foreman heard her sigh.
The foreman rushed the growler, and he held it to his lips,
And drained the bucket empty even to the last few sips.
He passed the bucket to the girl, "Here, have a drink," he cried,
And, when the girl looked in the can, these words she then replied:
"You think that you are smart, you brute, you think that you are slick,
But that is what I call a nasty, low-down, ornery trick;
And no guy ain't no gentleman, and no guy ain't no Earl,
Who'd hand an empty growler to a thirsty working girl."

—*Luke McLuke in Cincinnati Enquirer.*

A boiler maker apprentice confesses to the *Railway Mechanical Engineer* that the more a foreman encourages an apprentice the more willing is the apprentice to work and strive harder to succeed. One word of encouragement is worth more than all the scolding.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

How to Locate a Leak in a Steam Boiler

In looking over the article under the above title written by Mr. R. W. Robinson, of Philadelphia, and published in the January issue, I presume the article was made up in a conscientious way, yet there are several points about it which are not made clear.

I presume from what he says that the boiler from which he took the steam was carrying 125 pounds. He also states that the "T" used was a 3-inch T. The cut shows two layers of brick on top of the improvised screw jack. What gets me is how he got two layers of brick to hold down this 3-inch T under a pressure of 125 pounds to the square inch?

Another point not made clear is—do I understand Mr. Robinson that he injected a steam jet under the dome flange and that it followed a course down the saddle connection and up the side of the dome to point "A," where he claims a jet of steam shot across the dome? I wish Mr. Robinson would make this more clear, as it would take more than himself and his machinist to make me believe that this was a successful method of repair and that two layers of brick would hold down a T with an exposed area of something like 7.068 square inches, with a load of 125 pounds to the square inch.

Milwaukee, Wis. N. Roberts.

Staying Circular Firebox

I am always very much interested in the articles in The Boiler Maker on boiler construction, but I should like to correct your correspondent's theory as set out in the February number in answer to a query: "Give the rule to find the number and size of staybolts required for a circular firebox 5/16 inch thick, 36 inches inside diameter and 36 inches high, to carry 125 pounds pressure."

Your correspondent should have added to his remarks on the formula

$$\frac{60{,}000\, t^2}{(L+1)\, d} = P$$

"provided that P does not exceed that found by the following formula:

$$\frac{8{,}100 \times t}{d} = P.$$

According to the British Board of Trade rules, ¾-inch stays, 4⅞-inch centers, would have given ample strength to the firebox—in fact, they allow of a working pressure of 192 pounds per square inch.

The following rules give ample scantlings for the working pressure of vertical fireboxes made of iron:

Formula A $$\text{W. P.} = \frac{C \times T^2}{(L+1)\, D}$$

provided that working pressure does not exceed

Formula B $$\text{W. P.} = \frac{8{,}100 \times T}{D}$$

where C = constant varying from 81,000 for vertical seams welded to 58,500 for vertical lap seams single riveted, not beveled, and holes drilled (punched holes should not be allowed).

T = thickness of plate in inches.
L = length or height of firebox in feet.
D = outside diameter in inches.

If Formula B does not give the required pressure, the firebox should be stayed as for a flat surface.

If Formula B gives the required pressure, but Formula A does not, a row or rows of screwed stays should be fitted around the firebox circumferentially. These stays may be from ¾ to 1 inch in diameter and pitched 7 inches apart. They should be screwed into the shell and firebox plates and their ends riveted over to form good heads. These screwed stays would not serve the same purpose as stays in flat surfaces, but would act as a stiffener to the firebox, virtually reducing its height, in the same way as an Adamson ring acts in flanged furnaces commonly used in Cornish and Lancashire and Cornish tubular boilers.

Example.—Firebox 30 inches diameter, 3 feet high, ⅜ inch iron plate, vertical seams, single riveted lap joints, not beveled, and holes drilled. Working pressure desired, 100 pounds.

Formula B $$\frac{8{,}100 \times \frac{3}{8}}{30} = 101 \text{ pounds W. P.}$$

Formula A $$\frac{58{,}500 \times \left(\frac{3}{8}\right)^2}{(3+1)\, 30} = 68 \text{ pounds W. P.}$$

Therefore one row of screwed stays should be fitted around the firebox at the middle of its length. Length in the formula is then

$$1\tfrac{1}{2} \times \text{W. P.} = \frac{58{,}500 \times \left(\frac{3}{8}\right)^2}{(1\tfrac{1}{2}+1)\, 30} = 109 \text{ pounds.}$$

Pressure is limited to 101 pounds by Formula B.

There is no necessity to fit a lot of screwed stays equally spaced all over the firebox in this case. My experience is that this firebox would be quite safe, and I would be glad to read the views of any other of your readers on the proper way of strengthening fireboxes.

Wellington, New Zealand. Firebox.

Which is the Best Boiler Maker?

In speaking of Jimmie O'Connors and George Wright, in the "Talks to Young Boiler Makers," in the December issue, if Jimmie O'Connors only desires to do boiler making and patchwork, and not gain a knowledge of the strength of boiler work, George Wright should have the advantage or be the choice in a case of a lay-off, although there is always a job open for a boiler maker with such a recommendation as the writer gave Jimmie O'Connors, for boiler shops must have someone to do the work that can be depended on for a good job.

As for George Wright not doing as neat a job, and perhaps not as rapidly, he may do the work according to what it has to hold. If he should be riveting or calking he probably does the work according to the pressure at which it is to be tested. If, as you say, he knows the strength of seams and plates he certainly knows it is not necessary to calk a rivet with as much pains on a tank or low- pressure work as he would on a Class A boiler, which is tested under strong pressure—knowing this means a saving of time.

If a boiler maker goes to the trouble to learn the strength of plates and seams he is in a condition to let engineers know whether they are running their boilers under safe pressure or not. Or, he can go and erect a tank or stack, and if the people where the work is going up should ask him how much the tank holds or how much pressure there is on certain seams, or how much shearing strain there is on rivets on a smokestack ring, he is able to give an approximate idea of what is asked. By knowing this, and as well understanding blue prints, he is in a condition to hold a job higher than just a plain boiler maker who only knows how to do the work. For these reasons he ought to be the choice in a case of a lay-off, as it would also encourage him in studying.

G. LACEY.

The Gage Glass Story

That answers to questions written viva voce under examination do not represent knowledge reduced to practice is illustrated by the following incident:

It is, of course, common knowledge that most city fire brigades incur considerable expense in the training of their men; a fact not so well known is that instruction, both theoretical and practical, in the management of the plant under their care is also given. All the necessary elementary facts are imparted in class and practical demonstrations of actual gear and instructional models are a part of the course. Promotion depends largely upon the results of such tuition and the men are keen to get an inside as well as an outside knowledge of their plant. Not all fire brigade work consists in spit and polish, nor does the wearing of brass buttons constitute a capable fireman.

The class had been given a lecture on boilers and the practical demonstration consisted of a boiler under steam and another opened out for inspection; also the class were rather raw recruits.

The instructor, holding a spanner in his left hand, with his right upon the opened boiler, put question after question to his pupils, receiving satisfactory replies. Coming at length to the water gage, he put the question individually as to what each would do in the event of the glass breaking. The replies varied considerably. The class had received no instruction on this point in the lecture. Letting the hand holding the spanner travel quickly backwards toward the gage glass of the boiler under steam, the instructor (who had carefully chosen his position with regard to the contingency, and without shifting his eyes from his pupils) broke the glass.

The class bolted for their lives. In relating the incident to the writer the elderly instructor added with a smile, "Nothing like practical example to enforce an argument."

Before we smile at the matter, it is perhaps as well to remember that the budding firemen were not engineers, had never in their lives heard the report of such an occurrence. Also we may all freely admit that our own first case of a broken glass was unnerving and shook us up more or less, although we realized what had happened and knew the probable effects and the remedy.

Any member of the black squad with sea experience has some shame in the remembrance of a lonely night watch as a raw junior when his first glass went. His frantic struggles to shut off the steam-end first, scalding his hands with the emerging water from the bottom cock. His final triumph by shutting off the water-end first, and how with shaking fingers he replaced the broken by a sound glass. Cases have been known where a profane senior has been called from his slumbers by a frightened junior, but none confess afterward to this.

It is all in a day's march, but the fireman incident conjures up past experience long forgotten, and in place of a smile we temper our mirth with the pity born of comprehension and knowledge.

Anyhow it is safe to bet that the class did not forget the incident in a hurry. Instruction of similar type might be more general, it impresses the mind as no amount of usual instruction is very likely to do.

A. L. HAAS.

Dangers Due to the Construction of Locomotive Boilers

Referring to my letter on page 124 of your April issue which refers to the danger of the locomotive boiler by its construction, in which I called attention to the danger of the release of flexible stays in locomotive fireboxes by unequal tension, this, I stated, might be caused by the inertia in a locomotive drawing a heavy train coming to a sudden stop, as was the case at Rahway, N. J. The same thing applies to locomotives that may be in a collision. The impact every time will, in my opinion, from a careful study which I have applied to the locomotive boiler during the last eight years cause these movable stays to let go. The last New Haven wreck, and then another, goes to show that when these movable stays are used what I have stated is practically correct.

Quoting from the Philadelphia *Inquirer*: "In the first few minutes after the impact and the compressing and crushing, while the startled and shocked passengers were too bewildered to start the work of relief, the boiler of the Gilt Edge engine exploded with a terrific report, scattering fire and débris in all directions. In this explosion it is believed the maimed and pinioned passengers were further mangled and the death list was further increased. By the time the first passengers, who had been hurt, were out of the cars of the two trains, the wreckage was burning. There were no means at hand to fight the flames."

There is no doubt in my mind that if this boiler had been constructed with a flexible firebox with *fixed stays* there would have been no explosion of the boiler firebox, which, as you will see from the quotation, was caused by the contents.

It is high time that some better judgment is used in the construction of our large locomotive boilers. The only thing, I must confess, is the fact that we do not have more accidents. From an engineering standpoint, I consider the locomotive boiler, as built, a menace to public safety on account of the use of these movable stays, its size and the pressure at which it is worked.

Media, Pa. WILLIAM H. WOOD,
Mechanical and Constructing Engineer.

The Brick Arch

How often in bygone days has the brick arch been damned by our old-time boiler makers! I do not believe there were many boiler makers in "ye olden times" that believed or thought that the brick arch was beneficial to the engine. The bricks were formerly large and heavy and clumsy to handle, and oftentimes required the strength of an ox to place them properly in the firebox. And after they were in place it was necessary to plaster the joints and cracks or seams with soft fire clay, which added additional horror to the job.

I will state that the working of a set of flues over a hot brick arch is far from pleasant, and on account of the old-style arch brick being heavy and hard to remove after being heated, they were not molested unless it was absolutely necessary to do so. Therefore the boiler maker would oftentimes throw in a board upon the arch to sit upon while he calked the flues. And what an awful calking some of the flues received, especially some of the lower flues next to the arch, as it is impossible to hold the tool at the proper angle upon the bead, on account of being too close to the arch. This fact, however, in addition to the heat of the arch, often produced inferior workmanship, which was detrimental to the flues and flue sheet.

Whenever it was absolutely necessary to remove an arch the bricks were knocked down and broken more often than they were taken down intact. I would attribute this cause to the fact that the bricks were heavy and thick and would hold the heat for a long time, thereby making them hard to handle. In the earlier days the quickest way was the best, that is, from the boiler maker's point of view, so he got a sledge and worked accordingly.

However, this method of removing brick arches was very costly for the railroad company, so very much so that several large companies discontinued the use of the arch for this reason alone. Arches were often destroyed that could have been used time and time again. However, I am pleased to note that the railroads are again responding to the use of the arch, which, in my opinion, is indispensable with the construction of a first-class engine.

I am also of the opinion that the arch is a large factor towards proper combustion. It also eliminates the stopping up of flues to a great extent, it offers protection to our flue sheets and flues by keeping cold air away from same every time the firebox door is opened. It should also be considered along the lines of fuel economy. It also produces increased circulation, and good circulation produces a good steaming engine. It gives greater length of life to a set of flues. I may be safe in stating that an engine with a brick arch will not produce as much black smoke as an engine without a brick arch. Years ago we experienced trouble with brick arches falling down while engines were out on the road.

This defect, however, has been eliminated by the use of the arch tube. When the railroads first began to use arch tubes, and for some time afterwards, they experienced a great deal of trouble, due to accidents on account of burst tubes. In most cases these tubes were blistered or burnt, which was caused by the arch tubes becoming dirty on the inside. This dirt was a collection of foreign elements that would adhere to the inside of the tube, and, as the tube is located in such a manner as to come in contact with most of the intense heat in the firebox, it would readily cause the tube to blister, bag or thin out in these places, which would in time let loose and cause trouble. These tubes have also been known to pull out of the hole. This, however, has been eliminated by belling or beading the tube ends on the inside of the inner sheets.

And, I am sorry to say, that in those days this bagging was often times layed on the brick arch. I do not know where some of these old timers got the idea from, but they used to state that this blistering or bagging always occurred directly under the arch brick, and that the arch brick laying on the tubes caused the tubes to stop up inside or become baked with mud or scale.

To my mind this is all a myth. The real trouble was that they didn't keep the tubes clean. With our present-day practice we have pneumatic tube cleaners and we use them often, consequently we have no trouble with our arch tubes or brick arches. We are using the Security Sectional Arches and are getting good results. They are light to handle, durable and economical. They cool quickly, are interchangeable, and access to the flue sheet is readily gained at any and all points by simply turning the bricks back upon the arch out of your way.

I have taken particular notice in regard to the flues stopping up on engines carrying a brick arch and one that does not, and especially on superheated engines on our road. I find that the engine that carries the brick arch very seldom has flues stopped up, and consequently the boiler maker helper in the round house does not have to blow out flues only on a regular washout, which is about once in every five days. I also have noted that the time consumed on these occasions averages about fifteen minutes per engine. On the other hand, practically the same class engine which does not carry a brick arch gives us considerable trouble by stopping up, and has to be cleaned out each trip in the round house.

When I say cleaned out, I do not mean merely blown out with air, because air would not remove the accumulation that collects on the superheater units in the superheater flues. The boiler maker helper has to take a steel bar and a hammer to remove this collection. I have seen these large tubes completely stopped up with this foreign matter, and I have also seen the helper spend one hour getting the tubes clean. Possibly these tubes could be cleaned out in one-half the time if the engine was cold, but owing to the intensive heat in the firebox it is impossible to remain in one for any length of time, consequently the time consumed is about double. Therefore the expense incurred in this one item alone would more than pay for an arch in a very short time, and would also add increased capacity fuel economy and reduce the smoke. The flues and firebox would be protected, resulting in longer life and more flue mileage per engine.

I am also of the opinion that the firebrick used in our locomotive brick arches must be manufactured by expert chemists to withstand the intense heat of different kinds of fuel under many varying conditions. However, the best is the cheapest when considering the benefits derived from same in one of our modern locomotive fireboxes.

Oskaloosa, Iowa. GEO. L. PRICE.

Journeymen and Trade Journals

If this be an age of practical work, it is also a time when the everyday workman is studying the theory behind his profession, or practice, as never before.

The accountant whose ambition will not permit him to remain a mere adding machine is tracing the evolution of his art from the clay tablets of the Assyrians up; the man engaged in railway traffic spends his leisure learning the "why" of transportation from the primordial pack mule down. Boiler makers and others engaged in the art of forming and constructing materials for use in the boiler shop are giving their earnest thought to all the latest practices, and becoming proficient in the knowledge of the varied "additional" arts that are now considered a part of the boiler maker's profession, so that in order to be abreast of the times in your particular vocation it is necessary that you follow the latest expositions of thought and practice.

Private experiences, discoveries, new processes, expert opinions, are all tabulated and circulated, and the mechanic or professional man of to-day who does not study his trade journal becomes a derelict in the Saragossa Sea of fogeyism, develops dryrot and founders.

This is an age of work. Mere work commands two dollars a day. The triple entente of Think, Learn and Work commands from one thousand to fifty thousand dollars a year. Thus we have many, many two-dollar workmen.

No allusion is made herein to the masters, managers or superintendents of the commercial fields, but these remarks are written by a journeyman—if you will—for like journeymen.

I fear that too many of the crafts measure their work by the rule of thumb, and level it with levels filled with prejudice instead of spirit, just because the majority of us do not read our trade journals carefully, study out the problems that are continually being presented, and follow up the pro and con on individual subjects as they arise.

The thought, work and life of the trades throughout the world are willing to come to our doors, weekly or monthly, but we do not invite them. We are as wise in our profession as the shoemaker who, having learned of his grandfather to make shoes by hand, tried to compete with a modern factory.

The slogan of our time is efficiency. We have been taught, and are solely responsible for maintaining and transmitting the efficiency of our different crafts, but do we realize the responsibility we bear? Are we studying to be efficient?

Shall we only scratch the ground with a crooked stick, as did the men of our father's time, or shall we plough the fields, twelve furrows at once, with a traction engine?

Fellow craftsmen, let us study our trade journals. Let us resolve to rise above the two-dollar class, remembering there is no excuse for inefficiency in this world.

JOURNEYMAN.

Which Type of Boiler is Safest for a Warship?

Before trying to answer J. S. Grant, I must ask if he is a relative of U. S. Grant. I wonder why it is that Grants are always thinking about war and warships and boilers for warships. I, as a poor meek American, had "never thought of that." as Goldberg the cartoonist is wont to say. Nothing but efficiency and economy have been hammered into me, and I am so full of it that you can hardly hammer anything else in. Still, I get Mr. Grant's point and it is surely worthy of discussion.

The way it looks to me (and I know very little about marine engineering) the Scot would "win in a walk" under forced running for several days, with nothing to use but sea water and no chance to clean the boilers. It is my impression from what I have read on the subject that Mr. Grant is right, and that under extreme punishment the Scotch boiler will be found "there with the goods." The point is interesting—so interesting and important that I would like to hear from some real naval engineers on the subject. Maybe Mr. Grant is such an engineer and is just "kidding us." If you know all about it, Mr. Grant, please tell us.

I have in my files a report of our valiant fleet which once steamed around the world. We all remember the occasion. Not one was sunk. This report shows that Babcock & Wilcox boilers burned the least coal per horsepower while running from San Francisco to Manila, that Scotch boilers were a close second; then came Niclausse boilers, and lastly Thornycroft. But, as Mr. Grant will doubtless point out, these battleships weren't chased across the Pacific, so the question still stands unanswered.

Personally, I would rather see the United States have inefficient but uncatchable and unsinkable boats than to have efficient boilers for pleasure cruises that won't "stand the racket" when up against an enemy. N.

Hot Work, the Upkeep of Flues in the Round House and Some Things That No Boiler Maker Can Compete Against

Hot work in the roundhouse is a very disagreeable job, and most boiler makers detest this kind of work. Conditions, as a general rule, are not as they should be for the boiler maker, and with a little improvement better results should be obtained. In this article I refer principally to oil-burning locomotives, but the same will apply to coal or wood burners.

Locomotive boilers are subjected to more or less abuse while on the road and should receive every care and attention on arrival at the roundhouse. The day of engine failures, caused from leaking fireboxes and flues, is fast drawing to a close. If the engines are given the proper care and attention, there should be no excuse for engine failures from this source.

Many engine failures are due to poor handling by the roundhouse force. The hostler, fire builders and machinist foreman care very little about leaky fireboxes as long as they can get their work done. The boiler maker foreman, or boiler maker where there is no boiler foreman, should have absolute supervision over all boiler work for reasons given below.

Eliminate the authority of the roundhouse machinist foreman who has supervision over the boiler makers, and who claims that it does no harm to the firebox or flues to bring the engine into the house, put out the fire, blow off the steam through the relief valves, and let the water out to grind in a gage cock or boiler check, who then fills the boiler with cold water, starts the fire, and has the engine ready for service within a couple of hours. He is the man who thinks that the only boiler maker on the job is the little man who will jump into a hot firebox, with steam on, calk a set of flues, and have the engine ready for him in about thirty minutes. How can any boiler maker prevent engine failures with a foreman like this?

The machinist foreman has been the cause of many a good boiler maker losing his job. I knew a machinist foreman that discharged a good boiler maker for refusing to calk a crack 12 inches long that developed in the front course of the barrel of a boiler just below the butt strap of a straight seam. The barrel was ½-inch steel, lap joint with double row of rivets, offset butt strap inside. The next morning this seam failed, but by chance nobody was injured.

I knew another machinist foreman that turned a boiler maker in for refusing to plug a crack in the barrel of a boiler. He then got a machinist to do the job, and they commented on what a fine job they had done, and, best of all, they got away with it.

Not long ago, while prossering flues in the firebox, I burst a flue. I was using a six-pound flogging hammer to drive in the prosser pin. When I requested the machinist foreman to take this engine out of service he became very indignant, rushed out of the office, climbed into the firebox, examined the flue, brought out the flogging hammer and weighed it. He then insisted that I plug the flue, against my protest. I plugged the flue, the engine made two trips and died on a limited passenger train the third trip, causing a delay of one hour and fifty minutes, not saying anything about delays to other trains. The boiler maker got the blame as usual.

Is it any wonder that there are engine failures under these conditions?

The above are absolute facts and show how absurd it is to give such men supervision over the boiler maker and boiler work. Weighing the flogging hammer is about as fine a bonehead stunt as I have ever seen or heard of, as if a boiler maker could not strike a light or heavy blow with a six-pound hammer!

The boiler maker foreman in the roundhouse should be a good, practical boiler maker, with a number of years' experience at this kind of work. The engines should be reasonably cool, so that a man can work in them and do a good job without sweating himself nearly to death. If the engines are given the proper attention when being washed out, there will be less hot work to do.

Keep the best boiler makers in the roundhouse and eliminate the second and third class man, as a poor man in the roundhouse can do more damage in one week than several good men can make good in a month. Using the apprentice in the roundhouse is false economy, and he should only work there in the last year of his apprenticeship. The road to economy and success nowadays is in using good material, doing good work, and having reliable men to do it.

The life of the flues depends upon the material in them, how they are put in to start with, and the care that they receive from the boiler makers doing running repairs. The long stroke air hammer has ruined more flues, broken more bridges, bellied more flue sheets and cracked more flanges than any other tool, and should be abolished on hot work. The standard prosser should be used at all times, and should be long enough to set the inside bead up tight against the inside of the flue sheet. This is very important, as the inside bead acts as a brace to hold the flue tight in the sheet when the flue is expanding from the heat. Prosser the flue tight in the hole, and that is all that can be done with the prossers.

Some men claim that the smooth prosser, with the inside bead ground off, is the best. For a test take two engines with flues about the same age, running under the same conditions; use the smooth prosser on one engine and the standard prosser on the other. If the flues are giving any trouble, it will not take long to find out what prosser to use.

The flue rollers should never be used to work flues within the firebox end. They only tighten the flues on the outside edge, bell out the flues and roll them out thin, ruin the coppers, bell out and ruin the holes in the flue sheet, and if used continually will soon shear the heads off. The mandrel pin acts about the same as the rolls, and should never be used to work flues in the roundhouse. When beading the flues, use a tool that fits the bead. I prefer to use the square heel beading tool, as it is almost impossible to cut or scar the flue sheet or to work a burr into the flue hole. Do not calk the life out of the beads. A set of flues with the beads flattened down, collars or rags on the beads, the flue sheet scarred and cut, is plain evidence that some one is not attending to business.

When the fire has burned the life out of the flues and the beads become soft and mushy and will not stay tight when prossered, it is time to take the flues out and avoid engine failures. A few engine failures add considerably to the cost of a set of flues.

Some time ago I made a trip on an oil-burning locomotive over a mountain grade. When we started the flues were perfectly dry. In going 35 miles, up hill and down hill, the fireman lost his fire four times; when we arrived at the terminal, about half of the flues were leaking, and it is a wonder that all of them were not leaking. If this engine had failed on the road, the engineer would have blamed the boiler maker, as usual.

Not long ago we received an engine just out of the back shop, with new flues. All of the flues were prossered on the flue sheet. This engine, after being in service a short time, came in one morning perfectly dry, remained in the house all day, was fired up at night and moved to another track outside the house. The next morning the engine was dead and all but a few flues were leaking. This was caused by abuse from the roundhouse force. But if the flues had been properly prossered and the inside bead set tight up against the inside of flue sheet, this never would have happened, especially with a new set of flues.

If this engine had died at the other terminal, where there was nobody but an engine watchman, it would have meant the calling of a new crew and another engine, the dead-heading of the other crew back, and hauling the other engine back or sending the boiler maker over to calk the flues, costing the company in all about $25, and the boiler maker would have had a hard time explaining to the satisfaction of the master mechanic why this engine failure occurred. THE RAMBLER.

"What Constitutes Proof" and "What Kind of Boilers are the Best?"

The above excerpts are taken from the February issue of THE BOILER MAKER.

Now one might make the abrupt statement and be correct that all types of boilers are good, but some are better than others. Our friend, Mr. N. G. Near, I see from a previous article, is a college graduate—this may account for some of the statements he makes.

Getting back to the above subject, the first thing to consider is what service is the boiler expected to perform—conditions, location and the water to be used are all very essential. The opinions of mechanical men are at great variance when it comes to advising one in the purchase or choice of boiler units. Some put up the argument of having the only safety boiler, others that their boiler is the ideal of efficiency. Some advocate the horizontal baffle and some the vertical baffle. Designers choosing the horizontal baffle claim that at no time they force the gases to descend, while on the other hand we have the vertical baffle inducing the gases to ascend and descend, which has been proven to give higher efficiency and more uniform temperature.

The argument of keeping the gases longer in contact with the tube is a poor one and a detriment to the tube, and would inevitably lead to trouble. A liberal flow of gases is to be advocated at all times.

Sometimes the argument is put up by some builders that their boiler is so arranged that they mechanically assist themselves in keeping clean—provision being made for separating the solids when precipitation takes place and the solids taken care of by frequent blowing down. Whether this is so or not has not been determined.

You will find, Mr. Near, that in various parts of the country various types of boilers are considered the best in that particular locality. The best advice that I know of for the prospective buyer is to buy the best unit in the boiler market to meet the requirements. I will not discuss Mr. Near's paragraph about welding, but I will say that his seamless, rivetless boiler in the near future sounds very much like, "Did you ever see a cowless milk wagon?"

Boilers of all types have all been tested out and all their good points catalogued for commercial purposes, and these data are very elaborate in detail, as outside of patent units we know very nearly what we can expect of any type of boiler on the market at the present time. But as long as we build boilers either by the welding or riveting process, there will always be a scamp job crop up once in a while. For my part I'll take the riveted job.

By the way, I read an article by Mr. Near some time ago and he made the statement that the boiler maker of to-day has no thinking cap. When I read that article I thought of the Irishman who came into a boiler yard and became very much interested in several gangs of boiler makers who were busy finishing a very large boiler of the Scotch marine type. After watching them for some time, Pat approached one of the rivet boys and said, "What is it you're after building?" And the boy, being quick-witted, replied, "A dog house—can't you see." Pat hesitated a moment and in turning to leave made the remark, "I thought so, as I see so many pups around it." Now I do not mean that our friend, Mr. Near, is a pup, but he writes like a junior in the boiler business, and it may be news to him to know that some of the greatest engineering feats in the world have been successfully executed by boiler men. It takes more brain and brawn to make a good boiler maker than any profession I know of, yet I have seen shop conditions that were very poor and offered no encouragement to the young boiler maker who was ambitious. But things, you will find, have radically changed in the last twenty years. A foreman boiler maker was not the best in those days and was looked upon more as a bouncer and "chucker out," especially in the contract shops.

There is another condition which used to exist in large shops, the shop usually being run and controlled by a favored few. They were known as "homesteaders," and if a new man came along and was lucky enough to get a job the chances were that he couldn't raise enough tools to get out and do a good job, as the "homesteaders" usually had everything locked up. That was one thing I never could understand about boiler makers, and I always laid it to the fact that the business was being carried on by the low brow class.

Now if we proceed to the well-arranged shop of to-day you will find a very fine class of well-trained workmen who have studied out triangulation and all the modern methods of laying out, whereas twenty years ago it was all by rule of thumb, and the boiler maker didn't care how he laid out his work and didn't care whether the pitch ran out at 2⅛, 2¼, 8⅞ or anything else. The boiler maker of to-day—that is, 80 percent of them—are all possessed of a good thinking cap, and you will find sometimes that the thinking cap, or brains of a shop, is not under the foreman's lid, but possessed by some boiler maker who has to do it to hold his job. He hasn't got sand enough to get out and get a foreman's position, as his present foreman probably told him he couldn't hold it.

Milwaukee, Wis. N. Roberts.

Dangers of Gas Welding

Since the advent of the modern process of autogenous welding by means of the gas torch, many individuals whose training was conspicuous by its absence saw in the new process the opportunity of an easy living.

The great advantages offered by the process and the small outlay for the plant caused the process to almost fall into disrepute owing to inferior workmanship. Autogenous welding was advertised as a panacea for innumerable ills at a cheap labor cost. "Anyone can operate the plant with slight tuition" was the style of argument used.

In place of taking already trained men like smiths and boiler makers for tuition, the specialists were produced from untrained men in something over a month. Now every type of tool or process has limitations, which are found after repeated failure, and autogenous welding is no exception to the rule.

The skill of a mechanic consists in the avoidance of detail error and in knowledge bought by experience—in his ability to know that a job when done is rightly accomplished. A mechanic might almost be defined as one fully conversant with the limitations of his craft and with the tools and processes incident thereto.

Welding with a blow torch is one instance where a most unsound job can appear superficially perfect. Before the underlying principles of its operation were duly grasped and its limitations understood a deal of poor work was done and there are to-day engineers having been badly sold who are prepared to condemn it root and branch, owing to past experience.

Care and skill are needed to obtain first-class work of any description, and to these must be added conscientious scruples in the case of welding. Good work can be done, is being done, of a type impossible in any other manner; but it is insisted that such work can only be obtained at the hands of a really skilled operator.

The local man in possession of a cheap outfit is apt to get his experience upon the work entrusted to him. Good welders are as rare as good smiths, molders or boiler makers. The first and last of these trades seem instances where brief tuition would make reliable and dependable welders. In fact, in the near future the men in both trades will be expected to handle the blow torch as a regular tool of trade. Tuition in its use is now obtainable and many employers are taking advantage of the fact by having one or more mechanics trained for the purpose.

As a repair tool the gas torch has manifest advantages, while without due regards to its drawbacks no end of trouble may result. One danger in this connection of recent occurrence may be cited.

Various liquids, such as petrol, turpentine, spirits of wine and acetone, and many others inflammable and evaporative are under certain circumstances as dangerous as dynamite. Such fluids, by reason of their searching character and known properties, are scheduled by all transport companies. By reason of their properties such goods are carried in welded packages—in fact, it is nearly impossible to convey them in any other manner. Repairs to such packages are among the casual jobs likely to be locally done. Now a closed vessel subjected to the heat of a gas torch, with only a small residue of such substance inside, can almost wreck a neighborhood.

A steel barrel having contained acetone was sent for repair; the local shop operated upon it in empty condition with the bung in place. The quantity of fluid contained could not have exceeded half a pint, but the end blew out, and the damage caused cost $100 to satisfy claims. The average engineer is not a chemist, but at least a rule should be stringently observed never to operate upon a closed vessel under any circumstances whatever. Fortunately, the operator was not standing in the line of fire, but a fatality was only averted by the position of the operator at the time of explosion.

The need for sound work for pressure purposes needs no emphasis, and the contention is advanced with reason that only a mechanic duly trained to the use of the gas torch is competent to make a satisfactory operator. He at least knows the penalties of failure and is likely to have more regard for and exercise more scruples in the quality of the work turned out. The cost of repair in most instances bears no proportion whatever to the cost of the article dealt with, so that cheap labor or repair work is quite a misguided economy.

There is only one test which can be applied to a weld without that of a destructive character. Ordinary paraffin applied will in most instances, by reason of its searching character, detect unsound work.

London, England. A. L. Haas.

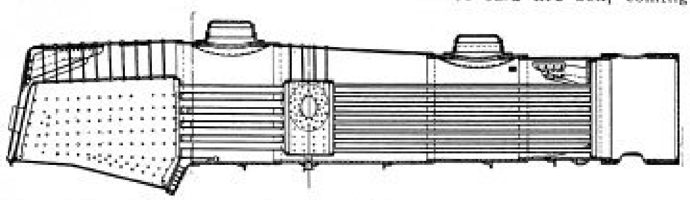
Selected Boiler Patents

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

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

1,164,741. LOCOMOTIVE BOILER. CHARLES MILLER, OF ALBANY, N. Y.

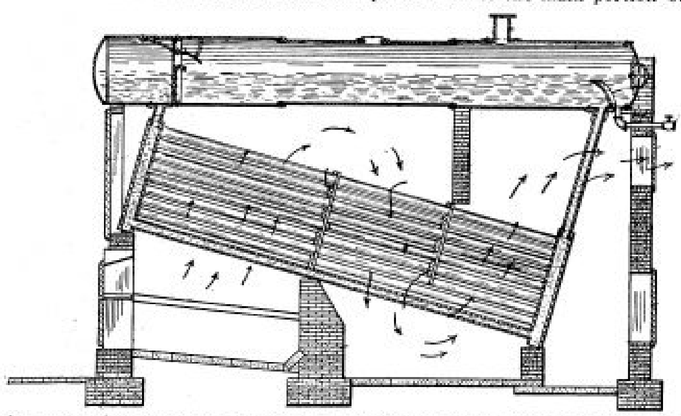
Claim.—In a locomotive boiler; an exterior shell; a fire box; a combustion chamber upon a horizontal plan to said fire box, and at a distance therefrom; tubes leading from said fire box to said combustion chamber; said tubes, welded to the rear end of said fire box, coming



directly in contact with the fire in said fire box without the intervention of the fire bricks; said combustion chamber being fastened to the shell of said boiler by bolts and sleeves; two or more domes on the upper surface of said boiler, substantially as described and for the purposes set forth.

1,165,064. STEAM BOILER. JOHN G. BROMAN, OF CHICAGO, ILL.

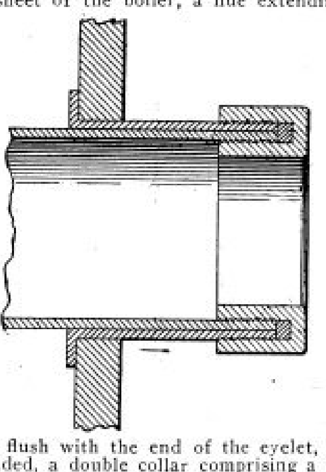
Claim 1.—In a boiler a steam drum, compartment therein for the water from which most of the steam is evolved, a passage permitting flow of steam and water from said compartment into the main portion of



the steam drum, means adapted to deflect the steam during said flow to free the same of entrained water, and a baffle plate adapted to direct the water outwardly from the drum, insuring a constant circulation of the water without turbulence. Ten claims.

1,165,184. DEVICE FOR ATTACHING FLUES TO BOILERS. PHILIP LARONY, OF CHICAGO, ILL.

Claim.—A boiler attaching means comprising an eyelet having a threaded portion extending outside the boiler, said eyelet being upset within the crown sheet of the boiler, a flue extending into said eyelet



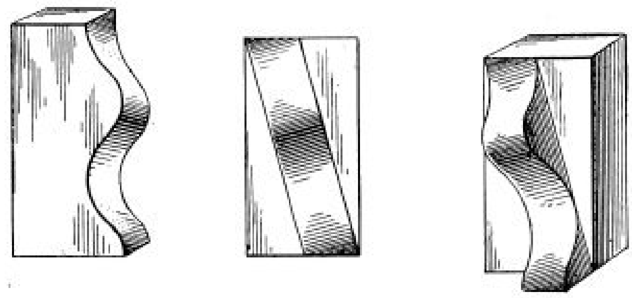
and having its end flush with the end of the eyelet, said flue being interiorly screw threaded, a double collar comprising a crown portion and spaced members forming an annular recess, said spaced members being interiorly screw threaded and being of equal distance from the crown portion, the threads of said double cap being adapted to be fitted to the interior threads of the flue and the exterior threads of the eyelet.

1,165,793. NON-SIFTING GRATE FOR FURNACES. WILLIAM McCLAVE, OF SCRANTON, PA., ASSIGNOR TO McCLAVE-BROOKS COMPANY, OF SCRANTON, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—An inclined non-sifting grate for fine fuel embodying an inclined supporting frame and a series of removable tops mounted thereon, each top having a plurality of plane substantially horizontal fuel supporting faces arranged at different levels and one overlapping the other, longitudinally of the grate, said tops being disposed in lateral series and being provided with projections overlapping laterally so that the growth of the tops both longitudinally and laterally of the furnace is compensated. Nine claims.

1,168,697. BOILER BRICK. ROBERT J. ALLEN, OF NEW YORK, N. Y.

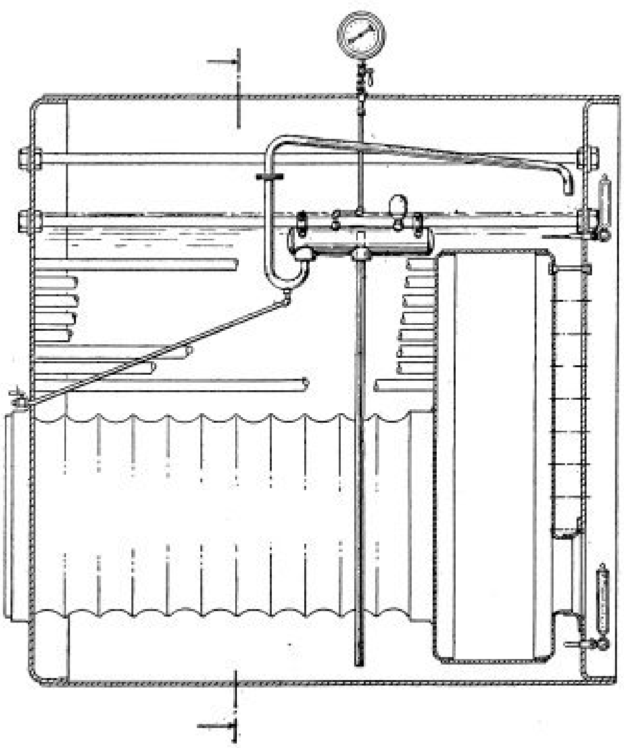
Claim 1.—A boiler brick provided with a sinuously disposed face for engaging and conforming to the sinuous side of a boiler header, such



sinuous face embodying a plurality of reverse curves, and equal in height to a plurality of ordinary brick. Two claims.

1,165,311. LIQUID CIRCULATOR. WILLIAM T. BONNER, OF NEW YORK, N. Y.

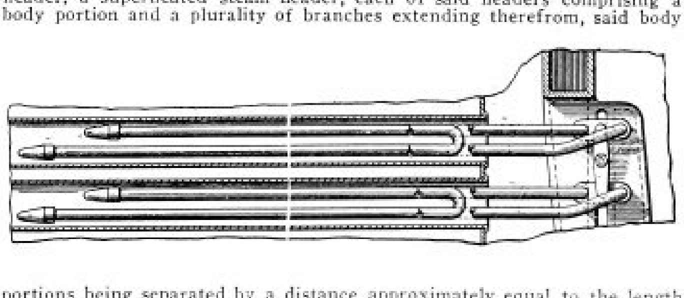
Claim 1.—In a liquid circulator, a closed pressure chamber, a tubular intake or suction member leading from a point below said chamber to a point of discharge within said chamber at or near the upper portion thereof, a tubular discharge member drawing from said chamber at or



near the bottom thereof and extending upwardly above said chamber, and a laterally extended perforated conductor section connecting with the upper end of said discharge member adapted to carry the discharging liquid beyond the limit of chilling influence upon the temperature of said pressure chamber and adjacent fluids. Nineteen claims.

1,165,977. STEAM-BOILER SUPERHEATER. JULIUS KINDERVATER, OF RICHMOND, VA., ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

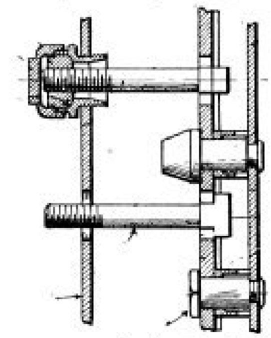
Claim 1.—In a superheater for locomotive boilers, a saturated steam header, a superheated steam header, each of said headers comprising a body portion and a plurality of branches extending therefrom, said body



portions being separated by a distance approximately equal to the length of said branches, the corresponding branches of said headers being disposed one directly behind the other in substantial alinement, and superheater tubes communicating with the side of the said branches. Forty-one claims.

1,168,728. FLEXIBLE STAYBOLT. WALTER A. KEITH, OF LOS ANGELES, CAL.

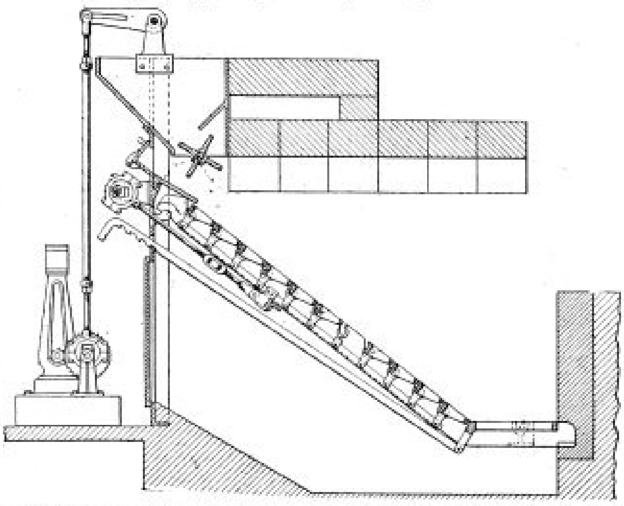
Claim 1.—The combination with a firebox comprising side and crown sheets and a wrapper sheet, of an anchoring band secured to the outer



surface of the firebox, crown and side sheets, and stay means pivotally secured to the wrapper sheet and having a sliding connection to the anchoring band. Four claims.

1,168,367. MECHANICAL STOKER. OTTO WUNDRACK, OF MAYWOOD, ILL.

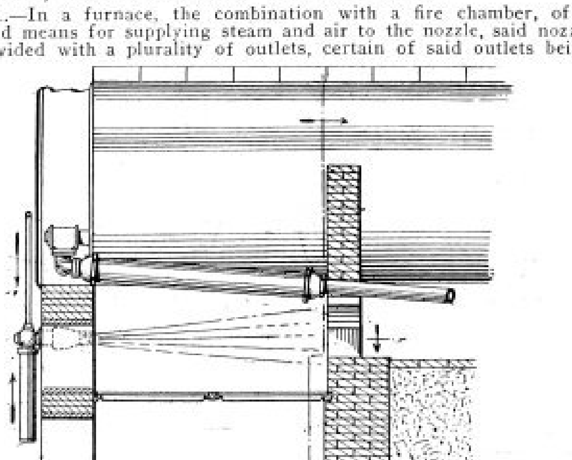
Claim 1.—A device for feeding fuel to furnaces comprising a grate consisting of a plurality of members each pivotally mounted contiguous to one edge and adapted to provide a continuous inclined fuel supporting surface or a stepped supporting surface, a reciprocal member connected



with all of said grate bars for moving the same alternately to said respective positions, a crankshaft for actuating said member, a ratchet wheel for actuating said crankshaft, a hopper for fuel adapted to discharge upon the upper end of said grate, a rotatable fuel feeding device in the discharge end of said hopper, a shaft therefor carrying a ratchet wheel, rocking arms equipped with dogs engaging said respective ratchet wheels, and a walking beam connected at opposite ends with said rocking arms. Two claims.

1,170,989. SMOKE-CONSUMING FURNACE. ORLAND D. ORVIS, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO UNITED FURNACE CORPORATION, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 1.—In a furnace, the combination with a fire chamber, of a nozzle, and means for supplying steam and air to the nozzle, said nozzle being provided with a plurality of outlets, certain of said outlets being



in the form of slots positioned for feeding sheets of steam and air in different planes and in different directions and other of said outlets being in the form of apertures for feeding steam and air on lines which cross with the sheets supplied through said slots. Four claims.

1,168,880. WATERTUBE BOILER. F. WALTER GUIBERT, OF DETROIT, MICH.

Claim 1.—A watertube boiler, having in combination, an upper and a lower drum, and tubes connecting the two drums, a number of the upgoing tubes protruding into the interior of the lower drum having their mouths in the lower parts of the lower drum. Three claims.

1,171,934. SPARK EXTINGUISHER. GEORGE H. EMERSON, OF ST. PAUL, MINN.

Claim 1.—The combination, with a locomotive smokebox, an exhaust nozzle and a screen interposed between the nozzle and stack and a dead

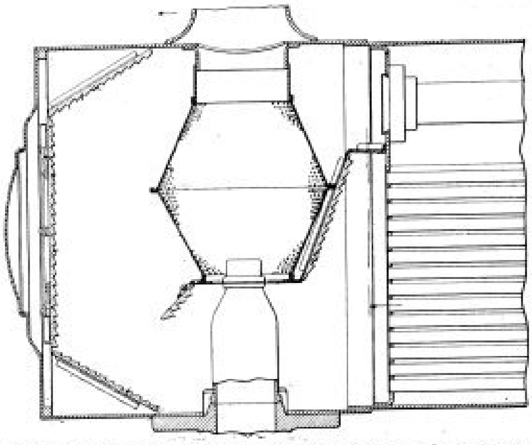
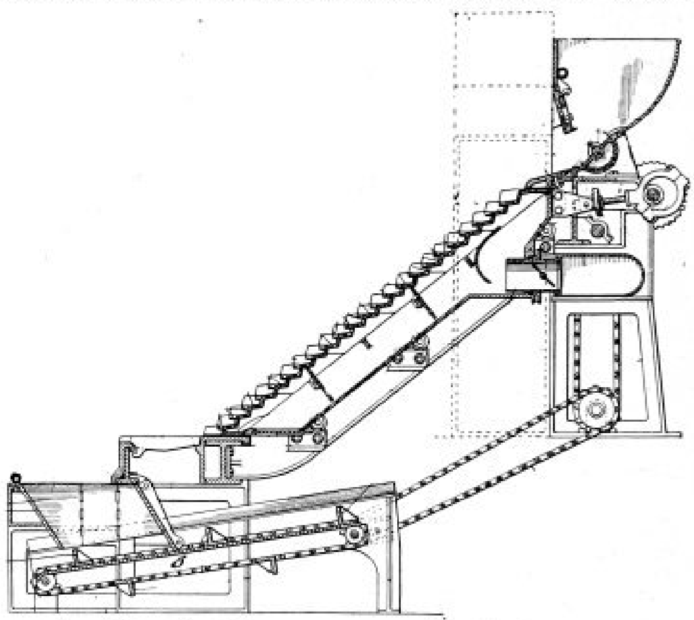


plate provided in the lower portion of said screen, of a roughened plate forming a forwardly and downwardly inclined extension of said dead plate, for the purpose specified. Two claims.

1,171,803. BOILER AND OTHER FURNACE. JAMES REAGAN, OF PHILADELPHIA, PA.

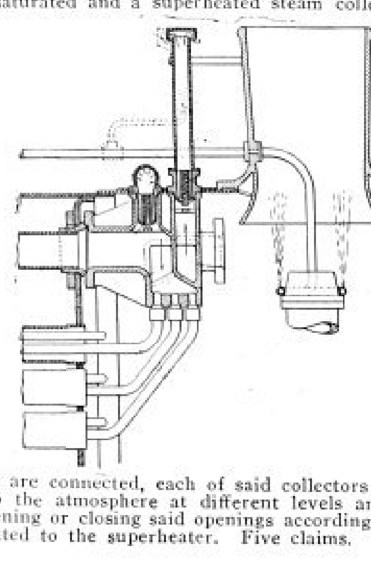
Claim 1.—The combination of a grate, a hopper, and an oscillatory feeder, said feeder having an upper and a lower actuating face, the



upper face being adapted to move transversely of the lower part of the hopper and cut out an increment of fuel therefrom, and the lower face being adapted to move such increment of fuel toward the grate. Twenty claims.

1,172,407. COOLING ARRANGEMENT FOR FLUE-TUBE SUPERHEATER ELEMENTS. PETER THOMSEN, OF CASSEL-WILHELMSHÖHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHÖHE, GERMANY, A CORPORATION OF GERMANY.

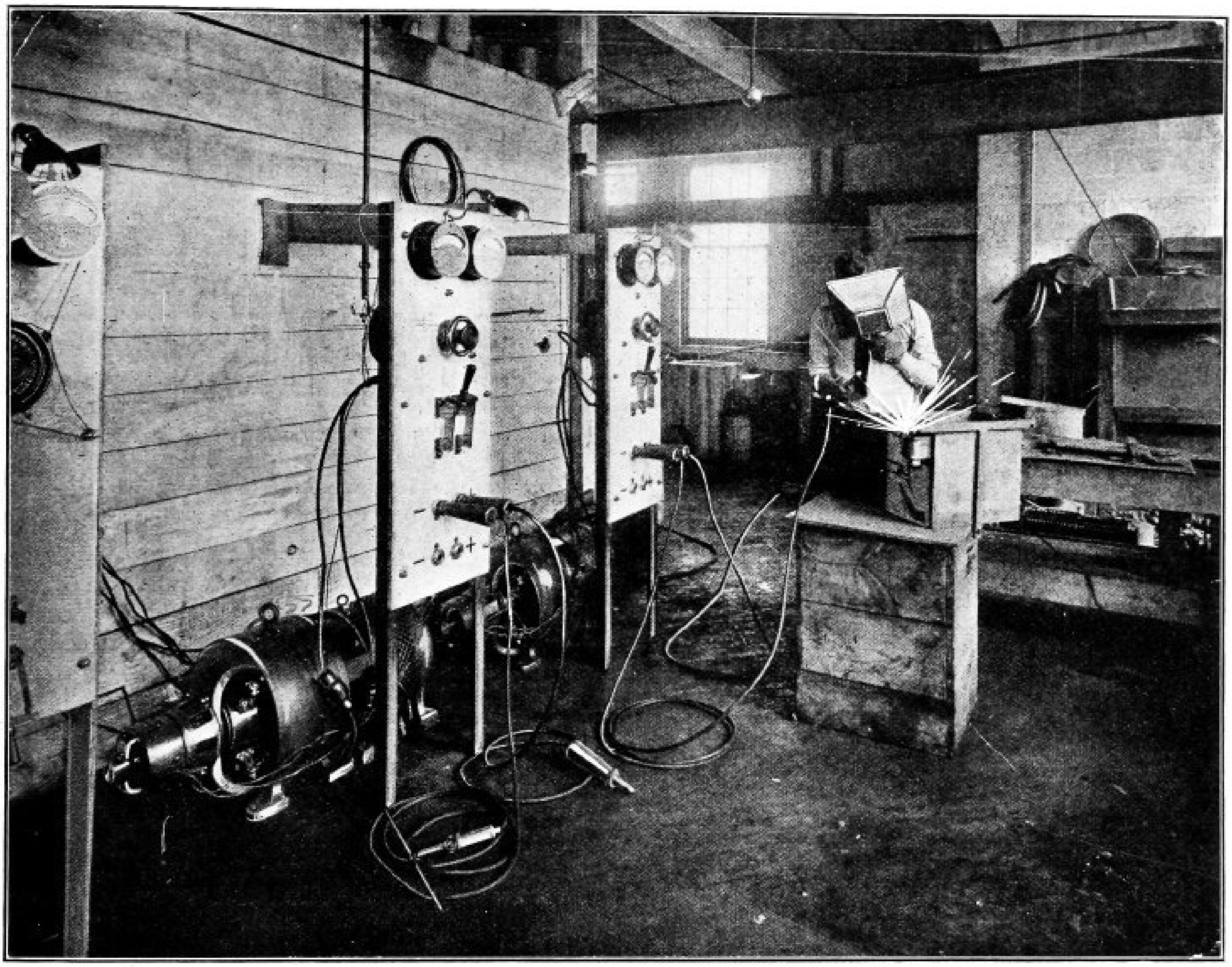
Claim 1.—In a locomotive having flue tubes containing superheater elements, a saturated and a superheated steam collector between which



said elements are connected, each of said collectors being provided with openings into the atmosphere at different levels and means for simultaneously opening or closing said openings according as steam is shut off from or admitted to the superheater. Five claims.

THE BOILER MAKER

JUNE, 1916



Electric Arc Welding Equipment in Operation

Welding with the Electric Arc

Advantages of the Electric Welding Process—Features of the Equipment and Its Operation

BY FRANK C. PERKINS

The accompanying illustration shows the electric motor generator set, switchboard and apparatus for welding with the electric arc as developed at Cleveland, Ohio. In welding with the electric arc, as with ordinary welding, the two pieces of metal when heated to the proper temperature and brought in close contact may be united into one solid piece. The foundation of the whole process of welding lies in bringing the pieces of metal to the proper heat.

This has been done in various ways, the most familiar being the forge fire, in which the blacksmith heats the ends of the two pieces of metal he wishes to weld. More modern methods include the oxy-acetylene torch, which burns gas to produce heat. The thermit process depends upon the chemical combination of two substances to produce great heat, and lastly the electric arc, which transforms electrical energy into heat for welding purposes.

It is pointed out that the only purpose of electricity in welding is to supply the heat. Thorough understanding of this simple fact will do away with most of the mystery with which this subject has been surrounded. The idea has been prevalent that electricity possesses some mysterious characteristic which makes it especially effective in welding work, but nothing could be further from the truth.

It is clear that the blacksmith's forge fire, the acetylene torch, the thermit process, or any of the other methods of producing great heat will heat pieces for welding equally as well as electric arc. The advantages which the electric arc enjoys are, first, the production of greater heat at lower cost, and second, the convenience in applying this heat where it is needed for welding purposes.

It is of interest to note that the anvil weld is applied to welding processes where the two pieces of metal, after being heated, are forced together by pressure in order to complete the weld. Again, the familiar example of this is the weld which the blacksmith makes by first heating in his forge. In regard to butt and spot welding, it may be stated that an application of this is the spot or butt welding process in which two pieces of metal are heated by electric means, and then pressed together to complete the weld.

Autogenous welding is a process whereby the metals are raised to such a temperature that they will fuse together on contact without pressure being applied. The main difference between the two processes is one of the temperature of metal at the weld.

THE ELECTRIC ARC

In electric arc welding the electric arc is a gap in an electric circuit and the current "jumps" or "arcs" across this gap. It does this against great resistance, because electric current does not pass easily through the atmosphere. Because of this resistance great heat is produced and the ends of the gap in the circuit become very hot. This process is of course much refined; as a matter of fact the metal which is to be welded usually forms one end of the gap, or one electrode, and a stick of carbon or a rod of metal forms the other electrode. The heat produced by the electric arc has never been measured, but it is variously estimated at a temperature of 6,500 to 7,000 degrees F., and is the highest temperature which can be produced at the present time.

It is claimed that the principal advantage of the electric arc for welding is the fact that it produces heat at lower cost. There are two methods of arc welding, one where a carbon electrode is used, and one where a metal electrode is used. With the carbon electrode the heat which can be obtained is practically unlimited, and metal can therefore be melted very rapidly—in fact, faster than with any other possible method applicable to welding.

In welding there is used a rod or wire of metal for the electrode in place of the carbon. This electrode is gradually melted and furnishes the molten metal for joining the welded parts. The electric arc may be used for welding practically all metals. There are several practical difficulties, however, which are always encountered in welding work. These limit the use of the process for commercial purposes somewhat.

It is maintained that the first difficulty is the expansion and contraction which results from heating a certain part of a piece of metal or how the heating of the rim of a metal wheel and the subsequent cooling of that part would set up strains in different parts of the wheel. This difficulty can be overcome by different methods. The whole piece is often heated before the welding operation begins or it may be annealed by heating afterwards.

In the matter of expansion and contraction, the electric arc has a distinct advantage over the oxy-acetylene flame, due to the fact that the intense heat of the arc is confined to a very small area. The oxy-acetylene flame always heats up a large area around the weld. The second difficulty in welding is due to the formation of oxides. Metals at high heat combine with oxygen; the oxides thus formed on the parts of the metal to be welded will prevent the metals coming in intimate contact and a perfect weld cannot result. The welded surfaces, however, may be kept clean by floating the oxide on top of the molten metal.

In considering the subject of welding of iron and steel, it is pointed out that the difference in welding of metals is best understood by studying some of the practical applications of electric arc welding and the simplest of these is the welding of cast steel.

WELDING OF CAST STEEL

It is well known that steel castings are produced by melting the steel, pouring it in a mold and allowing it to cool in the desired shape. Now if there is a place in this casting which is not filled out as it should be, it is a simple matter to melt steel in the electric arc and weld it into this low spot, because the material which is added is the same as that of the original casting—simply steel which has been melted and has cooled again. By adding metal of exactly the same chemical composition as the casting, the weld can be made identical with the rest.

In order to do this the casting is connected to one end of the electric circuit so that it forms one of the electrodes. The operator handling the other electrode brings it in contact with the surface of the casting, then quickly withdraws it a short distance, causing the electric arc to form between the carbon and the casting. After heating the surface around the low spot and melting the steel, he places a rod of steel in the flame of the arc and allows the metal to run into the low spot until it is filled.

In the electric welding of rolled steel, it is well to note that steel when rolled or worked is changed somewhat in its nature. It is made more compact, tough and elastic. The steel sheets, structural steel shapes, steel rails and various other products are produced by this rolling or working process. When two pieces of such material are welded the work is done by melting the steel at the point of weld, and allowing it to cool again, usually adding some metal from an outside source.

CHANGE IN THE METAL

Of course the metal will not be the same as the other metal. It will be cast steel because the melting has taken away all the effects of working or rolling. This is a most important fact to remember in electric arc welding of rolled stock. The material in the weld can never have exactly the same properties as that in the original piece. It may have the same tensile strength, but it will never have the same degree of elasticity. This is a limitation of any welding process. The nature of the weld can be controlled, of course, by the kind of metal that is added.

It is claimed that low carbon steel will make the weld more ductile; high carbon steel will make it higher in tensile strength. Welds can be secured in rolled stock which are stronger than it is possible to produce by the methods of riveting. This is readily seen when it is remembered that the efficiency of the quadruple riveted double strapped joint is not greater than 85 percent, while the arc welded joint may be made with an efficiency of 90 percent without particular difficulty.

It may be stated that the process by which wrought iron is manufactured leaves a certain amount of slag in the metal. In welding, care is taken to float this slag out of the weld. Otherwise wrought iron is treated in exactly the same manner in arc welding as rolled steel. Either carbon or metal electrode is used, depending on the size or shape of the pieces to be welded.

It may be mentioned that the current for electric arc welding must be direct current, and the voltage required is from ten to fifty volts, depending on whether a metal or carbon electrode is used and upon the kind of work being done. Alternating current is not practical for use in electric arc welding. The alternating current arc is difficult to control and the heat is not so easily applied as with the direct current arc. A large part of the heat generated in the electric arc is liberated at the positive electrode—that is, at the electrode from which the current flows. In an alternating current arc the polarity of the electrodes changes with each alternation of the current—that is, a certain electrode will be positive one instant and negative the next, so that the heat is divided equally between the two electrodes. With the direct current one electrode remains positive and the heat is generated at this point, thus making it easily controlled.

As to the direct supply current, it may be stated that where the current on the power line is continuous or "direct" it can be used for welding purposes simply by cutting it down to the proper voltage. This can be done by putting a resistance in the circuit, which means that the extra power not needed for welding is simply wasted in the heat passing through the resistance. If the direct current supply is 220 volts and it is cut down to 30 volts for electric welding purposes, the ratio of power used to power taken from the line is as 30 is to 220. More than six times as much power is wasted as is actually used for the welding operation. With an alternating supply current this must be changed to direct current, and must also be cut down to the proper voltage for welding.

Electric Welding Equipment

The electric welding equipment is simple and efficient. The purpose of all electric arc welding machinery is to take the available supply current and deliver it in proper form for welding work. The simplest form of machine is a motor (either alternating or direct current, depending on the supply). This motor is turned by the current from the supply line and the motor in turn drives a generator which is made to deliver direct current at a voltage more nearly suitable for welding.

In one type of motor generator offered for welding service, the current is delivered at a constant voltage of 75 volts. In order to do welding work this 75 volts must be cut down to from 10 to 50 volts, depending on the work, so that there is still from 30 to 80 percent waste, owing to the use of resistance. However, some saving results from the use of such a "constant voltage" machine, because it lessens the amount of current wasted by resistance.

It is claimed that the variable voltage machine is better adapted to welding work, as it is so made that the generator delivers just the voltage required by the arc. For instance, in welding at the time the electrode touches the piece to be welded the voltage is nearly zero, and as the electrode is drawn away the voltage increases with the length of the arc. It will be seen, therefore, that the voltage is constantly varying. A machine which will give exactly the voltage required will make a great saving. With this type of machine no resistance whatever is necessary, and no power is wasted in this way. The only object of welding equipment is saving of power, and this type of machine gives the greatest possible saving.

Comparing the cost of various forms of welding, suppose the arc uses 150 amperes current, the voltage of the supply line is 250 volts, and the voltage really necessary at the arc for welding purposes averages 25 volts, and assume that the current will cost 2 cents per kilowatt hour. Then comparing the cost of electric power first, when welding with simply a resistance in the circuit; second, when welding with a 75 volt constant voltage motor generator; and third, when welding with a motor generator which will deliver just the voltage required. Where the motor generator is used approximately 25 percent must be added for loss in the two machines.

Taking the system utilizing the 250 volt lines with resistance and 150 amperes using 37.5 kilowatt hours per hour welding, the cost of power per hour of welding would be 75 cents. Now with the motor generator 75 volts constant with resistance using 14.06 kilowatt hours per hour welding, the cost of power per hour of welding would be 28 cents, while with the motor generator variable voltage, average 25 and no resistance, using 4.69 kilowatt hours per hour welding, the cost of power per hour of welding would be 9.4 cents.

Method of Control

The arc welder shown in the photograph is so constructed that it generates at all times exactly the voltage required by the arc and at the same time gives a current which is practically constant. On this account no resistance is ever necessary in the circuit to cut down the voltage, and therefore no power is wasted. This feature is due to special windings in the generator.

It is claimed that the method of control is much simplified by this elimination of resistances and any reasonably intelligent man can learn to operate the welder in one or two days' time. This is of great importance, because most welding machines are operated by men who are neither electricians nor mechanics. Labor is a great factor in the cost of welding, and the welder should be so simple that it is not necessary to have a highly skilled man to do the work. Emergency service is frequently demanded in arc welding plants, and for that reason these arc welders are designed to stand long, heavy duty and to carry overload without damage to the machine.

Individual units are sometimes installed of two or more arc welders, and one may be in use, the other idle for the time being, but is not consuming any current, as would be the case if the installations were made up of one large welder. Where there is sufficient work to require more than one operator, a separate unit is installed for each man. The advantages of this plan are obvious. The user of the arc welding process can in this way do the work at the lowest cost and with the smallest initial investment.

Individual Units

It is held that by installing individual units, the money invested in welding equipment may always be kept proportional to the amount of work done. The arc welder operates at the lowest possible power cost, due to the fact that no resistance is necessary. In addition to this fact, the use of an individual plant for each operator makes it possible to operate each plant only when there is use for it, and then at maximum efficiency. Owing to the fact that no power is wasted in resistance banks by the welder, the actual power required to do welding is small. This welder for ordinary service (with the exception of large steel casting work and heavy cutting) can be operated on any power line large enough to carry a 10 horsepower motor. This advantage permits the installation of the plant at almost any point in the shop where there is a power line, or it may be made portable and connected where needed.

It is claimed that in large railway shops and other plants where the time alotted to do the work is limited and a shut-down of the welding plant holds up the rest of the organiation, the installation of individual welders is the only insurance against great loss due to a total shutdown. Arc welders are flexible in their operation. Any number of the plants may be operated individually or in parallel. For instance, the operator can, without the service of an electrician, connect three 150 ampere plants in parallel to get 450 amperes for heavy carbon electrode work. He can then individualize the plants again in a few minutes.

John Studies the Parabola and Hyperbola

Big Names Make Simple Problems Difficult—John Learns How to Construct Conic Sections

BY JAMES F. HOBART

"'Lo, John, more trouble, I see! What is it this time? Shoot it! Let's get it out of your system as quickly as possible! What is it?"

"It's parabolas and hyperbolas, Mr. Hobart. I had been trying to get outside of that story about ellipses and along came Bill Reader from the big shop and he threw it into me to ask you about hyperbolas and parabolas. Said he wanted to know all about 'em, what they were and how to get 'em shop-broke so he could lay 'em out.

"Bill said he met the Professor the other day and asked him what were parabolas and hyperbolas? Bill said the Professor took off his spectacles and said: 'The parabola and the hyperbola are conic sections, as also is the ellipse, and we might also say, the circle, although the circle might be regarded as the limit of the ellipse in one direction, while a point was the limit in the other direction.' Bill said he tried to make the Professor tell him more about "conic sections," but the Professor spouted so much about 'directrix, transverse and conjugate axis, latus rectum, parameter, focal distances, vertices and eccentricity, that he, Bill, had to duck and leave the Professor there talking all by his lonesome. Say, can you show those shapes to me so I can se 'em?"

"I'll just do that, John. I'll let you see the shapes, then you will understand just what we are talking about. Conic sections means, literally, sections of a cone. Get the pattern maker to turn out a wooden cone for you, same as shown by Fig. 1, then take it to the band saw and make four cuts in it as shown by the four planes drawn through the cone. The cone is represented by *A*, *B* and *C*. If you saw off the top through *E F*, the piece removed will be a little cone and the cut will show a perfect circle, same as the bottom of the cone, *B C*, only smaller.

"Now, John, tip the cone up sidewise and run the band saw through on the line *G H*, and the cut, when the piece is removed, will show a perfect ellipse. Tip up the cone more when you saw, and the shape will be more like a circle. In fact, it will become almost a circle when tilted only slightly; therefore, the circle is one limit of the ellipse, as the Professor tried to tell Bill. See it?"

"Yes, I believe I do. If I cut the whole cone into ellipses, I can get all sizes and shapes, from nearly round and as large as *B C*, down to almost a *U*-shape or a straight line, when the cone is tipped up so as to cut almost parallel with side *A B*."

"Yes, John, that's the idea, but if you tip up the cone as far as that, you don't get an ellipse when you make the cut. When you tip up so as to cut parallel with a side of the cone, as with *A B*, then the cut will show a parabola instead of an ellipse, and this is the only angle at which the cut will give a parabola. This cut is shown at *I J*, the line being parallel with *A B*."

"Oh! I see! I can slice up the whole cone, getting a *U*-shape section when cutting parallel with and close to line *A B*, and obtaining all shapes of parabolas as I slice through the cone, until away down at *C*, I will get a little short, wide section, and if I go far enough, all I will get will be a point. Gee! But that is what the Professor meant when he said 'the limits of the parabola were between a point and a line.' Say, but that's some stunt, though, isn't it?"

"A rather pretty illustration, showing the interdependence of the sections, John. But if you go a little farther and make the cut *I J* at an angle more nearly vertical

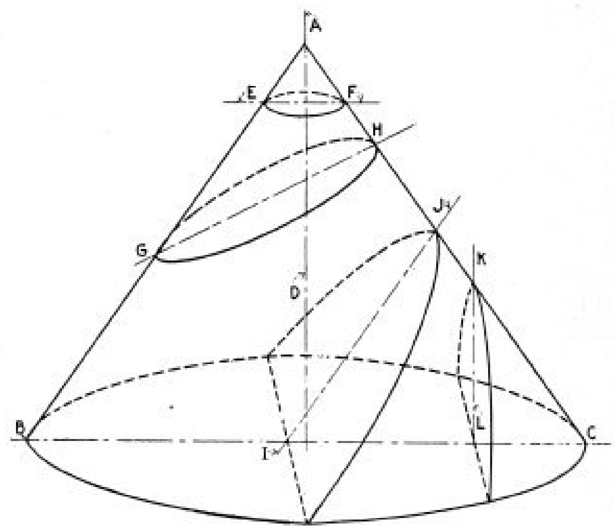


Fig. 1.—The Conic Sections: the Ellipse, Parabola and Hyperbola

than parallel with *A B*, then the cut does not give a parabola, but shows a hyperbola. The cut *K L* shows what I mean. To put it into other words, you begin cutting off points and circles, parallel with line *B C*, then by tilting the cone, you cut ellipses and parabolas, and, lastly, when the cone stands squarely upon its base, you will cut hyperbolas."

"Say, that is one of the most beautiful illustrations of that matter that I ever saw. And, say, won't there be a set of limits to the hyperbola too?"

"Sure, John. The limits are at *C*, when the hyperbola becomes a mere point, and at *A D*, where you cut right through the center of the cone and the hyperbola finds its limit in a triangle. A regular *A*-shaped figure with not a particle of curvature in either leg of the angle—just a bare letter *A*, or a '*V*' turned bottom side up."

"Well, well! That's a queer set of figures and of limits, too. I didn't know there were so many shapes of ellipses, parabolas and hyperbolas. But that picture, Fig. 1, speaks for itself and shows it right plainly. Oh, say, Mr. Hobart, is there any way of 'hog-tying' some of those parabolas and hyperbolas, same as you did with ellipses, so we can lay 'em down in the shop?"

"Sure there is, John. I'll get to that in a minute. And I don't believe I can do any better than to let you in on what is known as Biscovich's definition of a conic section. That gentleman said: 'A conic section is a curve, the distance of any point in which from a given point, is to its distance from a given straight line, in a given ratio. If the distance from the point is equal to the distance to

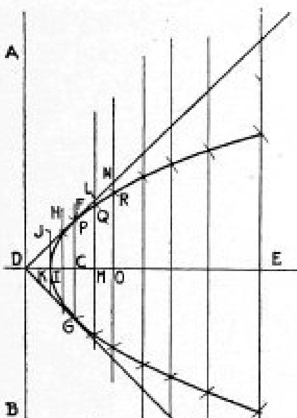


Fig. 2. Constructing a Parabola

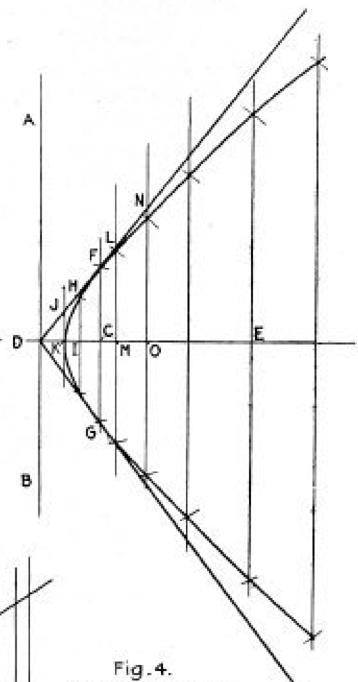


Fig. 4. Constructing a Hyperbola

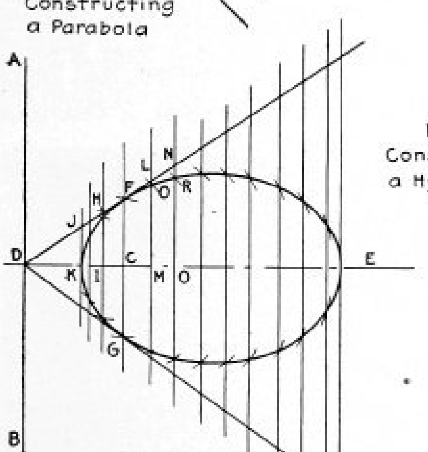


Fig. 3. Constructing an Ellipse

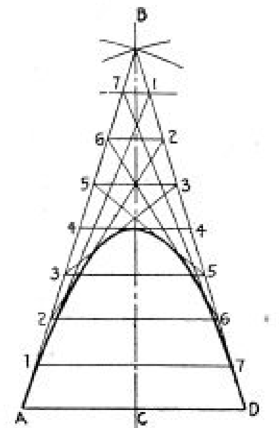


Fig. 5. Parabola Base and Height Given

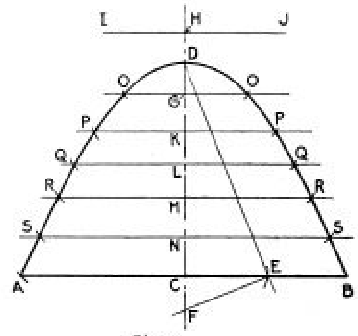


Fig. 6. Parabola from Abscissa and Ordinate

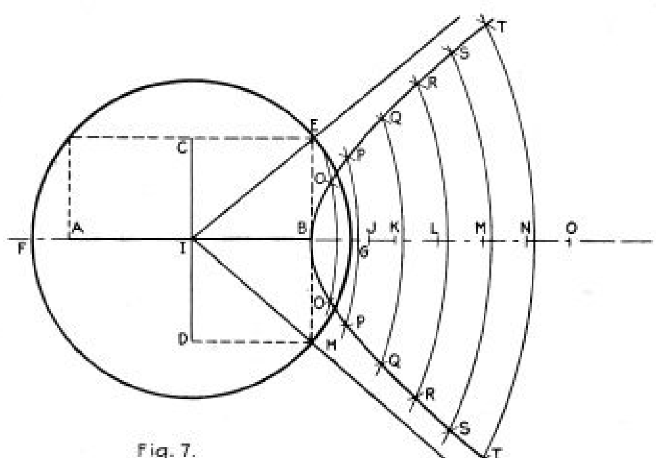


Fig. 7. Laying Out a Hyperbola from Transverse and Conjugate Diameters

Construction of Conic Sections

the line, the locus (figure or plan) will be a parabola; if less, an ellipse; if greater, an hyperbola. If the distance to the line is infinite (has no end) the figure is a circle; but if the distance to the point is infinite, the figure is a straight line.'"

"Mr. Hobart, does that geometry sharp mean to say that it only makes the difference of where you begin these figures, as to whether they come out ellipses or parabolas, boilers or smoke stacks?"

"That's what, John, and Figs. 2 and 4 will show that to be just what he means. In Fig. 2, the given line is *A B*, and the same reference letters are used in each of the three figures, so the description of one applies to all of them. Lay down the given line *A B* and from the given point *C* draw line *D E* perpendicular—square with—line *A B*. Let *D C* be the given distance of the point in the curve from the given line, then measure up from *C*, parallel with line *A B*, the same distance, to *F*, which is the point in a curve. And this point *F* we have taken at equal distances from line *A B* and point *C*. Lay off the distance *C F* below line *D E*, at *G*, then draw the lines *D F* and *D G*, carrying them as far as necessary to the vertical line through *E*, to form the limit of the figure.

"Next, draw a number of parallel vertical lines through line *D E*. Several of these parallel lines are shown at *K, I, C M, O* and *E*. Make these lines long enough to cut the diagonals *D F* and *D G*. With a pair of dividers, or a scale, take the distance on any of these lines, say from *O* to *N*, and lay it off from point *C*, as a center, cutting line *N O* at *R*, which will be a point in the curve we are seeking to lay out.

"Do likewise with lines *M L, I H* and *K J*, repeating the same below the line *D E*. Several points in a curve are thus found, as at *K, P, F, G, R*, and these points being connected, form a curve which is found to be a parabola."

"Well, well! Is that the way you track down a parabola?"

"That is one way, John. There are more ways than you have fingers and toes and you can look 'em all up in the books on geometry and drawing. But this way will answer our needs and the point I am making is that if you vary the ratio between the lengths of lines or distances *C D* and *C F*, you will vary the curve between the parabola, the ellipse and the hyperbola. To see just how, take a look at Fig. 3 and see how a slight variation in the lines *C D* and *C F* changes the figure constructed. In Fig. 3, the length of *C F* is less than *C D*, and after following the same process and directions as given for constructing Fig. 2, the result in Fig. 3 is found to be an ellipse, a figure which returns upon itself and encloses space."

"Do you tell me that the only difference in the origin of these two figures is in the lengths of lines *C F* and *C D?*"

"Look the whole matter through for yourself, John. Build another set of figures like Figs. 2 and 3 and find any other difference, if you can. And, furthermore, reverse the position of the lines *C D* and *C F* in Fig. 3. Put the long one where the short one is. Fig. 4 shows it, then construct the curve in exactly the manner described for Fig. 2, and, behold, you have an hyperbola, a figure, the arms of which are always extending themselves farther and farther from the center line, or transverse axis *D E*, or *C E* to speak more exactly. Now, John, in the parabola, Fig. 2, you find the extremes of the curve become parallel with *D E* on either side thereof and never get any farther or nearer that line, while in Fig. 3, the ellipse, the curves separate, run parallel to the axis, then converge and come together, enclosing space which neither of the other curves do. And there you have the conic sections, the manner in which they are laid out, the close connection between them all, as shown not only by the planes through the cone, Fig. 1, but by the construction of the actual figures in Figs. 2, 3, and 4. Get that, John?"

"I get it, Mr. Hobart. Got hold of it enough so that I can study the thing clear through when I get all by my lonesome. That is the only way I find to get at the real heart of things—just sit down alone and go right to the bottom of it. Then what I get stays with me. If I forget some of it, I can always dig it out again by taking the same course all by myself."

"That's the way to get results, John. I can show you a thing or two to set you a-thinking, or to ease you off a snag, but you have just got to do all the work yourself and dig to the bottom all by your lonesome, if you are to obtain lasting benefit from what you learn."

"I find it so, Mr. Hobart, and I'm doing more and more of that all-by-myself-thinking every year. But there is one thing more I wish you would show me, and that is how to apply the principles shown by Figs. 2, 3 and 4? How can I get down to brass tacks and work out a curve when they tell me: Make a parabola 62 inches high and 40 inches wide, or lay out a hyperbola with a conjugate diameter equal to *C D* and a transverse diameter equal to *A B?*"

"I see what you want John; you wish to know how to tie the knowledge to the work. Like the chap who studied the calculus and when he got through he didn't know how to apply the knowledge. Well, about every college graduate feels that way and it usually takes him two years after he graduates to learn how to apply his knowledge to doing useful work. Is that the idea?"

"That hits me from the ground up."

"Well, John, there are more ways of laying down these figures than you have fingers and toes. Were I to describe all the methods of laying down these curves, it would fill an issue of THE BOILER MAKER so full that there would be nothing else between the covers. So I will only give three methods, which will be a-plenty to set you to thinking out other methods."

"That's all I want. Just a litle something to tie theory and practice together while I make them both agree and pull evenly."

"Good. The ellipse was pretty well shown up in the story devoted to that figure and Figs. 5 and 6 herewith show two methods of laying down parabolas to given dimensions.

"John, draw the base *A D* equal to the width of parabola required, then draw the isosceles triangle *A B D* to just twice the height of the required parabola. Draw the centerline *C D*, then divide the sides of the triangle, *A B* and *B D*, into any number of equal spaces and number them 1, 2, 3, etc., as shown by Fig. 5. Then connect by means of light lines the points 1, 1; 2, 2; 3, 3, etc., as shown, and the figure formed below the lines thus produced will be the required parabola. A curved line sketched at *I J*, smoothing the angularity of the diagonal lines, completes the required parabola."

"Say, that is some stunt, too. Takes a whole lot of room, though, and a raft of long light lines."

"Yes, that method has its limitations and the one shown by Fig. 6 may prove more convenient in certain cases. In the method shown by Fig. 6, make the base *A B* to the given figure, then lay down the height of the figure directly at *C D*. Draw a central line *C D* and produce the line beyond *H*. Next, find the middle of the ordinate *B C* (bisect it), and from the point found draw the line *D E*, and then from *E* lay down a line perpendicular with *D E* to the central line *C D*. Measure from point *F*, where the line intersects *C D* to point *C*, and lay down the distance *C F* from *D* to *G* and also to *H*. Thus the distances *C F, D G* and *D H* are equal to each other. Draw the line *I J* through *H*, perpendicular to *C H*, and this line is the directrix and *D G* is the locus. Draw any number of parallel lines as at *K, L, M, N*, etc., and with a radius *G H* from *G* as a center cut arcs at *O O* for points in the curve. With *G* always as a center and with a radius *H K* cut arcs at *P P*. With radius from *H* to *L, M* and *N*, cut arcs *Q, R* and *S, S*. Connect these points with a curved line and the parabola is described with a given abscissa and ordinate."

"That is something like the method used in Fig. 3, isn't it? Only the distances are taken from the—what-do-you-call-'em—abscissæ, instead of from the ordinates as in Figs. 2, 3 and 4."

"Yes, John, once you get the scheme of these things well in mind, you can shot-cut, change over, and in fact do about anything you wish to make the work convenient and fit to the job you wish to use it on."

"I'll get parabolas and hyperbolas so they will eat out of my hand after a while, see if I don't. But it's geting pretty near whistle time, and I wish you would tell me about laying down the hyperbola. I see there is quite a diagram in Fig. 7, and if you'll put me wise to that I'll salt it down safe."

"Go to it, John. The line *A B* is the transverse diameter of the figure and *C D* is the conjugate. Draw lines *C E* parallel with *A B* and *B E* parallel with *C D*. Draw *I E*, and with *I* as a center draw the circle *E F G*. The points *F* and *G* will be the foci of the figure. With points *F* and *G* as centers, describe arcs at *O, P, Q, R, S*, each with radii *B J, B K, B L*, etc., and *A J, A K, A L*, etc., cutting the arcs *P, Q, R, S*, etc., through which a line may be drawn, forming the curve of the hyperbola.

"Do you get that, John?"

"Yes, I think so. You take the radius *B J* and *F J* and lay it off to *O O* from centers *A* and *B*. Is that right?"

"That's the ticket, John."

"Then you take all the other distances to *K L M*, etc., from *A* and from *B*, and lay off the arcs from *F* and *G* as centers."

"That's the way, John. Guess you will get along now without geting your legs tangled in either the hyperbola, the ellipse or the parabola."

Diagnostics of Steam Boiler Ailments—II*

Behavior of Tubes in Modern Watertube Boilers—Tube Movements Under Service Conditions—Causes of Tube Rupture

BY J. C. MCCABE †

The watertube boiler is accepted to-day as the most desirable type of boiler for boiler units over 150 horsepower. It may be of interest to state that in 1823 watertube boilers were designed expressly for carriages and other vehicles. Galloway, in his "History and Progress of the Steam Engine," published in London in 1829, says: "One hundred and fifty pounds of steam was raised in fifteen minutes from cold water. The dimensions of the boiler were: 20 inches diameter and 3 feet 6 inches long and it seemed capable of a uniform supply of steam equal to at least two horsepower."

Human ingenuity has been pretty well exhausted in devising various forms of watertube boilers, apparently with the purpose of having a boiler that would be different from any other boiler. The design of a watertube boiler that would provide for a free circulation of water, accessibility for repairs and a minimum risk of failure, is a job for a thoroughgoing engineer. It is desirable that the design be of such a character that the steam generated in the tubes may flow with the mingled water to a a point of disengagement, usually in a form of such ratio to generating surface as to render such action not too violent. In some boilers of the horizontal watertube type headers of excessive dimensions have been used, with the result that reactions checked the circulation. In some of the obsolete types like the Root boiler the water and steam were forced to circulate through a vertical series of horizontal tubes instead of discharging the quantity of steam generated at the end of each tube. This method proved inefficient and troublesome in operation, as much difficulty was found in keeping the water level.

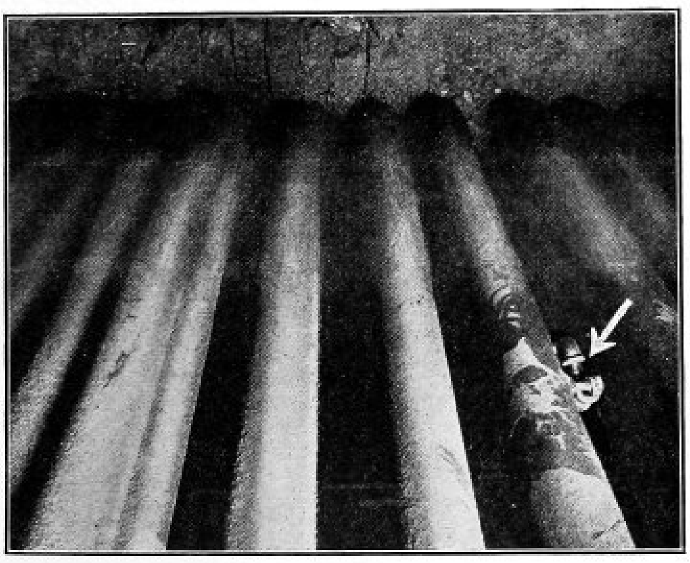


Fig. 14.—Attachment of Recording Device

The behavior of the tubes in present-day boilers will be of interest. Observations were made on boiler No. 14 in station A of the D. U. R. to ascertain as near as possible what happened during the operation of the boiler in the front tubes. The boiler is the standard type of Stirling, with four drums and three banks of tubes, of four tubes to each bank and nineteen tubes in each row and rated about 450 horsepower.

This boiler was fitted with a Murphy stoker. It was observed that a permanent set of 2½ inches existed in the tubes of the front row with the maximum at 54 inches from the mud drum. New tubes were installed in place of a few defective ones and a bolt ⅜ inch diameter was welded to the side of a new tube in the front row and a ⅜-inch pipe was attached to this bolt (Fig. 14). Circulation of water was maintained and kept at constant temperature. A record of the tube movement was communicated to the ribbon of a CO_2 recorder by means of the ⅜-inch pipe mentioned.

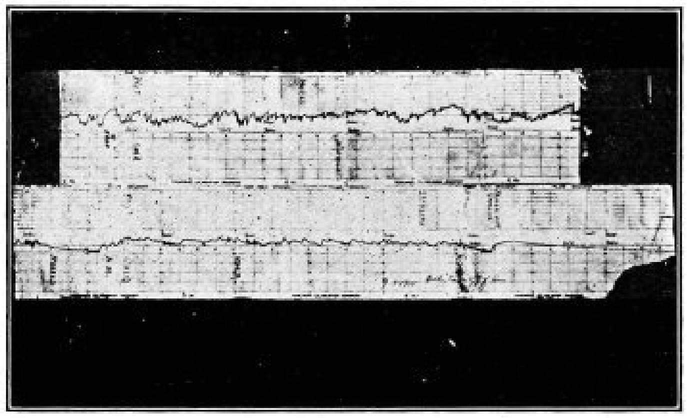


Fig. 15.—Record of Tube Movement

The boiler was fired up in the usual manner, and it was observed that the tube alternately moved toward the fire from its zero position and from the fire beyond the zero about 1/16 inch, or a total movement of ⅛ inch. This swing occurred every four or five minutes. As the water grew hotter the movement tended more from the fire, and when steam was formed the movement gradually increased to about ½ inch from the zero position and from the fire. Fig. 15 clearly shows the frequency and character of this movement, which amounted to a maximum of ½ inch. It will be noted that this bending was opposite to the bends at each end of the tube, which was 8½ inches on the bottom and 2½ inches on the top end. The front tube was 17½ feet long and 3¼ inches diameter. A rotation of one degree was measured on the lower drum. The boiler was operated slightly above normal rating. It will be noted that the side of the tube farthest from the fire actually got the hottest, and this was a new tube and used for the first time under observation. The opening of the fire door or the slicing of the fire was shown on the record.

Observations were made on boiler No. 5 at the Packard Motor Company's plant. This boiler is a Wickes vertical watertube boiler with tubes 22 feet long and rated about 400 horsepower. Observations were taken from a front tube about 10 feet 6 inches from the lower drum. A piece of ⅜-inch pipe was attached to a circular plate which served to hold the pipe radial to the tube. Water was

* Concluded from the May issue.
† Chief Boiler Inspector, Detroit, Mich.

circulated and kept at constant temperature. The Murphy furnace was attached to this boiler in the usual manner. The boiler tubes were 4 inches diameter. The deflection reached a maximum of 5/8 inch in this boiler. The movement of this tube is away from the fire, as in the case of the Stirling boiler just mentioned, and was proportionately about the same. It may appear that the force required to bend these tubes would be considerable. In the case of the 4-inch watertube, 187 pounds loaded at the center deflected the tube 5/8 inch with the ends free.

It is pretty well understood that boiler materials subjected to temperatures and usage that induce variable temperatures in parts of shells, tubes or drums will eventually render such parts gradually less safe for use.

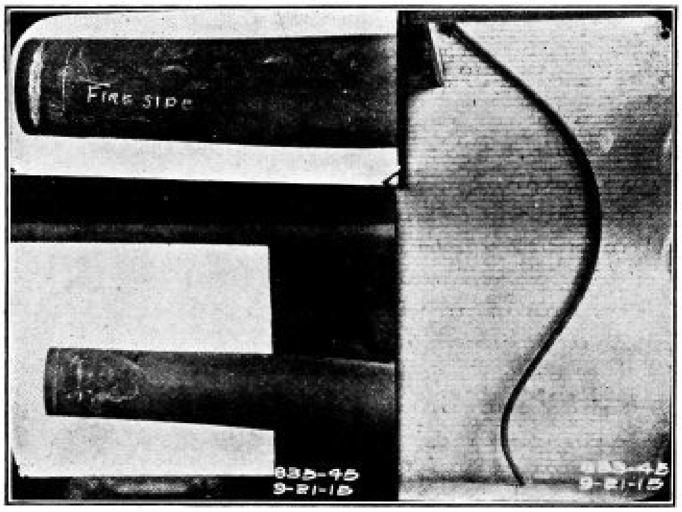


Fig. 16.—Tube from Stirling Boiler 36, W-Type

Obervations were made on a No. 36 Stirling "W" type boiler at the Delray plant to find if possible a reason for the pulling out of a tube in the thirteenth row, which is the row nearest the fire on one side of the boiler.

On September 20, at 8.55 P. M., tube No. 12, in the thirteenth row, blew out of the lower drum. This tube was hurled across the space over the fire and flattened two other tubes slightly, but not loosening them. The upper end of No. 12 remained in its place in the top center drum. Fig. 16 shows the tube as bent and two views of the end which was ejected from its place in the lower drum. At the end of the tube marked *fire side* it will be seen that a slight scale formed between the tube and shell prior to its ejection. This is conclusive evidence that the tube had taken a set toward the fire to some slight extent. On the other side slight scale formation will be noticed where the tube had taken two different positions on its way out of the tube hole.

Actual determination disclosed that with a 10-gage tube it would have to be shortened 1/4 inch to admit of forcing the tube flush with the tube sheet on the inside of the drum, and the force required to do this was measured as 285 pounds.

For the complete ejection of the tube a force of 600 pounds would be required with a shortening movement of 1/2 inch on the tube. The 600-pound load caused a slight set in the tube. With an area of about 1.4 square inches of tube end plus the circulation force in the tube the operating pressure would force this tube back from its projection of 1/2 inch into the tube if the tube were a nice fit, but not expanded in any degree. However, there was evidence of good expanding and belling, as shown by the clearly defined mark where sharp contact was made on the inner edge of the tube holes. This tube, if subjected to the same conditions as the other tubes in this boiler, would show the same behavior. This tube was, in my opinion, heated one or more times to a degree that caused it to lose over one-half its strength.

This would cause the tube to expand more than the other tubes, and leakage would make possible the scale formation shown in Fig. 16. For some time before ejection the tube was 1/8 inch outside the inner edge of the tube hole. This is shown by the scale formation. The tube, in my opinion, had a temperature at its lower quarter length ranging above 900 degrees F.

Measurement of the tube after ejection disclosed that it

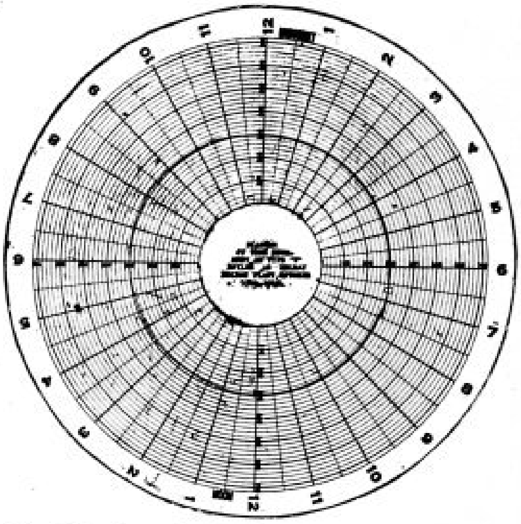


Fig. 17.—Record of Tube Movement in Type W Stirling Boiler

was slightly flat, measuring 3.281125 inches (3 9/32) on the greatest diameter and 3.2343 inches (3 15/64) on the lesser diameter. This gives a mean of 3.2578 inches for the diameter of the tube at the point bearing in the tube sheet. The tube hole was machined 3.2815 inches (3 9/32) with a tendency to enlarge from the use of the expander. It will be seen that the tube, after ejection, was .0234 inch less diameter than it had been while in its position in the tube sheet.

It is very evident from these facts that the tube had been heated to a degree in excess of temperature in the

Fig. 18.—Tubes Heated and Split with Acetylene Gas

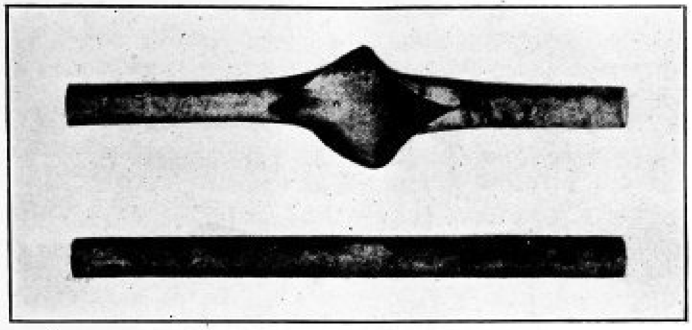


Fig. 19.—Split and Bulged Tubes from Stirling Boiler

tube sheet that caused a set in compression. This, I determined experimentally, was above 1,100 degrees F.

A test was made with a piece of 3¼-inch tube .14 inch thick and regularly expanded into a 1-inch plate to determine the load applied 22 inches from the tube sheet that would cause yield. A slight movement was noticed at a load of 1,800 pounds, but the tube remained tight in the sheet up to 2,500 pounds, at which point failure began, the load running up to 2,700 pounds with the tube nearly out of the sheet. The deflection was about 1 inch at end of tube.

Another test was made with a load of 500 pounds applied at the end of the tube 22 inches from its end. A flame was projected against the tube sheet and tube end and its behavior observed. Yield began at a temperature of 800 degrees F. At 1,100 degrees F. the load dropped to 400 pounds, with a deflection of ½ inch. On cooling, the tube was slightly loose in the sheet.

This tube, properly expanded, would require 1.4 × 40,000 to induce yield. This would be equivalent to 56,000 ÷ 7, or 8,000 pounds gage pressure. The tube would reach the yield point at about 4,000 pounds on its longitudinal section. This makes it evident that heavy tubes are not an essential.

The tube 21.5 feet long (258 inches) would expand .00167 inch per degree F. To expand and throw a point in the lower end of tube 13, 23 inches from the tube sheet, 1 inch lower, would require a temperature of 1 ÷ .00167, or 597 degrees F. The temperature of the steam was 391. 597 + 391 = 988 degrees F., or the uniform lowest temperature that would bend the lower arm to the ejection point. Considered as a column 21½ feet long at a temperature of about 1,000 degrees F. it is very evident that it would not support itself.

It is evident that this tube was loosened because of high temperatures at the point of junction with the tube sheet. This tube had a lever arm of 23 inches measured from the center of the tube to the face of the drum. The front tube will naturally take more heat than the other tubes farther back in the same bank. The bending moments will tend to work and compress the metal of the tube where bearing in the tube sheet. There is also a slight tendency to elongate the tube hole from the internal pressure. The shell 1 inch thick and coated with oil, if present, would admit of considerable rise in temperature in the tube sheet, which ordinarily with a furnace temperature would have a surface differential of about 15 degrees F., but the temperature of which may be considerably above that of the steam and water in the boiler. If the boiler rating is taken at 150 percent we would actually have (for 215 pounds)

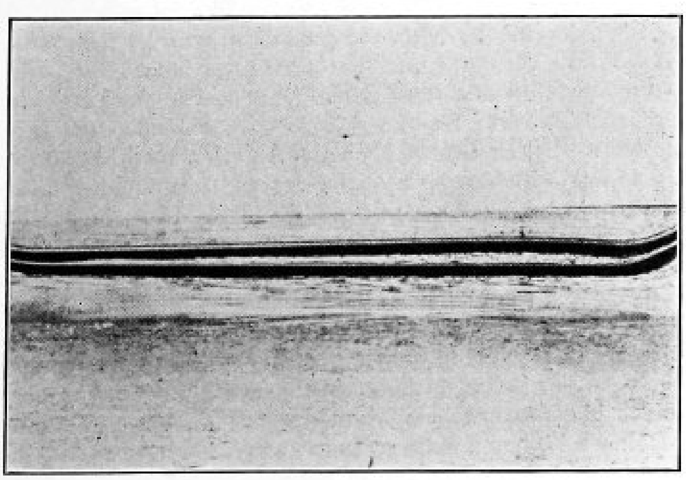


Fig. 20.—Tubes with "Set" Away from the Fire

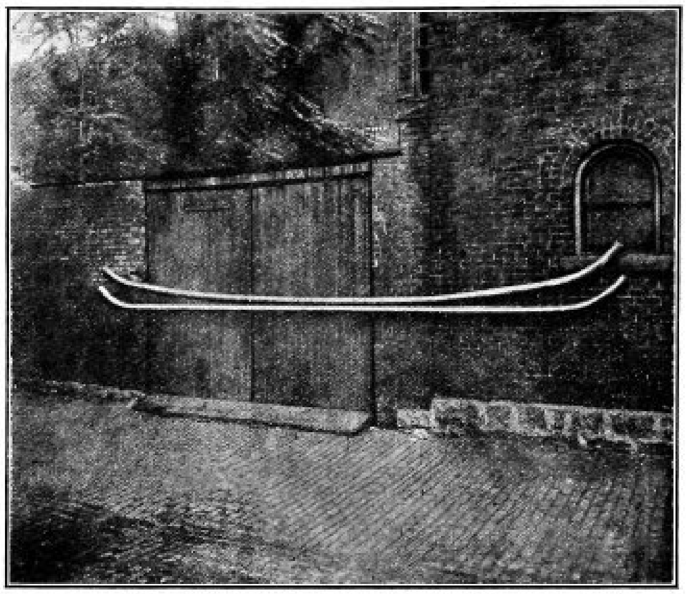


Fig. 21.—Tubes with "Set" Towards the Fire, Caused by Low Water

$$\frac{34.5 \times 1{,}202}{6.6 \times 144} = 43.63 \text{ B. T. U.}$$

exchange per square inch per hour, or 43.63 ÷ 3,600, or .012 B. T. U. per second per square inch. With the Smithsonian constant of .0005 unit per degree F. for 1 inch of metal we would have surface differential of $\frac{.012}{.0005}$, or 24 degrees F. This temperature condition would not seriously affect the holding strength of tube, as the diameter at the outer side of the tube hole would only be enlarged about .0005. But actually this could not be measured. The higher temperature on the outside surface would set up an internal stress equal to *a c t E*, and would amount to 1 × .0000065 × 24 × 300,000, or 4,680 ÷ 2 = 2,340 pounds per inch length of shell or drum. For this reason it is undesirable to use thick plates for direct-fire contact.

The lower drum would reach its yield point under a pressure of 220 pounds, with a temperature indicated by the formula: 36 (Radius) × 220 (pressure) ÷ thickness .45 (percent ligament) × 40,000 (*EL*) = 25.6 percent. This indicates that neglecting the stress due to the expanding of the longitudinal rows of tubes a temperature of 1,100 degrees F. would be required to strain the lower drum to the yield point with 220 pounds pressure through the ligament, it being the weakest part of drum. For the drum in the solid, a temperature that would weaken it to 19.8 percent would be required, or 1,300 degrees F.

A measurement of the temperature of one of the lower drums on boiler No. 28, the "W" type of Stirling between the twelfth and thirteenth row, near the fire and about 18 inches from the side wall gave a reading of 500 degrees F. at 100 percent rating, and 550 degrees at 150 percent rating (pressure 210 pounds). The theoretical temperature would be about 391 + 24, or 415 degrees F., for 150 percent rating, and 391 + 15 = 406 degrees for 100 percent rating. The excess of 550 — 415, or 145 degrees, in the first case, and 500 & 406, or 94 degrees, in the second, is probably due to the fact that the tube ends project 3/8 to 1/2 inch into the drums and pocket a film of steam with the resultant rise of temperature. The induced temperature does not in any way endanger the boiler, but the drum would be more efficient where exposed if a few tube ends were beaded close to the shell after slightly tapering the tube hole.

The increase of temperature in the drum to 1,100 degrees F., causing the diameter of hole to increase (.0000065 × 1,100 — 393 × 3.25), would only account for .0045 inch increase of diameter, which would not account for the ejection of the tube. The tube projected into and beyond the inner side of the drum 1/2 inch and was belled at the end to one-quarter over the nominal tube diameter.

Considerable oil was observed throughout the lower drum and on rows 12 and 13. I wish to commend the prompt action of the operating force in the handling of the emergency. With about 10 tons of burning coal on the grate no damage was done aside from the three tubes mentioned. Efficiency medals are in order.

An observation of the movement of the front tubes in boiler No. 36, Stirling "W" type, shows by Fig. 17 that the movement does not exceed 1/8 inch and that it does not occur with any abruptness. The mud drum moved 5/8 inch in a direction down and from the fire, and was apparently a natural movement due to the natural increase of temperature in the tubes. A rotation of drum found at the D. U. R. plant could not be found in this case. The apparent movement toward the fire of the front tube is accounted for by the extension of the angle formed by lines connecting the mud drums' centers with the upper drums. The front tubes form an angle of about 10 degrees to the vertical. Hence the movement is due to general causes rather than local heat effect. The great height of the lowest point of the tubes above the grates prevents flame contact with the tubes to a great degree, and the presence of 10 to 15 tons of coal radiating heat to the front banks of tubes from the opposite side of the furnace affords a nearly equable heat envelopment on each side of the front banks of tubes and the resultant lack of deformation found.

For years the impression has prevailed that the furnace should be placed close to the boiler. This practice has been a source of many boiler troubles and should be discontinued. The Wickes and Stirling boilers first mentioned would have shown less tube movement if the same stokers used were not placed so close to the boilers as to not only produce serious local heat effect, but also less economy of operation.

One of the serious troubles experienced in the operation of watertube boilers is the rupture of tubes. Accidents of this kind are not at all rare. These accidents have been attended by loss of life and considerable damage to the boilers. Several experiments have been made to determine as far as possible the conditions under which a tube will rupture and also bag or bulge.

A 3¼-inch seamless steel tube .13 inch thick, having a tensile strength of 55,800 pounds and an elastic limit of 46,600 pounds was used, the elastic limit being 83½ percent of the tensile strength. It was desired to ascertain at what temperature this tube would yield or take a deformation under an internal pressure of 200 pounds of air. Calculated from its elastic limit, a pressure of

$$\frac{46{,}600 \times .13}{3.25 - (.13 \times 2) \div 2} = 4{,}052 \text{ pounds}$$

is indicated as the pressure at which this tube would begin to yield under a temperature of 400 degrees F. or less.

By the formula

$$\frac{R \times P}{t \times E.L.} = \text{or} \frac{1.514^{*} \times 200}{.13 \times 46{,}600} = .0499 \text{ percent,}$$

or about 2,000 + degrees F., indicated from the curves as the yield temperature.

The tube was heated to 2,000 degrees F. with 200 pounds gage pressure, and upon cooling, an increased diameter of 3/32 inch was found. Several similar tests were made with the same approximate results. These tests show clearly to about what temperature a cylindrical vessel must be heated before it will deform under a given pressure.

Fig. 18 shows the effect of heat on some tubes. The tube marked (1) was filled with steam at 75 pounds pressure, and an acetylene flame projected against its wall. It was pierced in 15 seconds. The tube marked (2) was filled with water at 77 degrees F., and the flame pierced it in 30 seconds. The water was raised to 90 degrees F. One inch from where the flame came in contact with the tube a sensitive Hoskins pyrometer couple was inserted and the temperature was raised only 43 degrees F. It is estimated that 230 B. T. U. were shot against the tube in the 30 seconds. This would be upward of about 1,400 times as much heat as would be projected against a boiler ordinarily, and then not so directly. Tube (3) shows the result of a pressure-heat test where heat was somewhat localized, and rupture occurred around 2,300 with 125 pounds of air. Tube (5) was a similar test. The heat ran around 2,500 degrees F., but was only estimated.

It was desired to cause an actual rupture in a 3¼-inch seamless steel tube in a manner similar to those of frequent occurrence in watertube boilers. The tube selected was found to have a tensile strength of 60,800 pounds, with an elastic limit of 45,800 pounds. This tube had a constant air pressure of 200 pounds kept on it. It was heated to 2,000 degrees F. and quickly taken from the furnace and a stream of cold water shot on it for about 1 foot of its length. This was repeated several times, but without result. Finally the tube was heated to 2,100 degrees F. and it ruptured with a mild explosion, tearing longitudinally for 18 inches and opening 10 inches wide, the reaction bending the tube back. Fig. 19 shows the ruptured tube and the tube tested to its yield point. The tube was heated to 1,975 degrees F. with 200 pounds pressure of air. On cooling, the diameter had increased 3/32 inch.

Fig. 20 shows a tube taken from a standard Stirling boiler which had a set of 2½ inches from the fire. Fig. 21 shows a Stirling tube with a deformation toward the fire of about 6 inches. The behavior of tubes under flame contact is to bend away from the fire. If scale or low water occurs the tube moves toward the fire.

There can be no doubt that the ruptured boiler tubes fail from having a short longitudinal section, of a few inches usually, heated somewhat above the yield of the metal. It is well to remember that boiler metals under heat can not increase their tensile strength, like the metal under temperature below 400 degrees F., which actually obtains a higher tensile strength when loaded beyond the

* Radius corrected for temperature.

yield point. Under high temperature any yield under load precipitates failure.

The fact that a tube has been overheated can readily be told by the use of a tape. Occasionally a welded tube fails from sheer weakness. The rupture of a tube follows much the same phenomena that occurs in a boiler explosion. After the initial rupture there is a drop of pressure in the tube, followed by an explosive rate of evaporation in the tube of several percent of its water. This causes the projection of water from both ends of the tube towards the point of low pressure and causes an extended rupture through the solid metal of the tube. The ruptures in tubes are invariably caused by the presence of non-conductors on the inside of tube wall. Greater care should be taken to purify feed water for boilers. Flame contact on tubes is sure to cause heavy deposits of sediment at such points because of the evaporation of greater amounts of water at such points.

A seldom-appreciated cause of disaster is to be found in steam piping. Nearly twelve years ago seven Heine boilers exploded in the St. Louis Traction plant, due to the failure of a 14-inch fitting on the steam main. This caused a rapid drop of pressure, which resulted in an explosive rate of evaporation of possibly as much as 10 per cent of the water in the boiler, with the result that the water was thrown against the upper part of the shell, and resulting in complete failure. The fact that there were seven explosions almost simultaneously indicated clearly that the cause was not due to hidden weakness of the boilers.

Vibration and cast iron fittings have no place in a modern steam plant.

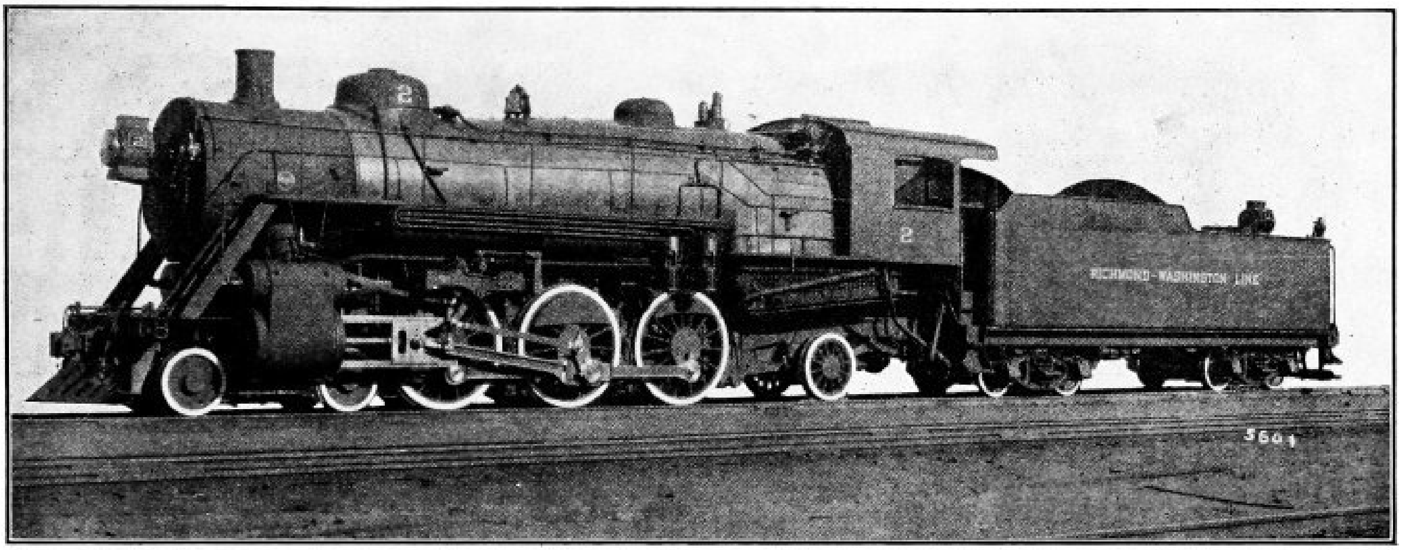
Safety, economy of operation and avoidance of the smoke nuisance demand a radical departure in boiler furnace installation. Architects and engineers can bring about this reform by designing the boiler room for the desired boiler, and not by endeavoring to find a boiler to fit an undersized room in an obscure corner in a basement.

Locomotive orders thus far in June exceed 115, maintaining the previous high rate for this year. The Lehigh Valley has ordered 40 Santa Fe and 30 Pacific locomotives from the Baldwin Locomotive Works. The Lehigh Valley has ordered 55 new locomotives in the last eight months, besides the above order of 70.

Modern Pacific Locomotive Equipped with Schmidt Superheater

An up-to-date Pacific type locomotive recently built at Philadelphia, Pa., for the Richmond, Fredericksburg & Potomac Railroad, has cylinders 26 by 28 inches. The boiler is of the wagon top type, with a diameter of 80 inches. The thickness of sheets is 13/16 inch and 15/16 inch, and the working pressure 200 pounds.

The firebox has a length of 114⅝ inches, a width of 84¼ inches and a depth at the front of 83 inches and at the back 67¼ inches. The thickness of the side, back and crown sheets is ⅜ inch and of the flue sheet ½ inch, The water space at the front is 5 inches and at the sides and back, 4½ inches. The tubes have a diameter of 5½ inches and 2¼ inches. The engine is equipped with a Schmidt superheater having a superheating surface of 973 square feet.



Pacific Type of Locomotive Built for the Richmond-Washington Line

The heating surface of the firebox is 232 square feet and of the tubes is 3,942 ssuare feet, while that of the arch tubes is 31 square feet, the total being 4,205 square feet. The gate area is 66.7 square feet.

The weight on the driving wheels is 188,000 pounds, the weight of the total engine being 293,000 pounds, and of the engine and tender 472,000 pounds. The tender has a tank capacity of 10,00 gallons, and a fuel capacity of 15 tons.

In an ordinary horizontal boiler the seams which run parallel to the floor along its sides are called longitudinal seams. The seams which run around the boiler are called vertical seams. The seams which run across the heads parallel to the floor are called horizontal seams. A longitudinal seam is, of course, also a horizontal seam, but as it runs longways of the boiler, longitudinal is a better name for it.

These three seams have to be designed to meet different strains. The vertical seams are subjected to a pressure which tends to draw them apart in the direction of the longitudinal seams, and these strains come from the pressure of the steam on the two ends of the boiler. The horizontal seams, or those on the ends of the boilers, are subject to strains which have a bending effect varying from the greatest strains in the middle to the least of the strains at the ends.

Members and Guests of the Master Boiler M

Master Boiler Makers' Association Hol

Four Days' Programme Brings Out Disc

Current Practice in Oxy-Acetylene and Electric Weld ing of Barrel Sheets Discussed—Maintenance of Sup

THE tenth annual convention of the Master Boiler Makers' Association was opened at the Hollenden Hotel, Cleveland, Ohio, on Tuesday morning, May 23, at ten o'clock, with Mr. Andrew S. Greene, president of the association, in the chair. After an invocation by Mr. John H. Smythe, past president of the association, the president introduced the Honorable Harry L. Davis, mayor of Cleveland, who cordially welcomed the members of the association and their guests to the city.

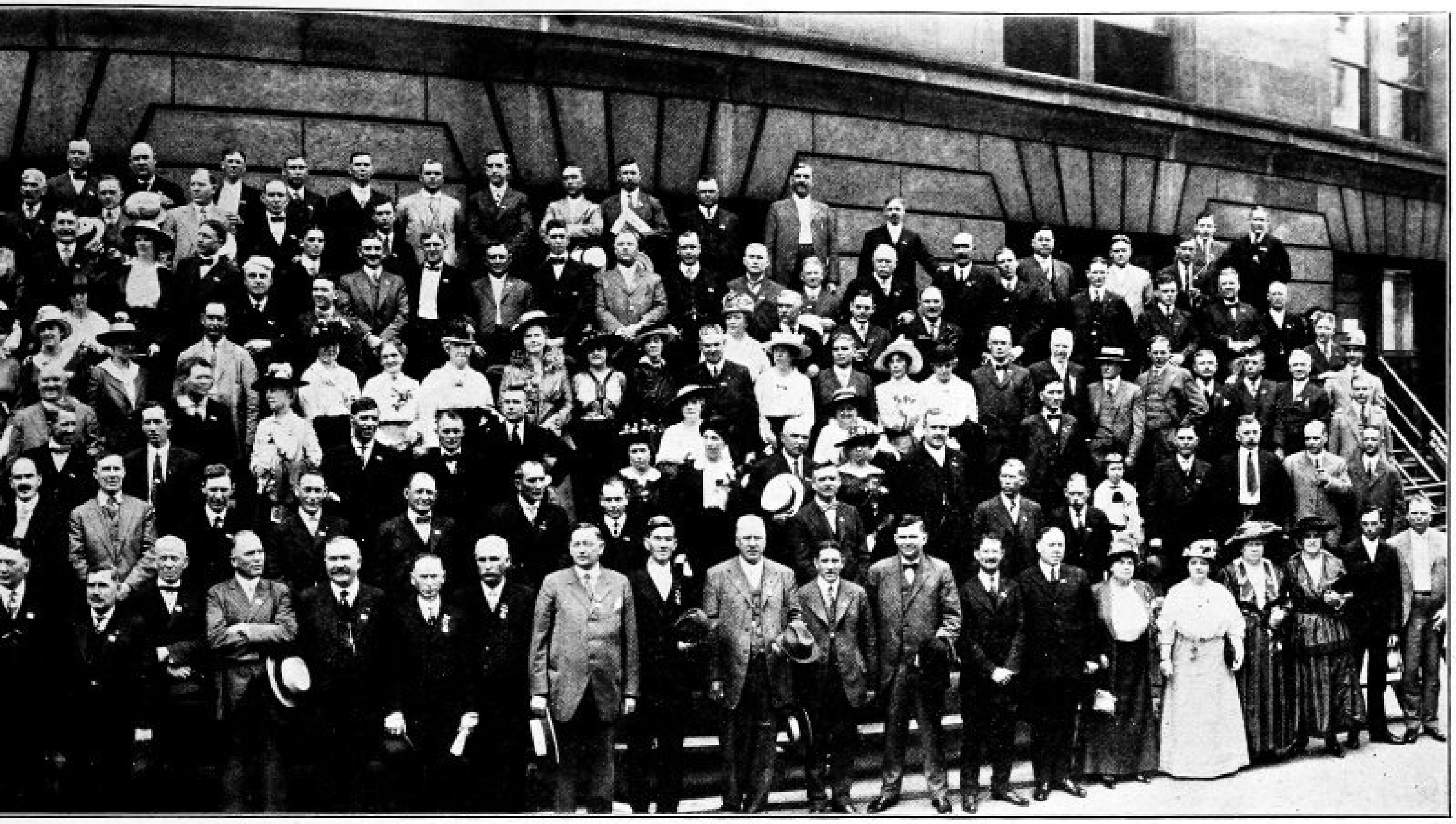
Speaking for the city's administration and for the citizens of Cleveland, the mayor expressed the wish that the convention should be successful in every particular, and assured the members that everything possible would be done to make their stay in Cleveland enjoyable.

In responding to the mayor's address, Mr. P. J. Conrath, past president of the association, pointed out that many of those present still had fond memories of the successful convention held by the Master Boiler Makers' Association in Cleveland in 1907, and of the enjoyable time spent with the people of Cleveland during that convention. He also pointed out that Cleveland has something in common with boiler makers, for a large portion of boiler plate, as well as a good portion of the rivets which are used in assembling boilers, are manufactured in Cleveland, and it was in Cleveland nine years ago that the two associations of master boiler makers were consolidated into one powerful and influential organization which has since flourished and contributed to the benefit and success of the boiler trade.

Owing to the absence of Mr. D. R. MacBain, superintendent of motive power of the New York Central Railroad, Cleveland, Ohio, the address which he had prepared to deliver at this session of the convention was read by the secretary.

Abstract of Mr. MacBain's Address

The subject of "Oxy-Acetylene and its Advantages in Boiler Repairs" is one which, in my opinion, should be given the closest attention on the part of all concerned in the work we are carrying on, and, notwithstanding the increasing application of electric welding devices and the uses to which such devices can be applied, it would be a mistake at this time to allow the oxy-acetylene process to drop out of our minds in the slightest degree, because I believe it has a distinct field in certain lines of work, and that it will always prove more advantageous for that particular line of work than any of the electric welding processes so far developed. I do not make this statement with any thought of disparaging the electric apparatus in any way. On the other hand, it has its advantages and



ssociation at the Cleveland Convention

Tenth Annual Convention at Cleveland

sion of Practical Side of Boiler Maintenance

—Reasons for Bulging of Front Flue Sheets and Crack- heater Tubes—Removing and Replacing Wide Fireboxes

has a field distinctively its own, which, in my opinion, cannot well be covered by the oxy-acetylene process, so that both processes should have our best thought and attention at all times with a view that they may be developed to their highest point of advantage to us in our maintenance work.

Referring to the subject of boiler flues, which are of such length and thickness that they sag on being applied to the boiler and vibrate with the momentum of the boiler when in service, this subject is of a considerable interest to me because I have made certain investigations and experiments in that line which to my own satisfaction have demonstrated that there is a certain movement of the flues caused by excessive heat or cold that increases or decreases the sag in the longest flues a considerable extent under the varying conditions of service from the time that the fire is first applied to the locomotive until the time that the locomotive is hauling its train on the road. The indications are that under certain conditions of service the sag in the tube is actually straightened out and under other conditions the sag is increased. With this fact well established it should be possible to couple up the information so obtained with some of the results found in flue maintenance in regular locomotive service.

All boiler makers are thoroughly familiar with the fact that when an engine with the flues set in the old manner comes in leaking badly it is usually possible to run a piece of good, thick paper between the bead and the flue sheet at the back end, especially after the engine has been cooled off, but has not become cold. Inasmuch as the boiler maker usually goes into the firebox to make repairs on such flues just as soon as the heat in the firebox is reduced to a point where it is possible to go into the box, such repairs usually result in clinching the flues in whatever position they may happen to be, regardless of whether they are extending anywhere from one sixty-fourth to one thirty-second inch further into the firebox than they should. Clinching the flue in that position, beading it up and then turning the engine out has the tendency after that operation has been performed a few times to shorten the nominal distance between the flue sheets, usually resulting in the back flue sheet being pulled in towards the shell of the boiler in the greatest zone of leakage.

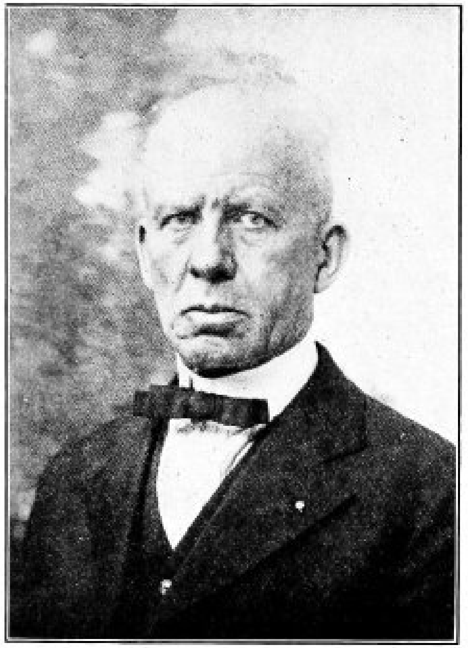
The questions which we should try to answer are:

1. Why do the flues protrude into the firebox as outlined above?

2. What can be done to avoid the flues pushing back through the back flue sheet in this manner?

Mr. McBain commended the work of the committee

HON. D. A. LUCAS,
President-Elect



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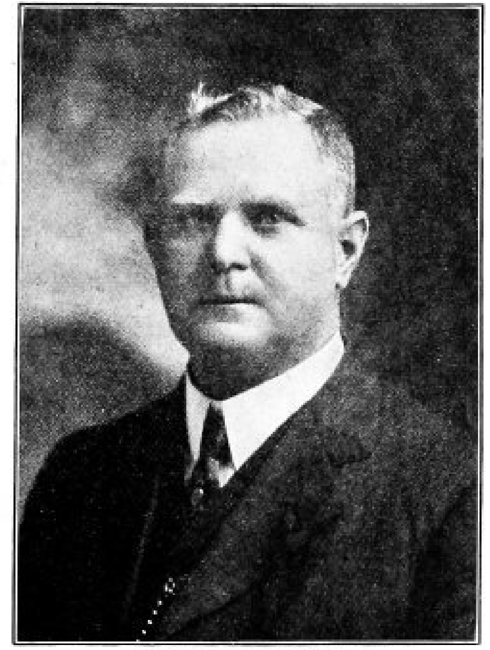

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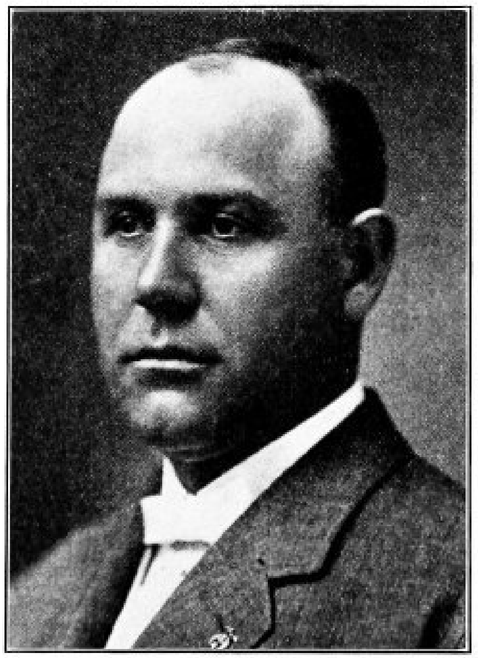

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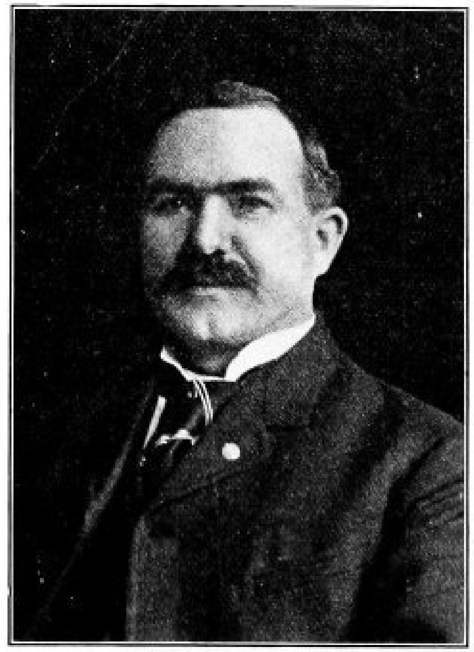
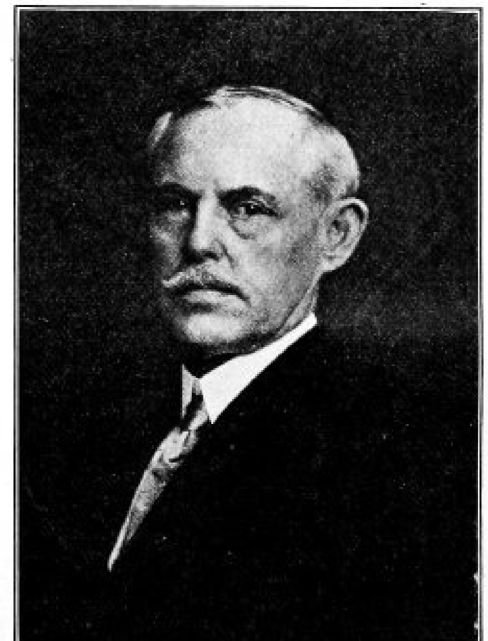


FRANK GRAY,
Treasurer



HARRY D. VOUGHT,
Secretary

which recommended an extension of time limit for the removal of caps with flexible staybolts, as he believed that the removal of these caps for inspection as now provided for under the Interstate Commerce Commission's rules is entirely unnecessary, does not add anything to the safety of the boiler and imposes an unusual and unnecessary expense on the railroads. He hoped that the locomotive boiler inspection department would find it consistent to make such concessions as will be of mutual benefit to the carriers, and to the commission as well, in this respect.

When we arrive at that stage of perfection, declared Mr. McBain, wherein all unnatural stresses in the firebox in its relation to the outer shell and the barrel of the boiler are relieved—and I believe this to be entirely possible—we will have removed ninety-nine percent of the troubles incidental to locomotive boiler maintenance. Is not this thought worthy of your fullest and most earnest consideration? It is my personal opinion that some one some of these days will design a front and back flue sheet with such flexibility as will absolutely relieve strains at the flue anchorages at both ends. Just how this will be accomplished it is hard to say, but it seems to me that the proper plan to work upon is in putting in a front flue sheet that will move with the lengthening and shortening of the flues without resistance a sufficient amount to relieve the strains both in compression and tension, to which we know flues are now subjected in ordinary service.

At the conclusion of Mr. MacBain's address, Hon. D. A. Lucas, vice-president of the association, took the chair and the president read his annual address.

Address of Mr. Andrew S. Greene, President

Our association has come together for the purpose of taking into consideration the many subjects that are to come before this body for discussion, with a view, if possible, of enlightening us all. None come here but to be enlightened and edified by the information available.

To my mind the pursuit of the boiler maker is one of the most difficult and trying of any of the pursuits of life. It is filled with disappointments, it is filled with deviltries, and climatic influences have their effect upon results. Even our superiors sometimes in a measure are overbearing to us in their expectations. The critic does not stop very long to think or consider before passing judgment upon boiler work. Our occupation, more than all others in the railroad business, is fraught with disappointment and more susceptible to harmful influences that we cannot control. Hence it was that the pioneers in days gone by planned and conceived this association for the purpose of endeavoring by mutual intercourse to overcome those powers which are apt to do us harm in our business.

They indeed built wiser than they knew. Imagine some years ago the temerity of a few of these men getting together and planning an association that was to go on from year to year: and be it said to their credit, unless I am incorrectly informed, they never missed a meeting! Annually, as the years pass on, have these men come together, and discussed and talked over matters pertaining directly to their business, and also the business of their employer. It is unnecessary for me to recount, as has been done on former occasions of this kind, the amount of good that has inured to the railroad company, our employers, by this meeting together, by this social intercourse and by this interchange of reason and judgment. Time has been shortened in our work, obstacles have been overcome, material even has been analyzed and the bad has been quietly put aside, and while rank weeds are still found in the garden, as time passes on, they will disappear under right cultivation. The railroads will soon learn that the boiler maker is getting educated, that he is getting right up to what is required of him, to do permanent work that will stand and be a credit to the man who performs it.

SECREATRY'S REPORT

Harry D. Vought, secretary of the association, reported that in 1915 the total number of members of the association was 370; at the previous convention, held in Chicago, 63 new members were added and 45 reinstated, making the total number of members 478. On March 31, 1915, the membership totaled 426.

ANDREW GREENE,
Retiring President

The next speaker called upon was Mr. W. C. Connelly, president of the Boiler Manufacturers' Association of the United States and Canada.

Abstract of Mr. Connelly's Remarks

The topics that your association are discussing and working along are quite in line with some of the things that the American Boiler Manufacturers' Association is doing. At the present time our greatest efforts are being put forth for the establishment of a uniform boiler code throughout the United States, pertaining to the construction of steam boilers. Of course, that does not take in the locomotive type of boiler that you are most interested in, because that is governed by Interstate Commerce laws.

Our convention will be held on June 20, and we are working along the same line, all dealing with the same elements—steam, high pressure, superheat, bad water conditions. The water conditions interest us greatly. I think it is one of the greatest problems we all have to deal with. You take the water here in Cleveland, which is good, and then you get some other point, where the water is very bad, and the boiler comes into the shop, and it is up to you gentlemen to put the boiler right.

Locomotives to-day have a very much higher pressure than those of a few years ago. Practically all of the boilers that are being put in to-day are superheater boilers. That is a new feature. Even in stationary service, we find a great many stationary boilers being put in with

300 pounds steam pressure and 350 degrees superheat. At the present time boilers are being manufactured of 2,500 horsepower, the largest boiler in the world. We are all progressing; the stationary man is doing all he can and we are doing big things as boiler manufacturers.

Treasurer's Report

The treasurer's report showed the total receipts for the year to be $2,016.97 and the total expenditures $1,463.09, leaving a balance of $553.88.

Following various announcements by the secretary, a series of moving pictures was exhibited by the National Tube Company, Pittsburg, Pa., showing the entire process of the manufacture of tubes, from the mining of the ore to the shipment of the final product.

Dr. J. S. Unger, manager of the Central Research Bureau of the Carnegie Steel Company, Pittsburgh, Pa., delivered a very interesting and instructive lecture, illustrated by lantern slides, on the effect of sulphur on boiler steel.

WEDNESDAY MORNING SESSION

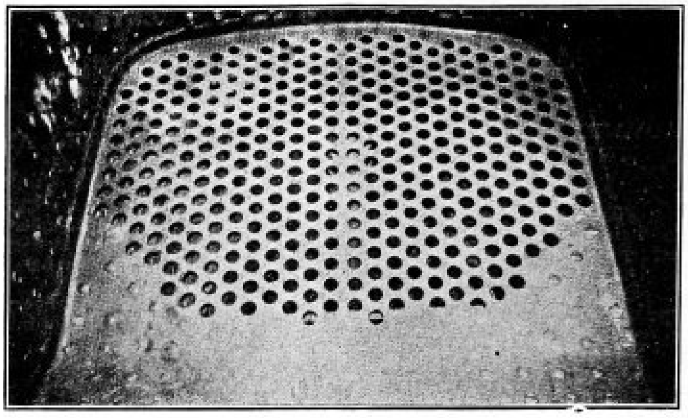
The Wednesday morning session was called to order by President Greene at 9:15 and in the absence of Mr. Frank McManamy, who was scheduled to address the convention at this time, the regular order of business was taken up.

Oxy-Acetylene and Its Advantages in Boiler Repairs

The oxygen and acetylene is obtained in suitable containers for use in the shop, or the acetylene can be manufactured as used, by a stationary plant, from carbide. In the stationary method the acetylene is piped from the accumulator through the shop to different stations, and the oxygen is obtained in suitable containers and attached to a manifold and then piped through the shops to these stations. The gases are here combined in the torch. In this method low pressure gas is obtained, which is advantageous because a more even flow is obtained.

In the high pressure method, oxygen and acetylene containers are mounted on a portable truck and the flow regulated by valves, the gas being again mixed in the torch.

Oxy-acetylene is used in both welding and cutting in boiler repairs and construction. The various kinds of welding work that can be done are as follows: Firebox sheets, door sheets, patches, mudrings and flue sheets; and it is also used for filling in thin spots in sheets, building up calking edges and for miscellaneous purposes, such as welding oil tanks, etc.



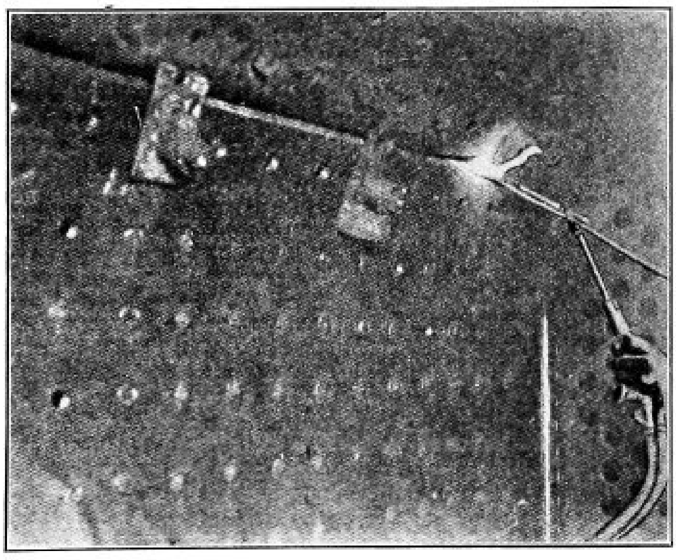
Back Flue Sheet Welded to Wrapper Sheet

Welding—In preparing for general welding, the plates should be cleaned of all dirt and scale, then fitted together line to line as closely as possible. The plates are beveled to a 45-degree angle to the full thickness and bolted properly in place.

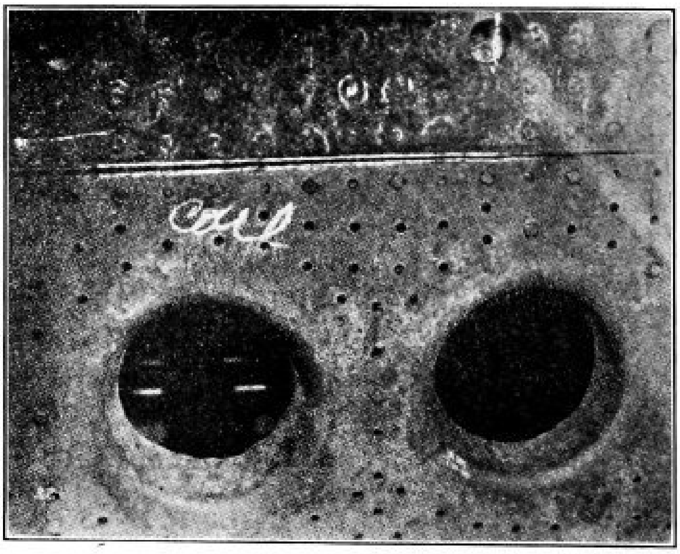
Two methods are followed. In some shops the plate is dropped 1/8 inch per foot, while in others the plate is put in place and all rivets and staybolts applied before the welding is begun.

The operator should take due care to have the proper mixture of the oxygen and the acteylene, which his experience will teach him. This is most easily told by seeing that he does not get a double cone on his oxygen flame and that his acetylene flame does not "sputter." In case he gets too much oxygen the plate will oxidize or burn, and where too much acetylene is used the plate crystalizes or hardens. Due care must be taken to avoid a porous weld.

In welding, the flame should be worked back and forth in such a way as to heat both sheets evenly and melt both at the same rate, until the edges are welded together. After the sheets have been welded at the feather edge the V should be filled by applying the Swedish iron wire evenly until the V is filled up 1/16 inch above the surface of the plate. This is worked in spaces of about 2½ inches. Then go back and heat to a welding heat and fill in with wire. Some shops weld sheets at different points and



Welding Crown Sheets



Three-Quarter Door Sheet Ready for Welding then come back and make the weld continuous, while other shops weld straight along.

Cutting.—The oxyacetylene may be used for cutting steel, cast steel and wrought iron. Its uses in boiler shops are as follows:

(1) Cutting out fireboxes all parts.

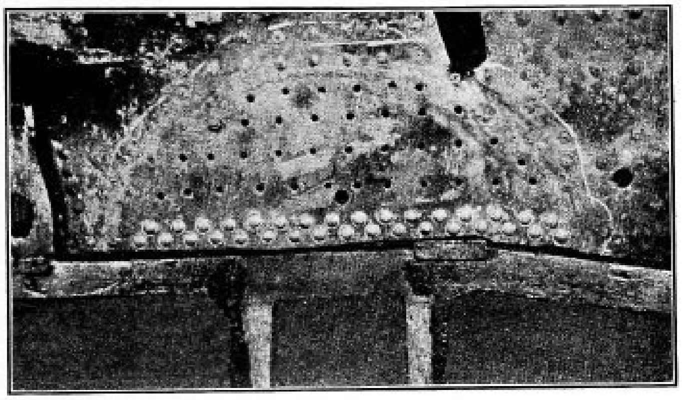
(2) Cutting out smokestack holes and cylinder holes in smoke box.

(3) Cutting off staybolts for driving.

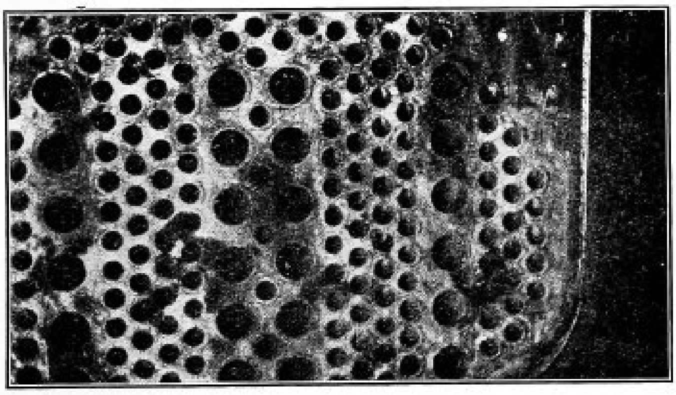
(4) Cutting seat boxes and running boards for pipe holes and appliances.

(5) Other uses too numerous to mention.

In preparing for cutting the operator should see that all hoses are free from dirt, that the torches and gages are in good operating condition, that the gases are so regulated as to produce a good cutting flame, which experience soon teaches.



Welded Patch on Outside Wrapper Sheet



Welded Cracked Bridges in Back Flue Sheet

After the torch is working satisfactorily to satisfy the operator, he holds it about ½ to ¾ inch from the metal to be cut and exercises due care in following all lines and marks made for his direction.

The time in cutting can be reduced from 50 to 95 percent in any and all classes of work with which we come in contact in a locomotive boiler shop.

JOHN HARTHILL, Chairman.

Before discussing this report the chairman introduced Mr. Frank McManamy, chief locomotive boiler inspector of the Interstate Commerce Commission.

Abstract of Mr. McManamy's Address

Many factors must be considered in connection with the successful operation of large modern locomotives and high speed trains, but none is more essential both to speed and safety than the condition of the locomotive boiler. It would be an injustice to the many other classes of reliable, efficient railroad employees who are faithfully and earnestly laboring not only to maintain but to improve the wonderful transportation system of the country, to say that the work of the boiler maker was the all-important factor. It is true it is highly important to have a properly designed, well constructed and maintained boiler, because locomotives cannot be operated without steam. It is equally true that no matter how efficient the boiler, without properly designed, constructed and maintained cylinders, wheels and other mechanism you do not have a locomotive. It is also true that no matter how efficient the locomotive, if it is not properly operated it may be a source of danger, rather than an efficient servant. Therefore, it would doubtless be improper for any one class of employees to claim pre-eminence.

On the other hand, no one should underestimate the importance of the duties he is performing, because better work will always be done by an employee with a keen sense of its importance, and turning out a locomotive with a poor boiler is about the same as erecting an expensive building on a poor foundation.

The duties and responsibilities of the foreman or master boiler maker are constantly increasing, and it is necessary for men who fill those positions to broaden out and take advantage of every opportunity that is offered to improve and to learn the best methods of doing their work. Constant effort and study are required to keep up with the march of progress; therefore, meetings of this kind are of value, not only to the master boiler maker who attends them, but to the company by which he is employed.

Meeting and becoming better acquainted with fellow craftsmen from other roads, and discussing matters of mutual interest, not only results in accumulating new ideas, but it fills men with enthusiasm and makes them more eager to perform their work in the best and most up-to-date manner.

One of the best advertised movements in the railroad world to-day is what has come to be known as the Safety First movement. Many of us here have been in railroad service when comparatively little attention was paid to the safety of employees, and looking after himself was considered a part of the employee's duty. Something over twenty-five years ago the number of men killed and injured in railroad service began to attract the attention of the public, and movements were started by the employees to obtain the passage of laws for the promotion of safety for railroad men. Strong opposition was encountered from sources where support for the movement might reasonably have been expected, and it was only after a number of years spent in the work and after a number of laws had been passed and enforced to an extent which proved that it not only was a protection to their employees, but it was actually cheaper to protect employees than it was to pay for their injuries, that the movement was actively taken up by the railroad companies under the slogan of "Safety First."

It will perhaps surprise most of you to know that the records of the Interstate Commerce Commission show that during the last twenty-five years 223,721 persons were killed and 2,184,339 injured in railroad accidents, and that before the slogan "Safety First" was ever heard more than one million railroad employees had been killed or injured in their daily work.

Do not understand me as criticising the Safety First movement. Far from it. The movement, belated as it was on the part of the railroads, is welcome. Where it is sincerely observed, it is a boon to both the railroads and their employees, and is doing much to prevent accidents. As one railroad which is a pioneer and one of the most consistent advocates of the safety movement puts it, "It takes less time to prevent an accident than it does to report one."

In fact, where "Safety First" has been actually made a part of the principle on which a railroad is operated, instead of simply being given a place in its advertising literature, it has proven so profitable that it is being extended even to the handling of freight, a recent report to the American Railway Association by their Committee on Packing, Marking and Handling of Freight, showing that during 1915 a saving of $7,626,519 was made on 112 railroads by the adoption of Safety First methods. If such results as this can be accomplished in the handling of freight, surely the movement as applied to employees is worthy of our best efforts.

It may be asked, What can this convention or its members do to promote safety? The answer is, It can do a great deal. It is true it represents but one branch of railroad work, but it is an important branch. The men of whom this association is composed have charge of large shops and many workmen who are engaged in the construction and maintenance of locomotive boilers and their appurtenances, and are therefore responsible in a great measure for the safety, not only of the workmen who construct, but those who operate the product. No industrial operation is of sufficient importance to justify the unnecessary loss of human life in its accomplishment.

The purpose of the locomotive boiler inspection law and of the amendment thereto was to promote safety. The organization created thereby represents but a small part of the work which the Federal Government is doing for the protection of life and limb. In its particular field, however, remarkable progress has been made, and a general summary of the results accomplished by the law will be of interest.

During the first four years the Federal locomotive boiler inspection law was in force 330,739 locomotives were inspected by Government inspectors, 13,445 of which were found to be in violation of the law and were ordered out of service for repairs. The result of this work is best shown by a comparison of the number killed and injured during the first and fourth years under the law. During the year ended June 30, 1912, there were 856 accidents caused by failure of locomotive boilers or their appurtenances, resulting in 91 killed and 1,005 injured. During the year ended June 30, 1915, there were 424 such accidents, which resulted in 13 killed and 467 injured, a decrease in four years of 48 percent in the number of accidents, 87 percent in the number killed, and 53 percent in the number injured. The records for the first nine months of the current year in comparison with the corresponding period for the previous years, show a further decrease in the number of accidents and in the total number of casualties; the number killed is somewhat greater than for the preceding year, but is still below the average. This is especially noteworthy in view of the strain on the railroads, their equipment and their employees due to the unprecedented volume of traffic during the past year, and conclusively shows not only the importance of, but the results which follow Federal supervision over locomotive equipment.

We do not attempt to make the claim that the Federal inspectors are responsible for all of this improvement. We will claim, however, until a similar improvement is shown in some branch of railroad service that is not covered by the law, that the Federal law is responsible therefor.

I have given these comparisons between the years ended June 30, 1912, and June 30, 1915, because of a change in the Federal laws which will make it difficult to continue the comparison on the same basis. I refer to the amendment of March 4, 1915, extending the work of the Federal inspectors to the entire locomotive and tender, as well as to the locomotive boiler and its appurtenances; and in order that our position in this matter may be entirely clear, I will say that this amendment made absolutely no change in the Federal locomotive boiler inspection law, and none in the method of its enforcement. It is true, it added to the duties of Federal inspectors, and perhaps will make it impossible for them to inspect so many locomotives, but no change will be made in the method of handling the work under the locomotive boiler inspection law.

The Locomotive Boiler Inspection Bureau in its relation to the railroads has always taken the position that the work of preventing accidents and promoting safety to employees and the traveling public can only be successfully accomplished where genuine and intelligent interest and hearty co-operation between the railroad, their employees and the Government exists, for which coercive measures are but a poor substitute. It must not be assumed from this, however, that the question of co-operating with us in this work, and to what extent, will be left to the discretion of the railroads. Where such co-operation is not voluntarily given or is only given when no expense or delay to equipment is caused thereby, then the power that is conferred on us by law will unhesitatingly be used to accomplish the purpose intended.

It is but fair to say, however, that a large percentage of the railroads are co-operating with us to a very great extent, otherwise such wonderful results in the prevention of accidents could not have been accomplished, and as the beneficial results of the law become more and more obvious, co-operation is more unreservedly and wholeheartedly given.

Mr. M. O'Connor, past president of the association, responded to Mr. McManamy's address.

Discussion of Report on Oxy-Acetylene Welding

Mr. Harthill: Oxy-acetylene welding, as your committee predicted, will be a modern art in boiler work for the next few years. Your committee says in their conclusion: "It is the opinion of your committee that with a modern apparatus, competent and experienced welders and the proper facilities for handling the work, the results will be the best that are known in the modern boiler-making art. Your committee predicts that within the next few years oxy-acetylene will be the standard practice in all boiler shops for the work we have covered and that many more uses will be found for it." I have here some statistics that were obtained after making tests of different methods of welding ⅜-inch plates by the acetylene process.

Kind of Weld.	Thickness of Weld.	Percent Increase of Weld.	Tensile Strength.	Elongation.	Efficiency of Weld.	Remarks.
Original piece—No weld......	.390	....	59100	25.5	100.0	
Pieces loose, and close together	.445	20.3	56520	11.0	95.6	Slight traces of crystalization.
Pieces tight, with ⅛ in. open'g	.483	24.5	41650	4.0	70.5	Slight traces of crystalization.
Pieces tight, with ¼ in. open'g	.512	32.6	39820	2.5	67.4	Slight traces of crystalization.
Pieces tight, with ⅜ in. open'g	.490	26.0	34340	2.0	58.1	No traces of crystalization.
Pieces tight, with ½ in. open'g	.528	40.1	34630	2.0	58.6	Slight traces of crystalization.

D. A. Lucas: I find that not all of the trouble lies with the welder. We had a good deal of trouble with the operators but a whole lot depends on the material. I have made tests and found that to my satisfaction, a good percentage of the failures is caused by material. Of late we have, while we established a record and went along all right, under the same process and everything, we began to have failures, and upon investigation we found we were not getting the metal that we had previously gotten for that work and I have tested out the different welds in several ways, and the most efficient test I got was in taking and preparing two jobs the same and giving them to two different welders. Now, neither pulled the same, so it was either in the material or in the operator. They did not stand the same operation; did not stand the same test. We started this oxy-acetylene process in 1910 and we are still finding new fields every day for its use. I think it has come to stay and is one of the best things we have gotten in boiler making for several years. I thank you.

Mr. Stewart: We have been welding with oxy-acetylene since 1910 and we believe we have passed the experimental stage. We have been doing such work as you see in the pictures here in the report for the past two years; we have been welding firebox ends with very good results. We have had no failures at all in welding fireboxes. You will notice the picture on the welding of the flue sheets on both sides, on account of expansion. We weld the flues, the door sheet and the door collar ,and we also weld the sheet to the back end. We weld side sheets, and I never drop the side sheets! that is something the committee did not agree on. Sometimes we put the sheet in and put the staybolts and the operator can get to the weld; sometimes we only put in one row of staybolts and then weld, but if the welders are busy we put in all the staybolts and drive the mudring, but we never drop the sheet for expansion. We put the sheet in and weld the flanges on the end. I notice that lots of people do not weld the flanges; they think that is too slow; they rivet them. We also find that the side sheets are defective and the flanges are to a certain extent defective. With regard to putting in the crow sheet from failures from low water we do that very often; it is an overhead weld and we have success in that operation. We also handle fireboxes—five pieces of the firebox and weld it completely. We find that is a great saving over the old method of handling the boxes. We weld front flue sheets on small engines where we don't care to spend much money; we burn off the bridges, put in a new sheet and weld back the bridges. As I said, we have had this system since 1910 and we have had no trouble.

Mr. Patrick: I would like to ask Mr. Stewart whether you use any special material?

Mr. Stewart: Yes, we use a special material. It is made by a special process.

Mr. Westover: With regard to oxy-acetylene welding we have been using it for the last four years. I have heard a great many of the members of this Association talking in little groups together in regard to the work they are doing, and I would like to make the fact known about the work we are doing in the Northwest country. We have a heavy class of power out there, mainly Mikado engines, and we are having trouble with the top of flue sheets cracking out. The old method used was to plug up the holes, lap the inside of the sheet, but we have found it of great benefit to come down as high as eighteen inches on the flange. We have trouble with the three-piece fireboxes; we put in the side sheet; we cut out all the longitudinal seams and the firebox is welded four inches from the line of staybolts. We have made several tests in Portland, and I also have the honor of having put a boiler in a steamboat, and I came in contact with the Federal marine laws, which are very rigid. Some of the members of this Association may know Mr. Fuller, who is a chief inspector. He made us produce physical tests of the welds before he would allow us to put in a boiler that was welded in that boat, and it has given satisfaction. I have occasion, many times through out general manager, to make investigations and inspections of marine boilers and give advice on oxy-acetyelene welding.

Thomas Lewis: We have passed the experimental stage. I believe it was in our shop where the first complete new firebox was welded; that was done, possibly, three years ago and that engine is now in service and has been continually in service with the exception of changing the flues. We have not had to do any boiler work on that engine with the exception of taking care of the staybolts and the flues. We have practically elimnated what is known as fire-cracks in the riveted seams. We are doing at the present time practically all of our firebox work. I don't think we are now putting in any fireboxes in the old way; that is, riveting the door sheets and the flue sheets—they are all welded. Another firebox that we have recently welded has a combustion chamber. I believe that the combustion chamber is about forty-eight inches deep. That firebox with the combustion chamber is practically one piece—everything is all welded—there are no rivets applied excepting the mudring. We have six of the engines with these fireboxes now in service. The first one, I think, has been out about three months and is giving entire satisfaction. It has been part of my duty to follow up this work and make inquiries at the different terminals where the engines were returned, and I have made a personal inspection to see whether there were any leaks developing, and I feel confident and glad to tell you that up to the present time there are no leaks or bad defects that I have found. We are doing all kinds of work. We make all kinds of repairs and we have practically eliminated the seams in the fireboxes, even patches.

Mr. Pratt (Chicago & Northwestern R. R.): I believe it is the general consensus of opinion of the thinkers in the railroad world today that the greatest opportunity is in the boiler. The advent of the superheater seemed for a time to overcome or offset some of the advantages that had been gained by compounding, so much so that many, perhaps the majority, of the designers abandoned the principle of compounding the steam in the cylinder, to obtain the greater expansion and adopted the superheat, which gave equal if not greater economies. Now that the superheater is, I might say, a standard on most locomotives, not excepting switch engines, there is some thought again being given to the compounnding of your steam economies. However, when you see the large locomotive boilers today it looks to me as though the chance for improvement is greater in locomotive boilers than any other part of the steam locomotive.

I hope before this subject is closed that some of the members that have had success in the welding of holes in the back flue sheet in bad water districts will explain just how they accomplish it. On the Chicago and Northwestern Railroad we were over enthusiastic in the welding of flues, and we imagined that of our past troubles the greatest perhaps was leaky flues in bad water districts, and we thought that just as soon as we welded those flues our troubles would be all over. But we have found almost the reverse of that. There has been trouble with the welded flues; in the small flues particularly. In the good water districts it is a grand success, but where we welded them in the bad water districts, unfortunately, it has not been successful. We have made a few experiments, and I have here several samples of welds that we have made. One shows a recess in the back flue sheet in which the beads were turned and then it was welded over, showing a thorough soldering of the joints between the flue sheets and the turned end of the flues, the idea being to make so firm a connection between the flue sheets and the flue that you can prosser them about to the limit with your expander without breaking the weld loose between the flue sheet and the flue.

We believe that the reason that we have trouble in the ordinary welding, electric welding of flues in back flue sheets in poor water districts is because the scale accumulates on the flue and we do not knock it loose as we do in the ordinary expanding of the flues.

Another piece shows how when the flues are to be removed that it is only necessary to chip off the weld and the flues will come out without damage to the flue sheet. On the Chicago and Northwestern, we have bad water; water that pits badly, so it would be interesting to have the subject of pitting and grooving discussed. A piece was brought into the office yesterday morning which shows what was left of the flue sheet. It is entirely eaten away and there appeared to be no grooving about it at all. It seems to me that pitting and grooving is another proposition that you gentlemen have got to solve sooner or later, and that every possible theory that is advanced should be run to earth, as this is a cause of tremendous expense and difficulty to the railroads today and should be overcome in some way.

Advantages of Oxy-Acetylene Welding

ABSTRACT OF REMARKS BY A. R. HODGES, FOREMAN BOILER MAKER, FRISCO SHOPS, MEMPHIS, TENN.

In the first place, the oxy-acetylene welding process is a decided advantage in the subsequent upkeep and maintenance of the locomotive. Under the old method of boiler work and engine repairs, leaky seams and rivets and defective side sheet patches, as well as many broken parts of engines and tenders, rendered the locomotive incapable of efficient performance, but with the oxy-acetylene welding process employed in boiler repairs, much of this trouble is completely eliminated. Its use completely eliminates all seams and rivets which are exposed to the direct attack of the fire, and when patches are applied it restores the plates to the original smooth surface. The life of the firebox is increased one hundred percent and an original firebox applied by this method will last longer and render better service than when applied by the old method. This being true, it logically follows that the outside casing sheet and back end of the boiler is conserved accordingly. Therefore the leaking of fireboxes, from all sources, which in the past caused us so much trouble, impairing the efficient performance of the locomotive and causing a high cost of maintenance, is entirely overcome.

Repairs to the engine and the tender performed by the oxy-acetylene welding process, make it possible to secure practically any mileage from a locomotive which might reasonably be expected, and the betterment of equipment will reach a higher percentage than can be obtained otherwise. Again, it is a decided advantage in repairing locomotives, on account of the rapidity with which the work is done, thus reducing to a minimum the time an engine is held out of service for repairs. By the old methods the repairing of a boiler was a very slow process and it was usually the complaint, "We are waiting on the boiler makers." In fact, the output of the shop was in a large measure dependent on the boiler department. With the oxy-acetylene process this obstacle is removed.

Again, the heavy tonnage that is being hauled and the fast speed that is being attained is proving very trying on the engine parts, especially the frames. During the last fifteen months we have had no less than forty-five broken engine frames on one division which maintains 138 locomotives. Under the old methods, this would have entailed enormous delays. We would have been compelled to send these engines to the general shops for repairs, and they in turn would have been compelled to furnish us with other engines for use. With the oxy-acetylene apparatus all these engines have been returned from the Memphis terminals, only three days on an average being needed to make repairs to an engine.

Another advantage of oxy-acetylene welding is that it eliminates the necessity of maintaining a large margin of power to handle the traffic. As a matter of fact, the margin of power required is reduced to a minimum. Hitherto each division master mechanic held his engines in service just as long as possible before shopping, and when shopped they would be "outlawed" from end to end. This is improper maintenance and to overcome this improper handling a large margin of power is absolutely necessary. With the oxy-acetylene apparatus, however, the wide margin of power otherwise necessary is reduced to a minimum and what might be termed "dead capital" is kept in circulation.

The next advantage of the oxy-acetylene welding and cutting process is that it makes it possible to accomplish heavy boiler and engine repairs in a small local shop with meager facilities and limited shop capacity. Also there is an important advantage by the marvelous savings effected in the reclamation of scrap material. This is accomplished in every instance without the necessity of having to remove castings, channel bars, I-beams or plates from the locomotive. Scrap piles are transformed into storehouses of serviceable material and the life of finished and applied equipment is extended from sixty to seventy-five percent, and in some cases a hundred percent.

One more advantage is found in that the oxy-acetylene process eliminates the use of a great many tools, reduces the demand for pneumatic hammers and motors, and makes it possible to produce high speed lathe tools at a greatly reduced cost. Oxy-acetylene welding and cutting is not a supplanter or a substitute, but an innovation of mechanical skill, super-abounding with economical advantage.

FURTHER DISCOSSION OF OXY-ACETYLENE WELDING

Mr. Wandberg: We are doing considerable oxy-acetylene welding, but I feel that the success or failure is due largely to your welders. You cannot hire them, you have got to make them, and it takes time. We have had trouble in our purchasing department purchasing the proper material. I believe that every man who has charge of welders should pay special attention to his welders. We do everything in the line of welding the firebox except the putting in of the fireboxes. We weld half side sheets, door sheets, door collars, inside combustion chamber sheets, and in fact weld other cracks on the top and under the flue sheet with great success. We have welded cracks in the side sheets up to eighteen inches long, and as time goes on our welders are improving. They are doing better work.

Mr. Madden: We have been using the oxy-acetylene welding for the past year and a half, and for some months we have done a great deal of patching in the side sheet and in different parts of the firebox, and I am sorry to say we were not successful, so we came to the conclusion that the only system for us to follow on our line was to renew the sheet. For instance, during the past year we have renewed and welded eighty-five flue sheets, one hundred and fifty-seven pairs of side sheets, forty 3/4-inch

flue sheets; that is, we put the top part of the flue sheet below the belly braces and renew them and with that type of work we are having the very best of work. We weld in lots of door collars; we also weld in a special dovetail above the belly braces in the bottom of the flue hole where they buckle out and crack. We have welded in three of those patches in one of our Western shops in about twenty flue holes and made a very nice job of it. We are also welding the top of flanges of the flue sheets, but we have made it a practice to cut the flue sheets off entirely and weld in new ones. We are well satisfied with oxy-acetylene welding on our road.

Mr. Borneman: I would like to ask Mr. Madden if they put in the rivets in the whole firebox before making the weld?

Mr. Madden: We put in all the rivets and sometimes we drive the rivets before making the weld. It is optional with the operator and the boiler maker. We do not cut off all the flanges. In some instances it is seventy-six inches, a radial box, and we weld along the length of the outside flue shell and belly braces to the other side.

Mr. Harthill: In regard to welding, I want to bring out a point which I came across on another test, made in another shop. It was ascertained that you have a pressure of 2,145 pounds when you are welding. Now, if you are going to get that and keep that strain in there doesn't that contribtue to failure? That is the point I want some gentleman to explain, where this strain goes to if it does not stay in the weld?

As regards material, I think that the very best is not too good to put in the firebox. I know that is true on our division: the New York Central want the best they can get. We want the best Swedish wire. If it is the least bit soft it is rejected. If you put in poor material you may expect failures—you will have poor results, and as to welders, you must make them yourself. It is not necessary to take a boiler maker or a blacksmith and make a welder of him; that is a mistake. You want to select a good, intelligent man and let him serve an apprenticeship; let him understand that welding is a trade by itself, then you will get results, and such a welder can give from 85 percent to 100 percent efficiency. He should get the highest pay, and if you do not do that you will not get the best results.

Mr. Westover: In the experiment how much did they drop the sheet?

Mr. Harthill: That was not my experiment. I hope that the member here who made the experiment will give us his experience.

Mr. Gallagher, of the B. & O.: With regard to dropping the sheet, we don't do that. We rivet the mudrin and drive them. We take care of that by corrugation.

Mr. Powers: On the Chicago & Northwestern we have about eighteen welders at the present time and about four months ago we made an experiment putting in side sheets, lapping them, not butting them at all, on three different engines, one engine with an OG and two with wide fireboxes, and up to the present date that engine has run without any failure. We also cut the knuckle the same as Mr. Westover spoke about and we take care of contraction in the same way, both contraction and expansion the same as Mr. Gallagher, with corrugation. Another interesting thing that we have been doing on engines with bad rivet seams, we cut the rivets out, cut half way through the side sheets, not the crown, and then scarph it and weld the rivet holes, weld right over the whole seam, don't smooth it cutting on the top calking edge of the side sheet. We have thirty-five or forty engines in service and so far have had one failure. We weld all the door holes in and weld the bottom of the front flue sheets. We weld side sheets in a good many cases. The side sheets on the Northwestern crack at times in the bad water districts and we have been able to keep engines in service many more months by using the oxy-acetylene. We think it is so important that we have installed a portable outfit in the roundhouses, so if they have cracks they can weld them right there in the roundhouse. We have welded our superheaters with oxy-acetylene, and up to date—we started about two years ago—they have given remarkable satisfaction. It takes considerably longer, and you must leave your copper out and not bead your flues over; you must make a homogeneous sheet. This has been remarkably satisfactory in bad water. I think in speaking about welding a man should specify what kind of water he had. We find that bad water makes a whole lot of difference in the life of your weld, and I think the man should state this.

A. N. Lucas: We have an oxy-acetylene outfit and we believe in it. We believe it is a good thing and it is the coming method of taking care of lots of our repairs. We have had the oxy-acetylene outfit for the past three years and we take care of all the welding. Since we installed it we have not taken a tire off. We have welded cracks as long as thirty inches without any trouble whatever. We are cutting out seams and cutting off thirty inches from the front end of the crown sheet and putting a radial track in. We are doing about everything that has been talked about.

Mr. Knauer: We have had oxy-acetyelene welding in our plant for about eight months and in that length of time there has been a great deal of work done. We have put patches on the firebox and put in two fireboxes complete, we have welded mudrings, and the superintendent of motive power is very well pleased. We have about 90 percent efficiency. We have had a few failures but no bad ones. We have welded top flues and side sheets and any part of the firebox, and also the firebox welded in complete.

Mr. Kelly: One member has stated that you must leave the side sheet loose, drop it so many inches because of the pressure per foot, and then another man gets up and says there is nothing to it at all, that you have got to put in your staybolts and put in corrugation. Now there is a big point right there, and it must be solved. There should be some right way to do this work either leave the sheet loose and keep the pressure off or if there is no pressure, put the sheet on and rivet it all up solid and weld.

D. A. Lucas: I can only speak here from experience. In 1910 I got the oxy-acetylene apparatus and a demonstrator with it. His idea was to drop the sheet as suggested by Mr. Harthill and others and I tried that experiment for quite a while and I did not get success. Now I don't advocate putting in a sheet and riveting it to the mudring and tying it perfectly tight, but put in the sheet, put in a few bolts, just ordinary bolts and the mudring, rivet your flange flue and door sheet and then run in your staybolts, now you are ready to weld. I am not able to state where the pressure goes nor how it is taken care of, but it don't seem to exist in real practice. I don't think there is anything in leaving a side sheet loose with an OG bend in it, but you might experience some trouble in the straight side sheet or a wide firebox with a perfectly straight side; you may have some trouble in that respect, but I attribute it more to material than strain.

H. R. Wark: As far as oxy-acetylene is concerned my experience has been brief. We welded on one side sheet with oxy-acetylene and one with electric. We dropped one-eighth of an inch and in welding the sheet it started to buckle and pull, which showed that there was some strain on it, but the sheet has held, and with electric welding we have welded a great deal.

The Chairman: In my opinion, welding is the coming thing, but I really prefer the solid sheet. I am one man who prefers the solid plate, 100 percent strength. I think myself, as president of this organization, that some of the members are going really too far in oxy-acetylene welding. While, without a doubt, it is the coming thing, I think there are men applying patches today in different parts of the firebox when it is really more of an expense to the railroad than if they were to put in the solid sheet, the solid plate or the full sheet. I think in putting in side sheets it is a good idea to weld a longitudinal seam, but in new firebox work welding in flue sheets, welding in door sheets, I really don't believe there is much made in that. On our railroad we don't have a flue sheet flange, or a door sheet flange welded; we calk them down to about one-eighth of an inch at the edge of the flange. We drive the rivets, countersink, and we never have any trouble with the seams. I believe with our method of working we are putting in our fireboxes cheaper than if we welded them with oxy-acetylene. I don't think it pays to weld up a long crack. I don't think it pays to weld patches right in the center part of the firebox. Patches in the mudring and side sheet can be done successfully and will hold but patches right on the fire line in the bad water districts, I am afraid, will mean a good deal of trouble.

A. N. Lucas: I think it is perfectly right to put on patches, especially round patches. If you use good judgment in this welding proposition, you can save money. I don't believe in putting in a new side sheet if you have a crack of twenty-four inches in it; I believe in welding it up. You will find that the weld will stand.

Mr. Wandberg. With regard to patches, when we first started that we confined it altogether to small patches. We have patches as large as 36 by 50 inches, and they have been in service two years and we have no failures.

Have any of the members had any experience in laying the patch right on and then welding? I am satisfied in my own mind that in doing that there is no strain on the sheet. I allowed about a quarter-inch lap.

Mr. Hempel: Mr. Wandberg and Mr. Lewis laid great stress on the quality of the metal. I do not think it matters much what quality of metal you use, if you even use the same quality of metal as the original plate. I think it is more in the operator being able to properly fuse the metal.

We do not use the oxy-acetylene welder on the Union Pacific Railroad, but we have had the electric welder in operation for the past six years.

Mr. Young: I had occasion to witness a test in the welding of a half side sheet to see how far it would travel. It was left loose and dropped about three-sixteenth inch and the welder went to work and worked from the sides and then from the center and after it was cooled off the holes were perfect.

Mr. Knauer: About eight months ago we had a Mallet type engine and the side sheets cracked. Everybody knows the scarcity of material, and the firebox foreman and inspector decided to weld in the entire length, 10 feet. We put in corrugations of three-fourths of an inch between the lower staybolts. We have not had any trouble with it and we put in a number since then and they have given us first-class service. The strain is taken care of by the corrugations.

It was voted to carry the subject over to the next convention.

Electric Welding and Its Advantages in Boiler Repairs

Welding by electricity was started at Mount Clare July, 1913, with a one-man machine. After a short time we had another installed and have now on requisition one four-man machine.

Most of our electric welding has been confined to the welding of flues, because the flues are not yet far enough advanced to do much of any other work.

Since the installation of the two one-man machines at Mount Clare, on each of which we have been running three eight-hour shifts on each machine for some time past, we have welded flues for 754 engines—178,890 small and 12,206 superheater flues—a total of 191,096 flues. This was from July, 1913, to October, 1915.

We have welded a side sheet on a yard engine which has been in continual service since 1913, and the sheet is as good now as when welded, as far as the weld is concerned.

To get good results, the machine should control the voltage, so as to keep it uniform at the weld. Fluctuations in the voltage or amperes mean a difference of temperature at the arc and weld. A weld will not be uniform throughout under such conditions. An automatic controller should be devised to control the voltage at the operator's hand.

Without proper wire it is very hard to make a good weld and a great many of the cracked welds are due to using bad wire. We are now using a Swedish iron with good results.

When welding a crack the section of crack should be built up and should be greater than the plate thickness by about 1/8 inch or 3/16 inch. Layer after layer should be applied across the width and length of the crack until it is filled up. This method allows the metal to cool and prevents a great deal of contraction by removing the strain from the weld.

All parts to be welded must be thoroughly cleaned with a roughing tool or sand blast. The latter is preferable when it can be used, as it cleans the work properly and removes all foreign substances.

The welding of flues is very important. It is our practice to set all flues back to head prior to welding, and the boiler must be steamed before welding so as to burn all the excess oil under the bead. If this is not done the result will be that the weld will be porous, due to the oil coming out as soon as the welding of the flue begins, making an interior weld, as oil will not allow the electrode to properly adhere to the flue.

About the proper amount of current to use to weld flues, at our shop, is as follows: 60 to 65 volt direct current, 130-145 amperes, using 5/32 inch diameter wire, and also a flux coated on welding wire by dampening the same and then applying flux, the work to stand until dry.

When welding flue sheets, door sheets and door necks with electric weld all the calking edge must be chipped and cleaned with a roughing tool. All fire-cracks must be chipped to 45 degrees bevel to rivet edge. The weld must begin at the bottom. It will not remain tight if welded down.

All the work must be calked with roughing tool to close all pores in the metal after welding. All cracks must be chipped to 45 degrees bevel to the bottom of crack to make a safe job.

All flues must be welded from the bottom on both sides. If possible, weld the flues with water in the boiler. This is good practice, as the water keeps down expansion and contraction of the flue and head, and also exposes all defective welded flues. A weld can be made much faster without water in the boiler, as water keeps down radiation to a certain extent and the flues will not weld as fast.

Fireboxes can be successfully welded instead of riveting. Make the weld come in between the first and second rows of staybolts, which will stiffen them. To do this the flue sheet and door sheet flanges must be deeper to allow the weld to come in between the staybolts.

All mud ring corners can be welded by lapping the weld over calking edge. Calk with a blunt, square tool. If this is properly done, it will eliminate further trouble. All shell patches can be welded along the edge and will prevent trouble from leaks.

The average time to weld a set of small flues 2¼ inch diameter is at the rate of about 20 per hour; for superheater flues about 6 per hour. It all depends on the operator and the machine. It takes about four hours to weld around the calking edge of a flue sheet, measuring about 18 feet over all, averaging about 40 inches per hour steady welding. Steel can be successfully welded, and all machine parts can be welded and machined to size. All engine frame rubs can be filled in solid. Wheel tires can be welded where worn and machined. All flat spots can be filled in, thus saving the renewal of a tire. All liners can be tacked to prevent them from working out.

Electric welding is very good to repair cast iron, such as broken gear wheels, frames of drill presses, housings of punch machines and bulldozers or machinery of any kind that is not subjected to heat, as the weld usually holds when the metal is kept at an even temperature.

P. F. GALLAGHER, Chairman.

[A supplementary report was also included, giving some information supplied by the Lincoln Electric Company regarding the welding of steel plates.]

DISCUSSION

Mr. Newgirg: About five months ago we had two bad side sheets and we removed the rivets, beveled down the sheet, cut off the flange, removed the staybolts and beaded out the bad cracks; we electric welded it and it is giving us good service.

Mr. Hempel: We have a number of electric welding machines. We run from 200 ampere to 300 ampere machines. The quality of work being done at our shop is excellent; we do all kinds, as much machine work as boiler work. I don't agree with your president that we are going too far either in the electric or oxy-acetylene welding. We simply replace the worn parts. We are going to get away from rivets. That is something that is coming. We have not had many failures with the electric welding, so I am not going to go back on the electric welding proposition or the oxy-acetylene proposition. The reason we use the electric welding is because we think it is cheaper, and it is the best, but in an up-to-date shop you should have both kinds. I do not think there is anything you can do with the oxy-acetylene welding that you cannot do with the electric.

In the various districts out of Cheyenne they weld around the flues of the engine as it comes into the shop; that is, in a good water district, but in the bad water districts we weld just about as few as we can. We have very poor success in bad water districts. However, we do prolong the life of that flue. We extend the life from about six to eight months, and probably get from ten to twelve months' service out of them. I believe it is right to weld in flues with the water in the boiler. In the electric welding of flues, or welding with the oxy-acetylene, which I do not do very much, the flues come loose at the end, to some extent in the hole, and I am inclined to think that by welding the flues with the water in the boiler it has a tendency to keep it cool and keep the flues from contracting. The flues after being welded, should be rewelded without water in the boiler, or very little, just sufficient to take up the slack that has been caused by the electric welding.

As far as expansion is concerned, when we first started the oxy-acetylene welding we dropped the sheets about an inch and seven-eighths, starting at one end and welding up. After visiting quite a number of shops doing this class of work and looking into it very thoroughly, I became convinced there was nothing in it, so I went back and I had my plates put in without dropping them below the mudring. If you weld your plates and drop it, you must continue; don't stop the operation until the job is finished, but if you put in the plates, put in all the bolts and take your plate, when you get up to it, pound your metal gradually as you go along, very slightly, sufficient to take up the expansion. If there was not pressure if the plates did not contract and expand, if they did not buckle up this way, what is the cause of your cracks? When the plates are cold there is a stress on them and all you need to do is to take your hammer, tap it lightly and take that out. I think you should pound your metal and then let your plate go into service and they will be about the same as the original plate.

In electric welding of flues we are apparently going up against something we are not looking for; we find the cracking of the flues lengthwise. We have been electric welding flues only for a year or a year and a half, but we have been using the electric welding for six years and have had very good success. If the original plate will crack, the electric welding or the acetylene welding will crack in time.

D. A. Lucas: As I understand it, you used to drop your plate, but you have discontinued it now; you don't drop it any more.

Mr. Hempel: No, we do not drop it now; it is not necessary.

Mr. Powers: I would like to ask if in dropping your plate an inch and seven-eighths you drop that on one end, and when you got across to the other, had the plate gone up the inch and seven-eighths?

Mr. Hempel: The inch and seven-eighths went up entirely. The operator was very careful to get the plate exactly right; he was very careful not to expand the metal much, for if he did the plate would not come up, so that is what led us to believe that we could take care of the expansion by not dropping the plate, but by pounding the metal.

Mr. Gray: We have had the electric welder on our road for about three years, and we put in all the half side sheets and door sheets and patches with the electric welder. We have not used the oxy-acetylene for that purpose at all. If the flue sheet is good enough we simply cut down the flange of the flue sheet and cut through, sometimes six rows of staybolts and sometimes ten; it depends on the sheet. We put the mudring bolts in, and we don't leave less than three-sixteenths inch opening, sometimes three-fourths inch or sometimes seven-eighths, but I don't figure on that. They commence to weld anywhere and finish up anywhere, or they can stop anywhere, and I can say that we do not experience any trouble. The rivets are driven and the staybolts and we chip the weld off and rough it and then weld, and you can hardly tell where the weld is. We have been following that practice right along.

As to patches, we put in an offset to take care of the strain, but found that we have had trouble there sometimes. We finally found that it happened mostly in vertical welds, and we decided to make our patches so we would not have any vertical seams.

C. A. Nicholson: About two years ago we put in an electric welding machine on the southern railroad and we have been working that successfully. The first thing we started was the electric welding of flues. In the first twelve months we put in about 35,000 flues and about 25 or 30 side sheets. We found at first that in welding the strain was so great on the sheet that after we got through, especially about the last end, in about a week it would break. In regard to patches, we changed our method and lapwelded with a half-inch weld. Sometimes we get the welding done before the staybolts are put in, and sometimes we have the staybolts in and the job completed and ready for the welder. We have never had one failure on that, and we have them in all shapes. About cracks, we have had a good deal of failures. We V'd them out and welded, but they would come back and be cracked, so we welded them over.

C. R. Bennett: How do you discover a defect in a weld before the engine goes into service?

Mr. Gray: Bobbing down the weld shows its condition. If it is not perfect, it will crack.

Mr. Nau: The electric welding process is a "life saver" in houndhouse work.

P. S. Hirsh: We have welded cracks as long as 45 inches. We have also welded 40,000 2-inch flues. We have been welding superheater flues for nearly four years.

J. B. Tate: We have about 3,300 locomotives equipped with welded flues. The troubles from leaky flues have been eliminated. We have failed to find a crack in a firebox welded by the electric process that hasn't cracked again. I would like to ask what profits are gained by the owners of the roads from using these modern appliances?

George Austin: Flue welding to the back flue sheet is the most important phase of the question under discussion. Good work can be obtained by both methods of welding. In some districts the trouble is not altogether due to the water conditions. The quality of the fuel has an important influence upon the results, especially where the fuel causes a heavy deposit and honeycomb. An excess of metal from the weld will cause such deposits. Under such conditions much success cannot be looked for with welded flues. I should like to ask how welded flues can be repaired?

S. M. Carroll: Fifty percent of the success of electric welding is due to cleaning the sheet. The flues are beaded and expanded and then welded, using an electric current of from 60 to 70 volts and of 90 amperes. The welding equipment, the size of the wire used, and the way the machine is installed are all important. We have tried welding the flues both with water in the boiler and without water in the boiler and have found no difference.

Mr. Powers: Welded flues fail in bad water districts. To repair the flues, cut off the weld and expand and bead over the flue.

Mr. Madden: During the four years' experience we have had with the electric welder, we have had some failures, but we have 300 engines with welded flues.

Mr. Tate: Our standard practice of putting in flues is to put water in the boiler and then weld.

Mr. Wintersteen: Flues welded by electricity in the big shop and then neglected have had to be renewed within from four to five months, whereas they used to last from one and one-half to two years. We didn't have facilities for repairs, but used a hammer and torch, hammering out the weld.

Mr. Pratt, of the Chicago & Northern Railroad, advised soldering the bead and prossering the flues every thirty days.

Mr. Stewart: We have been welding flues for eighteen months in bad water districts and roundhouse work at night has been eliminated. The flues have been put in in many ways.

Mr. Gray: All of our superheater flues are welded in, and we have had no failures. We use a 10-pound copper 1⅞ inches thick. We have welded only one set of small flues.

It was voted to carry the subject over for another year.

Before adjoining the morning session, Mr. Pratt was unanimously elected an honorary member of the association, and the retiring president was elected a delegate to the forthcoming Railway Master Mechanics' Convention.

THURSDAY MORNING SESSION

The Thursday morning session was opened at 9:15, with President Greene in the chair. The first speaker called upon was Mr. T. J. Carroll, assistant general superintendent of motive power of the Baltimore & Ohio Railroad.

ABSTRACT OF MR. CARROLL'S ADDRESS

The locomotive boiler under the service conditions of to-day is the container of an amount of energy the magnitude of which few stop to realize. It is impossible to overestimate the importance of keeping this construction in proper condition to withstand the chance under ordinary circumstances that this energy may be released through the failure of any part. If weak design, improper workmanship, poor maintenance, defective appurtenances or careless operation allow this energy to be suddenly released, it may cause loss of life and the wholesale destruction of property. It is particularly important that all of us who are connected in any capacity with the construction and maintenance of boilers should constantly keep in mind that we have a very great responsibility resting upon us in imparting to all others over whom we have jurisdiction, or with whom we come in contact in our work, the great importance of following out the rules laid down by those who are vested with the authority to prepare and issue such rules and regulations.

This can be accomplished in numerous ways, and it would be difficult to lay down a set of rules for this purpose. However, there is one question that has been impressed upon me a number of times, and that is, Why is inferior work turned out of shops? The results of the investigations of a number of cases of this kind would indicate that on the part of workmen and, in a number of instances, on the part of men in supervising capacities, there has been indifference or lack of appreciation of the importance of doing the work in the best possible workmanlike manner, and a failure fully to appreciate the disastrous results that may come from not doing it properly. It is, therefore, the duty of us all continually to impress upon those actually engaged in the performance of this work the importance of doing it in the best possible manner, thereby guaranteeing safety to themselves, their fellow workmen and the public, as well as doing credit to themselves. You are the men upon whom a great deal of dependence is put to see that the boilers are maintained in such condition that they meet the Federal and other requirements in every detail and thereby make them safe to life and property beyond all doubt. This is the earnest desire of the managing officials of our railroads.

It may be possible that the workmen are not sufficiently instructed in regard to their work, or that the instructions which are issued to them from time to time are insufficient or not entirely clear, and that the men are not checked up to be reasonably sure that the instructions are fully understood. If the instructions are insufficient, or not clearly expressed, the matter should be taken up and such revisions made as will make them perfectly clear. It should be ascertained that the men are fully equipped, both as to experience and instructions to perform properly the important duties entrusted to them. The association should look into this matter thoroughly and see what can be done by the railroads along this line.

In the absence of Mr. T. W. Lowe, past president of the association, Mr. E. W. Young, district inspector of the Interstate Commerce Commission, responded to Mr. Carroll's address.

Do Long Flues Which are of Such Length and Thickness That They Sag on Being Applied to the Boiler Vibrate with the Momemtum of the Locomotive in Service?

This report consists principally of an abstract of a paper read before the New York Railroad Club on May 20, 1910, describing some tests made on a large Pacific type locomotive of the New York Central Railroad to ascertain why the back and front flue sheets become deflected or distorted. The theory was that while the locotive was working, the fire hot and the circulation good, the expansion in the boiler proper between flue sheets was greater than that in the flues.

The standard gage flue of the New York Central is No. 11 B. W. G, but for this test No. 13 B. W. G. was used. When installing these flues each flue, before it was struck at each end, was depressed at the center 1 5/16 inches, with the result that the whole set of flues had a sag of about 1 inch more than the normal when installed. To measure the movement of the flues in service a needle was attached to one of the top flues at the center and extended up through the shell and attached to a recording device. A record of the movement of the tube was kept from the time the fire was started until 200 pounds pressure was raised.

Almost immediately after the fire was started the needle began to pull downward and continued in that direction until it had pulled downward fully ⅛ inch. It remained practically stationary for a few moments, then began to rise and continued in that direction until about ⅛ inch above the normal position. At that point the steam pressure began to rise and the rise of the needle from that point up to 175 pounds pressure was gradual, but very rapid from 175 to 200 pounds, with the result that the total rise of the needle was 15/16 inch.

On the first road test, immediately upon starting out the needle began to pull downward. The maximum downward pull was 3/16 inch, while the engine was being worked hard and running at good speed. The record for a second road test was practically a duplicate of the first.

This engine was afterward put into regular service on heavy passenger trains, and at the same time another engine of exactly the same class, having a set of standard No. 11 B. W. G. flues set to correspond with standard practice, was put on the same line of service. The engine with the special flues and special setting, in making 69,856 miles never failed while the engine with standard flues and standard setting in making 71,774 miles had a few detentions charged to it on account of flues leaking. The percentage saving in cost of maintenance of the engine with the special flues amounted to 26.7 percent. There was no perceptible difference in the condition of the flues in the firebox of either engine.

In the discussion of this subject at the 1905 meeting of the Master Boiler Makers' Association it was well established that flues would sag more or less, according to the length, that this sag was beneficial and that there can be no vibration with flues submerged in water, but that flues would move to some extent with the surge of the water.

C. L. HEMPEL, Chairman.

P. J. Conrath: Water will float the flues. An intermediate sheet, however, will be no improvement, as it makes it difficult to remove the flues.

Mr. Westover: Vibration was noted with flues 20 feet 7 inches long between flue sheets, on an engine running on a mountain division. The flues struck the rivets of the first course of the shell plating, although there was a ¾-inch clearance between the flues and the rivets. Holes were worn in the tubes and they had to be removed.

Mr. Hempel: Vibration cannot take place with a boiler filled with water; only when the boiler is empty. The tubes will move some, however, with the surging of the water in the boiler. The sagging of the flues is beneficial.

Mr. Madden: Tests made by measuring the movement of a needle gage resting on the tubes and extending through a stuffing box in the top of the boiler shell did not show any vibration. The vibration was prevented by the pressure and the weight of the water in the boiler.

Mr. Gray: With flues 10 feet 6 inches and 12 feet 8 inches long, we have had more trouble with cracking of the front flue sheet. With flues 16 to 22 feet long, there has been no cracking.

Mr. Fowler: Flue vibration may be a function of the track. Greater pitting in long flues may be due to the greater stresses in the long than in the short tubes.

It was voted to carry the subject over to the next convention.

Why Do Front Flue Sheets Bulge, and How Can it be Eliminated

The sheets have a very small amount of material to assist in keeping it straight. The amount of work and the tools used, as well as the experience of the man doing the work of putting in the flue, governs the bulging of the sheet, which the following record and experiments will conclusively show with reference to the effect of the various methods used for fastening the flue in the front end.

By using the rollers by hand each hole stretches 0.007 inch. With the self-feeding roller and hand pin the hole stretched 0.029 inch. With the self-feeding roller and air motor the hole stretches 0.021 inch, and by taking for a basis a flue head having 400 holes in it, the first method, or hand rolls, we stretched the holes 400 times 0.007, which equals 2.8 inches. The second operation, that is, self-feeding rolls and hand pin, we stretched the holes 0.029 inch, or 400 times that, which equals 11.6 inches. The third operation, or self-feeding rolls and air motor, we stretch the hole 0.021 inch, or a total for 400 holes of 8.4 inches. The amount of excess material is distributed over the space worked upon.

As the bridges between the flues do not upset proportionately to the increase in the sizes of the holes, to do the stretching of the material at certain points each individual hole must take care of a portion of the material round it, thus making the bulging of the sheet a local condition.

This test was made with a ½ inch sheet and 2 inch flue, 0.135 inch thick.

J. B. TATE, Chairman.

DISCUSSION

J. B. Tate: We went into this subject very deeply and presented only facts. The bulging of the front flue sheet is due to the flues or the manner of setting the flues. There are some spots in the boiler plate softer than others. Each operation we stretch the plate. Distortion can be expected after four or five renewals of flues. The trouble is actually due to the tools and the man using the tools.

Mr. Hodges: The bulging of the front flue sheets is due to the rolling and expanding of the flues. The first expansion stretches the metal until it is resisted by the band of the shell. Then a stress is set up in the plate, causing it to contract and distort, affecting also the back flue sheet. To overcome that, we made a small flue sheet and corrugated it all around the outside next to the flange. Across the top of the flue holes a corrugation was put in lengthwise of the solid plate. I am satisfied that a corrugation all around the flue sheet and the corrugation across the top of the flue holes will solve the problem. Expansion and contraction in the sheet must be taken care of by flexibility.

Mr. Wandberg: By making the pitch of flues smaller, you can get in the same number of flues and still leave space for the corrugations around the flue sheet.

A. N. Lucas: Was the corrugation put in to prevent bulging or to prevent cracking in the flange? It is not possible to put a corrugation all the way around the sheet. It would not help one iota. We used ¾-inch flue sheets in oil-burning engines and also ½-inch flue sheets. These cracked at the heel of the flange, so we used ¾-inch front flue sheets and ⅝-inch back flue sheets with good results. The front flue sheet lasts as long as the boiler. The bulging of the sheet is due to the use of the big motors in rolling the flues; not to service.

D. A. Lucas: The bulging is due to the first operation in the flue sheet. If the sheet is too small or too big, it will move when stretched into place or when straightened. Straighten the back flue sheet and let the front flue sheet go where it will. As the sheet grows older it will stretch. Corrosion and cracking take place on the sides and top of the sheet, not on the bottom.

Mr. Wintersteen: How long have the ¾-inch front flue sheets been in service?

Mr. Lucas: Seven or eight years.

Mr. Wintersteen: You will have trouble with them. We had ½-inch sheets which gave all kinds of trouble. There was a regular epidemic of trouble with them eight years ago. We took out the half-inch sheets and put in ¾-inch sheets and the epidemic was over, but in seven or eight years the ¾-inch sheets gave out.

Mr. Crites: The Pennsylvania Railroad has four Baldwin locomotives with the front sheets bulged 1¼ inches. This shows that the strain was in the sheets from the first operation.

Mr. Hempel. I don't think corrugation will overcome the trouble. The continued rolling will make the metal thicker at the rolling edge of the holes. Roll the flues just as lightly as possible and you have done all you can to overcome the trouble, unless some new style of construction is devised.

It was voted to accept the commitee's report and close the subject.

Best Method of Cleaning and Maintaining Superheater Flues

Nothing decreases the efficiency of the superheater more than dirty or clogged superheater tubes. Keeping superheater tubes free from cinders and clinkers depends upon the round-house forces, and more particularly upon the boiler foreman and inspector. It is every important that superheater tubes be inspected before each trip. Flashlights or electric lights with shields should be provided for inspecting.

It should be required that the clinkers and cinders be removed from the superheater tubes at the end of each trip, and if necessary they should be blown out. Steel bars from five to eight feet long with a chisel point should be used to break up the clinkers and honeycomb off the end of the unit. Other bars with hooks at the end should be used to pull the clinkers out of the tube, and it is very important that all the clinkers and honeycomb be removed from the tube, for if these are blown back into the tube they are liable to lodge on the supports of the unit pipes and will soon clog the superheater tubes. A ¼ inch or ⅜ inch pipe not longer than the tube should be used for blowing out the soot and cinders, care being taken that the pipe is run under the unit pipes and pulled back and forth until the tube is cleaned.

The best time to clean the superheater tubes is, of course, at the washout period, when the engine is cool, but this depends upon the grade of coal used, for with the use of some coal it is necessary to blow and clean superheater tubes each trip. Sometimes superheater tubes become clogged at the front ends, owing to clinkers and honeycomb being blown toward the front and allowed to lodge on the unit bands or supports. Therefore, an electric light should be shoved through the peep-hole in the smoke-box and tubes be inspected their full length, in order to avoid this condition at the front end.

As it is not necessary to remove the superheater tubes at the end of the three-year period in order to comply with the law, if the boiler can be cleaned and inspected, it is, therefore, recommended by many railroads that the superheater flues be welded at the firebox end. The tubes can be cleaned on the outside or water side, while in the boiler by the use of scraping rods and bars, pneumatic flue cleaners, and sometimes by heating the tubes. When it is necessary to remove the superheater tubes they can be cleaned in the flue rattler.

When it is necessary to safe end superheater tubes, many railroads recommend that not over one safe end be used. When the old safe end is cut off each time it is at least possible to re-tip the tube three times. After that they can be cut down for shorter engines.

It is the recommendation of this committee and other boiler foremen that the safe end go on the firebox end, where the condition is more severe, and where the new material is most needed. It is also recommended that the outside edge of the superheater flue hole be kept at least 3 inches from the inside of the flue sheet flange.

T. F. POWERS, Chairman.

DISCUSSION

Mr. Powers: The kind of coal used has a lot to do with keeping superheater tubes clean. Inspection is also of great importance. The companies which manufacture superheaters send out inspectors themselves for this purpose. The best method of safe ending is on the back end of the tube, with never more than one weld.

Mr. Hempel: The superheater tubes can be cleaned without removing the flues by using a pounding apparatus, operated by compressed air. The apparatus is a homemade knocker. The flues cannot be cleaned as well in place as by removing them, but the scale can be cleared off sufficiently to give the engine another shopping.

Mr. Gray: We have had six years' experience with superheaters and we have a special man in charge of the cleaning. One man takes care of the small tubes and one man has the large tubes. They use a chisel or a long chisel bar. A ⅜-inch pipe ten feet long is used to blow the stuff out at the front end. Cleaning scale from the flues in the boiler depends upon the kind of scale.

Mr. Wandberg: When you cannot knock the scale off, take the flue out. It is cheaper.

Mr. Lucas: Every time superheater flues are taken out, a cleaner is run through the flues. There is considerable deposit of coke on the inner surface of the large flues. The same tool is used for the small tubes.

James Kelly: The accumulation of deposit in the superheater tubes has been so great that we have taken out cores eight, ten and fifteen inches long. The swaged end of the tube was practically filled up, plugged solid. It is necessary to get a torch and make a personal inspection with the torch to find out how much deposit is in the tubes.

Mr. Powers: The submerged rattler is good with running water. We put in large and small tubes together and find that we do not dent the large tubes.

Mr. Lewis: We use a water rattler. Putting in big tubes by themselves made dents in the tubes. We then put in 2¼-inch tubes with the large tubes and got the best results.

D. A. Lucas: We use an old style dry rattler. We rattle the large flues by themselves, but have to fill up the rattler full.

Mr. Wandberg: We use a dry rattler, but the rattler must be completely filled up with the tubes to prevent denting them.

It was voted to accept the committee's report and close the subject.

What is the Most Economical Method for Removing and Replacing Wide Fireboxes on Locomotive Boilers?

The different conditions and facilities at the different shops have a great deal to do with just how this work should and can be done. If the shops are equipped with cranes, hoists, electric or oxy-acetylene processes for cutting and welding, mud-ring riveters and air tools of all types, it makes an altogether different proposition than when they do not have these facilities.

It seems to be the opinion of the committee as a general proposition that this type of firebox should be removed in the following manner:

After removing all flues, the boiler should be taken from the cylinders and frames and placed on the floor in the boiler shop, all stay and crown bolts drilled out with air drills, or cut off with the electric or acetylene processes' cutting mud-ring rivets off with hand chisels or punch and sledge, or by the use of an air hammer or rivet buster; then break the staybolts down with a staybolt breaker or leave them in the old firebox sheets, dropping the sheets or pieces of sheets on the floor. After this has been done all stay and crown bolt burrs can be cut or burned out of the holes.

All necessary repairs to the cylindrical parts, as well as the firebox sheets, are made and sheets cleaned while the new fireboxes are being fitted up, riveted and calked, and then the boxes are ready to be applied.

It is not necessary to remove the back head or disconnect the boiler at throat sheet to apply wide fireboxes; neither is it necessary to remove any boiler braces, except the braces applied to the back flue sheets. If the boilers are on the floor and crane service is available the boiler can be turned over in any desired position. This is a very great advantage in making this class of repairs, as it will make the work much easier, and in our opinion is a much quicker and handier method for doing this work.

In applying these fireboxes your committee differs some as to the manner in which this work should be done. In some localities they apply the sheets one at a time and bolt them up inside of the firebox casing. Where the fireboxes are applied in this manner the rivet holes are all countersunk and rivets driven on the inside of the firebox by the use of air hammers. It is claimed that where fireboxes are applied and rivets driven by this method, the flanges of the sheets are protected, and there will be less trouble on account of the sheets cracking out at the rivet holes. At some shops all fireboxes are applied in this manner, while at others they are applied to only certain classes of locomotives. As a general proposition it is the opinion of a great number of men doing a great amount of this particular class of work, that the boiler should be removed from the frames and taken to the boiler shop proper. When this is done, the fireboxes should be fitted up, riveted, chipped and calked, both inside and outside, ready to be put into the casing by the time the boiler has been cleaned and repairs made to the barrel and outside firebox casing sheets, or new sheets applied if necessary. The firebox can then be put in place if cranes are available. In removing and applying fireboxes in this manner, by taking the boiler off the clinders and the frame, the machinery can be taken to the machine shop and repairs made, while the boilers are being repaired and new fireboxes being applied.

The committee does not think it advisable to cut the back head out or disconnect the boiler at the throat sheet at any time to remove any wide type fireboxes. This is an unnecessary expense as well as it will destroy a good tight seam or joint. It is liable to cause fractures and cracks in your flanges and plates by the driving cut of rivets that are in these seams. If these rivets had never been disturbed, the defects as given above may never develop. Any wide type fireboxes can be removed and applied without disconnecting the boiler at throat sheet, or cutting out the back head, by one or the other of the methods set out in this report for doing this work—by applying the boxes after they have been riveted together, or by putting in one sheet at a time and riveting all inside of the boiler. The only objection that might possibly be found with the latter method is that you may not get your iron tight on the water side, and it is not possible to calk the sheets.

In the opinion of the committee, when boilers are removed from the frames, the fireboxes should be riveted, chipped, calked and completed before being inserted into the casing. It is also the opinion of the committee that, either one of the above-mentioned methods for the removing and replacing of wide type fireboxes would be the most economical method of performing this particular class of work.

B. T. SARVER, Chairman.

DISCUSSION

A. N. Lucas: We used to take out the back head, cut the throat sheet and break the bolts. That was the old method. We have done away with this. We now drill the bolts and cut the rivets, take out the rivets, cut the back head, assemble the box and rivet it from the inside.

Martin Gary: We cut apart the firebox at the connection, turn the box upside down and break the bolts with a staybolt breaker. The method of doing this depends largely on the shop equipment. Some shops have overhead cranes and others do not have the facilities for turning the work upside down. We have never tried out the piece-by-piece method. The sheets are burned out, but we break the staybolts.

Mr. Madden: We strip the boiler from the engine. The stays are drilled and, after drilling, the bolts are broken out with a breaker. The box is assembled with the heads riveted in. This method makes a saving for the company.

Fred Bayer: We first cut the sheet from the inside with a torch and drill the bolts just through the sheet from the outside. The boiler is laid on its side and the bolts cut with an air hammer. The box is taken out and the heads examined. The new box is built on the floor and riveted up and placed in the boiler. The method of procedure depends upon the equipment of cranes and other facilities in the shops. This is the most economical. We cut off the staybolts with a torch on the water side. Scale on the bolt inside hinders the cutting.

D. A. Lucas: The best method is the cheapest. Take off the cylinders and take the boiler to the boiler shop. Drill the stays and radials, drill the Tate bolts on the inside and save the bushings. If the stays are all rigid, drill all the bolts on the outside and cut the heads off and knock them off. If a torch is handy, cut all the sheets. After the bolts are all drilled, place the boiler on its side and take an ordinary punch and knock the bolts off, several at a time, and let the box fall in.

Fred Bayer: If you have no cranes and have to jack the boiler around, it is more economical to do the work on the boiler on the frames.

A. N. Lucas: We have an ordinary shop, no overhead cranes. We don't take the frames off for a new firebox and we don't disturb the mudring.

It was voted to close the subject and discharge the committee.

What is the Advantage of Cutting Off Staybolt Ends with the Oxy-Acetylene Over the Old Methods of Nippers and Chisels?

The advantage of cutting ends of staybolts off with the oxy-acetylene, are:

1. The bolts are not disturbed after they are once applied.

2. We get a uniform length to drive without long corners.

3. The heat anneals the end of the staybolt, which is a great advantage in the riveting, as the operator is better able to do a good job in upsetting the bolt without leaving any ragged edges, and as all staybolts are applied from the fire side of the firebox, this is a great advantage where a first class job is desired. Some may think that by cutting off staybolts in this manner the heat penetrates through the bolt to the firebox sheet, but this is not so, as the operation of cutting is done so quickly the heat does not have time to reach the sheet.

THOMAS LEWIS, Chairman.

MINORITY REPORT

I have been unable up to the present time to cut very many staybolts off with oxy-acetylene, but I have cut off a sufficient number of ends to prove, I think, that we cannot cut them off as cheaply as we can with the staybolt nippers we have for doing this work. It may be recommended as inexpensive on general repairs to use oxy-acetylene in cutting off a number of bolts scattered on the boiler and as preferable to using a chisel bar.

I note in cutting the bolts with oxy-acetylene the sheet gets so hot that it is impossible to place the hand on it in some places.

We have at present but two oxy-acetylene outfits in our boiler department, but have recently put in Prest-O-Lite outfits and I have no doubt but what bolts scattered in the boiler can be cut off cheaper with acetylene.

Referring to application of bolts from the inside sheet out: I would not recommend this, as it is my practice to tap all holes from the outer sheet inward and apply the bolts the same way. In tapping out a stalbolt hole with a motor, the vibration of the motor hanging with the weight attached from a pulley has a tendency to increase the size of the hole where first entered. The hole in second sheet as a rule is of the original size of the tap. When entering the bolt, it will always be noted that it will not be as tight in the hole that the tap was first entered in as in the second hole; thus you are able always to get a tight bolt on the inner sheet where it is absolutely necessary in order to prevent leaky staybolts.

L. BORNEMAN.

DISCUSSION

Mr. Lewis: The best method must be determined by each shop. The committee's report simply states what was done at the author's shop and the reasons for it. The method has proved more economical and gives better results than by using a chisel and nippers. The burning off of the staybolt is done so rapidly that the high heat has no chance to do any damage.

Mr. Wandberg: No method is cheaper than cutting with air, if the nippers are dressed right and if the bolts are driven from the outside.

Mr. Gibson: We used a chisel first, then an air hammer. We are now burning off the bolts and find it beter.

C. R. Bennett: After burning off the bolts, they are looser and hardened. What is the cause of this?

Mr. Stewart: Too much oxygen. The burning method is the best if you get the right pressure. It is quicker, but you must get the flame right. We bend the tip of the torch so that the torch rests against the sheet and the flame is directed properly at the right distance from the sheet.

D. A. Lucas: The operator has usually used too much oxygen when the results are bad.

Mr. Lewis: The torch anneals our bolts. The operator has been too long on the bolt if it hardens. The success of this method depends upon the operator. It took us a year to train a man properly for the work.

It was voted to accept the committee's report and discharge the committee.

Basic Versus Acid Steel for Fireboxes

Acid open hearth steel may be distinguished from basic open hearth steel by its being normally higher in silicon, and usually in phosphorus, but lower in manganese.

Acid Open Hearth Process.—The acid open hearth furnace is heated by burning within it heated gas and air, each of which has been previously preheated before it enters the combustion chamber. The metal lies in a shallow pool on a long hearth which is lined with siliceous material, and is heated by radiation of the intense flame. The impurities are oxidized by slag lying on top of the metal. The action is so slow, however, that the carbon in the pig iron takes a long time for combustion. The operation is, therefore, hastened in two ways: (a) iron ore is added to the bath, and (b) the carbon is diluted by adding with the furnace charge large proportions of steel scrap, often as much as 75 or 90 percent. It takes from six to ten hours to purify a charge. The manganese and silicon go into the slag first, then the carbon boils off as a gas. When this has proceeded to the desired point, the bath is recarburized and the metal is cast into ingots. The characteristics of the acid open hearth process are:

(a) A long time in purification.

(b) Large charges are treated in the furnaces, the modern practice being usually fifteen to one hundred tons to a furnace.

(c) At least a part of the charge is melted in the purification furnace, and

(d) The furnace is heated with preheated gas and air.

Basic Open Hearth Process.—The basic open hearth process is similar to the acid open hearth process, with the difference that a sufficient amount of lime is added to the bath to form a basic slag. This slag will dissolve all the phosphorus which is oxidized, which an acid slag will not do. The characteristics of the basic open hearth process are the same as those of the acid open hearth process, with the addition of

(e) Lime is added to produce a basic slag.

(f) The hearth is lined with basic instead of siliceous material, in order that it may not be eaten away by this slag, and

(g) Impure iron and scrap may be used, because phosphorus, and, to a limited extent sulphur can be removed in the operation.

Comparison of Purification Processes.—Acid open hearth steel is believed by engineers to be better than basic, and is usually specified for all important structures, although not so rigidly to-day as a few years ago. This is in spite of the fact that phosphorus and sulphur, two very harmful elements, are lower in basic steel.

The basic process is less expensive than the acid, because high phosphorus pig iron and scrap are cheap, and the lower cost of materials used more than balance the greater cost of the basic lining and lime additions, and the circumstance that the acid furnace has a higher output because heats are shorter.

For the layman to state which process will make the better boiler steel, is an impossibility. It is necessary that one should have some practical and scientific knowledge of the processes to determine which is the better.

J. C. CLARK, Chairman.

The report of the committee was accepted and the subject closed.

Cracking of Barrel Sheets, Where They Crack as Well as the Shape of the Crack

Barrel sheets are likely to crack in any part of the boiler, but occur most frequently in the lower part of the boiler, Cracks occur in the lower part of the boiler at the girth seams, usually running in girth seam direction. This is caused by the barrel sheets becoming inefficient, owing to pitting or corrosion, or to the girth seam leaking.

Cracks also occur on the lower half of boiler where frame braces or tee irons are riveted or studded to the barrel sheets. The sheets generally crack at the end of the tee iron or angle irons, the crack running lengthwise of the boiler; but the cracks found at this part of the boiler are likely to be found extending in most any direction, according to the cause. We believe the cracks found here are due primarily to bad condition of machinery, such as bad pounds or broken frame, causing undue strain upon the barrel sheets at these points.

Cracks occur at the longitudinal butt joint seams between the rivet holes, in a longitudinal direction, or at edge of outside welt strap, in a longitudinal direction. The cause for these cracks is either due to improper design of the boiler, bad workmanship, or possibly poor material. However, we believe that practically all of this is due to bad workmanship. Either the sheets have not been properly rolled or the rivet holes have not been drilled and carefully reamed.

Cracks also occur where washout plugs are applied to the bottom of the boiler. Such cracks generally begin at the edge of the washout hole made in the barrel sheet and extend outward in any direction. This is caused by decreasing the strength of the sheet in cutting away the washout hole.

The only way we know of to prevent cracking at the bottom of boiler at girth seams is to keep the bottom of the boiler clean and free from the impurities which cause pitting and corrosion.

Cracking of barrel sheets where frame braces and tee irons are riveted or studded to the sheets can be overcome to some extent by applying reinforcing plates of proper thickness and design to the inside and the outside of the boiler where the braces or tee irons are located.

Cracking at the longitudinal butt joint seams can be overcome by greater care in rolling the barrel sheets and properly drilling and reaming the rivet holes.

Cracking at washout plates can be overcome by applying reinforcing plates on the inside and outside of barrel sheets where the washout plates are applied.

C. R. BENNETT, Chirman.

DISCUSSION

Mr. Young: Failure to obtain a true circle in the barrel sheets causes cracks, especially where the seams are flat.

Mr. Breyer: The cracking is due to the difference in expansion and contraction of the shell plating and the T-iron bars. The shell is hot and expands while the heavy T-irons are comparatively cool and resist expansion. I do not believe in riveting the T-iron bars to the belly of the boiler on large modern power.

Mr. Crites: I would like to see the rivets left out altogether.

D. A. Lucas: It is wrong to rivet the angles to the shell. Going over high spots they carry the whole weight of the engine and the compression on the shell in some cases has caused cracks 48 inches long between the lines of rivets. Lubrication of the expansion pads is necessary.

Mr. Powers: We have not riveted the angles to the boiler in modern power.

Mr. Lewis: I have heard recently of the cracking of shells at the saddle castings on Mallet engines. The omission of rivets is a very good practice.

It was voted to accept the report of the committee and close the subject.

What are the Best Rules to Follow in Arriving at the Maximum Heating Surface of a Locomotive Boiler?

All that part of a locomotive boiler exposed to the flame and hot gases in which water is in contact, is termed heating surface, and the common rule to follow is as follows:

Take the side sheets from top of mud ring around across the crown sheet by the outside length of firebox, less draft openings. The door sheet, top of mud ring up, less the fire hole and arch tube openings. The back flue sheet top of mud ring up, less the outside area of tubes, also arch tube openings. The inside circumference of arch tubes by the length. This is termed the firebox heating surface.

The flue heating surface is the circumference of the outside of the flues by the length between the front and back flue sheets.

It appears from information at hand, consideration is given the value of the heating surface of flues, in proportion to the length, and to be an accepted fact that the evaporating of water from the flue heating surface diminished as the flues get longer. It also appears that consideration is given to the width of the bridges of flue sheet, that is, one inch bridges being of greater value for evaporation than bridges of lesser width. The heating surface of the firebox being the most valuable is made as large as the limitations will permit.

It is held (notwithstanding the diminishing value of the flue as it gets longer) that nothing is lost by using a long flue; on the other hand, something is gained, since it is no harder to maintain, and absorbs in its length much of the heat which would be expelled out the stack.

The report of the committee was accepted and the committee discharged.

CHARLES P. PATRICK, Chairman.

THURSDAY AFTERNOON SESSION

At the Thursday afternoon session Mr. L. R. Pyle, fuel supervisor of the Minneapolis St. Paul & Sault Ste. Marie Railroad, addressed the convention, calling attention to the growing importance of the spark arrester problem because of laws being enacted in some of the states which seriously interfere with the operation of the locomotives. The subject of his address was "Relation of the Effective Area of Opening in Locomotive Spark Arresters to the Power Developed by the Locomotive." He urged that this subject be given careful consideration so that a record of reliable information would be available for use in opposing unreasonable legislation.

It was voted to take up this subject at the next convention.

What are the Advantages and Disadvantages of Fusible Plugs in Crown Sheets of Locomotive Boilers?

The design of the fusible plug is similar to the wash out plug in its general construction, except it is not so large, and on its inner face is made conical or concave, penetrating in its depth to about 3/8 inch or 1/2 inch of its entire thickness; then 1/4 inch drill is used to pass through it entirely.

This brass plug, measuring about 1 1/4 inches to 1 1/2 inches in diameter, composes the plug which contains the fuse. Into this concave inner face is poured a soft metal which should fuse or melt at not less than 650 degrees F.

This plug is applied between the first and second rows of crown bolts or radial stays at the front end of firebox near back flue sheet, at which locality low water would first be in evidence, due to the fact that the crown sheet at this point is something like 3 inches on an average higher than any other part of the firebox.

The function of this fusible plug is to fuse when low water exists. The function of the fusible plug also embodies its advantages, but if it is to retain its efficiency, perform its function, and prove an advantage, it must be given the proper attention. To do this, it should be removed and cleaned at least once every thirty days, preferably at the time of each staybolt inspection. If permitted to remain in crown sheet more than thirty days, or for an indefinite period of time without proper attention, a thin scale will form over the fusible metal and an accumulation of mud will gather around the plug, thus forcing water away from the plug, permitting it to reach a higher temperature than it should, and causing the soft metal to fuse or melt, producing the same effect as though there had been low water, when such was not the case.

When the fusible plug is permitted to be in this condition, it is quite evident that it ceases to be an advantage, but altogether a disadvantage, and should be removed entirely.

In the following we wish to point out its positive disadvantages:

1. The location of these plugs is such as to render them a disadvantage. In placing them between the first and second rows of crown bars or radial stays in forward end of firebox near back flue sheet subjects them to a fierce attack of fire which burns the plug out very often, necessitating its removal.

2. On account of the thickness of the plug, including the fusible metal, places firebox side of the plug an excessive distance from the water. This permits the brass part to reach a high temperature which may be sufficient at times to cause fusible metal to melt without low water.

3. Variation in the temperature of this plug and the crown sheet surrounding it renders it difficult to be maintained tight in the sheet, the square having become defective, and the threads burned and corroded. It is almost impossible to tighten with wrench effectively. Therefore, it is necessary to resort to the hammer and calking tool to stop the leakage, or else remove the plug, clean out the threads and apply a new one. This we deem necessary once a week, or at the end of each round trip (water conditions governing). This procedure will rapidly enlarge the hole in the crown sheet, as well as increase the diameter of the plug, making it necessary in a short while to apply a patch, or bush the hole in order to reduce it, which in time would prove more troublesome than a leaky plug.

4. The continuous and frequent removal of fusible plugs in order to maintain them tight and serviceable, would require the lowering of the water each time this operation was performed, and when terminated the water would necessarily have to be raised. If there is a hot water washing plant in operation, well and good: but if not, it follows that cold water must be forced into the boiler, which is very damaging to the flues and firebox sheets.

The fusible plug has doubtless been extensively used, more or less, on all of the railroads of this country, but seems to have met with disfavor, and is now being dispensed with.

A. R. HODGES, Chairman.

The report of the committee was accepted and the committee discharged.

What are the Advantages or Disadvantages in the Use of Standard Thicknesses of Copper Ferrules for Both Good and Bad Water Districts or Territories? Is it Better to Use Light Copper in One District and Heavier Thickness in Another, or is Any Difference Experienced?

The committee to which this subject was assigned was unable to get any further information than had hitherto been presented and therefore no report was presented on the subject. It was voted that the subject be passed and the committee discharged.

Cleaning Boilers in Back Shop or Round House When All Flues Have Been Removed and the Most Economical Way of Doing it

The general method of cleaning scale by pneumatic hammers and air tools was indicated in sketches accompanying the report of the committee. The committee reported that very light hitting hammers are better than the usual heavy hammers in boiler shops. The method of using a sand blast for cleaning was recommended as doing a good job. The cost, however, depends on local conditions. In some cases more cleaning may be done than is necessary. In fact a light scale may be beneficial. The committee believed that cleaning the seams and joints may be better than a thorough cleaning of the boiler. The conclusions of the committee report were as follows:

(1) When the flues are removed the boilers can be cleaned in from ten to fifteen hours.

(2) Pneumatic tools for cleaning purposes should not be sharp or hit hard enough to rough the surface.

(3) The sand blast method is no cheaper, but does a better job.

DISCUSSION

Mr. Powers: Has anyone any information regarding the use of the sand blast with water to keep the dust down?

Mr. Baird: I have used both methods, the hammer and the sand blast. There is one thing I would like to say about the sand blast, wet or dry, and that is that no one can work on the boiler while it is being cleaned, so we have gone back to the hammer again. We use a small light hammer, and we get good results. By using that we get away from cutting and nicking the metal.

Mr. Stewart: We use a stone cutter and an inch and a quarter chisel. We have very cheap labor and we can put them on the boiler, and this does not interfere with any work going on. We find that a very cheap method of scaling the boiler. The average time required is about eight hours, I should say.

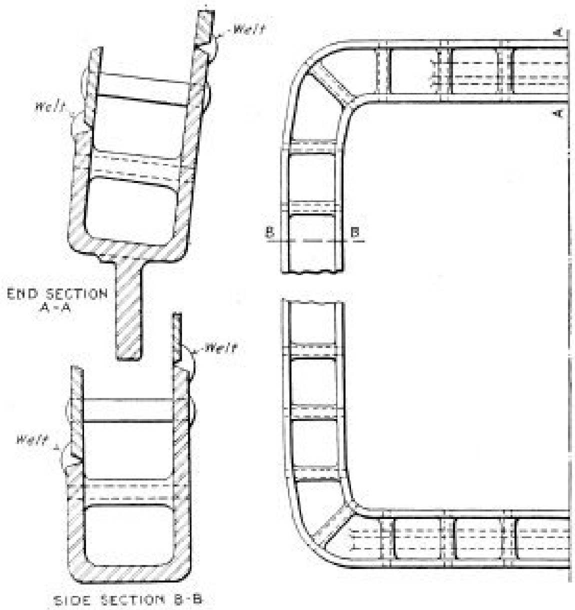
Mr. Hodges: In the South we use negro help, which is cheap. The cleaners can go into the boilers after working hours and not interfere with other work on the boiler.

The report of the committee was accepted and the subject closed.

Proper Thickness and Best Mud-Ring to Use in Locomotive Boiler to Keep Side Sheets from Cracking

The accompanying illustration shows a cast steel mud ring invented by Messrs. Smith and Harter of the Missouri Pacific Railway, assistant mechanical superintendent and mechanical engineer respectively.

This ring is channel-shaped with flanges on each side to take the firebox sheet, the inner flange being half a staybolt pitch shorter than the outer flange in order to facilitate the welding of firebox sheets to same and keep



Cast Steel Mud Ring

the seam below the fire-line; also to secure a row of staybolts in casting and sheet in order to take care of the stresses in welds.

To secure the two walls from spreading and give required stiffness at the bottom of the ring, braces are cast between the walls. In these braces a ¾-inch hole is cored to lighten the casting.

A mud ring of this description will have many advantages over the present ring in use. Being very much lighter in construction naturally makes it more flexible and eliminates stresses in firebox sheets caused by the rigidity of the present design. It will be a smooth surface on side sheets, permitting cinders and ashes to pass into ashpan and prevent side sheets from rusting away, owing to the rivet heads of mud ring obstructing ashes that pass between the grates and side sheets. With the mud ring welded it should also eliminate all mud ring corner trouble, which is very annoying as well as costly to railroads in bad water districts.

T. P. MADDEN, Chairman.

The report of the committee was accepted and the subject closed.

Mr. Madden: The design shown in Fig. 2 is something new in the construction of locomotive boilers; in fact, I have never seen one put in use. It is our intention to apply one of these mudrings, and I hope I will be in a position to make a come complete report at our next meeting. You will notice that the mudring is made of very thin cast steel. It will be much lighter than the mudring and will therefore be more flexible, and in my opinion should respond more readily to the different temperatures of the firebox. This being the case it should eliminate the stresses on the firebox plate. Another advantage of this mudring is to eliminate all rivets; due to different devices of welding it has enabled us to get out this ring and weld it, as we think, successfully. It will also eliminate all mudring corner trouble. It will also eliminate the corrosion that takes place in the mudring. In later designs the bottom of the ring has been changed from a straight to a semi-circular form.

Gage of Arch Tubes

A. N. Lucas: I would like to have some information in regard to arch tubes; I would like to know how many of the members here are using No. 7 gage or heavier, how many are rolling and beading same. We have been using a lighter gage for a good many years, and we are now going to use No. 7 gage.

A majority of the members signified that they were using No. 7 gage or heavier and were beading the tubes.

Secretary Vought announced that fifty-nine new members had been secured at the convention.

Past President's Association

Mr. J. T. Goodwin, past president of the association, announced that the past presidents of the association had formed an organization to be closely affiliated with the parent organization. The object of the new association was to get together annually for closer association to keep in close touch with the various interests. The first meeting of the organization was called at the end of the afternoon session for the purpose of permanent organization.

Discussion of Miscellaneous Topics

Mr. Crites: I know of a little invention that I would like to tell you about. It is to aid the men working on the front end. When the engine comes in the round house it is warm. A patch may have to be put on or there will be a leak in the front end, and it is pretty warm for a man to get in there. Take a pipe about 14 feet long; make a three-inch circle on the end, run it against the flue sheet and put the air on it, and it blows all the hot air out of the front end, so that a man can go in there and put a patch on the netting or examine the leak, and he will not mind the heat a particle. It is a fine thing. I would like you all to try that when you go home.

A. N. Lucas: In regard to the front end and the blower pipe, the old method had been, for the last fifty years or more, to drill a hole in the smoke arch and put the blowpipe down below the netting and then bend the pipe and come up through in front of the exhaust pipe. This blower pipe is full of water all the time, and every time we wash the boiler out we wash the front end and the boiler washers would disconnect this and kick it out of the way, and then it would be put back by hand, and it was never tightened up and the steam always leaked. I think the proper place for the blower pipe would be above the netting, and it should be put in and anchored there so it won't move; this will do away with the wearing of the hole in the plate and around the exhaust pipe, and allow the sparks to come out. I think if you will take that home and try it you will like it.

Mr. Gray: I think that is a very good suggestion. For the last fifteen months we have stopped up the old blower hole and drilled a new one just at right angles with the nozzle, and then run the pipe right straight across and turned it at the edge of the nozzle, and we have done away entirely with the old blower up there.

Mr. Powers: I would like to ask some of the members of this association how they have overcome pitting.

Mr. Fowler: For six months I have been engaged in examining water. I had the water analyzed from a tank and found nothing the matter with it. Then I looked at the boiler and the tubes were pitting out in about nine months. I quit analyzing the water in the tank and I began analyzing the water in the boiler, and then I found an entirely different story. I found that with 200 pounds of steam pressure the quality of the boiler water was not the same at all. The water had not been acid, but by a reaction after evaporation it contained nearly two grains of sulphuric acid. After we analyzed the concentrated water we found nearly four grains of sulphide and also hydrochloric acid. This is a pitting medium, and it would go right into the tubes and cut holes in them. Now, I don't know exactly what happened to the water, but I have a suspicion that the organic matter in the water, by the action of the heat, was decomposed and formed a sodium of chloride which the salt stole away from that and the sodium went to sulphate and then to ammonia and went off in steam; that the chloride was an ammonia combine and then we got magnesium chloride. I think that is exactly what happened, but I don't know what we are going to do to get rid of that. I have just one suggestion to make. We tried putting in three pounds of arsenate of soda at each washout and apparently it did the work—preventing the corrosion and preventing the pitting of the tubes in that particular bad water district.

Mr. Powers: We have a good water district and have no pitting there, but we installed some heaters for washing out purposes and filling up, and I know of one particular flue in the heater which pitted out in less than 60 days, although it was brand new. We have tried both the iron and steel, but they are just about the same. The same water going into the locomotive does not pit at all, and in another district it is just the extreme opposite. It pits both the iron and steel just as badly.

D. A. Lucas: I have experienced the same trouble as Mr. Powers. We tried both steel and iron and have practically the same results. I find in watching the flues that you will have a set of flues pitted at the front end and others pitted at the back end. I think some waters deposit the pitting product at a lower temperature and others at a higher temperature.

Mr. Fowler: If you take the water that I spoke of a few moments ago, where the magnesium chloride in it has broken down the salt, that water has got to be very hot before the salt will break down, and apparently under the high pressure the same combination is necessary. I don't know but that magnesium chloride would only be formed under the condition at a high temperature, and therefore the pitting would occur at the back end of the boiler; on the other hand, magnesium would break down under a boiler temperature corresponding to 60 pounds pressure, so if the megnesium chloride breaks down at that temperature it already starts to form hydrochloric acid right at the start. On the Southern Pacific I hear they are meeting with excellent results with the alkaline condition. If you can get the alkaline beyond a certain point there is no corrosion, but you are apt to get a light water that will foam, and the average engineer would rather have corroded tubes than get foaming, so he cannot drag his engine over a hill. We have decided that if you get the alkaline at about three-tenths of one per cent, that is inside the point where the increased corrosion occurs, and it is ordinarily a safe amount to use. That is what they are doing on the Southern Pacific with marked success in stopping the pitting and corrosion in both the locomotive and stationary boilers. I am told that the United States Navy did the same thing; they carried their water to a high point of alkalinity, up to three percent, which made a very light water, a water that would not do for a locomotive, but apparently gave them enough steam so that it could not get to the cylinder, and for a good many years they have been holding their water that way; but last February they issued an order that the water should be dropped down to three-tenths of one per cent. I don't know the results, but the change was made after several years of successful fighting of corrosion, they had been carrying a high alkalinity.

On motion the meeting then adjourned.

FRIDAY MORNING SESSION

At the Friday morning session the following officers were elected for the ensuing year:

President—Hon. D. A. Lucas, general foreman boiler maker, Chicago, Burlington & Quincy Railroad, Havelock, Neb.

First Vice-President—John B. Tate, foreman boiler maker, Pennsylvania Railroad, Altoona, Pa.

Second Vice-President—Charles P. Patrick, foreman boiler maker, Erie Railroad, Cleveland, Ohio.

Third Vice-President—Thomas Lewis, general foreman boiler maker, Lehigh Valley Railroad, Sayre, Pa.

Fourth Vice-President—T. P. Madden, general boiler inspector, Missouri Pacific Railroad, St. Louis, Mo.

Fifth Vice-President—E. W. Young, general boiler inspector, Chicago, Milwaukee & St. Paul Railway, Dubuque, Iowa.

Secretary—Harry D. Vought, 95 Liberty street, New York.

Treasurer—Frank Gray, foreman boiler maker, Chicago & Alton Railroad, Bloomington, Ill.

L. M. Stewart, foreman boiler maker, Atlantic Coast Line, Waycross, Ga.; John Harthill, general foreman boiler maker, New York Central Railroad, Cleveland, Ohio, and John Raps, general boiler inspector, Interstate Commerce Commission, Chicago, Ill., were elected to the executive board, of which Thomas F. Powers, general foreman boiler maker, Detroit, Chicago & Northwestern Railroad, Oak Park, Ill., was chosen chairman, and W. H. Laughridge, general foreman boiler maker, Hocking Valley Railroad, Columbus, Ohio, was made secretary.

Officers of the Supply Men's Association

The officers of the Boiler Makers' Supply Men's Association elected for the ensuing year were as follows:

President—B. A. Clements, Rome Merchant Iron Mill, New York.

Vice-President—Charles B. Moore, Oxweld Railroad Service Company, Chicago, Ill.

Secretary-Treasurer — George Slate, The Boiler Maker, New York.

The new members of the executive board elected for a term of three years were H. S. Covey, Cleveland Pneumatic Tool Company, Cleveland, Ohio, and George R. Boyce, A. M. Castle & Co., Chicago, Ill.

Women's Auxiliary

Mrs. Frank Gray, of Bloomington, Ill., was elected president of the Women's Auxiliary of the Boiler Makers' Association.

Registration at the Convention

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R. B. Alfonte, Oxweld Ry. Service Co., 339 Indiana Ave., Chicago, Ill.
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J. T. Anthony, American Arch Co., 30 Church St., New York.
G. A. Barden, Chicago Pneumatic Tool Co., 1740 Market St., Philadelphia, Pa.
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W. S. Bean, Oxweld R. R. Service Co., 339 Exchange Bldg., Chicago, Ill.
Geo. W. Bender, Mudge & Co., Chicago, Ill.
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Mrs. H. Young, Cleveland, O.

Annual Banquet

On Thursday evening, May 25, the banquet given to the Master Boiler Makers' Association by the Supply Men's Association, was held in the Crystal Room of the Hotel Hollenden. The menu was such as to excite the most jaded appetite. After dinner the tables were cleared away in record time and several of the master boiler makers voiced their appreciation of the efficient manner in which the Supply Men's Association had conducted the entertainment during the convention. Immediately following the speeches an elaborate entertainment program was ushered in, followed by dancing, which lasted into the early hours of the morning. All who attended this function agreed unanimously that it excelled any like entertainment of the past.

Exhibitors

American Arch Company, New York.
American Flexible Bolt Company, Pittsburgh, Pa.
Baldwin Locomotive Works, Philadelphia, Pa.
Bethlehem Steel Company, So. Bethlehem, Pa.
The Betz-Pierce Company.
The Bird-Archer Company, New York.
The Boiler Maker, New York.
Bourne-Fuller Company, Cleveland, O.
Breakless Staybolt Company, Pittsburgh, Pa.
W. L. Brubaker & Bros., New York.
Burden Sales Company, New York.
Brown & Co., Pittsburgh, Pa.
Carnegie Steel Company, Cleveland, O.
The Champion Rivet Company, Cleveland, O.
Anthony Carlin Rivet Works, Cleveland, O.
A. M. Castle & Co., Chicago, Ill.
Chicago Pneumatic Tool Company, Chicago, Ill.
The Cleveland Pneumatic Tool Company, Cleveland, O.
Cleveland Punch & Shear Works Company, Cleveland, O.
The Cleveland Steel Tool Company, Cleveland, O.
Cleveland Twist Drill Company, Cleveland, O.
J. F. Corbett & Co., Cleveland, O.
Dearborn Chemical Company, Chicago, Ill.
Detroit Seamless Steel Tubes Company, Detroit, Mich.
The Draper Manufacturing Company, Port Huron, Mich.
Ewald Iron Company, Louisville, Ky.
J. Faessler Manufacturing Company, Moberly, Mo.
Falls Hollow Staybolt Company, Cuyahoga Falls, O.
Flannery Bolt Company, Pittsburgh, Pa.
Foster Paint & Manufacturing Company, Winona, Minn.
Globe Seamless Steel Tubes Company, Chicago, Ill.
Hilles & Jones Company, Wilmington, Del.
Imperial Brass Mfg. Company, Chicago, Ill.
Independent Pneumatic Tool Company, Chicago, Ill.
Ingersoll-Rand Company, New York.
Jacobs-Shupert U. S. Firebox Company, Coatesville, Pa.
Locomotive Superheater Company, New York.
McCabe Manufacturing Company, Lawrence, Mass.
Mahr Manufacturing Company, Minneapolis, Minn.
Monongahela Tube Company, Pittsburgh, Pa.
Mudge & Co., Chicago, Ill.
National Tube Company, Pittsburg, Pa.
Christopher Murphy & Co., Chicago, Ill.
National Boiler Washing Company, Chicago, Ill.
Otis Steel Company, Cleveland, O.
Oxweld Railroad Service Company, Chicago, Ill.
Prest-O-Lite Company, Indianapolis, Ind.
The Parkesburg Iron Company, Parkesburg, Pa.
The William B. Pierce Company, Buffalo, N. Y.
The Railway Journal, Chicago, Ill.
Rome Merchant Iron Mill, New York.
Ross Schofield Company, New York.
Jos. T. Ryerson & Son, Chicago, Ill.
Spencer Otis Company, Chicago, Ill.
Scully Steel & Iron Company, Chicago and New York.
S. Severance Manufacturing Company, Glassport, Pa.
Simmons-Boardman Publishing Company, New York.
Standard Tool Company, Cleveland, O.
Strong Kennard & Nutt Company, Cleveland, O.
Talmage Manufacturing Company, Cleveland, O.
The W. S. Tyler Company, Cleveland, O.
Vulcan Engineering Sales Company, Chicago, Ill.
Alan Wood Iron & Steel Company, Philadelphia, Pa.
Worth Bros. Company, Coatesville, Pa.

Shell for Circular Segment Head

In fitting a new shell to the segmental head, as shown in the figure, the usual method of laying out is not as convenient as in the case of a complete new layout and the following method seems more adaptable.

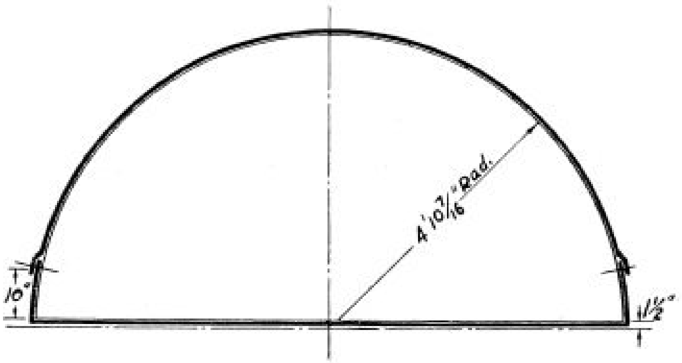
Converting the dimensions to inches and taking the full diameter, plus the thickness of the plate, to find the circumference, we get:

$$\begin{array}{lr} \text{Diameter} = 58.4375 \times 2 = & 116.875 \\ \text{Thickness } (5/16) & +\ .3125 \\ \hline & 117.1875 \\ & \times\ 3.1416 \\ \hline & 368.15625 \end{array}$$

Divide by 2 for semi-circumference,

$$368.156 \div 2 = 184.078$$

From this we must deduct $1\frac{1}{2} \times 2$ for the distance of chord from the center, plus 10×2 for the distance of the line of rivets from the chord. Notice that the arc between the extremities of the diameter and the chord ($1\frac{1}{2}$ inches) is equal to the distance along the arc for all practical purposes.



Semi-Circular Head

$$\begin{array}{lr} \text{Semi-circumference} = & 184.078 \\ 1\frac{1}{2} \times 2 + 10 \times 2 = & 23.00 \\ \hline & 161.078 \end{array}$$

Total length of top plate from rivet line to rivet line = 161.078 inches, or 13 feet 5 1/16 inches, to which we add the width of the lap, or 2¼ inches, giving as total length of plate 13 feet 7 3/16 inches.

For the lower plate we take the diameter 116.875 inches and add 2 × the thickness of plate for bends, or 116.875 + .625 = 117.5 inches, to which we add 20 inches (10 × 2) and 2¼ inches for the width of the lap,

$$\begin{array}{r} 117.5 \\ +\ 22.25 \\ \hline \end{array}$$

Total length lower plate 139.75 inches, or 11 feet 7¾ inches.

Now the distance between bends for the lower plate is equal to the diameter, plus the thickness of the plate, or

$$\begin{array}{r} 116.875 \\ +\ .3125 \\ \hline 12)\,117.1875 \\ \hline \end{array}$$

9 feet 9 3/16 inches length between bends.

As a check on the figures and for the purpose of laying out the rivet holes to match those in the head, a heavy paper template may be used to transfer the rivet holes from head to shell plate. In any case, the holes should be layed out carefully so that they will match up well, since the original holes in the head are not apt to be in very good condition.

J. L. WILSON.

Designs of Boilers

In these days of high speed, heavy trains and long runs, the locomotive boiler is a very important factor in railroad economy. No matter how good the engine may be, its efficiency is decreased to a great extent by an inferior and especially a leaky boiler.

The chief requirements of a boiler are: (1) That it should be amply strong in all its parts to withstand the pressure to which it will be subjected; (2) that it should provide an abundant supply of steam for the cylinders of the engine it is attached to; (3) that it should do this with the least possible expenditure of fuel; (4) that it should be of such design as to admit repairing cheaply and readily; (5) and that it should be easily kept clear of scale and sediment besides being easily inspected.

First cost within reasonable limit is a minor consideration that should not be allowed serious consideration, for, broadly speaking, a locomotive boiler cannot be too good.

The cylindrical part, or waist, of the boiler can easily be constructed to stand the maximum strain coming upon it with a fair factor of safety—say, five, which is good practice. It is only a question of good plates of the proper thickness, a strong seam and honest workmanship. As soon as the boiler is put into service, however, deterioration begins, and it is the retarding of this as much as possible that should be considered in the design. There is no doubt whatever that when a butt joint is used corrosion along the seam is much less than with the lap joint. Why this should be true is not altogether clear. The most plausible hypothesis is, that with the butt joint the strains due to the steam pressure are uniformly distributed over the whole circle, while with the lap joint when the boiler is under steam there is a tendency for the plates to straighten out, the result being that the sheet bends to some extent on each side of the lap. This tendency causes scale that may be deposited to flake off, leaving the surface of the sheet exposed to furrowing and corrosion.

The firebox end of the boiler is where the greatest danger lies, and it is this part that claims the major share of attention of boiler designers. Sheets that require severe flanging, such as the throat sheet and top connection on flat wagon top boilers, should always be made 1/16 inch or ⅛ inch thicker than the others, so as to make up for the thinning out arising from the operation of flanging.

The most troublesome things about a locomotive boiler are broken staybolts, and every increase in the size of boilers witnesses increased danger from such staybolts. As is well known, staybolts usually break close to the outer sheet, and may generally be found broken in the two or three upper rows along the sides, except towards the ends of the box where they extend down as far as the sixth or seventh row from the crown. The cause of this breakage is generally understood to be due to the constant bending backwards and forward caused by the difference in expansion between the sheets. There appears to be no remedy for this troublesome condition unless the ball and socket joints prove effective.

A very important consideration in boiler design has been the means employed to support the crown sheet. When the feed water was free from substances that deposited sediment, the crown bar was the most satisfactory means for supporting the crown sheet, but in regions infested with scale and mud-depositing water the radial stay has become the most satisfactory sustainer. At first considerable apprehension was felt as to the security of the radial owing to the angle at which many of them must pass through the sheets, but that line of weakness has been overcome.—*Railway and Locomotive Engineering.*

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

Boiler manufacturers throughout the United States and Canada should not forget that they have an important engagement at the Hollenden Hotel, in Cleveland, on June 19 and 20, when the American Boiler Manufacturers' Association meets for its twenty-eighth annual convention. The boiler code, uniform cost systems and other important subjects will be up for discussion.

For several years past a large part of the discussion at the annual conventions of the Master Boiler Makers' Association has centered around the committee reports on oxy-acetylene and electric welding as applied to locomotive boiler repairs. Some of the members of the association, who have taken an active part in this discussion each year, have now had five or six years' experience with this work, if not longer, and they are fully justified in feeling that their work in this direction is far beyond the experimental stage. With this experience, methods of doing various classes of work with the welding apparatus are becoming fairly well standardized and the results can be anticipated with a fair degree of certainty. It is not strange, however, that both the methods and results should vary in different parts of the country, for in the railroad field uniformity in service conditions and equipment facilities is practically impossible. Notwithstanding this there is hardly any class of boiler repair work in a railway shop to which some successful application of the welding and cutting processes cannot be made with substantial savings in both time and material. Not only does the consensus of opinion of the leading men in the field seem to be that these processes are the "coming thing" in the boiler shop, but the claims made for them in the early stages of their introduction seem to be well sustained by experience.

Notwithstanding the extensive investigation and discussion of oxy-acetylene and electric welding, there is still a difference of opinion as to the best method of welding firebox sheets. Some believe that the sheets should be dropped ⅛ inch per foot to allow for contraction while the seam is being welded, while others believe that the best results are obtained by putting the plate in place and applying all rivets and staybolts before the welding is begun. When first starting in to use the welding apparatus many boiler makers dropped the sheet to take care of the contraction and expansion, but later discontinued this practice and put the plates in place before welding. As little trouble resulted from cracking of the welds with the latter method, it was concluded that the stresses set up in the plate by contraction due to the welding were more a matter of theory than of reality. At least, there seems to be no reliable evidence as to the magnitude of such stresses, although some attempts have been made to measure them. Other factors, such as the quality of the material, preparation of the plates and, most important of all, the skill and experience of the operator, have a most important influence upon the success of welding, and they must be given careful consideration in determining the best method of welding.

Welding flues in the back flue sheets of locomotive boilers has generally proved successful in good water districts, but in bad water districts trouble is experienced and a good many failures are reported. The possibility of eliminating troubles from leaky flues by welding the ends of the flues to the tube sheet was at first hailed with enthusiasm, and to-day thousands of locomotives are giving successful service with flues applied in this manner. In bad water districts, however, something beyond the ordinary method of welding is apparently necessary. On the Chicago and Northwestern, as explained by Mr. Pratt at the Master Boiler Makers' convention, the welding of small flues to the back flue sheet in bad water districts was not a success, and so a new method had to be devised. A recess was cut in the back flue sheet, into which the beads of the flues were turned and then welded over so as to form a thorough soldering of the joint between the flue and the sheet. This, it was expected, would permit the expanding of the flue without breaking the weld loose between the flue sheet and the flue. Another method of overcoming this trouble, adopted by a Southern road, consists in applying the flues in the usual manner without welding and then whenever the flues start to leak they are welded up, thus prolonging their length of service.

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.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Priming in Boilers

Q.—What causes priming in boilers? R. H.

A.—Improper boiler construction, insufficient steam space, too high water level, engine too large for steam capacity of boiler.

Feed Water Entrance

Q.—Where should the feed water enter into a boiler? L. D.

A.—In stationary boilers the feed water is carried into the boiler below the water level, so that it does not come directly in contact with hot sheets.

Dry Pipe

Q.—I would like some information in reference to areas of openings in dry pipes. Up to the present time I have not been able to find any reliable authority on this question. INSPECTOR.

A.—Authorities differ as to the proportion of area in the dry pipe with respect to the cross sectional area of the steam outlet or nozzle. For example, according to Wilson and Flathers' treatise on steam boilers, they state as follows: For ordinary stationary boilers a pipe 6 to 8 feet in length, with perforations having a total area considerably in excess of the area of the steam pipe, is found to be all that is required as an anti-priming apparatus. The larger the collective area of the perforations as compared with the area of the steam pipe, the more quietly will the steam flow through them, and when the steam is in the dry pipe and separated from the water, the velocity of the steam can have no effect in producing priming. , H. de B. Parson's treatise on steam boilers states that the aggregate area of the holes for steam entrance into the dry pipe should be equal to that of the steam main.

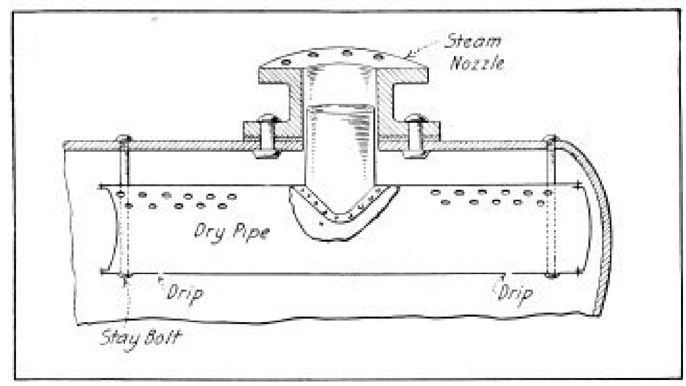


Fig. 1.—Dry Pipe

In tubular boilers, dry pipes are often installed in the manner as shown in Fig. 1; also troughs are used in the place of pipes with closed ends made from No. 12 or 14 gage sheet iron. They may be made of cast iron, brass cr copper. Brass and copper, if used, are liable to cause galvanic action unless such metals are thoroughly tinned, which process, together with the increased cost of material over iron or steel, makes such pipes expensive.

As the diameter of the pipe (Fig. 1) is two to three times larger than the steam outlet on the nozzle, the length from 5 to 8 feet depending on the length of the boiler, and the collective area of the holes being two to three times that of the cross sectional area of the steam outlet, it is well to make the dry pipe as long as the shape of the boiler in the steam space will permit, so as to distribute the withdrawal of steam over as great an area as possible. The size of the perforations may be made 3/8 inch or 1/2 inch in diameter. The required number of perforations for any given area when their diameter is given may be found as follows:

$$\frac{\text{total area of perforations}}{\text{area of one perforation}} = \text{number required in dry pipe.}$$

Hydraulic Flanging

Q.—We would like to know if domes could be flanged on a hydraulic press, and also about the process.

A.—*Operations in Forming.*—In flanging domes by hydraulic presses there are two methods the writer knows of by which such work may be done. One process of forming is first to prepare the pattern of the dome as for hand flanging, roll it to form and bolt it. Then by the use of specially formed dies, the flange of the base is bent to fit the curvature of the boiler. In the case of dome bases, as for heavy locomotives, they are formed out of flat steel sheets of proper size and shape in a four-column press.

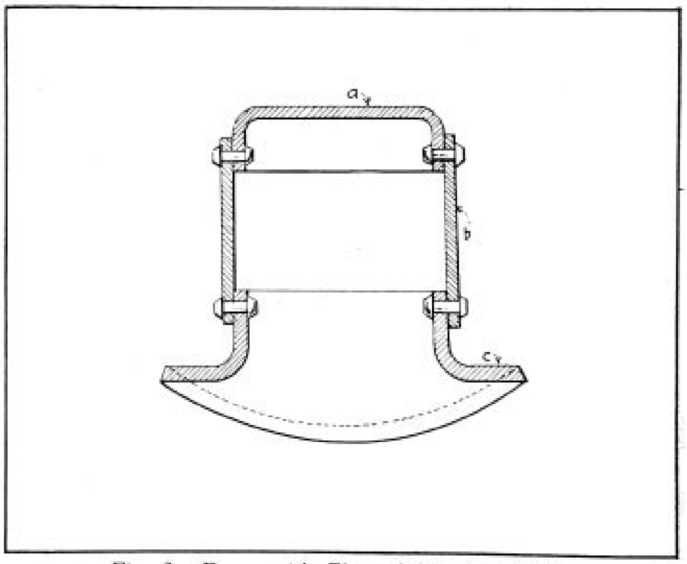


Fig. 2.—Dome with Flanged Head and Base

The plate must be heavy, owing to the reduction of material in the plate thickness, due to the stretching or flow of the metal when subjected to the pressing operations of forming.

The flat disk of steel plate is first heated to a red heat in a suitable furnace; the plates should not be heated any hotter than a red heat; if hotter they cannot be formed properly by the dies. The first operation is the pressing of the plate to a cylindrical form, in which case the flange will be flat. The next operation involves the formation of the flange to fit the curvature of the boiler with suit-

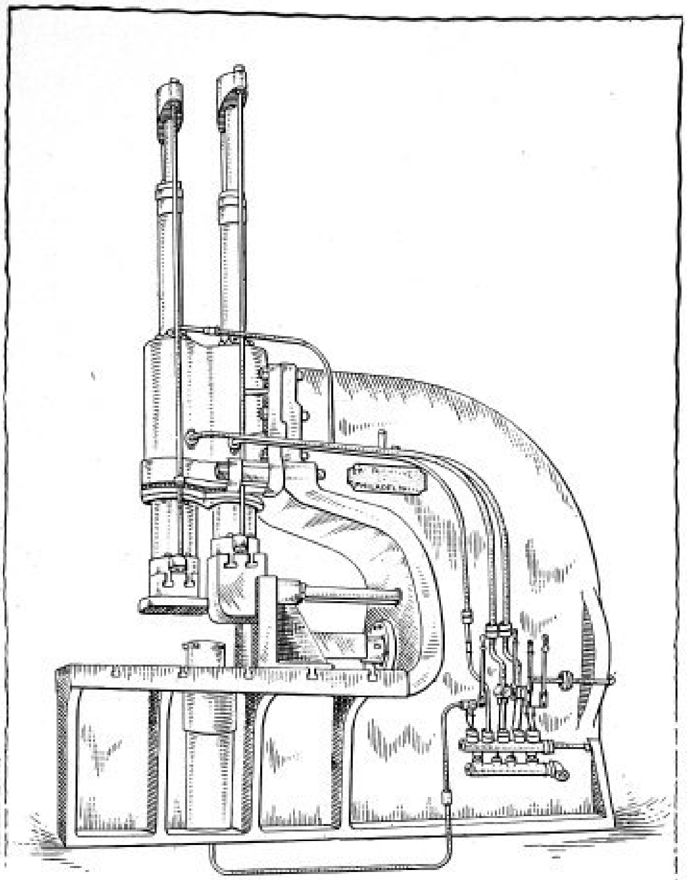


Fig. 3.—Sectional Flanging Machine

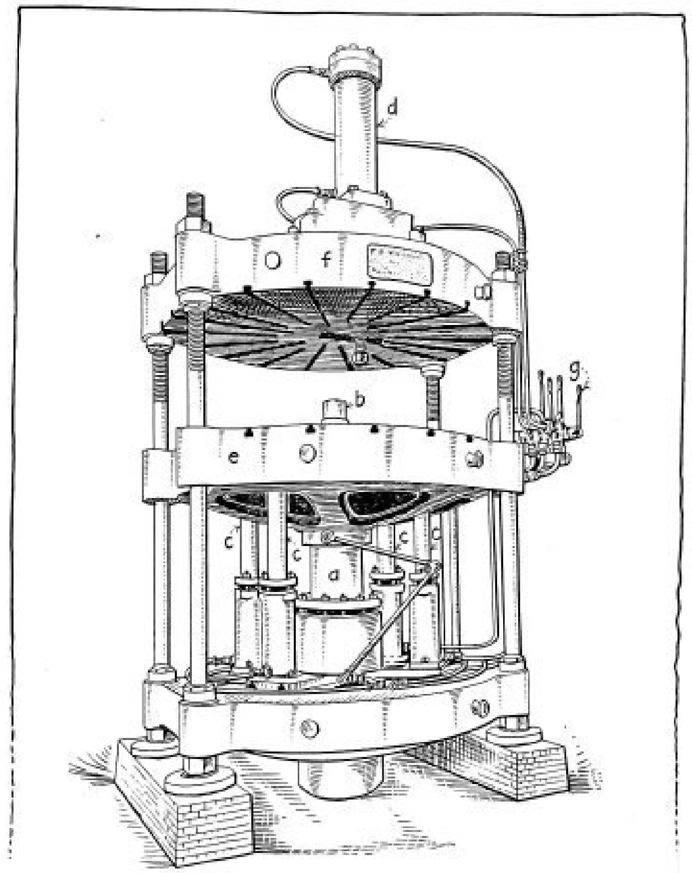


Fig. 4.—Four-Column Flanging Press

ably shaped dies. The top piece, or head, *a*, Fig. 2, is a circular head which is also pressed into form on a four-column press. Section *b* is a circular shell riveted to the base *c*, and head, *a*.

Types of Flanging Presses.—In small shops probably the sectional flanging machine, Fig. 3, is more desirable, as it has a wider range, but for heavy material, where there is a vast amount of duplication of the same piece or pieces, the four-column press is preferable.

One of the modern designs of a four-column press, Fig. 4, is applicable for flanging heavy locomotive heads, throat sheets, etc., and also heads for stationary boilers of the various types. The following brief explanation of its parts and operation may be of interest at this time.

There are seven rams, operated by hydraulic pressure, each of which performs a certain part in the working up of heads to different shapes. At the beginning in the operation of forming, water is let into the cylinders which contain the rams. Pressure is then placed upon the water which acts upon the ram, forcing it to do certain work. The main ram is shown at *a*, in which is also contained an internal ram, *b*, that is employed for flanging lighter work that does not need the force of the larger ram. The four jack rams, *c*, are employed for clamping purposes, and the overhead ram, *d*, can be employed for flanging manhole openings in boiler heads, while the outside flange is being held for flanging.

In flanging round heads, the male die is bolted to the upper platen, *f*, and the ring, or female, die is clamped on the movable platen, or block, *e*. The disks are heated to a read heat and placed in position on the female die. By operating the levers, *g*, controlling the hydraulic pressure, the jack rams are moved up, thus holding the disk to be formed against the male die. Then the main ram, *a*, is forced upward, flanging the outside of the head.

Design of Dies.—In designing dies for such work, the thickness of plate must be considered, and also its shrinkage. A good rule is to add .008 of the diameter of the finished head to the female die for heads up to 60 inches in diameter, and .01 for those that are larger than sixty inches in diameter. The outside diameter of the male die may be found by subtracting twice the thickness of plate plus 1/16 to ¼ inch for clearance from the outside diameter of the finished head. No set rule, however, is applicable to all classes of work, so this matter is directly one for the designer of the dies to work out, taking into consideration the character of the work and results of his experience in handling such problems.

Consider, for example, a head to be made of ½-inch plate and 60-inch outside diameter. Then, working from the female die as a basis, we have $60 \times .008 = .48$ inch—call it ½ inch. The inside diameter of the female die will therefore the $60 + ½ = 60½$ inches when cold. By the constant use of the formers they expand, due to heat taken from the heated heads. The heads when cooling shrink from their original size when heated and for that reason these allowances are made. The diameter of the male die is found by subtracting two times the thickness of plate from 60½ inches, or $60½ - 1 = 59½$ inches outside diameter.

It is a well-known fact that the deeper the flange and the lighter the plate the greater is the tendency of the plate to "gather" or buckle in the curvature of the head. To offset this feature allowances for clearance must be made. In cases where boiler heads have a flange not greater than 4 inches in depth, allow 3/16 inch clearance for gather, which in this case makes the male die $59½ - 3/16 = 59\ 5/16$ in diameter. If this clearance is found to be too great, reduce the curved edge of the male die which forms the curvature at the root of the flange. For example, if the radius of this part is ¾ inch make it ½ inch. The objection in having the male die too small is that it causes a greater degree of curvature at the root of the flange than what is required. By following the above directions, however, in shortening the radius this is overcome.

The explanation relating to design of dies and allowances for cylindrical heads is general practice with all dies. So the matter in handling any character of pressed work resolves itself into first determining what kind of hydraulic press is required, the design of suitable dies, their successful manipulation and proper apparatus for heating and handling the sheets when forming so as to reduce the cost of operation as much as possible.

Calking Seams

Q.—I should like very much to have you publish an article with illustrations showing the proper way to calk tanks, and I would also like to have you mention the different names of the tools used for this work. I would be interested in knowing the exact amount of lap required for different thicknesses of metal. There are always quite a number of arguments put forth regarding this matter, and I would like to have you give us a few facts. The tank work I am interested in includes oil tanks and water tanks. I am not particularly interested in steam boiler shop work, but would like to know about the calking on this work. We have had quite a lot of trouble with oil leaks, and I am sure the amount of lap on some of our work has been entirely too much. TANK MAKER.

A.—Calking is the operation of upsetting or closing the edge along the outside lap of riveted seams. Joints should therefore be so designed and the operations of forming and riveting, etc., so done that the seams need not depend

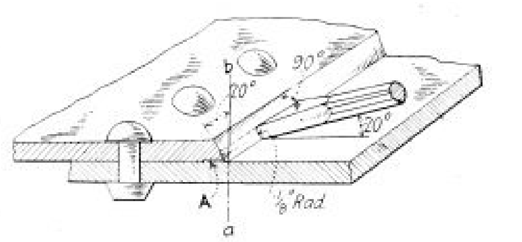


Fig. 1.—Showing Position of Round Nose Fuller

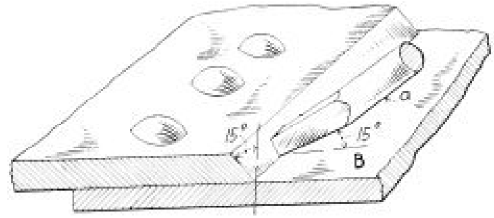


Fig. 2.—Showing Position of Square Faced Calking Tool

Position of Tools in Calking a Seam

entirely upon calking to make them tight. In tank work the main requisite is tight seams. Tank seams are not designed as for steam boilers; therefore, the lap from center of rivets to outer edge of plate need not be as great, and the pitch between may be much narrower to insure tight joints. The size of rivets is larger in proportion to the plate thickness, as compared with corresponding plate work in boiler practice.

In preparing the sheets for tanks, it is well to remove all burrs which are produced in punching the plate. Any small particles of metal in between the laps will invariably cause leaks and make it difficult to calk the seam tight.

Size of Lap.—The width of lap for single riveted seams in boiler practice is usually made 1½ times the diameter of rivet, and is measured from the center of rivet holes. For tanks made of heavy plate it may be less, being made 1⅛, or 1¼ times the diameter of rivet used. Too much lap should not be allowed, as the plate will spring when being calked or when in use.

Size of Rivets.—The rivets for tanks should be of such size that will give a good joint requiring only a small amount of calking. In considering this matter, it is necessary to figure on the pitch and driven size of head, so that there is sufficient clearance between a driven rivet and an adjoining one, which is in the process of forming, so that the rivet set will have ample room to drive the rivet home and pull the plates firmly together. It is not good practice in heavy plate work to punch holes less than 1¼ times the plate thickness, due to the fact that punches are liable to break if made smaller in size; also a very large clearance between the die and punch is necessary in punching holes equal or smaller than the plate thickness, thus producing holes with a large taper. It will be seen that for tanks a large diameter of rivet as compared with plate thickness is essential.

Calking the Seams and Tools Used.—In upsetting the edge of seams there are two calking tools employed. In boiler practice the one shown in Fig. 1, known as the *round nose fuller,* is recommended. Round nose fullers should not be made thin, as in the use of such a tool it has a tendency of driving in the edge and thereby springing the plates apart. Light blows on the tool, produced either by hand or air, should be the aim, as otherwise, the plate will be forced or sprung and not calked. For some classes of work a tool, as in Fig. 2, commonly called a square faced calking tool, is used. Care, however, in its use must be taken, since the sharp lower edge may be driven into the lower plate, *B,* and thus damage the sheet. Some mechanics, to avoid the liability of cutting sheet *B,* round the lower edge of the tool off a little. The edge of the seam to be calked should be beveled or chipped off at an angle of from 15 to 30 degrees, but should not be over 30 degrees. The location of the bevel edge, Fig. 1, as compared with the vertical line *ab* indicates the angle. The tool should be held at right angles, that is, perpendicular to the beveled surface. If held any lower than this, the plate will be forced back, causing it to spring or bulge, as shown at A, Fig. 1. If held too high, the tool will be forced against the lower sheets and not calk the seam.

OBITUARY

Thomas McNeil, Sr., a pioneer boiler manufacturer of Pittsburgh, Pa., and president of James McNeil & Bro. Company, died on May 28, in his 76th year. He was born in Rutherglen, Scotland, and came to America when 8 years old, settling with his parents in Canada until 1860, when he came to New York City. During the Civil War he was employed in the United States Navy Yard at St. Helena Islands, looking after transport vessels for the United States Government. In the year 1865 he came to Pittsburgh and with his brother James started in the boiler business. In 1900 the business was incorporated under the present name of James McNeil & Bro. Company. Mr. McNeil was well known to the boiler manufacturers, and his thorough knowledge and long experience in steel plate construction work made him an authority in this line. He was granted several patents in connection with his business, and he was one of the first manufacturers who advocated and developed the use of riveted steel pipes for large diameter conduits. Mr. McNeil was known for his frank and friendly disposition and he commanded the respect of all with whom he came in contact by his sincerity and forceful personality, coupled with an all-around knowledge.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Effect of Using Soda Ash on Boilers in Bad Water Districts

In a bad water district, where we have three 100 horsepower boilers, the foreman has been using a quart of soda ash every twenty-four hours. There was not much scale in the boilers, but the boilers and flues were badly pitted. The belly of the boiler was not touched, but the sides and braces were badly pitted. There were fifty-four 4-inch flues in the boiler, and we had to scrap twelve of them. Others were badly pitted but could be used again.

We have cut the amount of soda ash in half to see what effect it would have. I have noticed that where we used soda ash it always pitted the boiler and flues. Since cutting the amount down and taking the flues out oftener we get better results.

Daniel A. Rogers, Foreman Boiler Maker,
Fellows, Cal. C. C. M. O. Company.

Zinc, the Boiler Cleanser

I have just read in a reputable journal that European engineers are using zinc in boilers to a considerable extent for the purpose of keeping the boilers clean.

Pure zinc plates separated by steel or iron washers are strung on a bar inside the boilers. The iron and zinc being in contact, a galvanic current is developed which "prevents foam and keeps the boiler clean for an indefinite period."

It has always been my impression that galvanic currents should be kept out of boilers as much as possible, that such currents are the cause of pitting sometimes, and that they are best reduced by making the boiler of as high grade steel as possible, free of foreign elements and with no other kind of metal than steel in use in the boiler.

Perhaps nature has changed since Hannah died, but before loading my boilers with zinc I want to be sure that the newly adopted process is a success.

New York. N. G. Near.

Rolling Boiler Plates While Hot

I am pleased to note that several readers of The Boiler Maker have taken up the question that I brought up in the August, 1915, issue. It would not cause much trouble or expense to try a test piece of steel, as there are boiler experts experimenting on such things who have the equipment to do so. There are several boiler makers that believe it would cost too much to build boilers in the manner which I specified. In my opinion, such men have not visited or worked in boiler shops where they make a specialty of building Class A boilers, for such shops have the tools to do most any kind of work.

I feel sure that there will be many changes in boiler laws for a few years to come. The boiler inspectors are just beginning to learn the nature of steel and the strain it has to go through in the shop while being worked up. I think it will be only a short time before boilers will be rolled at the rolling mills, instead of in a boiler shop.

Most any boiler maker that works on the bending rolls knows, or is supposed to know, that the outside surface of a cylindrical plate is strained while it is being rolled. It must stretch a little in order to get the circular form, and the outside diameter of the plate must be longer than the inside diameter, and the consequence is the steel must go somewhere, and when the outside surface of the plate stretches it must weaken the plate to a certain extent.

I feel sure that a piece of boiler plate has a stronger tensile strength before it has been rolled than it will have after having been rolled, or after having been straightened out again and tested. I believe that a boiler shell can be rolled at the rolling mill just as soon as it leaves the plate mill and while it is still hot. Such a method will save some of the tensile strength as compared with rolling the steel to the same diameter when cold. All that is needed is for some steel makers to build a set of rolls that will roll a plate hot and then prove to the inspectors that the shell is stronger than it would be if rolled cold. If the inspectors were convinced of this they would adopt that system.

Bay City, Mich. Glenn Lacey.

Calculation for Size of Boiler

In The Boiler Maker for January there is the following question: "What is the best method for figuring size of boilers required for compound engine with cylinders 10 and 20 inches diameter and 14-inch stroke, cutting off a 10½-inch stroke, working pressure 160 pounds, piston speed 600 feet per minute.

"Probably natural draft would be used, but what difference in size of boiler would it make if forced draft were applied?"

An answer with calculations is given. It involves M. E. P. and other technical matters. As a boiler maker, I would figure this question straight from the known data as follows:

High pressure cylinder, 10 inches diameter; stroke, 14 inches; cut-off, 10½ inches. Therefore, at each stroke

$$\frac{\text{10 ins. diameter area} \times 10.5}{1728} = \frac{78.54 \times 10.5}{1728} = .4775 \text{ cubic feet}$$

steam is consumed per stroke of piston.

$$\frac{\text{piston speed}}{\text{length of stroke in feet}} = \frac{600}{1.166} = 515 \text{ strokes per minute.}$$

Weight of steam per cubic foot at 160 pounds pressure = .389 pound. Then weight of steam consumed per hour = .4775 × 515 × .389 × 60 minutes = 5760 pounds steam required by engine per hour. No particulars are given of the auxiliary plant, but the weight of steam consumed by the auxiliaries may be found in a similar manner and included in the total required.

Consider a boiler to evaporate 5760 pounds water per hour, natural draft. If firing is done with ordinary care and the heating surfaces of the boiler are kept clean, then a boiler efficiency of 67 percent can be maintained. Assume draft = ½ inch water gage, which will easily burn 20 pounds coal per square foot grate coal. Calorific valve 14,500 B. t. u.

W P = 160 pounds.
Feed water temperature 100 degrees F. } Factor of evaporation = 1.167

$$\frac{14500}{966} = 15 \text{ pounds from and at 212 degrees F. and}$$

$$\frac{15 \times .67 \text{ efficiency}}{1.167 \text{ factor of evaporation}} = 8.62 \text{ pounds water actual evaporation per pound coal.}$$

$$\frac{\text{steam required}}{\text{actual evaporation} \times \text{rate of combustion}} = \text{grate area} =$$

$$\frac{5760}{8.62 \times 20} = 33.4 \text{ square feet grate.}$$

Ratio of grate surface to heating surface = 1 to 35.

$33.4 \times 35 = 1170$ square feet heating surface.

With forced draft a fuel consumption of 30 pounds per square foot grate is common and a boiler efficiency of 75 percent can be kept up under good condition, then actual evaporation

$$= \frac{14500 \times .75}{966 \times 1.167} = 9.65 \text{ pounds water actual evaporation per pound coal.}$$

$$\text{Grate area} = \frac{5760}{30 \times 9.65} = 19.16 \text{ square feet grate.}$$

Ratio of grate surface to heating surface = 1 to 45.

$19.16 \times 45 = 862$ square feet heating surface.

This figuring is for a Scotch boiler. It should be noted in boilers of this type compactness is a disadvantage. Make a boiler that a man can get all about it for examination or cleaning. The initial cost is soon repaid in fuel alone; ⅛-inch scale increases the fuel bill at least 15 percent.

JOHN BELL.

Newcastle-on-Tyne, England.

Special Tools for the Boiler Repair Man

In large establishments it is customary to keep a repair man for all outside work, who is always ready to go on any kind of a job at a very short notice, and such a man is usually provided with a kit of special tools, for, unlike the shop man, who can go to the tool room and draw any tool to suit his purpose, the repair man must carry his tool room with him. When instructed to get ready

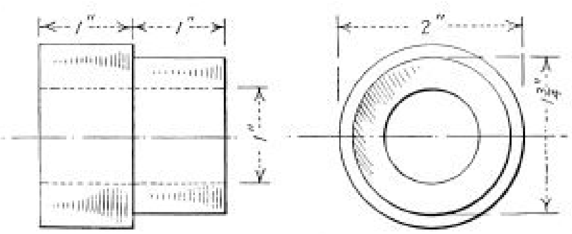


Fig. 1

for a job of any kind he must go over in his mind the whole operation he is to perform while away, and assemble the tools that will enable him to accomplish this end without again returning to the shop.

Should the job be the changing of a set of flues he will be required to provide himself with the various size rolls for the size tube to be changed, also a backing out bar, and should the engine prove to be of the dinky type he will find it very hard to work in the smoke box of such an engine. Again should it prove to be a steam shovel that he is to work on, he is up against it again when ready to roll the top end, for working down in the cone-shaped smoke box of a shovel boiler is no cinch. To avoid this hard and unsatisfactory way of working, the writer had some special rolling pins made to fit a socket for an extension rolling pin.

Fig. 3 shows the end of the rolling pin, which are made for sizes 1½-inch up to 2¼-inch rolls. The dimensions given are the same on all pins, so the necessity of carrying more than one socket will be avoided. Fig. 4 shows the socket end, which is made of a good quality iron and is about 7 inches long. To make the socket ready to use take the distance from the front flue sheet to 6

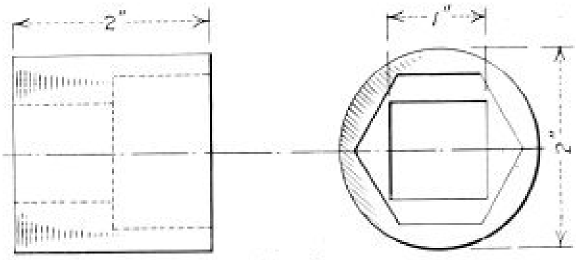


Fig. 2

inches or 8 inches outside the smoke box of a locomotive, or on the steam shovel from the top head to 6 inches or 8 inches above the top of cone. Get the blacksmith to weld a piece of ¾-inch round to the required length. Within 4 inches of the end punch a ⅜-inch hole for the rolling pin. Now take the rolling pin selected, insert in the socket end, get a wire nail and drive in the 3/16-inch hole, bend over and your extension rolling pin is ready

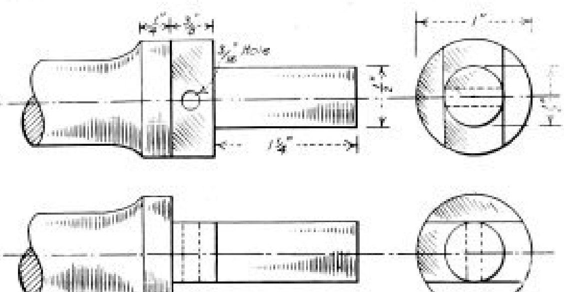


Fig. 3

for action. When the job is finished cut off the socket end and pack up.

Now it often happens that a job of this kind takes a man many miles away from home and traveling on a passenger train such a tool as a flue backing out bar would be out of the question. To overcome this trouble the writer was provided with backing out heads in sizes 1½ inches, 1¾ inches and 2 inches, and made of the best tool steel. Fig. 1 shows this tool.

To use this useful tool, a piece of iron or steel was swaged down to fit the head and allowed to project

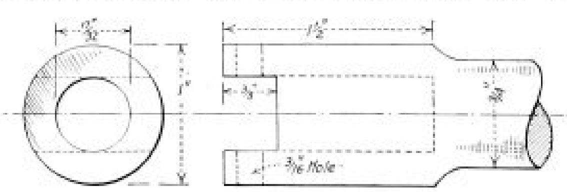


Fig. 4

through just enough to rivet the end over slightly. As many of these jobs are at coal mines, rolling mills, or on railway construction work, steel bars of the proper size are easily obtained. Now when your flues are well split and opened up in the firebox, and your big hole cut in the front end, and the beads cut off the stiffeners in the smoke box, you are ready to back out the flues.

Besides backing out flues with this bar, it is a splendid tool to hold the flues while the lip is being knocked over in the firebox.

Sometimes it is necessary to remove a steam pipe or a nozzle box in the front end before the flues can be got at, and the repair man is expected to be a master mechanic and get those things out of his way. Even where the firm getting the work done provides a man to do this work, he generally comes armed with hammer, chisel and monkey wrench. Here again the writer was provided with another special tool to meet the case. Fig. 2 shows the tool, made like the others of best tool steel, and to make it ready for service all that was required was to square the end of a bar to fit the end, bend the end at right angles, insert in the tool and you are ready for business. This tool, like the others, is made in three sizes, ¾ inch, ⅞ inch and 1 inch—in fact, it can be made to any size that you want.

It is the custom to give the repair man all the information possible as to the job he is to work on—the shop number of the locomotive, its make and style, etc.—so that, when he is getting out his tools, he is then able to take along with him the right kind of tool to do the work and at the same time keep his load down to a reasonable weight.

No doubt there are many of the readers of this magazine who have felt the want of some such tools as above described, and have had to worry to know how they were going to get around knocking out the flues without a bar, or how they were going to double their long legs under them so that they could cram themselves into a steam shovel or dinky smoke box. To such, I trust, the above tools may prove as serviceable as I have found them.

Pittsburg, Pa. FLEX IBLE.

Talks to Young Boiler Makers

The old upright boiler with its flanged connection and four-inch pipe, which went through the side of the building of Mike Dunnavan's boiler works, was noted on his books, or, rather, in his inventory, as "heating apparatus." It heated the back of the foreman very satisfactorily and kept warm the little knot of men who drew around it to eat their lunch while seated on empty rivet kegs.

It was Monday noon, and the usual crowd had gathered to coal up, as some of them used to call it, and there was a good deal of laughing and joking because there had been posted a notice by the boss stating that from that day on the wages of all hands would be advanced 15 percent. Of course, this would make any crowd of boiler makers feel good, but it seemed strange to the crowd that Pat Hicks, the best boiler maker of them all, and generally known as old man Hicks, did not seem to enthuse over the advance in pay. Patsy Bolivar, a young fellow just out of his time, put it up to Hicks to know why the raise did not suit him? "I have had two big pieces of luck in my life," answered Hicks. "To get Nora to marry me was the first one, and the second one was learning my trade under a man who was a crackajack at it, and who took the trouble to make me learn everything he knew.

"Nora was a school teacher and was great on figuring out things, and every penny I have saved she has taken care of, and if it hadn't been for her I would not have been worth a cent to-day. The first year I was in America I haved $100, or, rather, she saved it for me, and I loaned it to a fellow to help build his house. I got 10 percent on it. You could do that in those days. Since then I have been saving money right along and loaning it. But, boys, the more I saved the less interest I could get for my money, and to-day you can only get 5 percent; so you see, it has taken twice as much capital today to get the same income as it did when I started in to work here.

"You fellows think that this 15 percent raise is going to help us a lot, but I tell you it will not help us any. Here's what is going to happen: You, Bolivar, have just got married and have rented a nice little house at $20 a month and you rent out the top floor to a couple of old maids for $10 a month. On the first of the month around comes the landlord for the rent, and he will say very polite like: 'Mr. Bolivar, I am sorry to inform you that I shall have to lift the rent on you to $23,' or, perhaps, he will say $25. You will put up a great big holler, and he will tell you bold-faced like, 'You can afford to pay more rent because you are getting more wages.' Then you go upstairs and lift the rent on the old maids, and it's rough on them, because they are not getting any more wages. Then you will go down to the butcher's; the chuck steak has jumped from 15 to 20 cents a pound. Then the grocer's prices will all go up, and you will put up another holler. These people will come back at you with the fact that as the shops have lifted your wages the clerks in the store and the men on the wagons had to get a raise, too, as was only fair, and the men on the farms and on the railroads, and everywhere else, have all got a lift too, and if you want groceries or meat, or anything else, you will have to pay more for it.

"Now, boys, just look at the facts: If the boss jumps your wages what are the possible results? They are these: First, the boss has got to be satisfied with smaller profits, or, second, the customers have got to pay the boss more money for boilers, or, third, we men have got to do more work for the bigger pay. Do you think you are going to do the last?"

The crowd did not seem very much inclined to think that they would, but Hicks continued: "But you will for a few days and then drop back into the old jog again. If the customers are asked more money they won't buy so many boilers. If the boss makes less profit, what then? You say you don't care whether he gets a large profit or not. This is just where you make a mistake; this is where his smaller profits will hit you. When things slack down he'll let a lot of us go, perhaps all of us, because smaller profits will not tempt him to make any stock boilers. The result of this is that you will have to hunt another job or loaf for a while. If you loaf, you are eating up your capital, and if this shop is slack in boiler work it's a pretty sure thing that other shops are slack, too, so it will be hard to find another job."

"Well," broke in one of the young boiler makers, "what would you have us do—tell the boss that we won't take the raise and he can knock off 15 percent from our past wages?"

Old man Hicks said very slowly: "I am not sure but that would be wise, but it won't be done. If I knew how to fix all this I would be president of the biggest company in the world instead of patching boilers. It's a great big question, it is a great big puzzle and I can't figure it out, but this I do know: That it don't make any difference what wages are paid so long as what you get is enough to let you live on. To put it another way: it's what the money in the envelope will buy for you and not the number of dollars in it.

"Here's one more thing that I want you to think about: If all the boiler makers in the United States are paid $25 a day there will still be boilers made and bought, but only by the people of the United States. If we sell each other boilers in this country there is no money made for the country no matter what price they are sold at. There is no more water in the pot if you stir it up: the only way this country can get rich or more money for its people is by digging gold and silver out of the ground, or by selling something to another country, as then their money will be coming to us, and so there will be more money for all of us. As far as I can figure this thing out, if we want to export stuff, the question of wages will have to come in, and I think they will have to come down. If, however, we are only trading with each other, it makes no matter whether the wages go down or stay up. We are mighty smart people in the United States, but there are other smart people in the world, too, and you can't get around it. People will buy the cheapest boiler if they can get as good material, workmanship and design.

"There goes the whistle, let's go to work."

W. D. FORBES.

Technical Legalities or Legal Technicalities

Many are the stories, instructive or humorous, which center round the profession of the law. Unlike journalism in its general aspect, legal folk, while apt to split hairs, are yet avid for facts. Their consideration of these must be impartial and from every angle of view must of necessity be free from prejudice and bias, whatever their presentation of the case involved. It is for this reason —that is, detachment from personal issue, no less than from their acquaintance with the law and its formulas and delays—that the advocate is employed. Only an acute intellect can at short notice obtain sufficient knowledge of an alien business to surprise those versed in its intricacies and who are in close contact therewith.

A specialist in modern welding has several times been cited as an expert witness before the courts, acting both on his own behalf as adviser, as well as in a consultant capacity to advise counsel briefed in other cases. He has an unfailing respect for the mental agility of the legal fraternity in technical cases.

In one case concerning contingent damages for a faulty boiler weld, the chief witness on the other side was a representative of a boiler insurance company whom it was desired to make liable.

My friend had given evidence as to the imperfect welding of the job, was followed by the insurance company's witness for cross-examination. Counsel elicited from him the opinion that a welded seam might be subjected to compressive, but not to tensile stress. Further, that his company would certainly not insure a boiler where such construction was permitted.

A brief aside by counsel to my friend led to the following dialogue:

"You are quite sure of your facts that a weld is not permissible in such a connection?"

"Yes, positive."

"Then let us take a specific instance. Your company insures watertube boilers?"

"Yes."

"Are the tubes composing such boilers welded or not?"

"They are welded."

"Are such tubes exposed to tensile stress in their material?"

"Yes."

"Thank you; that will do."

In his speech the evidence elicited as above obtained the verdict for counsel's client.

The single admission was sufficient, and the lawyer had no knowledge except a whispered aside to my friend and half a dozen words of suggestion.

Yet broadly stated the boiler insurance man was right, and the verdict, although in accordance with the evidence, was contrary to fact. Welded seams are not permitted in a boiler shell. Tubes which are welded are of small size, easily replaced and failure rarely leads to material damage, being of localized character. Further, the danger to life and limb is infinitely less than the rupture of a shell. The point of the matter is that the witness neglected to qualify his answer, possibly the natural confusion in an unaccustomed position lost his side their case.

Such an instance points to the need for technical assessors on the bench or a special trade jury.

The technical case, hinging as it does upon matters abstruse to the layman, and involving as it does conflicting evidence from both sides from the mouths of equally qualified expert witnesses, led to a famous remark of a well-known English judge.

In a racy speech dealing with his experience over a long period on the bench, he compared the makers of falsehoods in a descending order as liars, d—— liars and expert witnesses. The latest story current concerns the late Lord Chief Justice of England, Lord Alverstone. I extract it as given in a London newspaper:

"What the late Lord Alverstone used to regard as the finest compliment ever paid to him during his career at the bar is related by his cousin, Mr. E. R. Calthorp:

"An engineering case in the North relative to certain defective boiler work was being tried, and was attracting great interest among the local workmen, who crowded the court every day. On the last day of the case, while 'Dick Webster' was addressing the court for the plaintiffs, a burly boiler maker foreman came in and sat down next to one of the principals of the plaintiff firm, to whom he was well known.

"As the address proceeded and dealt faithfully and searchingly with abstruse technical details and the various odd customs of the shops, the eyes of the foreman opened wider and wider, and at last he turned to his neighbor and whispered: 'Who's that feller taking to the judge?' 'Why, that's Mr. Webster, our counsel,' was the reply. 'Wha-a-a-t?' crescendoed the foreman. 'Do you mean to tell me that feller's only a lawyer? Garn! 'E knows a sight too much for that' (almost roaring, so that the Court itself looked up), 'I tell yer that feller's a boiler maker!'

"The sincerity of the compliment greatly appealed to Lord Alverstone, or to Mr. Webster, as he then was."

In conclusion, the interest taken and the knowledge displayed by our lawyer friends who specialize in technical work rests in many instances upon solid foundations.

There are several engineering treatises of acknowledged excellence, one on steam turbines, for an example, another on sea water distillation, written, not by engineers, but by barristers-at-law, and it is a matter for amazement on the part of the technical man that a legal mind should prove a mind of mechanical instinct as well.

A. L. HAAS.

When a square cornered patch is to be heated, remember that the corners can be easily overheated.

It is a very good thing to drill holes at the ends of a crack in a plate before you patch it, as this prevents the crack spreading.

Heating metal, say a rivet, to a low red heat is a common requirement and care should be taken to make apprentices understand that a red heat in bright sunlight is one thing, while on a dark day, or in a dark room, it is quite another. Much depends then in what light the heating is being done when it comes to color.

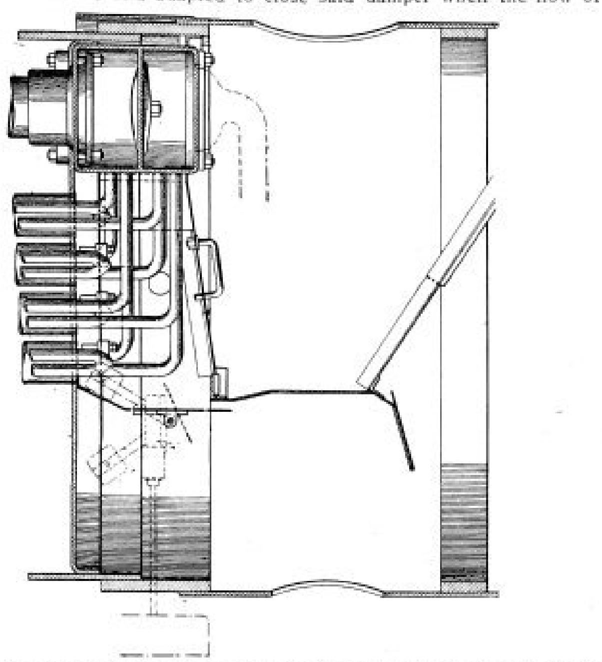
Selected Boiler Patents

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

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

1,172,000. DAMPER FOR BOILERS. CHARLES D. YOUNG, OF ALTOONA, PA.

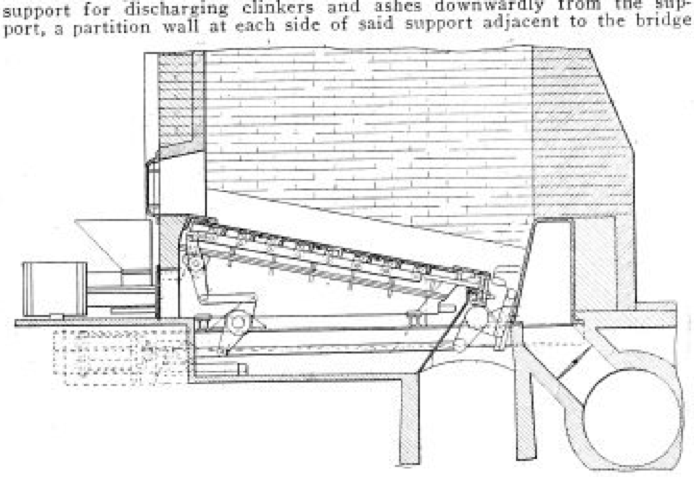
Claim 1.—The combination with a steam boiler having fire tubes and a superheater located in said fire tubes, of an oscillatory damper journaled in the smokebox of said boiler and adapted to control the flow of gases through said fire tubes, mechanism operated by means of fluid pressure from the locomotive and adapted to close said damper when the flow of



steam to the superheater is cut off and to open the same when the steam is turned on, comprising a movable piston stem provided with a slot therein, and an arm fixedly secured to the oscillatory damper shaft and projecting through said slot, substantially as described. Five claims.

1,172,290. FURNACE. WILLIAM J. KENNEY, OF CHICAGO, ILL., ASSIGNOR TO UNDERFEED STOKER COMPANY OF AMERICA, OF CHICAGO, ILL., A CORPORATION OF NEW JERSEY.

Claim 1.—In a furnace, a support for a bed of fuel arranged within the furnace, a hollow bridge wall arranged in rear of and spaced apart from the support, means arranged between the bridge wall and said support for discharging clinkers and ashes downwardly from the support, a partition wall at each side of said support adjacent to the bridge



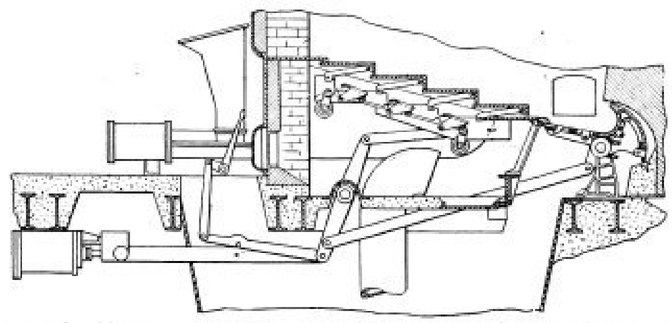
wall, a third partition wall at the rear of said support, the partition walls extending downwardly so as to confine the discharging clinkers and ashes to the space directly in rear of the support, metal walls projecting above said support at each side thereof, there being passageways leading from the ends of the hollow bridge wall around the outside of the said metallic walls and the side partition walls and into the space beneath said support, and means for introducing air into the interior of said bridge wall. Ten claims.

1,172,243. BOILER FEED-WATER REGULATOR. ROGER W. ANDREWS, OF PITTSBURG, PA., ASSIGNOR, BY MESNE ASSIGNMENTS, TO ERIE PUMP & EQUIPMENT COMPANY, OF ERIE, PA, A CORPORATION OF PENNSYLVANIA.

Claim 1.—The combination of a boiler, a feed-water pipe, a balanced valve in said pipe, and a feed-water regulator; said regulator being adapted to vary the level of the water in said boiler and comprising an expansion tube; one end of the operative portion of said tube and the desired maximum water level in said boiler being approximately in the same horizontal plane, and the other end of said tube and the desired minimum water level being approximately in the same horizontal plane; the upper end of said tube being connected to said boiler above the maximum water level, and the lower end of said tube being connected to said boiler below the minimum water level; one end of said tube being rigidly supported, and operating means connecting the other end of said tube with said valve and in such a relation thereto as to supply less water to the boiler than the load requires when the load is increasing and to supply more water to the boiler than the load requires when the load is decreasing, said relation being such as to hold said valve substantially closed when the water in said boiler is at the maximum level, and to hold said valve open the maximum amount when the water is at the minimum level. Six claims.

1,172,292. SELF-CLEANING STOKER. WILLIAM JOHN KENNEY, OF WILMETTE, AND HENRY PHILLIP GROHN, OF CHICAGO, ILL., ASSIGNORS TO UNDER-FEED COMPANY OF AMERICA, OF CHICAGO, ILL., A CORPORATION OF NEW JERSEY.

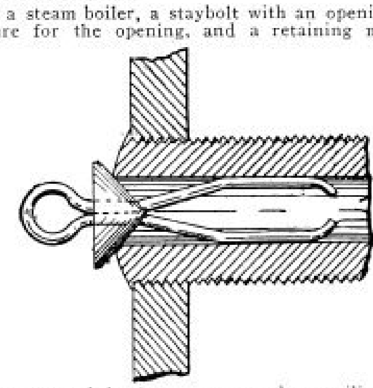
Claim 1.—In combination, a furnace, a retort in the furnace, a stepped-panel beside the retort for receiving clinkers and ashes therefrom, each



step of said panel comprising a movable section, and means for moving said sections one at a time in the direction of the length of the panel so as to shift the panel bodily in the direction of its length. Nine claims.

1,172,350. STEAM BOILER STAYBOLT PLUG. BURR B. FREER, OF OIL CITY, PA.

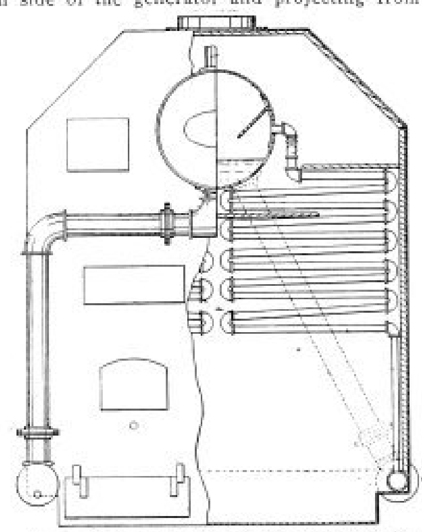
Claim 1.—In a steam boiler, a staybolt with an opening throughout its length, a closure for the opening, and a retaining member extending



through the closure and having at one end a resilient portion in engagement with the wall of the opening and at the other end a suitable finger piece. Four claims.

1,172,401. STEAM BOILER. HUGH S. STUDDERT, OF SEATTLE, WASH.

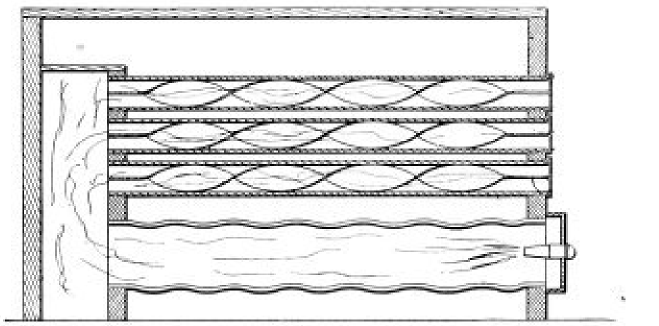
Claim.—In a steam generator, in combination, a casing, a horizontal steam drum extending outside the casing at each end, horizontal mud-drums at each side of the generator and projecting from the casing at



each end, down-flow pipes at each end of, and entirely outside of, the generator connecting said steam-drum and said mud-drums, a series of generating coils connected in pairs immediately outside the steam drum and connecting said mud-drums and said steam drum, said generating coils having one opening into the steam drum for each pair of coils, said openings being placed above the water level in said steam drum, a baffle-plate in said steam drum immediately above the said openings and inclined downwardly, a baffle-plate at each side of the generator extending from end to end of the series of generating coils, and extending inward less than half the width of the generator, and a baffle-plate placed below said first baffle-plates, and extending from the side less than the width of the generator.

1,174,533. STEAM-BOILER-TUBE RETARDER. KNOWLSON TOWNSEND, OF SAN FRANCISCO, CAL.

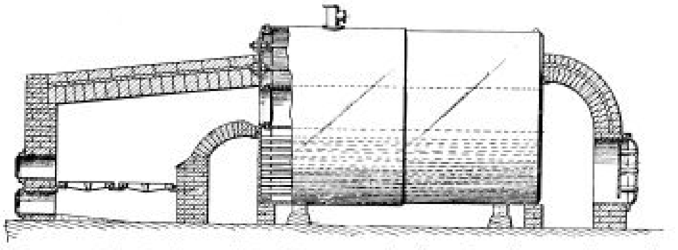
Claim 1.—In a boiler, the combination of a flue tube and a retarder, the said retarder comprising a metal strip insertible into the flue to



divide the flue into a pair of air passages, the outer end of the strip having bendable portions adapted for being bent over the tube outlet to restrict the area of the said outlet. Three claims.

1,174,583. STEAM BOILER AND FURNACE THEREFOR. ROBERT JOY, OF OSWEGO, N. Y., ASSIGNOR TO THOMAS P. KINGSFORD AND VIRGINIA K. HIGGINS, BOTH OF OSWEGO, N. Y.

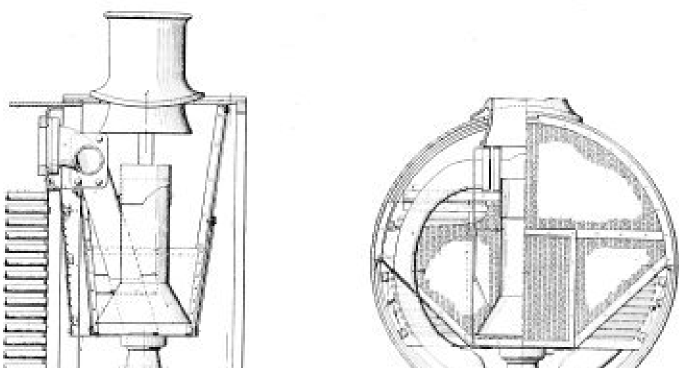
Claim 1.—A steam boiler of the horizontally disposed cylindrical shell type, having fire flues extending therethrough approximately just below the surface of the water therein, and smoke tubes extending through the lower portion of said boiler, in combination with a furnace arranged



in front of the boiler and having a combustion chamber or throat delivering the burning gases to the front ends of said flues and having a smoke chamber at the front ends of said tubes with an offtake discharge, and a wall in rear of the boiler and forming a return chamber from the rear ends of said flues to the rear ends of said tubes.—Eleven claims.

1,174,623. LOCOMOTIVE. IRWIN A. SEIDERS, OF READING, PA., ASSIGNOR OF ONE-HALF TO HIMSELF AND ONE-HALF TO AGNEW T. DICE, JR., OF READING, PA.

Claim 1.—In a locomotive, the combination with the boiler shell, the tube sheet dividing the steam and water space of the locomotive from the smoke box, the smoke stack outlet, the fire tubes connected to said tube sheet and the exhaust nozzle located in the lower portion of



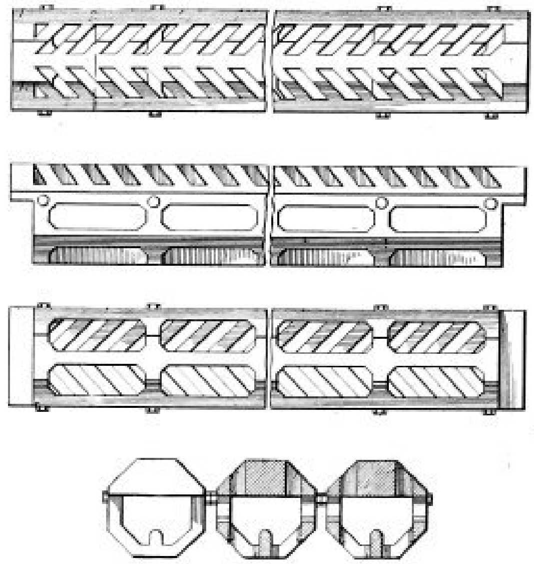
the smoke box, of a table projecting across the smoke box and formed with a central foraminous portion surrounding said nozzle and upwardly inclined side portions, and screens connected to the front and rear edges of the table and dividing the smoke box into an outlet compartment communicating with said smoke stack and an inlet compartment into which the fire tubes discharge.—Seven claims.

1,169,784. FURNACE BAFFLE-PLATE. WILLIAM FABER, OF LONG PRAIRIE, MINN.

Claim.—As an article of maufacture, a furnace baffle plate comprising in a one-piece symmetrical structure, an imperforate concaved body of equal thickness from end to end and provided at its ends with attaching flanges the under faces of which lie in a common plane, the flanges being provided with attaching openings, the body being equipped upon its concaved side with parallel crescent-shaped ribs extended from one flange to the other and located along the longitudinal edges of the body and intermediate the longitudinal edges of the body, the body being supplied midway between its ends and upon its concaved side with a single transverse rib connecting all of the longitudinal ribs, the transverse rib being thicker than the longitudinal ribs and being of the same height as the longitudinal ribs.

1,175,823. GRATE BAR. ERNEST F. ROWLEY, OF BIRMINGHAM, ALA.

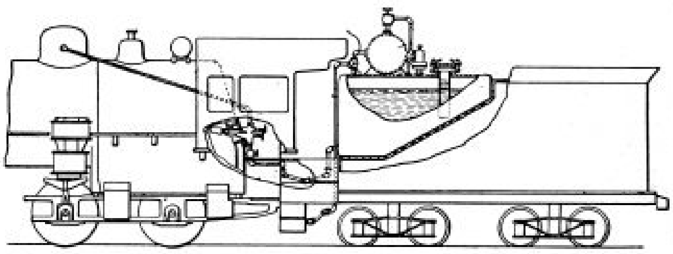
Claim 1.—A tubular grate bar unit having a greatly thickened and reinforced solid top portion included between and bounded by a flat top face, inclined side faces adjacent thereto, vertical side faces adjacent to the inclined side faces, and a flat bottom face which is parallel to the top face, said grate bar unit having also side and bottom wall



portions, the solid top portion being provided with relatively small draft apertures and the side and bottom wall portions which are relatively thin being provided with relatively large draft apertures.—Three claims.

1,175,900. LIQUID-FUEL-BURNING LOCOMOTIVE. HENRY CLAY JORDAN, OF SEATTLE, WASH., ASSIGNOR OF ONE-HALF TO JOSEPH ROGERS, OF VANCOUVER, BRITISH COLUMBIA, CANADA, AND ONE-HALF TO GEORGE F. ORCHARD, OF SEATTLE, WASH.

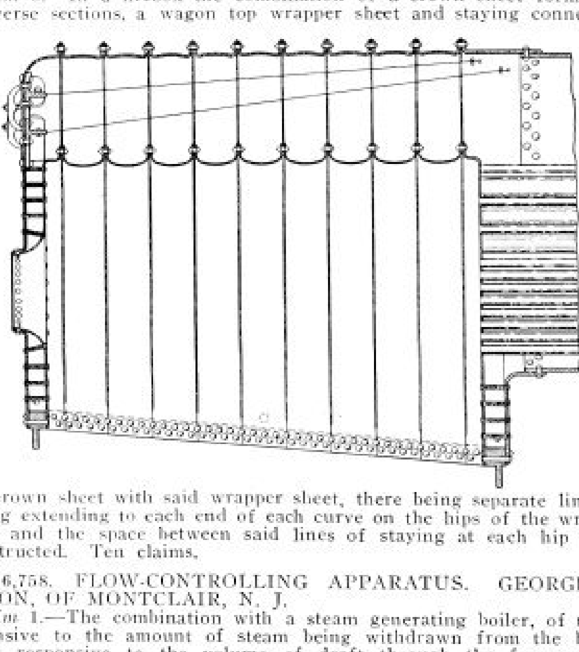
Claim 1.—In apparatus in combination with a burner, a liquid-fuel supply means an air reservoir, a connection between said reservoir and



said means, a pressure controlling valve in said connection, and means for locking said valve open. Three claims.

1,175,937. FIREBOX. CHARLES DUCAS OF NEW YORK, N. Y., ASSIGNOR TO JACOBS-SHUPERT UNITED STATES FIREBOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF PENNSYLVANIA.

Claim 5.—In a firebox the combination of a crown sheet formed of transverse sections, a wagon top wrapper sheet and staying connecting



said crown sheet with said wrapper sheet, there being separate lines of staying extending to each end of each curve on the hips of the wrapper sheet, and the space between said lines of staying at each hip being unobstructed. Ten claims.

1,166,758. FLOW-CONTROLLING APPARATUS. GEORGE H. GIBSON, OF MONTCLAIR, N. J.

Claim 1.—The combination with a steam generating boiler, of means responsive to the amount of steam being withdrawn from the boiler, means responsive to the volume of draft through the furnace, and means controlled jointly by the two first mentioned means for regulating said volume of draft. Five claims.

THE BOILER MAKER

JULY, 1916

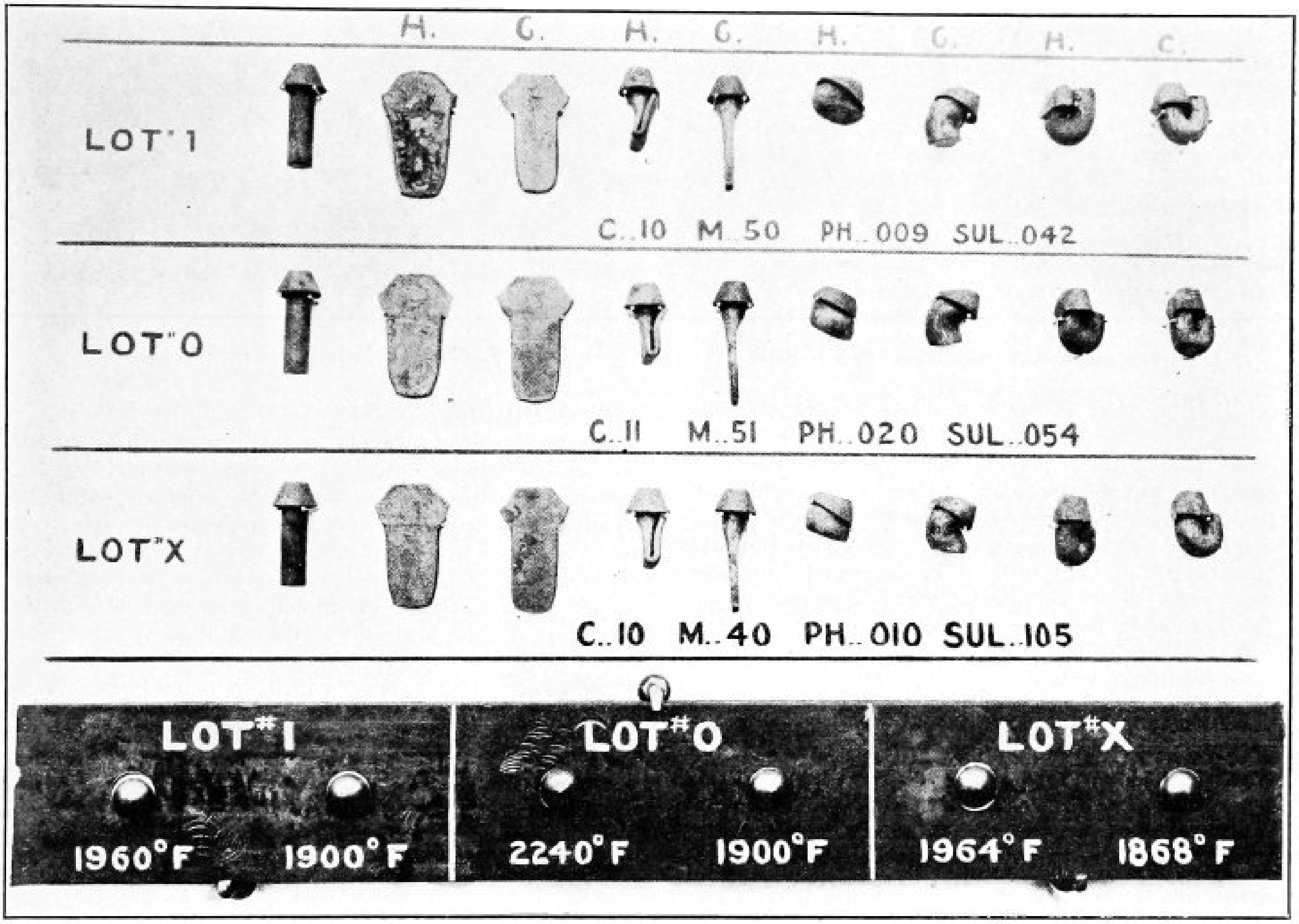


Fig 1.—Hot and Cold Forging Tests of Rivets

The Effect of Sulphur in Rivet Steel*

How the Working and Physical Properties of Rivet Steel are Affected by Increasing the Sulphur Content

BY DR. J. S. UNGER †

Sulphur in steel, whether justly or unjustly, is held responsible for the bad working of steel. As a result, the specifications covering the allowable amount of this element have been gradually lowered until, in certain cases, below .030 percent is the limit demanded. It is very difficult to reach this limit and, when reached, there is grave doubts, in the minds of many, whether the quality of the steel has not suffered by the excessive purification required to produce such results.

It is almost the universal practice when steel shows a tendency to work badly, or becomes red short, to make an analysis of the steel. If this analysis indicates that the steel has the proper or permissible amounts of the usual elements, but happens to be a few thousandths of a percent higher than the specified amount of sulphur, the sulphur is held responsible for the trouble. Such decisions are made without considering any other influences, such as the heating for rolling or the subsequent heatings necessary to work the material up into a finished product. Very few users of steel appear to have either the time or inclination to make a few trials at slightly higher or lower temperatures in manufacturing their particular product to determine if a steel, which is not

*Paper presented before the American Boiler Manufacturers' Association, Cleveland, June 19.

†Manager, Central Research Bureau, Carnegie Steel Company, Pittsburg, Pa.

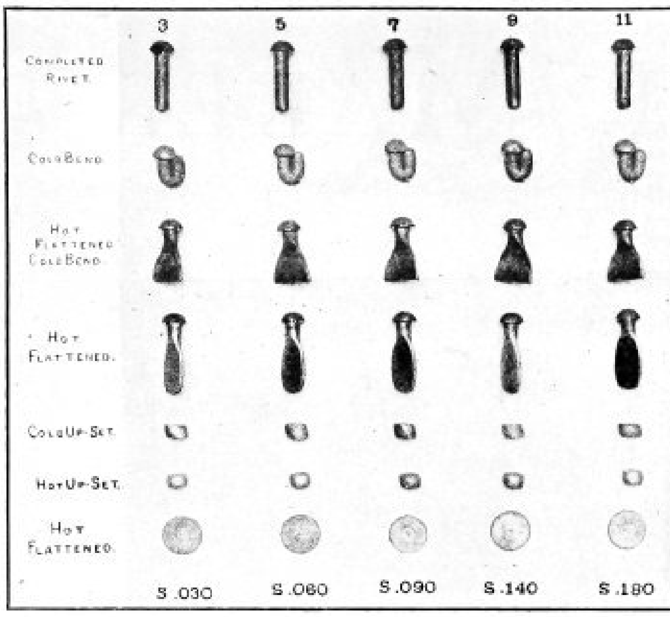


Fig. 2.—Hot and Cold Forging Tests, ¾-Inch Rivets

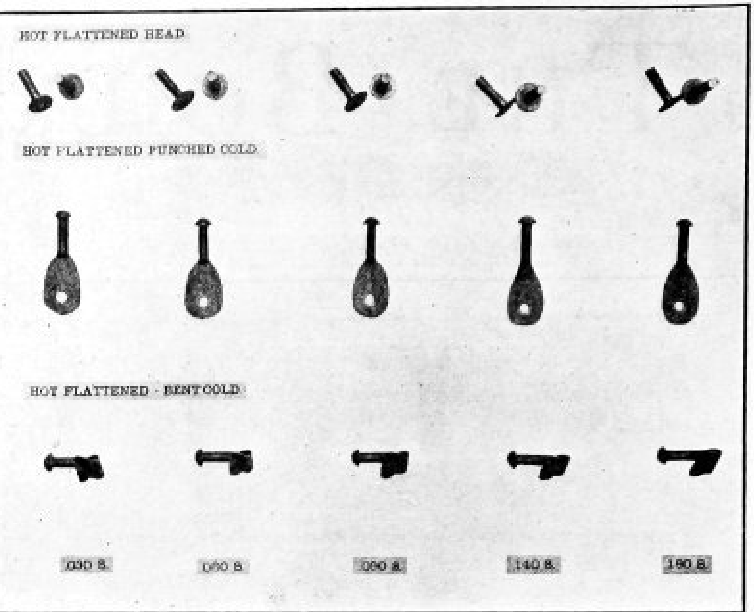


Fig. 3.—Tests of ¾-Inch Rivets, 0.09 Carbon

working at its best at the temperature they are using, could not be improved by a very slight change in their working temperature. The argument usually presented by them is that the greater part of their steel works satisfactorily by their shop methods, and they should always receive steel of the same quality. There is a certain amount of justice and truth in the argument, but sometimes it is based on an opinion which does not include all the factors in the case. At least four factors influence the results:

1. No two heats of steel are exactly alike.
2. No two users of steel use exactly the same methods in fabricating the finished product.
3. No two operators in the same shop work exactly alike.
4. The same material may work well at one time and unsatisfactorily at another, in the same shop.

It is not my intention to discuss these points at this time, but simply to call your attention to them.

The purpose of the experiments I will describe was to study the effect on the working and physical properties of rivet steel by gradually increasing the amount of sulphur in the steel until it had been raised to a point far above that usually found in such steel.

Composition and Manufacture of the Steel

The steel used was regular basic open hearth of carbon, .09 percent; manganese, .43 percent; phosphorus, .012 percent; sulphur, .031 percent. The sulphur content of certain ingots from this heat was increased progressively by adding weighed quantities of sulphur to these ingots, the additions being regulated to secure as near as possible a uniform increase of sulphur from one ingot to the next higher. The heating and rolling of these ingots was done in the regular way and all ingots were treated exactly alike. The finished ¾-inch diameter rounds were alike in every particular, as regards composition, heating and rolling, excepting that they carried different amounts of sulphur. The rolled bars showed the following amounts of sulphur:

.030 percent, .060 percent, .090 percent, .140 percent, .180 percent.

Hot Working Properties

The hot-working properties and some of the cold-working properties are shown in Fig. 2. Additional hot and cold-working tests are shown in Fig. 3. In Fig. 1 are shown some tests made on three separate heats of steel with different sulphur contents. Fig. 4 shows the ap-

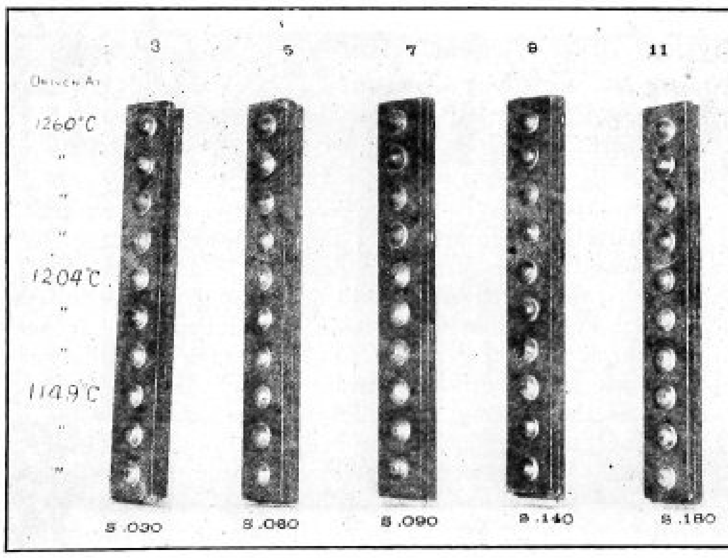


Fig. 4.—Riveting at Various Temperatures

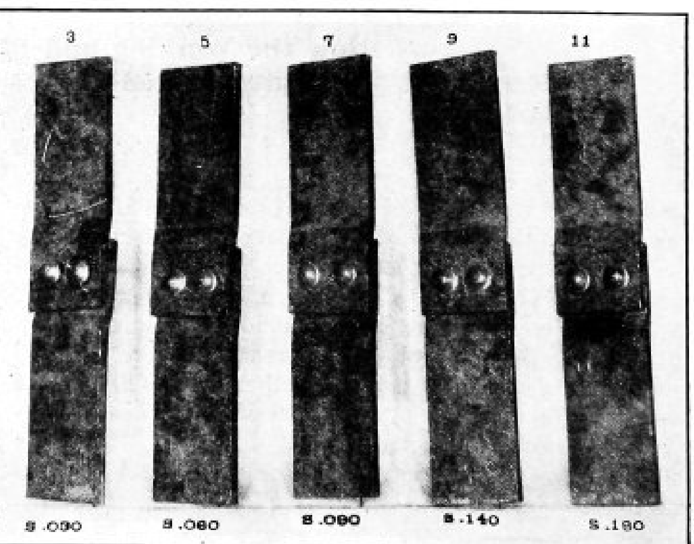


Fig. 5.—Riveted Joints

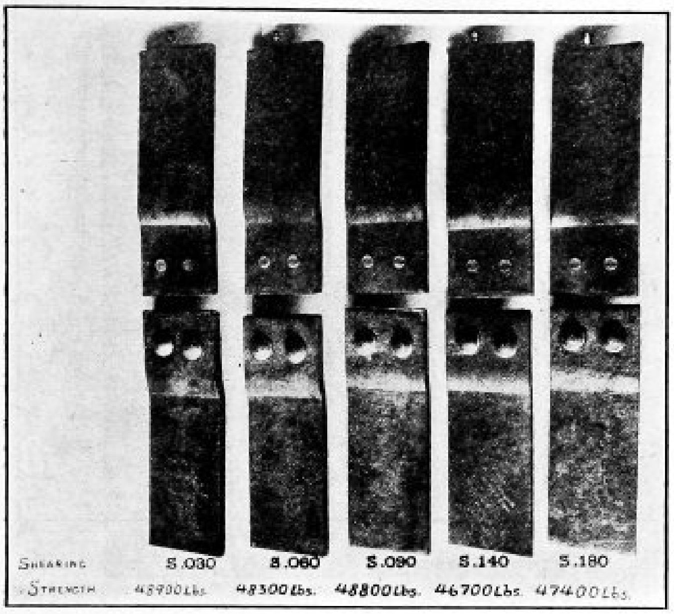


Fig. 6.—Shearing Tests of Riveted Joints

pearance of some bars riveted up at different driving temperatures.

A study of the appearance of the tests shows very little difference between the low sulphur rivets and those containing six times as much sulphur.

Cold Working Properties

To determine what might be expected of the rivets, when in actual service, a number of bars were riveted together, as shown in Fig. 5, and in addition a number of angles were riveted together. These samples were then tested to destruction, with the results shown in Figs. 6 and 7, and in Table I:

TABLE I.—DESTRUCTION TESTS OF RIVETED JOINTS AND ANGLES

Sulphur Content	Riveted Joints Shearing Strength	Riveted Angles Breaking Load
.030	48,900 pounds	33,240 pounds
.060	48,300 "	32,000 "
.090	48,800 "	30,000 "
.140	46,700 "	31,200 "
.180	47,400 "	26,180 "

Some tensile and bending tests on the rolled bars are shown in Fig. 8, and the results in Table II:

TABLE II.—TENSILE TESTS OF ¾-INCH DIAMETER ROUNDS AS ROLLED .09 CARBON

Sulphur Content	Elastic Limit Pounds per Square Inch	Ultimate Strength Pounds per Square Inch	Elongation in 8 Inches Percent	Reduction of Area Percent
.030	31,360	50,460	30.8	64.2
.060	32,740	50,900	30.2	65.3
.090	30,890	51,400	31.2	62.5
.140	31,600	50,700	32.5	64.2
.180	31,530	50,960	30.7	62.3

In Fig. 9 are found tests made on extra long rivets under ordinary conditions to determine if one rivet head would stand as well another. The nick bends and bending the head of the rivet were made to see if any differences would be found in these cold bends, due to the varying sulphur contents.

Fig. 10 shows a similar set of tests, but in this case the rivets were heated to a driving heat (1200 degrees C.), then taken out of the fire and quenched in cold water to show the effect of drastic cooling from a high heat.

A third set of tests, Fig. 11, similar to Figs. 9 and 10, were made on rivets which were heated to a blue heat (350 degrees C.), then quenched in cold water.

TABLE III.—TENSILE TESTS OF ¾-INCH RIVETS IN THE ORDINARY CONDITION

Sulphur Content	Elastic Limit Pounds per Square Inch	Ultimate Strength Pounds per Square Inch	Elongation in 8 Inches Percent	Reduction of Area Percent
.030	34,010	51,740	34.2	70.2
.060	32,820	51,050	34.6	70.4
.090	37,480	51,620	36.0	67.3
.140	34,320	50,320	33.7	67.1
.180	33,340	51,050	37.4	65.8

TABLE IV.—TENSILE TESTS OF ¾-INCH RIVETS QUENCHED IN WATER FROM 1200 DEGREES C.

Sulphur Content	Elastic Limit Pounds per Square Inch	Ultimate Strength Pounds per Square Inch	Elongation in 8 Inches Percent	Reduction of Area Percent
.030	44,100	69,700	8.1	62.5
.060	44,450	71,160	9.8	62.7
.090	54,690	76,600	7.6	53.7
.140	49,380	70,520	11.1	58.3
.180	43,730	67,850	10.6	54.8

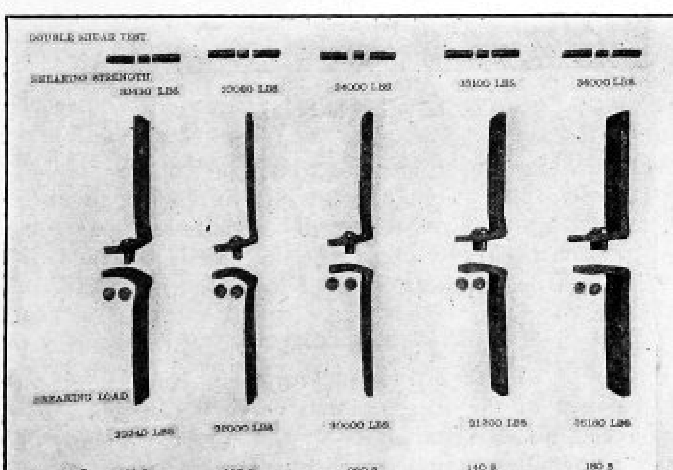


Fig. 7.—Tests of ¾-Inch Rivets, 0.09 Carbon

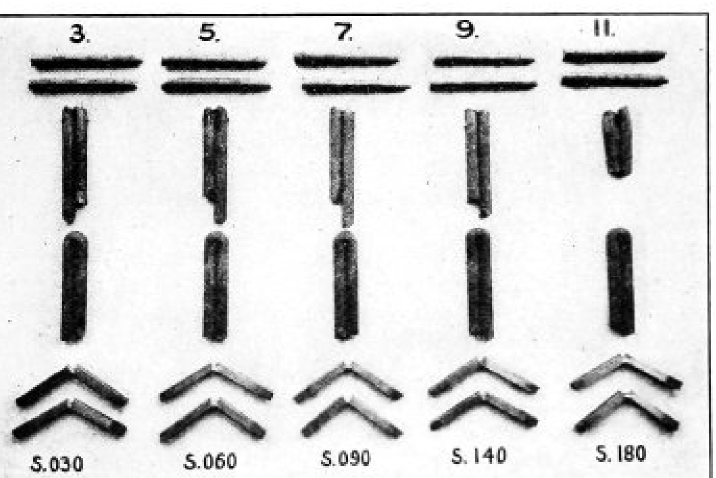


Fig. 8.—Tensile and Bending Tests

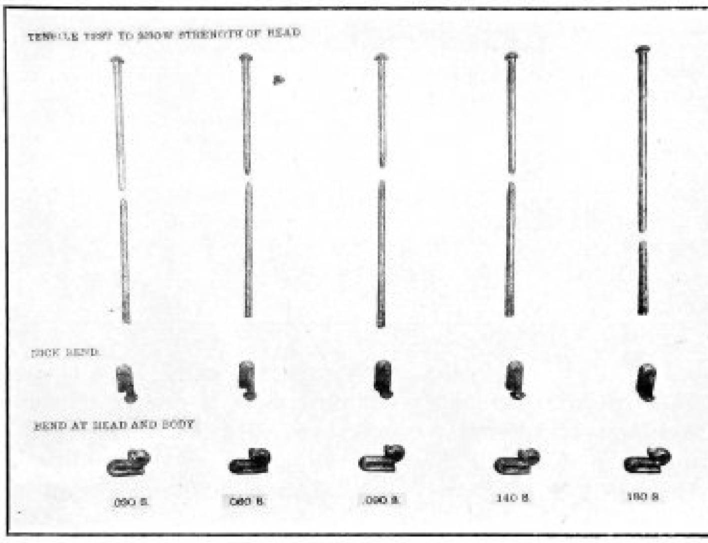


Fig. 9.—¾-Inch Rivets, 0.09 Carbon, Tested in the Ordinary Cold Condition

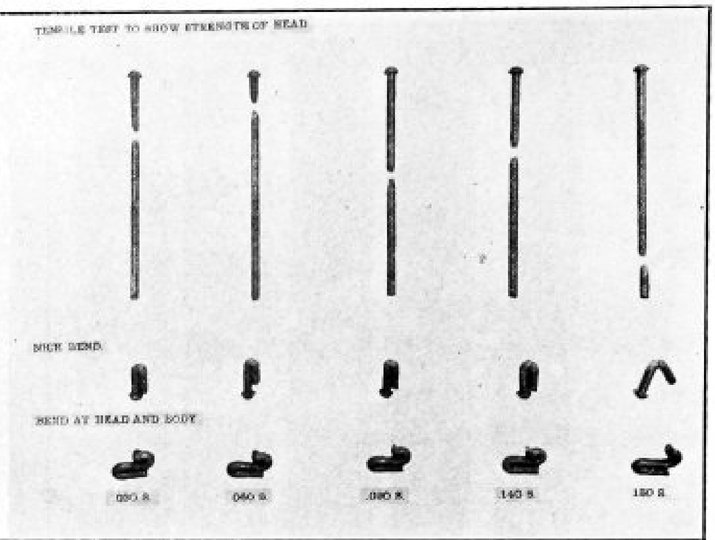


Fig. 10.—¾-Inch Rivets, 0.09 Carbon, Quenched from a Rivet Driving Heat of 1,200 Deg. C. in Cold Water, then Tested

TABLE V.—TENSILE TESTS OF ¾-INCH RIVETS QUENCHED IN WATER FROM A BLUE HEAT 350 DEGREES C.

Sulphur Content	Elastic Limit Pounds per Square Inch	Ultimate Strength Pounds per Square Inch	Elongation in 8 Inches Percent	Reduction of Area Percent
.030	32,700	50,630	23.0	61.5
.060	31,060	50,400	25.0	59.4
.090	33,430	50,140	32.8	59.2
.140	32,060	49,500	32.0	60.8
.180	32,200	50,510	34.0	60.4

TABLE VI.—SHEARING TESTS OF ¾-INCH ROUNDS

Sulphur Content	Shearing Strength in Pounds Double Shear
.030	33,430
.060	33,060
.090	34,000
.140	33,100
.180	34,000

The object in all these tests was to show whether the different treatments affected the rivets differently and whether the higher sulphur rivets were affected to a greater degree than the lower sulphur.

Tables III, IV and V give the results of the tensile tests.

In addition to these tests, a double shearing test was made on the ¾-inch rounds of each sulphur content in the ordinary condition. This test was made, as shown in Figs. 7 and 12, and the shearing strength of each is given in Table VI.

SUMMARY

The results of tests and photographs speak for themselves. These results can be duplicated by anyone who has the necessary facilities. No theories are advanced. The facts are before you. It is believed that the tests indicate the fitness for most purposes of a steel rivet containing slightly less than .100 percent sulphur.

So far as the author has been able to determine, there does not appear, by working tests or mechanical tests made on the finished rivet, to be any way of distinguishing between the quality of a rivet of .030 percent sulphur and one of .090 percent sulphur, if both have been subjected to the same conditions.

For many years before basic open hearth steel became common, millions of rivets were made and used of wrought iron or Bessemer steel. Bessemer steel is considerably higher in phosphorus and in most cases higher

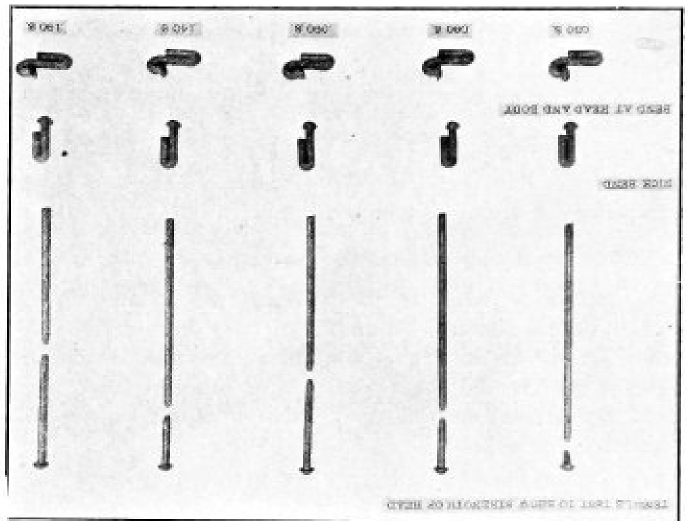


Fig. 11.—¾-Inch Rivets, 0.09 Carbon, Quenched from a Blue Heat of 350 Deg. C. in Cold Water, then Tested

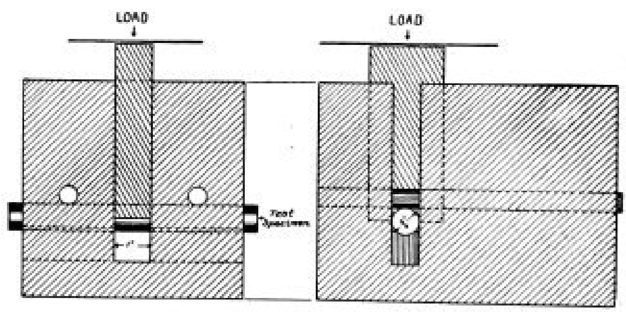


Fig. 12.—Double Shear Test

in sulphur, than basic open hearth. The greater number of such Bessemer steel rivets are still in service, furnishing us with the best possible evidence that steel may contain a much higher sulphur content than is specified today in open hearth steel, without injuring the quality of the rivet.

PERSONAL.—Isaac H. Levin, formerly chief engineer and chemist of the International Oxygen Company, has announced his resignation from the above company in order to devote his time to chemical research as a specialist in the electrolytic field. Mr. Levin's temporary address is 186 Hillside avenue, Newark, N. J.

Building Ice Machine Condensers

Difficult Bending and Fitting Operations Carried Out With Ordinary Boiler Shop Tools

BY JAMES FRANCIS

"Henry, take your gang and get at those ice machine condensers. There are twelve to be made, four sheets in each forty-eight sheets in all, to be bent up and riveted together, with heads and flanges, as shown by Fig. 1. The layerout has the sheets ready for you. They have all been sheared, beveled where necessary, and are marked for punching. Get busy and bend them up as soon as they are punched."

"All right, Mr. Foreman, I'll get right after it; but say, isn't that some bending job? The sheets are No. 10 and are six feet wide. The large radius is 24 inches in diameter, the small radius about 8 inches. Seems to me we are not very well fixed with tools for bending a job like that, are we?"

"Tools? Tools, nothin'! What dy'e want with tools? Any plug of a man can do work with special tools all laid out for him and any good man can do work without many tools. Now, Henry, it's right up to you whether you will be a 'plug' or whether you will get busy and rig up some of the shop stuff and bend those condenser sheets as well as though forms and bulldozers had been made purposely for the job. How is it, Henry; are you up to the work or shall I give it to Bill? He'll handle it all right, you know."

"Handle nothin'; I can do anything that Bill Duffle can do, and I'll bend those condenser sheets or bust things trying! But, say, what do they condense with those things, anyway? Why, they are four feet high, as shown by Fig. 1. What do they do with them, anyway?"

"Oh, they are going into that new ice plant which they are putting up on Blank street. You see, they advertise distilled water to make all their ice from, so they turn the water into steam, run it into these condensers—twelve of them set side by side and use the water of condensation for making the ice—that is, they freeze the condensed water and get pure ice thereby."

"It must take an awful lot of coal to evaporate all that water?"

"Oh, not as much as you think. You see, it's this way: the water to be distilled passes around outside of the condensers and cools them so the steam inside can turn back into water again. Now, they are a bit foxy in circulating that water. They let the cold water in over the farthest condensers, where the condensed water has become almost cold. Then the water passes over the next condenser, where it is a bit hotter and the water inside that condenser is hotter, too. They keep this up until the water outside of the condenser is almost boiling hot when it reaches the section of condenser into which the live steam is turned. In this way, much of the heat in the condensed water is saved and made to do useful work again by heating the water to be distilled. Sure, there is a lot of loss. They can't save all the heat, but they do save a whole lot of it in this way. And now it is up to you to make up those condenser sections—'pronto.'"

"Say, Mr. Foreman, I'll have to bend those sheets in the 6-inch rolls, won't I? There's nothing else in the shop which will get into the 8-inch bends?"

"Yes, Henry, the 6-inch rolls will do the trick and you won't have to do much rigging-up, either. Here's one of the sheets sketched out in Fig 2. The letters *a, b, c* show where the bends stop and start, and you must mark each sheet just like this one. Better get the layerout to make you a templet like that shown by Fig. 3. Get him a piece of 2½ inch by ⅛ inch strap steel and let him lay off the points *a, b, c* and *d*. Then put this templet on

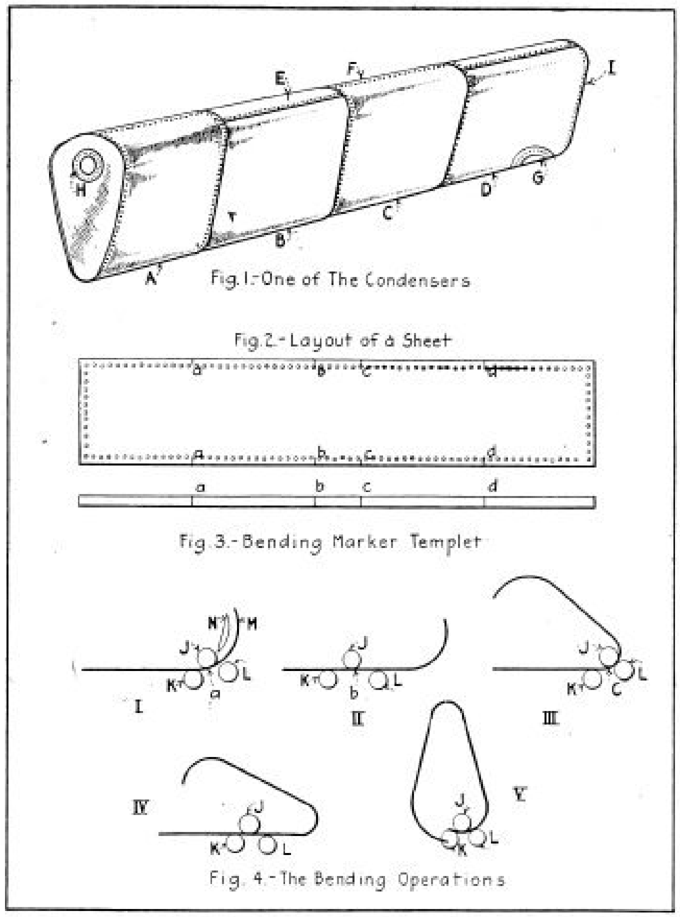


Fig. 1:-One of The Condensers

Fig. 2.-Layout of a Sheet

Fig. 3.-Bending Marker Templet

Fig. 4.-The Bending Operations

Bending Operations

each sheet, as in Fig. 2, and mark the points *a, b, c, d* on each edge of the sheet. Then when you get the sheet in the rolls, stop and start the bending fair with these marks."

"Won't we have to change the rolls a good many times when we bend these sheets?"

"Yes, Henry, you will have to adjust the rolls four times for each sheet, and that means some screw work."

"Can't we rig some stops so as to turn the screws until the rolls are hard against the stops, so as to save a whole lot of measuring?"

"No need of that, Henry. Just make three marks upon each end of the roll housing and bring those marks fair with a mark on the roll bearing, according to the radius being bent to. You will find where to make these marks as soon as you get a sheet into the rolls."

"All right, Mr. Foreman, but are all the sheets the same in that condenser? Are they inside and outside courses or do they telescope?"

WHAT THE SKETCH TELLS

"Look at the sketch, Henry. Doesn't that tell the story? It always seemed strange to me why a man, when he had a sketch, would not look to see what the sketch told him before he asked questions. If a sketch is well made, it should answer each and every question that need be asked regarding the making of any object. It is the purpose of sketches or drawings to show or tell how things are to be made, and if they don't do that, then it is time to have it out with the draftsman. Now, Henry, look at Fig. 1 and see if sheet *A* is not shown outside of head and inside of sheet *B*. Likewise sheet *B* is outside sheet *A* and inside of sheet *C*, and so it goes the length of the condenser except sheet *D* is outside of both sheet *C* and head *I*, which is not in sight, but sheet *D* will be the same as the other sheets, tapered the thickness of the metal and head *I* will be made small enough to go inside the small end of section *D*; therefore one head is smaller than the other an amount equal to two thicknesses of the No. 10 steel."

"How do they carry these condensers? They will be nearly 24 feet long?"

"Make them up in sections of two sheets each, Henry. Then we can handle them easily and we can put the two sections together after each section has been laid in its place. There will be a flange at the lower part of the end sections, as shown at *G*. This is the water outlet. Steam enters through opening *H* and in head *I* there is a manhole through which we can get into the condensers to drive the middle seam."

"I don't know, Mr. Foreman, why it is that I can't seem to find out things from the drawings. I wish I could, it would save time asking a lot of questions."

READING DRAWINGS

"You don't stop to look, Henry; that's just what is the matter. If you would only look at the drawings and study out the meaning of each and every line and dimension, then you would never have any trouble in finding answers to your questions right in the drawings. And better than that, you would not have to ask any questions, for the drawing would tell you the whole story. Now, Fig. 1 even shows you how the laps are arranged on either side of the center of the larger radius. Keep this in mind when you are bending the sheets and get them right side out or there will be trouble with the holes coming fair with each other."

"All right, Mr. Foreman, here goes for the first sheet. I have got it into the rolls but I don't know when the curve is sharp enough. Guess we will have to make a gage to bend this curve by."

"Hold on, Henry. The layerout made a templet for this very purpose. There it is in the pile of sheets. Pick it and try it on the curve, as shown at *N*, sketch I, Fig 4. The curve at *M* is too flat? Well, just back up the roll and screw it down a bit more. Then roll again until the sheet at *M* will fit.

"Templet *M*! What's that? You have got the curve a little too sharp? Never mind that. A few hammer blows distributed over the outside of *M* will loosen it up, all right. But you now have got roll *L*, or whatever roll is movable, about where it is wanted to roll the 24-inch circle. As it came a trifle small, loosen up the roll a very little and make a mark at each end of the roll so you can set the roll again same as it is now. This is the first of the three marks which you are to make on the housing."

"The sheet fits the templet *N* pretty well now at each end and in the middle."

ROLLING THE SHEETS

"That's good. Now run the roll very carefully and slowly until the bend arrives at mark *a*, as shown by sketch I. Don't be satisfied with 'pretty near' or 'within a hair.' I don't know what space is occupied by 'a hair' in the boiler shop but the stone mason when he says 'a hair' means within four inches. When he means to be exceedingly accurate and says 'within a red hair,' I know from experience that he means within three inches. So don't be slovenly about stopping the roll exactly at *a*. The closer you stop the bend to this mark, the less hand work you will have to do when you come to put the sections and the heads together."

"Pretty good now, Mr. Foreman, right up to *a* on either side of the sheet."

"Now, you've got to slack off on the screws and push the sheet through without bending it until the roll arrives at mark *b*, where the short radius bend begins. And, Henry; better set the rolls, as shown in sketch II, so that rolls *K L* just touch the under side of the plate while roll *J* grips the upper side just hard enough to prevent the sheet from slipping or sliding one way or the other. The spring of the sheet will allow the three rolls to be closed so there is a slight bend of the sheet between *K* and *L*, but not bend enough to make the sheet take a set. As long as the slight bend is within the elastic limit of the steel, the sheet will come back to a straight position again, so set the roll so it holds the sheet without bending it, then run the sheet through until roll *J* is exactly opposite mark *b*, as shown by sketch II."

"Shall I make another mark on the roll housing for the position of the rolls, shown by sketch II?"

"Sure, Henry. That will be the second mark. Now, screw down the roll until it curves the sheet to an 8-inch circle, as shown by sketch III. The third housing mark should be made with the roll in this position. It will take some fierce work at the screws to bring the roll down to the small radius, so you had better grease the screws pretty well and provide a good long lever to turn them with, for the screws sure will go hard when they get down into the pocket formed by the two other rolls."

"Say, Mr. Foreman, how am I going to start the roll exactly on mark *b*, sketch II? It is even betting that the sheet bends a little to one side of *b* when the roll is screwed down, and that would cause trouble.

BENDING OPERATIONS

"Right you are, Henry. You must manage to start the bending exactly on line *b*, at both edges of the sheet. I tell you what—just run roll *J* a little past mark *b* before starting to bend, then when the screw has been forced down and the short bend is just right, back up the rolls until the bend is just to mark *b*. Then you can go ahead and run the rolls the other way and stop them at *c*, sketch III, with the short bend completed. You will, of course, turn the rolls by hand for the last fraction of an inch so the bends may stop exactly at the proper marks. It will be a stiff pull on the pulley, but you can do it all right by putting a monkey wrench on the rim of the wheel for a lever to pull the pulley around with. Screw the wrench down so it slips snugly over the rim of the wheel and you can turn the pulley easily."

"Here we are at the next straight place between *c* and *d*, Fig. 2. Change the rolls again, I suppose?"

"Sure, Henry. Put them back to the straight position, shown by sketch II, and run the sheet through until you get to mark *d*. And here, sketch IV, you had better do the same as you did at mark *c*; viz., start a little past the mark and back up to it as soon as you get the roll set to the first mark again."

"I've got you, Mr. Foreman. I see the whole scheme now. Setting the rôlls to the "straight" position gives a chance to run the sheet through the rolls without permitting one side or the other to get ahead. It keeps the sheet square all the time."

"That's the idea, Henry; but you must look out when you change the roll as, in sketches I and III, there is a chance of the sheet coming loose and one edge shifting ahead or behind, unless you take care to work the rolls by hand as the sheet loosens so as to keep a light pressure on the sheet all the time. Either this, or you must watch the marks and make sure that the sheet is perfectly square with the rolls before starting to run over the straight position, *a b* and *c d*."

"Sure; I can keep one hand on the pulley when I back off the screw next to the driving end of the roll. The man at the other end can watch me and do as I do in moving the screws. And say, Mr. Foreman; when the rolls get to the end of the sheet, as in sketch V, why, won't the rolls be in the right position for starting another sheet?"

"Sure they will, Henry. Another sheet may be started right in as soon as you get the bent one out. But look out when finishing the bending of a sheet or you may have a nasty pinch of the hand or a finger nipped off by the first end of the rolled sheet when it comes around and bangs hard against roll *K*, as shown in sketch V."

"I suppose we will have some fun getting these sections together. If the bending goes past the line ever so little, it will make it hard to enter one section into the other."

"You had better look out for that, Henry, when you do the bending and get the curves started exactly on the marks. But there will, of course, be a little variation, no matter how close the work is done. And as these sections were laid out to be close fits one into another, it will be the best to open the ends a little before trying to enter the inside sheet. Just let one man hold a dolly about an inch below the row of rivet holes and let another man go around the end of the section and drive the sheet outward. In this manner he can easily flare the outer course so the inner one will enter easily in spite of small irregularities of blending which will equalize each other as the sheets draw themselves together during the driving-in action."

"I suppose we will have to drive the sheet down again after the rivets are in?"

"Probably there won't be any need of that. The sheets will probably come down when you drive the seam. If it does not, you can drive it down easy enough. But the rivets are so close to the edge that there will be hardly any need of closing down the sheet again. As these condensers must be watertight, the outside edges have been beveled a little so they can be calked enough to hold water under no pressure. You needn't worry, Henry, about the sheet coming back after you flare it a bit to enter the inside courses."

RIVETING THE SEAMS

"What is the best way of driving these seams, Mr. Foreman? It will be close work handling rivets inside the sections. Can't we back them in?"

"Sure, Henry. Back them in, by all means. It makes a better job—a tighter one, and three times as quick as driving from the inside. Just put three rivets in each section. Drive barely enough to hold them together, then enter one section inside the other, stick in three or four drift pins and up-end the two sections upon the floor of the shop. Send a man inside with a short, heavy dolly, which he can hold on in the small circle or anywhere else. Then start a drift lightly—better drift two holes—then push in a cold rivet and drive it with the airgun. The hold-on is flat and gives a thin flat head. The sheets must draw pretty close together with all the take-up of the rivet being done inside where the head is forming. I am in favor of backing rivets in all work under three-eighths inch thick. Why the other day, when we made that dryer shell, twenty feet long, we backed in all those rivets through the cast iron spider arms and everywhere else. There is less danger of breaking cast iron during the riveting of a shell against it when the rivets are backed in."

"Yes, Mr. Foreman, I remember that shell mighty well. It was 60 inches by 20 feet and we had to bend it by hand. Too long to go into the bending rolls, the sheet was, and the shell had to be all in one piece. Well, we bent it with mauls and sledges and we were only nineteen hours doing it, either."

"That was a good job, Henry, and I hope you will get as good a one on these condensers. Don't forget to drift two holes, then drive two rivets, then drift two more. This is much quicker than driving one rivet, then drifting one hole, and it will not pay to try and drift three holes, for the thin sheet don't stay in place well enough for that —there is too much variation when the sheets are pulled together."

"I'll look after that, Mr. Foreman. But by gracious, it is not as much of a job to bend those condenser shells as it looked to be before we got at it. Guess we can do some work in this shop without special tools, after all."

Courses in the Foreign Trade Announced

Dr. Edward E. Pratt, chief of the Bureau of Foreign and Domestic Commerce of the United States Department of Commerce, is the director of an educational course in foreign trade which has just been announced.

In Dr. Pratt's opinion the problem of our foreign trade expansion is largely one of meeting the demand for men trained to handle this business. The course in foreign trade is designed to aid manufacturers, banks, export houses and other concerns in giving adequate training to the men in their organizations who are handling or may be developed to handle their foreign business.

The course covers a treatment of the various factors entering into export marketing, such as world trade economics, export policies, export houses, direct exporting, the export salesman, shipping, financing, export technique, foreign and home law, and importing.

The course is supplied to corporations and firms at moderate cost, for study by their employees, and to others interested in foreign trade. It is being issued through the Business Training Corporation, with offices at 185 Madison avenue, New York.

BOILER TUBE FAILURES AT HIGH TEMPERATURES.—At the annual convention of the American Society for Testing Materials, Prof. C. F. Hirshfeld, chief of the research department of the Edison Illuminating Company of Detroit, emphasized how the metal surfaces of large modern steam boilers are performing a duty two and three times that of previous practice, and the fact has brought numerous complications and may even mean the use of different boiler metals. One way out of the trouble suggested by experiments is the use of higher carbon steel. The United States Navy has been driven to the use of nickel steel.

American Boiler Manufacturers' Convention

Progress in Adoption of Uniform Boiler Code—Confliction of Different Boiler Construction Rules—Boiler Shop Cost Systems

The twenty-eighth annual convention of the American Boiler Manufacturers' Association was opened at 10 o'clock on the morning of June 19 at the Hollenden Hotel, Cleveland, Ohio, with Mr. W. C. Connelly, president of the association in the chair. Mr. Connelly first introduced Mr. Thomas E. Durban, chairman of the American Uniform Boiler Law Society, who presented the following report on the establishment of the A. S. M. E. Boiler code in the various States.

Adoption of A. S. M. E. Boiler Code

Abstract of Report by Mr. Thomas E. Durban, Chairman of American Uniform Boiler Law Society

We have had the very best support from the mechanical engineers of the country. They have almost universally taken up the cause and worked it out to the best of their ability. We have had very good support from the boiler makers, although we have not had quite the support that we expected from the boiler making fraternity. Our financial support has been very good indeed. At our last convention in Erie we said that we would like to receive $12,000 to promote this work, and appointed, as you know, a number of different men representing different organizations, to raise the money, and through the advisory councils we were successful in raising about $10,000. We have paid all our bills this year and to-day we have approximately $2,000 in the treasury.

In New York we spent a great deal of time and an immense amount of effort and we had probably the best support we have received in any State. We were enabled to get some of the most prominent men in the State of New York to go before the judicial committee of the Senate in the interest of our bill. Our bill was passed by the House and passed by the Senate unanimously, but was vetoed by Governor Whitman. We made a tremendous effort to prevent the veto, but, as a matter of fact, the thing has shaped up now so that it really is in better shape than if he had not vetoed the bill.

Governor Whitman was not opposed to the protection of life and property as outlined by the efforts this Society is making, but he said they had an industrial commission in that State who were prepared to take this matter up. Therefore, in response to the pleas made to him to sign the bill and make it active, he said that the industrial commission had come to him and told him they would be very glad indeed to take up a boiler code and put one in operation, that it was their function, and if he vetoed the bill they would do that.

We believe that they will do that and we are much better satisfied now than if the bill had gone through as a legislative enactment, from the fact that if it goes through as a legislative enactment and the code itself is passed on by the legislature, each time there is a change in that code it is necessary to go before the legislature to have the change made; whereas, if it is in the hands of a board, as in other States, the changes can be made at the option of the board. Therefore our labors are greatly simplified if we get this into the hands of the commission or Board of Rules.

What appeared to be a defeat for the code in the State of New York is really the best thing that could possibly happen and we have full confidence that the industrial board will do this from the fact that they have already requested several men, both inside and outside the State, to act on the Committee. Therefore your Committee feels that its work has been accomplished in the State of New York.

In Louisiana the report reads: "A bill has been drawn and will be introduced in the legislature before their adjournment, which takes place on July 6, authorizing the Governor to appoint a committee to draw up rules relative to the construction of steam boilers. We are much indebted to Prof. E. W. Kerr, of the State University at Baton Rouge, for looking after the bill for us; also to Prof. W. H. P. Creighton, of Tulane University, and Mr. W. O. Hart, of New Orleans, for their activity in the matter, and their interest in having good laws adopted."

Since this was written, on the sixteenth, we have a telegram from Prof. Kerr that the bill has been introduced in the Senate of Louisiana and we have great expectations that it will be passed upon favorably. We have interviewed men of power there and men who do things in the State, and we really believe that we will get the law through.

In Michigan, Mr. John C. McCabe, boiler inspector of the City of Detroit, has drawn up a bill which will be presented to the legislature and which from our previous experience in the State we believe will be passed. We had a bill up two years ago in the State and it was not passed, due to the fact that we had not had time to educate the people to exactly what the bill meant and the necessity for it. Mr. McCabe has had very strong assistance in the State from Prof. John R. Allen, of the University of Michigan at Ann Arbor, who is doing all he possibly can for us.

In Alabama the American Society of Mechanical Engineers formed a local organization whose chief object was to make an attempt to have the legislature take up the code in that State. Mr. R. E. Brakeman is president of the local organization and is active in his support of the code.

In Illinois the code met with some resistance in the City of Chicago, due to the fact that inadvertent correspondence seemed to antagonize Mr. Nye, the chief boiler inspector. Through the efforts of Mr. Louis Mohr, of John Mohr Sons Company, who is a very active man in Chicago and throughout the State of Illinois, we have organized there to promote the code, and our organization includes some of the best people in Chicago and in the State. We are having assistance there from Sargent & Lundy, from the Chicago Edison Company, and in the State from the Kewanee Boiler Works and from the Illinois University and the personal assistance of Mr. Baker, of Kewanee, who is largely acquainted with Illinois politics, and we hope for the best in that State.

Your committee has devoted a great deal of attention to Texas, due to the fact that Texas is one of the largest users of boilers in the South and they have always been rather progressive in their methods of legislation. We appeared before the Cotton Ginning Association in Texas, which is largely composed of farmers who do the cotton ginning, and they have had the reputation of not caring to buy very high grade goods. However, with the assistance of Mr. C. S. Barry, of the Murray Company, and Mr. J. B. Weaver, of the Briggs-Weaver Company, we appeared at the convention of the Ginners' Association and told them what the code meant to them, and we got their endorsement. Some time after that we had the pleasure of an introduction to Governor Ferguson of Texas, and interviewed him on the subject and explained the code to him, and he said that he would be in favor of its being enacted in some manner in that State, and would so announce in his next message to the legislature, which would be in January. We then had an invitation extended to us to appear before the Texas Cotton Seed Crushers' Association, whose members are very large users of boilers, and with whom are connected some very able engineers. We explained the code to them and they passed a resolution recommending the adoption of the code by the State. We also have secured in Texas the co-operation of the *Dallas News*, which is one of the best newspapers in the United States. They have now prepared a series of some ten editorials which they propose to run as soon as the legislature meets. They have written a great many letters to various States that have laws on the subject and have become convinced that Texas should have a law on boilers.

In Kansas we have the very hearty co-operation of Mr. P. J. McBride, commissioner of labor, and he has attempted, in times gone by, to get some legislation of this kind, but says that he has failed before because he did not have the very support we are now bringing to him, and he writes us that if we will give him some assistance in the way of printed matter and a committee to go before the judicial committee when they get ready to consider the bill, he thinks we can get the bill there.

In the City of St. Louis we had the bill up with other measures and it was sent back for correction, but no opposition developed and we have every reason to believe that the City of St. Louis will shortly adopt the code.

The committee now wishes an expression from all its friends relative to their activities for the next year—that is, we would like an expression as to where we should concentrate our efforts. It will be impossible for the committee, with its limited amount of money and its limited help, to make a very strenuous fight in all States that have meetings of the legislature next year. We will have very strong support in Connecticut in the person of Mr. Breckenridge, of the Yale Scientific School. He has been very active and says he will do everything in his power to assist us in Connecticut. We have a number of promises from other men of equal prominence.

Your committee has been confronted in several States with the proposition that the legislation could be put through for a certain fixed amount of money, as low as $500. Your committee has taken the position, and will continue to take the position, that for the sake of having legislation of this kind passed, it would not give a two-cent postage stamp, and perhaps the fact that we have not been able to contribute anything to political organizations has somewhat defeated our efforts.

I want to call your attention again to the error in attempting to put too much legislation through at one time. In other words, I find that the menace to this legislation throughout the country almost unanimously lodges in the fact that there is a desire to attach to it a boiler inspection law and a licensed engineer's law. This thing defeated us in Virginia and Rhode Island, because the people who supported the bill were not ready at that time to stand for an engineer's license. The experience of your committee is that wherever legislation is introduced the code must be introduced and stand absolutely by itself and not have any entangling alliances, for if we do have those alliances we threaten the passage of the code.

Confliction of Different Boiler Codes

THE CHAIRMAN: There seems to be a confliction in different boiler codes as to whether or not steel castings, if used for mud rings in boilers should be 50,000 pounds tensile strength as a minimum or 60,000 pounds as a maximum. In one case Massachusetts calls for 50,000, and in the case of the A. S. M. E. code they call for 60,000. Is there anybody operating a plant who has had difficulty in this regard?

MR. JETER: The manufacturers of steel castings say it is not practical to make castings with a tensile strength lower than 60,000 pounds and have them good. Some manufacturers discard their castings when they run below 60,000.

MR. LUCK (chairman of the Massachusetts Boiler Law Department): We adopted on May 12 the specification of the A. S. T. M., Class B, for steel castings. There are some other changes to which I would like to call your attention.

Amendments numbered 1 to 67 inclusive, of steam boiler rules approved by the Governor on January 2, 1915, to be inserted in the praragraphs to which they refer, additional changes to be as follows:

Amendment 1. The pressure allowed on a boiler constructed entirely of cast iron with the exception of the connecting bolts and nipples, and installed within this Commonwealth on or before July 2, 1915, shall not exceed 25 pounds per square inch. The pressure allowed on such boilers installed after July 2, 1915, shall not exceed 15 pounds per square inch.

Amendment 3. (Last three lines): Safety valves on boilers installed after July 2, 1915, must be connected to a separate nozzle or opening in the boiler independent of any other steam connection and as close as possible to the boiler.

Amendment 4. Substitute the following for diagram on page 55.

We have here a new specification for fusible plugs. It differs from the others inasmuch as we have got a straight taper of, from end to end, about 5/8 inch to the foot, just as the U. S. Government calls for. In our rules it called for a longer plug; that is, the internal plug would extend 1/4 of 3/8 inch longer than the external plug; the internal plug would extend about 1 3/8 inches. That has been remedied. We have also put back a pipe-sized fusible plug into a small tube. They couldn't do it in some cases and we put back that three-eighths pipe-sized tube.

Amendment 10. (Add.) When the steam gage of a boiler is connected to water column pipe, there shall be brass pipe and fittings for the steam gage to water column connections.

Amendment 14. Repeal the amendment and restore the rule.

Amendment 15. Repeal the amendment and restore the rule.

Amendment 24. Pressure parts of superheaters attached to boilers or separately fired shall be of wrought or cast steel. Cast iron for pressure parts of superheaters is prohibited.

Amendment 26. (Steam domes, fifth paragraph): Heads of steam domes shall be convex, curved outward from the shell.

Sixth paragraph: When the opening in the shell to a steam dome is 4 inches in diameter or larger, the opening shall be reinforced to compensate for the metal removed along the longitudinal diameter of the opening.

Amendment 29. Boilers in process of construction: any inspector holding a commission or certificate of competency as an inspector of steam boilers for this Commonwealth, may make final inspection and test on a boiler built under the rules of the Board of Boiler Rules of the Commonwealth of Massachusetts, provided the authorized manufacturer of said boiler, or his representative, makes affidavit under oath that said boiler has been so constructed and furnishes the record of a properly authorized inspector who has followed the construction of the boiler.

Now we repeal the paragraph reading: the thickness of plates in a shell or drum shall be of the same gage.

Amendment 36. Drilling of staybolts: All staybolts except those in vertical boilers having furnaces not exceeding 44 inches in diameter, shall be drilled from the outside end to a depth of not less than ½ inch inside the boiler plate, and drilled to a diameter not smaller than 3/16 of an inch.

That means that all furnaces larger than 44 inches in diameter must have staybolts drilled from the outside on a hole not smaller than 3/16. Hollow staybolts with a hole not less than 3/16 inch diameter, and undrilled flexible staybolts of a design approved by this Board, may be used. If a hole larger than 3/16 inch is used, this hole shall be deducted from the cross-sectional area of the staybolt at the base of the thread in computing the allowable load on staybolts. That means that all furnaces 44 inches and under do not have to be drilled. If you drill them we will pass the boiler just the same, but above 44 inches in diameter they will necessarily be drilled on the outside.

Amendment 39. Planing of plates: the calking edges of plates and butt straps shall be planed, wherever possible, not less than ⅛ inch to remove the distorted edges of the plates.

Now we say "wherever possible." Where it is not possible it can be trimmed.

Amendment 41. (Next to last line of paragraph.) Change the word "shall" to the word "may," thus: "A feed pipe connection may be fitted with a brass or steel boiler bushing."

Amendment 42. Cast steel: Steel castings shall conform to the Class B specifications of the American Society for Testing Materials.

In that class I do not think there is an upper limit.

Amendment 49. (Transfer to part 2): The feed pipe of a boiler shall have open end or ends. When one or more globe valves are used on a feed pipe the inlet shall be under the disk of the valve.

Amendment 50. (Transfer to part 2): The feed water shall discharge about three-fifths the length of a horizontal return tubular boiler from the front head (except a horizontal return tubular boiler equipped with an auxiliary feed water heating and circulating device), and at or about the central rows of tubes above the tubes when the diameter of the boiler exceeds 36 inches and the pressure allowed exceeds 15 pounds per square inch. The feed pipe shall be carried through the head with a brass or steel boiler bushing and securely fastened inside the shell above the tubes.

The object and intent of that is to have a blow-off on your water column.

Amendment 57. (Transfer to part 2): On each water connection to a water column where there is a right angle turn, there shall be located at least one gate valve and pipe of a diameter not less than ½ inch for the purpose of blowing out said water pipe. This shall not apply to a right angle turn inside of smoke box.

Amendment 66. (Transfer to part 2): Boiler showing longitudinal lap crack. A boiler in which a longitudinal crack is discovered in a shell plate at or near a longitudinal seam shall be immediately discontinued from further service.

That will apply to boilers already installed as well as boilers you install hereafter.

Part headings to remain unchanged, except the heading to Part 2, which is to read as follows, to cover changes now proposed as above. Part 2: These rules apply to all boilers now or hereafter installed, unless otherwise stated. Paragraphs to be renumbered where necessary.

A Member: May we eliminate staybolts from now on on boilers under 44 inches?

Mr. Luck: You can if you get permission from the board.

A Member: You don't have to drill on the inside of the firebox?

Mr. Luck: No, neither inside nor outside on 44 inches and under; on over 44 inches you do. There has been a ruling by the former chairman of the board that fire plate stamping was for the plate manufacturer, and the board has ruled that when we come to cut up that plate into pieces there must be at least one stamp appear on the plate. All we look for is one stamp on the sheet, which is in the boiler.

A Member: Do I understand that you only want one stamp on the plate?

Mr. Luck: After the pate is in the boiler, one stamp is sufficient and we will pass your boiler.

A Member: We have had a fight on that question of more than one stamp on the sheet. We have to show more than one to the Massachusetts inspectors at the Duluth Boiler Works; we have got to show from 2 to 4 on the outside shell of the boiler or they will not take it.

Mr. Luck: One stamp will pass.

Mr. Fish: If I recall rightly, the specifications for boiler plates require the mill to stamp the plates in five places. That is done, I presume, so as to avoid all the stamps being cut out in the finished boiler.

One point I wanted to ask about in relation to heads. The Massachusetts rules differ somewhat from the A. S. M. E. code, from the thickness of bumped heads for different diameters, requiring a little heavier thickness than the A. S. M. E. It is one of those points where there is a lack of uniformity and it is a source of more or less inconvenience to boiler manufacturers. I was wondering if there was any particular reason for that, if it would not be possible to bring those two codes more closely in concordance.

Mr. Luck: We used to have a formula for the bumped head which, while theoretically correct, practically no one was using it because it was not heavy enough. The Babcock & Wilcox people were not using it, and the formula used now is the one that was used by the Babcock & Wilcox Company on their work, something that they used in practice right along.

A Member: One part of your rules calls for a bearing surface with a manhole plate casting 11/16. We design our boilers and put in 11/16 heads. If it stretches the material a little bit in the flanging, the inspectors make us reinforce.

Mr. Luck: Quite right; that 11/16 means 11/16 on all parts; it does not mean 11/16 on two parts and that the two ends where you draw it down shall be less. You have got to have a little heavier plate than that for a flange, admitting that 11/16 is not for strength but for bearing surface for the gasket so that the plate does not come through the gasket and cause a leak. The object of having 11/16 in the bearing surface is to keep a tight manhole there.

Mr. Jeter: When the Massachusetts rules went into effect in Massachusetts you had had a boiler law there for a number of years, and there is no question that the use of the boilers in Massachusetts was on a little higher plane than their general use throughout the United States. It was possible in Massachusets to establish a factor of safety of five on lap seam boilers at the start, but if any such law was attempted to be put into effect in the other States in this country, particularly in the Western and Southern States, if you prescribe a higher factor of safety than four, it would be utterly impossible to put the law into effect because it would be really confiscation of property purchased in good faith by the owners. Now it is not very logical to prescribe that factor as low as four; there are a great many foreign governments that use four as a factor of safety and are perfectly satisfied. Of course, I do not think that a factor of four should be adopted, and the code does not adopt a factor of four; it adopts five for new construction, which is not any more illogical than the Massachusetts rule, which allows four and a half on old construction and demands five for new; that is the same principle that produced the factor of four for old boilers; in the code it does provide that the factor shall be raised after a time limit has expired which will prevent the confiscation of the property of owners bought in good faith. The State of Ohio adopted four as a factor of safety at first, and have found now that they could raise it to four and a half, which they did about a year and a half ago or two years, so of course I think there are very good, logical reasons why the factor on old boilers in the code was made as low as four.

Mr. Baumhart (member of Ohio Board of Boiler Rules): In Ohio we allow a boiler to be constructed under the A. S. M. E. code, and if it is inspected under the Ohio code it may be stamped Ohio Standard. Ohio has not yet adopted the A. S. M. E. code, because we believe there will be changes and we want some of the other States to use it a few months before we adopt it also. Since the first of this year the Industrial Commission of Ohio has been overwhelmed with requests for special permission to install good second-hand boilers. They say they were unable to get prompt shipment of new boilers as required, and requested that we change the maximum or minimum factor of safety from eight to six as a temporary arrangement, which we did. Now some of you will say they were slipping a step backward, and perhaps that is true; you all know why that factor of safety was placed at eight on second-hand boilers of the lap seam construction. I believe that you will agree with us that if a lap seam boiler operating at a factor of safety of five in Mr. Connelly's yard is reasonably safe, and considered safe by the inspectors and men in charge of the department, it ought to be reasonably safe at the same pressure if it was in Mr. Champion's yard, and boiler operators have argued along those lines. While we did not comply with their request to submit the safety factor of second-hand boilers as if there had been no change of ownership, we do reduce it from eight to six and in some cases from six to five. That is only a temporary arrangement until such time as they can get boilers for prompt delivery.

Monday Afternoon Session

At the opening of the afternoon session the president appointed as auditing committee Messrs. G. S. Barnum, John D. Smith and Cliff M. Tudor. Resolutions, prepared by a special committee as a memorial to the late secretary of the association, Mr. J. D. Farasey, were then read by Mr. D. J. Champion and adopted by the association.

Following this the president delivered his annual address.

Abstract of President's Address

A year ago this month we gathered together at Erie, Pa., for the twenty-seventh annual convention of this association, and the attendance at that meeting, I believe, exceeded that of any previous meeting, as did also the accomplishments. You at that time re-elected me to the high office of your president, and I will now give you as best I can an accounting of such stewardship.

I first wish to express my sincerest gratitude to the gentlemen you selected to serve with me on the executive committee, and can say without exception they have given loyal support. During the past year we have suffered the loss of our beloved secretary, Mr. James D. Farasey, and this I feel as a personal loss, for the reason that we were both engaged in business in this city, were neighbors, and in addition had a great deal to do with each other for a year and a half, prior to his death, as officers of this association.

Since our convention in June, 1915, the industries of the United States, and more particularly those allied with the iron and steel business, have had an enormous increase in volume and the products used in the construction of steam boilers have advanced to prices heretofore unheard of. Generally speaking, I am of the opinion that all of us have had volume enough to keep our plants running at full capacity, yet I am not so sure that any of us will have the profit we now anticipate, at the time of closing our books, December 31 next.

My personal observation is that for a considerable period of time after the price of steel plates and tubes took on heavy advances a number of concerns were still quoting the "rock-bottom" prices of the early part of 1915, giving to the customer the advantage of their low contracts on plates and tubes. In addition, my personal experience during the past year has been, that a dollar expended for "productive labor" did not begin to yield the same return that it did a year ago. The consequence of this has been, more hours of labor on every boiler, and together with this condition, has been a marked advance in the rate of pay for all classes of labor, which has greatly increased our costs.

The manufacture of boilers is an industry requiring a fairly large capital for investment in land, buildings and machinery, together with cash for carrying on the business, and it is a business which at no time admits of abnormal profits, and on the other hand does not permit of even ordinary profit in many instances. I am of the opinion that the average boiler manufacturing plant does not turn its capital more than once in twelve months. I wonder how many of us have carefuly calculated what disbursement is made of every dollar received for sales; that is, the percentage of that dollar expended for productive labor, taxes, power, insurance, etc., and then totaled up same to see what if any part of the dollar was left for profit. I speak of this as I consider that "obtaining an honest profit" on our efforts is the paramount question before us during this convention.

Benefits of Membership in the A. B. M. A.

I have been endeavoring as best I could during the past two years to strengthen our membership, and while my efforts have been to some extent successful (as we show fully 25 percent increase), we have not been able to bring in all of the firms who should join, and I have been asked by some, "What are the benefits derived from membership in the A. B. M. A.?"

To us who are interested in the welfare of the association, we feel there are many benefits. This is the day of organization, and in every line of activity there are trade organizations. In fact, it is now recognized by our Government that organization in each line of trade is a worthy cause, and the Federal Trade Commission, as I understand, even urge manufacturers to organize, and especially to study and improve their conditions by uniform cost-keeping, etc.

Another benefit will be the "Uniform Boiler Code," which will soon be a standard throughout the United States, due to the efforts of the American Uniform Boiler Law Society, an organization which was the direct outcome of the "get-together" spirit of our 1915 convention. Again, the meeting face to face with your competitors from distant cities will very frequently prove of advantage, and when you need a favor from some one in his locality, knowing him, you will not hesitate to ask the favor.

There is an old saying that "competition is the life of trade," but I would like to revise same to read *co-operation* is the life of trade." And the best way to bring about co-operation is through a trade organization. In my address to you at our convention last year, I spoke of "co-operation," and also cautioned against factions, and my feeling in these matters is so strong that I again mention them. If any man has a grievance, let him bring same to the attention of your officers, or, take the floor during the convention and speak out what he feels, but *do not* resort to "playing politics."

This association ought to have as members every firm or individual manufacturing steam boilers and heavy steel plate construction, and all should contribute to the support of the association.

It is with pleasant recollections of the past, and with confidence in the future, that I will turn over my office at the close of this convention to my successor. If I have in a measure merited your good-will by my efforts as an officer of this association, during the past two years, do not overlook the fact that much of the credit for our success is due to the other members of your executive committee.

At the close of his address the president introduced Dr. J. S. Unger, of the research bureau of the Carnegie Steel Company, who delivered the following address:

Effect of Sulphur in Rivet Steel

(*This paper is printed on page 197.*)

DISCUSSION

A MEMBER: Do you suppose the high sulphur steel will corrode faster than the low sulphur?

DR. UNGER: In carrying out some corrosion tests, I have exposed wire, chain, milk can bases and sheets with different sulphur contents, and will be able to give you some definite data later. I do not advocate the very high sulphurs I have shown at all. I believe, other things being the same, it is impossible to detect the difference between the .030 sulphur and three times that much; I am unable to detect it.

MR. CUNNINGHAM: I would like to know if Dr. Unger can tell me why it is in heating rivets up to 5/8 inch diameter you can use a higher pressure than on anything over 5/8 inch. It is very destructive, that is, a high pressure of air, on 3/4 inch and over, but where you can use it it is very successful on 5/8 inch and under.

DR. UNGER: Just offhand, I would say that with the same intensity of combustion the small rivet, being a small mass, would heat up very much quicker and with much more likelihood of destroying it, burning it so it would not drive well, than the larger rivet; I would say that the small rivet would give more trouble than the larger one.

MR. REES: Do you maintain that there is no difference in the formation of the head in driving a hot rivet and a cold rivet? I buy a great many cold rivets from the Carnegie Steel Company; do they get a difference that way in the high sulphur?

DR. UNGER: None whatever, regardless of whether the rivet is going to be cold driven or hot driven. The manufacturer has no means of knowing, and they do not make a special grade for hot driving or cold driving.

MR. REES: I contend that the cold rivet expanded into the sheet forms a tighter rivet than any other method.

MANUFACTURE OF TUBES.

By courtesy of the National Tube Company, Pittsburgh, Pa., a series of moving pictures was exhibited showing the various processes employed in the manufacture of tubes, from the mining of the ore to the shipment of the final product.

Topical Questions

WHAT PERCENTAGE OF DEPRECIATION SHOULD BE MADE AGAINST FACTORY BUILDINGS PER ANNUM?

MR. COVELL: During the past year we have been reorganizing our cost methods, etc., and as a very important part of accurate cost keeping, of course we all know the demon burden; and one of the elements which make up the demon burden is how much to charge for depreciation on the various parts of your plant.

As a guide to start with, I addressed some 27 or 30 letters to as many representative concerns, not in any one line of business, but all in the general line of machinery or metal working manufacturing, as, for instance, shipbuilding, boiler making, machine tool works, hoisting works, sugar machinery and adjuncts, and kindred lines of business.

I received 23 replies, and the result was so startling that I tabulated them. This tabulation is given for a concern the name of which is suppressed. Firm A says "2 to 10 percent." Firm B says, "No real depreciation; everything charged off where possible to keep down surplus." Firm C, "4 percent." Firm D, "4 percent." Firm E, "2 percent." Firm F, "5 percent." Firm G, "5 percent." Firm H, "10 percent." Firm I, "4 percent." Firm J, "2 percent." Firm K, "5 percent." Firm L, "10 percent." Firm M, "2½ percent." Firm N, "Equivalent to rent." Firm O, "3 to 5 percent." Firm P, "2½ percent." Firm Q, "Do not write off a given percentage, but set aside a reserve for depreciation at the end of each fiscal year; variable, probably." Firm R, "3½ percent." Firm S, "2 percent." Firm T, "4 percent." Firm U, "3 percent." Firm V, "6 percent." Firm W, "1.6 percent."

The depreciation the different firms allow on power equipment runs from 2 to 25 percent, and one scientific gentleman gives 4.14 percent. On shop appliances, the minimum is 2 percent and the maximum 25 percent.

One firm says: "Carried at one-fifth value;" another says, "Arbitrary;" another says, "None." The scientific gentleman says "10 percent." The column on machine tools is interesting. Apparently there is more uniformity there. It runs from 4.09 percent from the scientific gentleman to 10 percent, and so on.

When I got that information and studied it, I must say I did not get any great amount of consolation as to what was the proper procedure in charging off depreciation and I am still just as much at sea, and I presume everybody else is, because I have never heard any man defend his viewpoint of the proper amount of depreciation by any valid argument. I have heard men say there should be no depreciation, that a machine tool is worth what you paid for it just as long as it performs its functions. Another gentleman will argue on that a machine tool is obsolete in a certain number of years, say 5, because new ones will take its place. Another says, "As long as we keep our machine tool in perfect repair and condition, it is worth as much as the day we bought it." Another says, "When you buy a machine tool and uncrate it, it is a second-hand tool, whether it has been used or not." Of course, that is speaking of normal times, not the present time when second-hand machine tools demand a premium. And so I came here hoping to receive a little light from the experience of others in determining on some real basis what amount of depreciation is to be charged and why you charge it.

MR. FISH: So far as buildings go, it seems to me that it depends very much upon the character of the building what depreciation you are going to allow on it, so that each individual case has got to be considered upon its own merits. I might say that it is the practice now very largely to have appraisals made by some of these appraisal companies or accounting companies, and they all have rather definite ideas and practices of their own.

MR. MACKINNON: Depreciation of buildings must depend to a very great extent upon the character of the buildings. It would not be reasonable to have the same percentage on an old type of a wooden building or a mixed type of building in comparison with a modern type. I try to have an inspection made of our plant by units to a certain degree so that I know in a general way the condition of those buildings, and I try to keep them up and endeavor each year to get at the correct figure, but as a matter of fact I do not believe that our percentage is ever twice alike. I cannot imagine using anything as low as 1½ or even 2 percent on any type of a building. That would give you a normal life of approximately 50 years. I believe that around 5 is nearly right on the general type of buildings, but it unquestionably must vary.

MR. FISHER: We are working on a plan now of charging off on brick and steel constructed buildings with fireproof roof, tile roof, 2½ percent, and on poorer buildings as high as 5 percent, not going into any frame structures, that is, brick and steel. Then, when we buy a new tool, we look it over and try to decide about how soon that tool will be obsolete rather than how soon that tool will be worn out, and we charge depreciation as high as 10 and 15 percent on these different tools. On the boilers we charge 5 percent depreciation and figure the normal life 20 years. The engine room appliances and power house we charge the same, but in shop tools we vary the percentage. We do not figure more than 10 percent on any of the larger tools. You cannot arrive at a fixed figure and put a fixed percentage on any tools or any buildings. The question of obsolescence enters into depreciation more than the actual wear and tear. If you think your building is of such a character that you can use it for a long term of years, I presume that 2 percent would be sufficient, and I have known of some cases where they have only charged 1 percent for depreciation on the buildings. As far as the building wearing out is concerned, if the steel work is kept properly protected from corrosion and your building is kept repaired, your building can stay in good condition for a good many years. It is just a matter of material and judgment as to how long your equipment can be used.

MR. COVELL: The average of all these buildings is 4.19, very close to Mr. MacKinnon's figure of 5.

THE CHAIRMAN: I have always been of the opinion that all matters of up-keep should be taken care of entirely as expense and should not go into capital. We find some people right here at home have not been doing that, and consequently have been inflating their values.

MR. BRODERICK: About 21 years ago I started in business in a frame building. At that time we started to charge off 10 percent, and thought we were coming out safe. We were in those frame buildings for 10 years. We had them charged off and thought we were to the good, but when we came to move we found out that we were losers. The buildings had not paid out in ten years; they owed us something. Eleven years ago I moved to Muncie, Ind., and put up a first class building, steel and brick. I thought the plan adopted for the frame building would apply pretty well with a first class building. Now, charging off for depreciation fluctuates considerably, but in the aggregate it figures up about 10 percent.

MR. FISH: In regard to this matter of the percentage of depreciation, there are two ways that can be considered: is it always on the basis of the original figure, or is the percentage on the depreciated value? If you take it on the depreciated value, you never get it entirely wiped out, it always has some value at the end of any time at all.

THE CHAIRMAN: If replacements are charged off to the first cost of the tool, 10 percent would be too high. That is Mr. Broderick's method. If maintenance is not charged against the tools, Mr. MacKinnon maintains that 10 percent is probably too high. They are probably both right if a fair average is struck.

MR. FISH: Some people have even gone so far in this matter of depreciation as to consider laying aside actual money for depreciation each year and place it in a savings bank on 3 or 4 percent interest. If that accumulates on itself, you are compounding your interest, you would not have to charge off as large an amount for depreciation as though you did not estimate it in that way; and again, if you do not put it in a savings bank, and keep it in your business, you might be entitled to charge your banking rate that you pay for borrowing money because you have that in your business.

THE CHAIRMAN: I do not believe that to-day there are three boiler shops in the United States that have built up a reserve account to take care of improvements or replacements or worn-out or obsolete machines, and I believe that that is a thing we ought carefully to discuss. I heard an address a short time ago in which the statement was made that anybody using electrical equipment who failed to charge off all of that equipment in seven and a half years, would in twice that length of time be out of business. The advance in electrical equipment is going on so fast that, while the machinery may not be worn out in that time, it would be obsolete in that time. We have an example here at home. We built a municipal plant here five years ago and put in some 5,000 kilowatt units, and to-day the city is talking of bonding itself to scrap those and buy some 20,000 kilowatt units. So it shows that we must be alert in taking care of our own depreciation and building up reserves for replacements.

MR. LOWE: I think depreciation is an unfortunate name for it. In making up the cost of running a power plant, a man uses not only so much fuel a year and so much labor a year, and so much oil, etc., but he uses up so much engine a year. If he pays $20,000 for an engine and it is going to last twenty years, then he uses up $1,000 worth of engine a year on an average, so I would have the capital account charged $20,000 for engine, and I would charge myself the first year with interest on that $20,000. At the end of the first year I would charge $1,000 off of that for depreciation, and credit that on the capitalization account. In that way your capitalization account would decrease $1,000 a year, and at the end of twenty years would disappear. You have been paying less interest every year and have paid your annual loss.

Now the five percent may have been too much or too little, but it makes a lot of difference what you are figuring it for. If you are figuring for your own business, you can afford to be liberal and go on the safe side; if a public service corporation is figuring for the purpose of fattening up rates and wants to put in a big depreciation, the consumer has a right to kick. It is largely a matter of what the depreciation is being figured on.

So far as obsolescence is concerned, you would not put in a new engine, for instance, or replace the engine by a turbine or other apparatus, unless the new apparatus would earn interest on its own account and interest on the amount that you are scrapping. So I should simply go right on without the account as I was going before, credit the account with what I could get for scrapping the other thing, and charge the depreciation off on the account plus the investment in the new machine, and let it pay itself out in that way.

THE CHAIRMAN: Mr. Lowe has brought out a question that we have down really as the next on our program, which says "Should 6 percent interest on total investment be considered as part of the overhead expense when obtaining total operating expense?" He makes the point that the first year you should have charged against that $20,000 engine 6 percent on the investment, or $1,200. I wonder how many of us are following that rule in getting 6 percent into our overhead—that is, 6 percent on our entire investment all the way through. As he explains, it should be on the engine. At our convention last year, or the year preceding, I believe there was considerable discussion on that point, and there were very few present who figured or felt that 6 percent interest should be considered part of the overhead. I maintained back in 1913 that it should be, that we should get 6 percent at least before we began to get any profit, the same as if we were renting or were tenants in a building and did not own our property.

MR. MACKINNON: I believe we will all find that the matter of computing overhead is arrived at usually by the earning capacity of the company, whether we need credit or do not. It goes without saying that we have got to present to our banks, if we are going to borrow, fairly good statements, and I do not believe that the methods that we practice as to how we should arrive at our overheads are exactly what we would do if we were making a big profit. I think that there should be a depreciation of machinery, there should be a depreciation of buildings.

As to public appraising companies, I have no regard for them at all as to appraising values. If you want to burn out, they are excellent. If you want to arrive at the real value of what you have got, you cannot do it with an appraising company; that has been my experience.

As to 6 percent on the value of the stock, if we took that money, a hundred thousand or two or three hundred thousand dollars, and bought bonds, or stock or what not, we would certainly expect at least 4 or 4½ or 5 or 6 percent on it. Why not expect that when we put it into a building or a business? We ought really to start from the beginning and charge a certain interest against our investment, and I am obliged to disagree with the gentleman who spoke prior to me, that you charge that against the capital stock, if I understood him correctly. That investment was made originally and should remain intact, and you should charge your 6 percent or whatever you apply against that investment, and by depreciating your machinery you get it down to a basis of scrap, and you are safe if you dispose of it on the scrap basis.

MR. KELLOGG: I am here in a sort of dual capacity, and I am not now speaking for the Kewanee Boiler Company, because I do not know just how they do, but in other manufacturing lines we charge off monthly a depreciation based on 2½ percent on brick, iron or concrete buildings, and 5 percent on other buildings, plus maintenance. In addition to that, we charge off on machinery, fixtures, etc., put it in three classes, one based at 7½, the other 10, the other 12½, and charge it off on that basis, plus maintenance. We charge interest account at the rate of 5 percent on the total capital invested, regardless of depreciation. When I say we charge it off, I mean that we keep a total account for insurance purposes and carry a reserve for depreciation. We go a little further. We charge off 1 percent a month on our total volume of business as an expense account. In addition to that, we charge off half of 1 percent for discounts. We keep a cost system throughout, the cost and selling price of everything. If you give up the business, you have your time, you have your ability to earn elsewhere, and, as Mr. MacKinnon says, if you had the money you could go and invest it elsewhere and at least get 5 percent, and hence interest should be charged, and I think the difficulty with the boiler manufacturer is that he does not figure those items in figuring his price to sell, and that is why you have got no money to charge off or have a reserve.

MR. BRODERICK: When it comes to charging off depreciation in a manufacturing business, I do not think that this body of men could get a better guide along those lines than some of America's largest financiers. Take the United States Steel Corporation for one; they have a fund, they charge off so much, they set it aside; you do not see them going out and borrowing money. When they want to spend fifteen or twenty million dollars they go to their depreciation fund and get it. If it will work well with a large corporation, it certainly will work well with a small one. When you charge it off, take the money out and put it to working some place; that is what all large corporations do. Charging off depreciation and placing it are two different things.

A MEMBER: On what basis is overhead charged by the members of this Association? Is it figured on productive labor or some other factor in their business?

MR. MACKINNON: There are various methods and they are widely divergent. Personally, I have been using the percentage on direct labor payroll. Many authors disagree with that absolutely; but I believe that I arrive closer and with much more satisfaction as far as our own business is concerned, and I believe I am safe in saying that I can show that we have made some money the way I figure.

In reference to that subject of interest, I take the position that as far as your real manufacturing is concerned you have not and do not show a manufacturing profit until such time as you have taken care of your capital stock with a fair rate of interest, which I call 6 percent. Now I do not think it makes much difference which way you handle that six percent, as long as you get it.

THE CHAIRMAN read extracts from a paper which he presented three years ago, answering further the question as to whether or not the overhead should be figured on productive labor.

The paper gave as a percentage of overhead 100 percent, but he believed that is pretty low at this day with labor conditions as they are.

MR. KELLOGG: From an examination of several different manufacturers of tubes, I find that quite a number figure on the basis of 150 percent of their overhead on their direct labor.

Mr. Mackinnon: Last year a member showed that his overhead varied all the way from 70 to 1,400 percent. It is a rather hard proposition unless you make a general average for your full year's business or for a period of five years, which is much safer.

Mr. Barnum: I think that the overhead should be determined on the production of the shop, which means the productive labor. The non-productive labor account is an important account. We keep in that power, light and water, repairs on boiler, shop tools, electric tools, machine tools and fixtures, pneumatic tools, patterns, riggers' tools, real estate and buildings, supervision, taxes, expense, electric supplies, revenue stamps, administration expense, automobile expense, interest, miscellaneous expense, office expense, postage, salaries, subscription account, telephone and telegrams, bad debts and collections, legal expenses, selling expense, which was Boston office and New York office, commission account, traveling expenses.

Last year all these items were 145.5 percent of our productive labor account. Now the year before we did a very small business, but all this expense business went on just the same and our overhead was 178 percent. The year before that we did a good business and it was only 12 percent. Now, what is valuable in these items is this; I have this every single month and by glancing over it I can keep track of the business. We charge 150 percent on our overhead; it will run below that and above that, but, taking an average of five years, I think 150 percent covers it; it has been very satisfactory to us. I cannot see how anybody can figure their overhead on their sales.

Mr. Greenoff: With the Bethlehem Steel Company the average depreciation on everything is not put in as an overhead—every superintendent for the Bethlehem Steel Company is paid on the bonus. He gets a cost sheet out that tells him everything, profits, losses and everything. Why should that go in on your overhead? Why shouldn't it go on profit as in the big corporations?

Mr. Kellogg: In the National Supply Association, which comprises nearly 200 members, it has been our custom each year to send out a credit form to the members giving the items of the different subjects which constitute the question of cost. Out of nearly 200 members this last year, we succeeded in getting replies from 47 members. The 47 varied 47 times on the question of cost. Some of the correspondence fell into the hands of the Federal Trade Commission and we received a letter from Mr. Hurley, who was at that time vice-chairman of the Commission, saying that he was interested in the subject and would be very glad if we would send him all the forms and correspondence pertaining to it. We did so, and received a reply that it was the judgment of the Federal Trade Commission that 95 percent of the failures to-day were due to the fact that the people did not know the cost and did not have a uniform system, and they have now employed experts and those experts are now at the disposal of any trade association, and they are going over our forms now that we are using, and we expect to have a complete recommended form issued by the Federal Trade Commission. They are so much interested that they would be glad, and they stand ready, to offer to any association like this the assistance of their accountants.

Mr. Cogswell: As to the basis of figuring overhead, we make a monthly statement, a tabulated sheet which shows our non-productive labor on our payroll and the productive labor. We figure overhead on the productive labor. The non-productive labor column is footed up and to that is added the general expense account, including fuel—all the expenses. That makes a total sum, we will say, of a thousand dollars for the month, of non-productive labor and expense. Now if we add 100 percent for overhead, we have got to have enough money so that the overhead will figure a thousand dollars; in other words, you have got to have a thousand dollars' productive labor for every thousand dollars of expense; if you do not you are going in a hole. The way I figure that, I take that column of expenses which includes non-productive labor, take productive labor, and figure out the percentage. Assume it is 100 percent, I carry that into a column, and if it don't foot up with the expense account, we are going behind; if it goes over it, we are saving on our labor cost. That is a very simple way to handle that, and to us it is very satisfactory.

Monday Evening Session

A new constitution and by-laws for the association, drafted by the executive committee, were read at the evening session and were unanimously adopted. Following this, Mr. David J. Champion, president of the Champion Rivet Company, Cleveland, O., read the following paper:

Fair Recompense

The labor of the boiler maker is of the most arduous and at the same time of the most intelligent kind. No one works harder than the boiler maker and no one is required to work more intelligently. Life and property depend upon your labor, as the product you manufacture is constantly threatened with destruction and deterioration.

The importance of fair recompense for your labor, therefore, is paramount. The great tendency on the part of many manufacturers is to underestimate the value of their product, and this comes mainly from the fact that a great many of you were once artisans yourselves, paid by the hour, trained in the shop and not in the office, and it is, therefore, hard for you to get over the habit of estimating hourly recompense added to the cost of material. Without seeking to criticise, I feel like saying that some of you seem to be forever figuring how cheaply you can estimate your product and shade the price you think your competitor is likely to bid.

It seems to me it would be a good idea to formulate a series of commandments, and call them "The Commandment of Progressive Boiler Making." These commandments to be religiously applied to every estimate before it leaves your office:

1. Quote the present market value F. O. B. your works for all material entering into the fabrication of the structure on which you are figuring (do not take advantage of a low-priced material contract if you have one).

2. Full cost of handling from the inception of the material into your works to the completion of same and loading for shipment.

3. Cost of labor, laying out, shearing, punching, bending, riveting, calking, testing, painting, etc.

4. Add a fair percentage (estimated on actual figures covering a year's business) for overhead, such as:
   - Interest on the entire investment.
   - Taxes and insurance.
   - Salaries of general office clerks, etc.
   - Fair dividends, compatible with what you could get for your money if intelligently invested.
   - Depreciation of plant, etc.
   - Cost of accident insurance, and possible loss sustained by accidents in your plant.

5. Use the time clock judiciously and make it help you in your work.

If I may be permitted to go a step further, I would suggest that you appoint an impartial and capable general engineer and estimator, paid jointly by your association, whose duty it should be to examine all important estimates and O. K. them before the price is named. This would entail your furnishing this supervising engineer an exact copy of your bid before it is made, this for the purpose of comparing it with the bid of your competitor, not with the view of materially changing your bid, but with a view of checking you up, so as to prevent abnormally high or abnormally low prices. These bids could be marked with a cipher word, the meaning of which would be known only to your supervising engineer, thus precluding the liability of criticism from any one. Your engineer could furnish you with the amount of your competitor's bid without mentioning names and you would then be able to determine whether you would care to revise your bid or not.

Each shop has its advantages or disadvantages, according to its equipment in turning out work, and bids should be based on taking advantage of the facilities you have in manufacturing as compared with your competitor, without giving away the entire benefit of your superior equipment, which cost you time, money and experience, simply to augment the surplus in the bank to the credit of the purchaser.

Avarice, spite, and retaliation should be eschewed from your vocabulary of business ethics, as these things only sow the seed of discontentment and failure, and while at times you would feel like "getting even" for some alleged wrong by resorting to the tactics above mentioned, you are only dragging yourselves deeper into the "slough of despondency."

"The truth shall make you free" is an axiom as old as Christianity, yet in business we seem to avoid it when we are trying to play the game, as we think, shrewdly. If the truth shall make you free, certainly falsehood shall make you slaves.

For instance, if A tells B openly, for the sake of establishing a basis of price, that he is going to bid one thousand dollars on a certain job, there is no law under the sun that can prevent B from quoting the same price. No Sherman law, or any other law, can prosecute B from getting as high a price as A. It is only secret understandings and agreements that are open to prosecution. This is the sequel to the success of the "Eddy Plan" now in successful operation by a great many manufacturers.

The days of bargain-counter prices in boilers are passed. Consumers who are in the habit of paying a longer price for everything of real value, naturally look with suspicion on low-priced boilers, and those who feel an innate confidence in the worthiness of their work are the last ones to name ridiculously low prices on their product. I could name many among you who, if they told the truth, would acknowledge that they had not made any dividend money in years and sometimes had nothing to pay for depreciation and replacements.

I have tried to lay before you a few facts as seen by an interested friend and I know from a knowledge of the personnel of your organization that you can formulate some plan for your material advancement that will amount to more than mere glory, sorely tainted with financial disappointment. I say all this, not merely from a friendly and philanthropic standpoint, but from a selfish standpoint as well. Which one of you, no matter how big a business you are doing, is a desirable risk, if every one of us who are supplying you with material has an honest suspicion that you, by reason of your "cut-throat" prices, are losing money, or just breaking even? Hardly a month passes by but some one of you are under consideration and inquiry by some money lender who is diligently making inquiries as to whether or not you are worthy of credit. You might as well come to the conclusion now that the days of low prices are the days of the past and peculiar to an age unenlightened by modern requirements.

In this article I am only trying to place before you my views as to how your work appears to the outsider. I trust something of advantage will be started, and that you will see it to your interest to take hold and make such changes as will eventually revert to your permanent stability and financial advancement. Now that the A. S. M. E. code is being, or soon will be, adopted by all the States, you have the basic element of just and intelligent figuring fairly before you, and there is no good reason for a great divergence in prices.

Treasurer's Report

The books of the association on January 3 showed a deficit of nearly $500. That deficit has been reimbursed, the association is entirely out of debt and now has a balance on hand.

Correct Method of Obtaining Labor Costs

MR. MCEWEN: I believe that as nearly as possible all labor that can be directly charged against the production of any article should be charged against it. In arriving at a means of doing so, I believe that an hourly or daily time card should be adopted and applied to each individual worker, so ruled and perforated that if a man works on more than one job he can turn in his time on starting on each respective job and discontinuing on each respective job. If the shop is large enough, a very excellent way of handling that is to have a man in the shop where the laborer can bring the card to him. A great many mistakes and errors are obviated by designating some one to do that.

MR. CUNNINGHAM: We tried the card system about 12 years ago. Each man is numbered and his name is put on the card, and on that card there are eight different operations that a man can work on, eight different jobs during the day, with a start and stop. In other words, when he comes in in the morning he punches that card on the clock and does not punch it again until noon, unless he changes the job, and when he changes the job it indicates the stop, and so on through the day.

MR. PLANK: We run what we call the bonus system. There are 164 odd operations in building one of the locomotive boilers that we manufacture. We have a sheet written out for every one of those operations. A shop clerk issues a ticket to the man who is to perform one of the operations, and if the man finishes the operation in an hour less than the time allowed we take 30 minutes and give the man 30 minutes.

MR. FISH: In a general way the time card system is best adapted to our use; it is a question whether you let the men do it or have a clerk to do it. Our experience has been that we cannot leave it to the men.

MR. FISHER: We find that we get more accurate time by having a timekeeper in the shop.

MR. FISH: Having the foreman notify the timekeeper, you save the time of the men going backwards and forwards and they can keep at their work, whereas if the men have to go to the timekeeper it is just that much time lost.

MR. COVELL: Our foremen fill out the cards in advance to cover the day's operation; it is seldom but what they can foresee the day's operation, and the clock does the rest.

THE CHAIRMAN: Our cost system requires the services of a timekeeper. In the shop is a timekeeper's office with doors at each end. When the men report for work in the morning they pass in at one door and take a key off a board with their number, ring in on an in-and-out clock,

and tell the timekeeper what job they are going to start on. A time slip is ruled up which shows all the operations of the ordinary boiler shop, and the right-hand corner shows that man's key number and his name. Below that is a number for the job. Opposite the title of the operation the man is to perform a check mark is made, the man's key number and name are filled in, and the number of the contract is filled in, and that time card is then placed under a time recording clock and stamped. The timekeeper places the card in a pigeon-hole bearing the number of this man. That stays in that pigeon-hole until that man reports that he is through with that particular job, and then a new card is filled out and filed in a similar manner for his next job. Every day the timekeeper is obliged to take all these time cards from these pigeon-holes and record them on a large assembly sheet which gives the title of the job. Every day all those cards from the elapsed time machine are charged on this assembly sheet so that every morning we have an exact record of the cost of every job up to the night before, and when the job is finished we have the exact cost of that job and of every operation on that job.

Tuesday Morning Session

Why a Boiler Manufacturer is Not a Merchant

ADDRESS BY C. V. KELLOGG

To-day I know of no industry that perhaps has the capital invested, the professional ability, the professional ingenuity that this line has, and yet, notwithstanding all this, there is no line of industry to-day that pays so little for the labor and the money invested. I am well aware that the political situation has affected, to a great extent, the business activity and the business policy of this country. I am aware that until recently political sides of all questions have been more or less antagonistic to business industry. Up to the present time this country has been working on the policy of introspection rather than looking to the future and for the future welfare of its citizens. Fortunately for us, the European war has brought the United States to the point where it must necessarily consider what is to be the future of its industries.

Prior to 1914 the production of iron in the world was about 70,000,000 tons a year, of which 55 percent was manufactured by the nations which are now involved in in this terrible war. The demand at the present time is about 10,000,000 tons a year. In this country, when iron is manufactured into rails or other products it is sold and used, and after it has depreciated to a certain extent it is shipped back and remelted. At the present time 250,000,000 tons a month is absolutely destroyed and wasted, and yet we ask, When this war ends, what will be the result? Will the bottom drop out of the market? Must we be fearful as to what the future is? The countries now at war will not be able to supply the demand which is necessary in their own countries for at least three years after the end of the war. The United States will be unable to produce one-half of the demand of the country for the next three years, and we may say what we please, the subject of demand and supply more or less controls conditions.

Now, going a step further, let us look into our economic conditions. As I said, this country has been, in its legislative capacity, antagonistic to business prosperity and business conditions. On account of what we have seen in the last 20 months, the entire economic, the entire political conditions of this country have been absolutely reversed, and to-day not only the men you send to Congress, but the officials who are holding these positions, have come to see that the business industry must be fostered, that business is and will be the life of this country, and hence what do we find?

To-day the Sherman Law is a dead letter. The people in authority who have been trying to enforce that law have realized that they must do something to counteract the effects which have been brought upon this country. They introduced into Congress two bills which were passed. One is known as the Clayton Bill and the other as the Coventry Bill. The Coventry Bill provides that it shall be unlawful for any manufacturer or ditsributer of goods to sell the same in one section of the country or to one customer at a better price than he sells to the other, barring volume and barring freight conditions; and I think if some of you will just bear that in mind, that you have more to fear from the Coventry Bill than you have from the Sherman Law.

President Wilson did one good thing—he appointed a Federal Trade Commission. The present chairman of that commission, Mr. E. N. Hurley, of Chicago, is a man who made a success in business life, came up from the ranks and was a successful business man. A letter which I have here, signed by Mr. Hurley, says that of 260,000 corporations in the United States not over 5 percent are making over $5,000 a year profit, and that when they talk about competition under the Sherman Act being unlawful, he says that ruinous competition is unlawful, that we want legitimate competition, and that when this country can get the business men and the business factors of this country to understand one thing, we will overcome these difficulties, and that is that 90 percent of the business men of this country do not know the cost of their doing business, that they do not stop to figure it.

This Trade Commission to-day has employed ten different experts to do nothing else, and their services are at the disposal of this association or any other to endeavor to educate business men up to adopt a uniform method of cost finding, so that this difficulty of ruinous competition will not be a hazard to this country.

Now let us look a little bit into your particular line. Don't you all have to pay substantially the same price for material? Can any of you buy at any appreciably greater advantage than the other? Isn't your cost of material substantially the same? Now, while some of you may be better equipped, while some of you may have better shops, yet your labor, while it may vary a little, is substantially the same, and is there any proposition that you can vary on at all, unless it is the question of labor or the question of marketing your goods? In 1914 and 1915 the cost of plates was based substantially on $1.15 Pittsburgh, and at that time, when that material was at that price—I am now speaking especially of tubular boilers—your cost of labor until the goods were placed upon the car was substantially 25 percent of your total selling price. On account of the rapid advance of material, you will find that your cost of labor is substantially 15 percent to-day, so that be there a large or any appreciable difference in these costs, which are not absolutely fixed to you, how can you, if you are figuring all upon the same basis, make a variation in the selling price of your commodity of 50 percent? Yet I know and I can show you from actual figures that many of you are endeavoring to market your product at a variation of 50 percent in your selling price. Either the man who is too high is trying to rob his customer, or else the man who is too low is trying to rob himself, and why should it be?

Now this probably has come about by the fact that it has been the practice of a manufacturer of material to make contracts for future delivery, and when there has been an advance on the part of the manufacturer because of other conditions which were beyond his control, those parties who had a contract for a future delivery would go out and endeavor to market that product upon a commission basis, and hence the market was demoralized. Another reason is that you who are interested in this industry have grown up and have been in the habit of figuring each isolated case upon your actual cost of material as per contract and your labor, and some of you without figuring the subject of depreciation and other items which were discussed here yesterday have been willing to go out and take business upon that basis without ever giving a thought to the future, without ever giving a thought to the conditions which would arise from that policy. I hope to see that day when the manufacturer of any line will refuse to contract for future delivery, and that this industry and all of us will be upon the same basis of purchase, sale, shipment and delivery immediately, and that the speculative feature will be eliminated.

Now you are entitled to a reasonable profit, based upon the cost of your materials, based upon the cost of your labor and based upon the cost of your capital invested, and there is another profit that I want to call your attention to, which is of as vital importance that I have not heard spoken of in these times, and that is a profit to take care of a loss which you will have and must sustain by reason of a decline in the market. There is another subject that is serious and we are facing, and that is the labor conditions. Look at the millions of men that are being killed. Emigration is stopped. The men in this country are going back and have gone. The enormous profits that some munition manufacturers have made has created an abnormal labor condition. How are you going to supply the men to fill the positions that you require to-day? I know that some of the large business industries of this country to-day are setting up a reserve, adding it into their cost of doing business to take care of the monies which they must lose by reason of labor conditions which they must face in the next three years. Are you doing it? Are you taking those things into consideration at the present time?

There is one other point which interests us all, and that is the tariff question. I want to read you the last expression of President Wilson upon this subject, which is of vital interest to us all, and these are the remarks of President Wilson in address to the Chamber of Commerce in February: "We ought to have a really scientific Tariff Board and I think we are going to have it. I want to say that before the whole face of affairs was changed in the economics of the world by the war I was not in favor of a Tariff Board, but since the whole face of affairs has been changed by the war, and since no man can tell, until the new facts are collected and digested, what the correct details of economic policy are, I am heartily in favor of a Tariff Board." Simply illustrating to you gentlemen and to us all, that the political situation of this country has absolutely reversed itself in the last few years, and it is now up to you, as business men, to work out your own salvation and your future.

As I have said, the Sherman law is a dead letter. There has been introduced in Congress a bill known as the Stevens' bill, which, if enacted, will provide that business men, manufacturers or distributors may get together and may agree upon a reasonable selling price, and they propose to appoint a commission which shall be known as the Trade Commission, whose authority it shall be to say whether or not the prices so fixed are reasonable. See how the tide is turning! To-day if anybody is suspected of violating the Sherman law, the remedy of the Government is simply to cite you before the Trade Commission, which proposes to foster associations, is at your service at any time and willing to co-operate with you and with any organization with a view of educating its members to know their own business.

Why should you not become more friendly? Why should you not know your competitor? Why shouldn't you, when you are figuring upon a proposition, see to it that you are honest to yourself, that you are not robbing yourself, and that you should confer together and see to it that you get a reasonable compensation for your products. You haven't any secrets in your business. Talk things over with your neighbors, get what you are entitled to, and then add a little for that profit which you have got to lose when the market goes down.

Election of Officers

The following officers were elected to serve for the ensuing year:

President—M. H. Broderick, Broderick Company, Muncie, Ind.

Vice-President—C. V. Kellogg, Kewanee Boiler Company, Kewanee, Ill.

Secretary and Treasurer—H. N. Covell, Lidgerwood Company, Brooklyn N. Y.

Executive Committee—G. S. Barnum, Bigelow Company, New Haven, Conn.; E. C. Fisher, Wickes Boiler Company, Saginaw, Mich.; Isaac Harter, Jr., Babcock & Wilcox Company, New York, and L. Mohr, Kewanee Boiler Company, Kewanee, Ill.

Canadian Boiler Laws

ABSTRACT OF REMARKS BY MR. D. M. METCALF, CHIEF INSPECTOR OF BOILERS FOR THE PROVINCE OF ONTARIO

In the first place, we require three blue prints submitted with specifications, which are our own forms, prepared in our office. They are to be submitted for approval.

After they are sent to the department, if they meet with our requirements, they are given a record number and allowable working pressure. One drawing is sent back to the manufacturer, from which he may build as many boilers as he desires from that one design, but if he wishes to make any change, he must submit a new blue print for approval.

If built in Canada the manufacturer must notify us when the plates are on hand before any work whatever is done, and I send an inspector to examine those plates for any defects, and if the plate is not satisfactory it is rejected. I am very glad to say that we only rejected forty-nine plates last year. If those plates measure up according to the specifications that have been submitted, they are stamped with an O. G., where that stamp will appear when the boiler is completed, and if the stamp of the manufacturer is not in a very good place our inspector has the privilege of transferring that stamp to where it will be seen, but the object of putting the O. G. on the plate is so that the manufacturer will not use some other plate on the boiler.

The melt number, tensile strength and maker's name are all recorded, and after the holes have been punched and the boiler rolled up ready for riveting, we are notified again and the inspector makes the second inspection. If everything is in good order he passes that inspection, and the third or final inspection is made when the boiler is measured. If the workmanship is found to be good, hydrostatic pressure is applied to one and a half times the allowable working pressure on all style of boilers except the watertube boilers, and we apply on those twice the allowable pressure.

If everything is found right, the boiler is stamped on the front head. Our inspector then fills out a shop inspection report sheet, and from this report sheet we issue the final certificate and duplicate, one with a blue border and one with a black border, and the manufacturer retains the one with the blue border for his file and the other is forwarded to the purchaser of the boiler.

We have a large number of boilers coming from the United States, and in this connection I would just like to read section 2 on registered boilers. "Boilers brought into the Province after July 1, 1913, for which drawings and specifications have not been submitted and approved nor affidavits filed, will be penalized by a deduction of at least 10 percent from the working pressure as calculated from the formula in the following regulations."

Now that is pretty severe. I have had trouble with some people shipping over Massachusetts standard and Ohio standard boilers and saying, "Well, that's good for 125 pounds in the United States." There is no doubt about that, but I am trying to enforce this law and must do it.

Shop inspection, I think, is the real thing. In Ontario we haven't got the annual inspection of steam boilers yet. We inspect all new boilers and all boilers sold or exchanged for subsequent use as a steam boiler.

In reference to boilers made in the United States or outside of the Province of Ontario, we will accept the shop inspection of any person, any inspector of any of the States of the United States or any inspector employed by an insurance company authorized to inspect boilers in the United States, but that inspection is not to be an individual inspection; the inspection must be made and the inspector must fill out our shop inspection report sheet and it is forwarded to our office and examined there, and if it is found to comply with the specifications the certificate is issued in the regular way.

MR. LUCK: In regard to the manufacturer of Massachusetts standard boilers, the inspectors first inspect the plates; they look for the heat number and they look for the brand and the tensile strength of material in the plates. Then, after the plates are punched and rolled, they look at them again, see that the holes are punched under size, again see that the holes are reamed, that the plates are planed; then after the boiler is finished they see the hydrostatic test applied. After the data sheet is filled out, the inspector personally signs his name on the data sheet and the data sheet comes to our office, or is supposed to, before the boiler leaves the shop.

The remainder of the Tuesday morning session was given over to routine business and an executive session.

On Tuesday afternoon the members of the association and their guests visited the plants of the Otis Steel Works and the D. Connelly Boiler Company.

The annual banquet of the association was held on Tuesday evening at the Hollenden. I. J. Lietsch delivered the principal address dealing with the relations between employers and employees.

Simple Problems in Laying Out

BY HARRY B. WRIGLEY

My experience with men engaged in laying out plates for boilers, tanks, etc., leads me to believe that your readers would be interested in the following articles, either or all of which I trust you will find acceptable for publication in your valuable journal.

First, to lay off an angle accurately without a protractor. Assume the angle to be 29 degrees 54 minutes. From handbooks containing tables of natural tangents, etc., it will be found that the tangent of 29 degrees 54 minutes is .5750. Now, the tangent of an angle represents the altitude in inches of a right triangle whose base is one inch long; therefore, if we make a base line 10 inches long, the altitude for the given angle will be ten times the tangent, or 5.75 inches, as in Fig 1.

Second, to divide a given straight line into any number of equal parts. This is purely a matter of proportional parts. Suppose it is required to divide the line *AD*, 7 inches long, into five equal parts. Referring to Fig 2, it is evident that we can take any line as *A-B* and measure oft five equal spaces, terminating at *C*. Next, connect point *C* and point *D* with a straight line and through points *e*, *f*, *g* and *h* draw lines parallel to

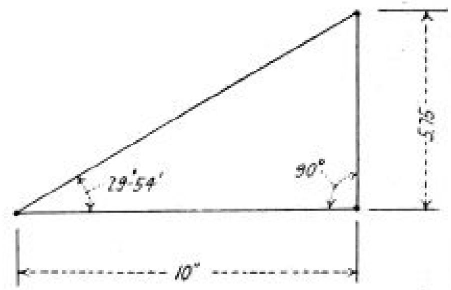


Fig. 1.

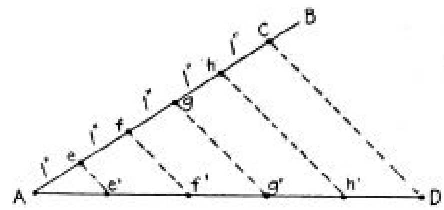


Fig. 2.

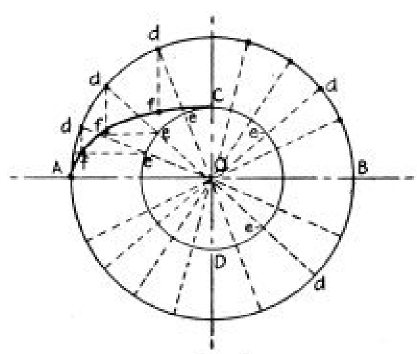


Fig. 3.

Laying Out Problems for Beginners

C-D, intersecting *A-D* at *e*, *f*, *g* and *h*, dividing the given line *A-D* into five equal parts.

Third, to construct a true ellipse, the length *AB* and breadth *CD* being given as in Fig. 3. From *O*, the center point of the axes, describe circles equal to their diameter; take any number of convenient points *d* on the outer circle and draw lines from these points to the center *O*, cutting the inner circle at points *e*. From points *d* draw lines parallel to *CD* and from *e* draw lines parallel to *AB*, and note the intersections *f*, through which construct the desired ellipse.

EFFECT OF BACK PRESSURE ON SAFETY VALVE.—There are many economical advantages to be gained by a safety valve that will operate without harmful effect of back pressure in the casing of the valve. First, the sizes of discharge pipes may be reduced, and second, several valves may be connected into a common discharge pipe.—*George H. Clark, in a paper on "Design of Steam Safety Valves," read before the Boston Section of the American Society of Mechanical Engineers.*

Treating Feed Water for Locomotive Boilers*

Discussion of Practical Methods of Treating Boiler Feed Water to Avoid Incrustation, Corrosion and Foaming

BY L. F. WILSON

The question of water treatment is an involved one, and the writer wishes it understood that it is not his purpose to read you an academic paper on the chemistry of feed water and its treatment. First, because such a paper would only interest those who happen to be chemists, and, secondly, because he could not if he would.

A great many have, no doubt, had a vastly greater experience than has the writer in combating the problems incident to the use of bad boiler feed water, and it is to be hoped that these gentlemen will not infer that this paper is to be a form of instruction in fighting boiler diseases. On the contrary, it has for its purpose the promotion of an exchange of ideas on the subject.

Those of us whose jobs are dependent upon the operation of locomotives, and that includes nearly every railroad man, are interested in their economical and efficient functioning. Those who are directly responsible for this efficiency do not wish to overlook any method or process by means of the use of which a satisfactory condition can be obtained for the least expense.

Locomotive boilers are, in some districts, the most troublesome part of motive power equipment. In every district the boilers require constant attention. Were a locomotive boiler operated under ideal conditions, it would practically never require repairs and never give trouble during its lifetime, and its life would be a long one.

Two locomotive boilers can be built exactly alike and placed in similar service, but in different territories. One of these boilers may reach a point within a few months when new parts are required and boiler repair work must be constantly done on it; the other may run the limit of time allowed by the new inspection rules before it even needs new flues. Why should this be true? We all know the answer: it is "bad water" in the first case.

Probably 90 percent of the operating and mechanical officers have, either continuously or periodically, been troubled with boiler feed water, which, owing to impurities in solution or suspension, cause difficulty and increased in the operation and maintenance of locomotive boilers. Usually these objectionable evidences of inadaptation of the raw water to steam requirements are ascribed merely to "bad water."

The term "bad water" may mean nearly anything or nothing at all. Evil tendencies, incident to the use in locomotive boilers of all kinds of water, evidence themselves in three ways; viz., in incrustation, in corrosion, or in foaming—sometimes all three together, but luckily we do not usually find much scale in a water which has a natural foaming tendency, or foaming in a water which has a large percentage of incrustating solids.

While we will avoid delving too deeply into the chemistry of water supplies it is well for all motive power men to know that, roughly speaking, the sulphates cause hard scale, the carbonates cause a mud precipitate and alkali salts cause foaming, if in predominancy. Therefore, a glance at a carefuly prepared analysis will serve to determine what may be expected to happen when the water is evaporated.

Sulphates precipitate only at a boiler temperature corresponding to 60 pounds or 70 pounds pressure. Carbonates preciptate at boiling temperature (212 degrees). This explains why low pressure boilers do not have serious scale troubles.

We all know the direct results of a coating of hard scale in a boiler: high boiler maintenance cost, higher fuel cost and failures on account of leaking. Foaming has even more direct results in cut cylinders, clogged up superheaters, and reduced pulling capacity to the point of failure.

Corrosion goes with the sulphate scale. It is the rankest fallacy to advance the theory that a coating of scale will protect a boiler from pitting. Corrosive action goes on under a sulphate scale by the release of acid incident to the high temperature, and the iron is turned into red oxide, so familiar to you all. Due to the unstable nature of the resulting sulphate of iron, we find that the acid is continuously liberated to attack the iron, leaving the oxide layer behind, as can be readly noted under a high temperature, high pressure sulphate scale. It occurs in "pits" simply on account of lack of homogeneity of the metal—some portions lending themselves more readily to acid action.

There are other theories as to pitting, but the writer has proved that while there may be cumulative action due to several causes, the one above mentioned is the major cause. Its truth can be tested by anybody.

The treatment of boiler feed water may be pursued by any one of three methods, which may be termed for the purpose of this paper: "external treatment," "semi-internal treatment" and "internal treatment."

External Treatment

By "external treatment" I refer to the wayside plant or mechanical water softener. In the treatment of boiler feed waters by this means, on a railway, it is customary to locate water treatment plants at points where huge amounts of badly incrustating waters are taken. Assuming, of course, that the proper chemical reagents are used, this method is ideal, under certain conditions, and has to its advantage a feature which appeals to steam engineers, in that it deposits the incrustating solids before the water is taken into the locomotive tenders; but its disadvantages are very evident, after some little thought.

We will assume that a division of one of our railways has water stations at five points—A, B, C, D and E. It is brought to the attention of those in authority that the water at station C is scaling up the boilers very badly, and after due consideration a water treatment plant is located at C, and it goes into operation. It then becomes evident that now the waters at B and D are very bad, although by comparison they were not considered so bad as that of C. It is also discovered that there is little improvement in the conditions of the boilers, because of the fact that there is only a small percentage of water taken on the division which has been treated.

* Paper presented before the Cincinnati Railway Club, Cincinnati, Ohio, May 9.

The officers are then up against the proposition of treating the rest of the waters. Now, each treating plant costs several thousand dollars, and they must be operated by men who must necessarily be on the pay-roll, and who must give their time to the operation of the plant. In lieu of this, they can, of course, get along with the slightly better results which they have obtained. It must be remembered that this is only one division, and in these times of stringency in the railway treasuries these officers are going to have trouble in securing the necessary appropriations. We must also remember that the chemicals which are used in these treating plants cost nearly as much and sometimes more than those used in other methods of treating.

In the above you will note that we are assuming that the water which has been treated by these treating plants is perfect boiler water. Unfortunately this is not always a fact; it is very frequently the case that the water which is delivered thus has acquired an evil tendency which it did not have in its raw state; viz., foaming. This means that the semi-internal treatment must be used, after all. That is, we must hold this water down in the boiler by the use of some anti-foaming compound.

The reason for this foaming tendency can be explained easily. The usual treatment, used to throw down the scale forming impurities, is sodium carbonate (soda ash). A reaction in the boiler splits up the calcium sulphate and the sodium carbonate and recombines them as sodium sulphate and calcium carbonate, the latter being precipitated as mud, and the former remaining in solution.

Mr. W. A. Pownell, of the Wabash, says that the boiler will be in a foaming condition when the sodium sulphate and other sodium salts have reached a concentration of 2,000 or more parts per million.

This concentration is increasing steadily as the water is evaporated and used as steam. It must be reduced by changing the water periodically or constantly, according to circumstances.

A good anti-foaming compound will allow of a far higher concentration and is, therefore, an economy in this method of treatment, as the enormous waste of constant water change is reduced to nearly zero.

SEMI-INTERNAL TREATMENT

I mean by the term "semi-internal" the addition of a boiler compound to the water in the tender tank. This method of treatment has been in use on many railways of the Continent for a great many years. It resembles in effect the method just explained, and I believe that it was first used systematically about thirty years ago, and the treatment was our old friend sodium carbonate, commonly known as soda ash. The use of soda ash, therefore, is of long standing, and its purpose was to throw down the incrustating solids only.

In waters which are not heavy in incrustating solids, the beneficial results from the use of soda ash or a good proprietary anti-scaling compound are so evident as to be undeniable. However, you expect me to knock it, and I am going to. Its very method of use is against it. Enginemen do not directly benefit by the use of a material which is given to them to use, which has for its sole purpose the decrease in boiler maintenance cost. The officers of the railways who are responsible for its use give instructions as to the amount to be placed in each tank of water. This amount is usually figured large enough to throw out of solution, by chemical combination, the sulphates which form scale. Unfortunately, where these sulphates are in large proportions a dose of compound which will take care of them is so large as to result in a concentration in the boiler which results in foaming, thus striking the engineman between the eyes. He is responsible for getting his train over the road, but he is not responsible for the scale in the boiler. What is the logical solution which occurs in the brain of this engineman? The soda ash will do no harm on the right-of-way or in the fireboxes; the fireman can take his choice, and nobody is the wiser.

There are many treatments which are designed to be used in just the same way as the above, and I thoroughly believe that while the results from some may be good to a certain extent, the disadvantages as above detailed apply to them all.

With respect to the use of compounds which are prescribed for certain water analysis and used by any method, they may work with beneficial results where one kind of water is used (that for which the compound is prescribed); but it does not seem logical to assume that for locomotive boilers this could be practical.

Some switch engines, it is true, may operate constantly in one water, and such treatment would work successfully. We are, however, interested in eliminating the evil effect of bad water out on the line.

A passenger engine may go over the divison on three waters. A freight engine may go over the same division on five waters, more or less. Each day these waters are taken into the tender tanks in different proportions, therefore each day the average analysis differs. Is there a chemist who would assume to find the correct reagents under such conditions? Yet these are the normal conditions.

(To be continued.)

Commendable Policy of Oxygen Manufacturing Company

An examination of the prices for oxygen during the last few years will show a constant reduction in price, the surprising thing about it being that the expected upturn in price which, following almost every other commodity, should have taken place shortly after the beginning of the war, is not to be found. The decline continues and prices are lower to-day than they were one year ago.

Inquiry as to the reason for this—in the face of a rising market—surprising condition developed the fact that the dominant company manufacturing oxygen has from the beginning developed a consistent policy of steadily reducing prices from year to year as production increased and as the volume of business decreased the ratio for overhead costs. That the Linde Company should persistently hold the market steady has established lower prices for oxygen to the great advantage of all buyers, and the metal-working industry has been enabled to use oxygen, which has now become a necessity to them, freely and without paying excessive prices, which the extraordinary demand and present business conditions would seem to have warranted.

There is a growing tendency in modern business to regard the interests of the buyer and seller as mutual, and even among modern corporations friendly relations can be built up by a policy as far-sighted and far-reaching as that of the Linde Company. While modern corporations may be said to have no soul, they have developed a keener business instinct which touches both the buyer and the seller, so that those organizations which in the long run can be depended upon not to take advantage of momentary fluctuations in price are the ones to tie to. The Linde Company will certainly make many friends by its policy, which under the circumstances must certainly be regarded as liberal, and they will undoubtedly reap their reward in the friendship and continued purchases of those who have been receiving the benefit of their present action.

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NOTICE TO ADVERTISERS
Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

One of the letters contributed to this issue contains a list of representative questions for boiler makers. A competent boiler maker, well versed in his trade, should be able to give a satisfactory answer to most of these questions, although differences of opinion and practice would undoubtedly lead to a considerable variety of answers. As a matter of interest to boiler makers in general, we would urge our readers to send in replies to any or all of these questions for publication. A complete discussion of the subjects thus brought up should be of value to everyone in the trade.

Dr. J. S. Unger, manager of the central research bureau of the Carnegie Steel Company, recently made a most interesting and valuable investigation of the effect on the working and physical properties of rivet steel, by gradually increasing the amount of sulphur in the steel until it had been raised to a point far above that usually found in such steel as supplied commercially. The results of this investigation were presented in the paper read before both the Master Boiler Makers' and the Boiler Manufacturers' conventions and the paper is published in full elsewhere in this issue.

In the first place, the tests indicated the fitness, for most purposes, of a steel rivet containing slightly less than .10 percent sulphur, and they did not show any way of distinguishing between the quality of the rivet having .03 percent sulphur and that of one having .09 percent sulphur, if both were subjected to the same conditions.

Years ago great quantities of rivets were made of either wrought iron or Bessemer steel, which contained considerably higher percentages of phosphorus and sulphur than the basic open hearth steel now commonly used for rivets. It is interesting to note that the great number of such Bessemer steel rivets still in service furnish conclusive evidence that steel may contain a much higher sulphur content than is supplied to-day in open hearth steel without injuring the quality of the rivet.

Members of the Master Boiler Makers' Association who have enjoyed the active co-operation of Mr. E. W. Pratt, assistant superintendent of motive power of the Chicago & Northwestern Railway, in their recent conventions, will be interested to read Mr. Pratt's statements as delivered in his annual address as president of the American Railway Master Mechanics' Association.

In commenting on the rapid progress which has been made with respect to reducing the cost of installation and operation of electric locomotives on steam railroads, Mr. Pratt pointed out that the steam locomotive must forge ahead rapidly in order to maintain its prestige. The controlling factor in the development of the steam locomotive, he very properly pointed out, is the boiler. In order to place steam on a parity with electric operation, the means available lie in the direction of higher boiler pressures, increased efficiency of evaporating surfaces, more perfect combustion, more uniform firebox temperatures and steam pressures, improved circulation, the heating of feed water by gases and waste steam, higher superheat and systems of compounding in one or more cylinders to reduce back pressure.

As shown by the committee report on the design and maintenance of locomotive boilers, presented at the Master Mechanics' Convention, the most generally adopted improvement in fireboxes is the use of combustion chambers, either of the ordinary type or of special construction, having a bridge wall with air inlets. The increase in the ratio of firebox volume and grate area, as produced by the installation of combustion chambers, is held to be beneficial, producing better steaming boilers, while the improved combustion has the effect of eliminating black smoke. In some cases the adoption of combustion chambers has been due to the desire to avoid excessively long flues, while others have considered that the construction is desirable on account of its being inducive to long flame travel and increasing firebox temperatures. There appears to be no appreciable increase in the cost of maintenance and repair with the combustion chamber than with the ordinary construction, while the life of the flues is greatly increased by their use.

According to this report, the use of long flues is not favored; for while the total evaporative capacity of the boiler may be increased by their use, the rate of evaporation per unit area of heating surface is lower and discounts the theoretical increase in capacity. As a matter of fact, tests show conclusively that about one-half of the heat transmitted by the tubes is transmitted in the first quarter of the tube length. The length of tube which is considered most satisfactory is one hundred times the inside diameter of the tube.

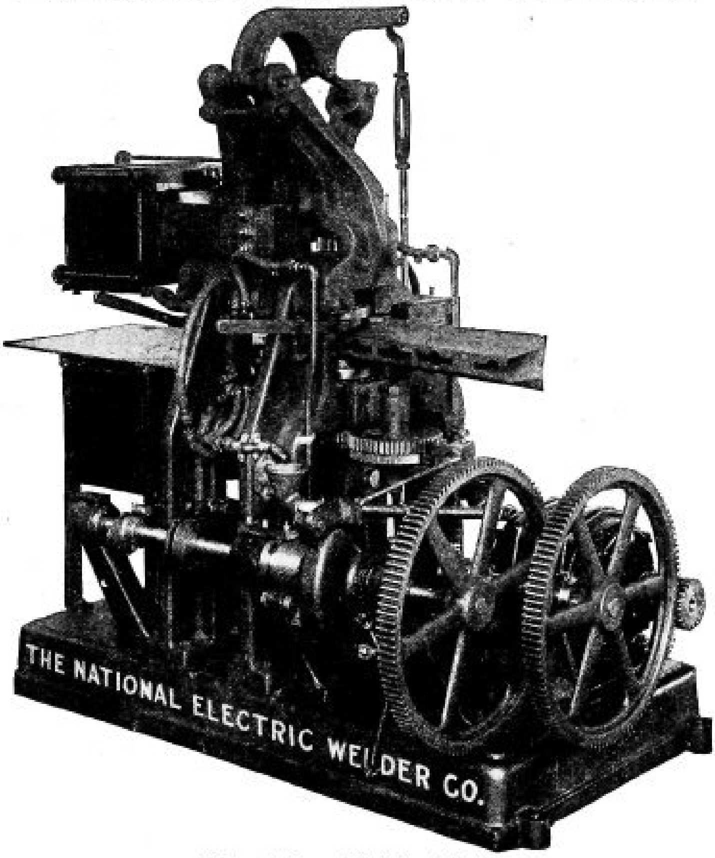
Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Automatic Electric Spot Welding Machine

As an instance of the extent to which electric welding can be developed, the accompanying illustration of a special spot welder is of interest. This welder was designed and built by the National Electric Welder Company of Warren, Ohio, and is used in assembling a V-I Section in an eastern plant which makes a specialty of presssed steel forms. The fact that the machine is wholly automatic in its operation will convey some idea of the high degree of mechanical and electrical skill involved in its construction.

Power is delivered through a train of gears from a 2-horsepower motor mounted on the machine base and operating at 1,200 revolutions per minute. The work is run



National Spot Welding Machine

through the machine in 12-foot lengths, the spot welds on each side being automatically made at the same time at the rate of 40 per minute. A cam (shown just at the left side of the second large gear) operates a rachet gear (shown to the left of the top of the second large gear) which in turn operates the friction rollers which carry the section through the machine. During the intervals between the ratchet gear movements the welding points are brought into contact with the work by means of the cam shown between the uprights of the frame just below the water hose.

The welding points are water-cooled, the temperature and flow of the water being indicated in the drip cup through which the water passes as it flows from the cooling system into the waste pipe.

Despite the seeming complication of parts the machine is exceedingly simple in working principle, so much so, in fact, that it would require actual abuse to impair its efficiency. The possibility of such abuse is provided for by unusual sturdiness of construction and liberal provision for emergency overloads.

This special machine will take the place of several riveting machines which will be utilized for work on which electric welding is not economically practical.

D. C. Motors of the Lower Horsepowers

To meet the increasing demand for direct current motors of the smaller horsepowers for direct connection and drive of all kinds of industrial machinery, machine tools and the many motor applications requiring a low power compact motor, the C. and C. Electric and Man-

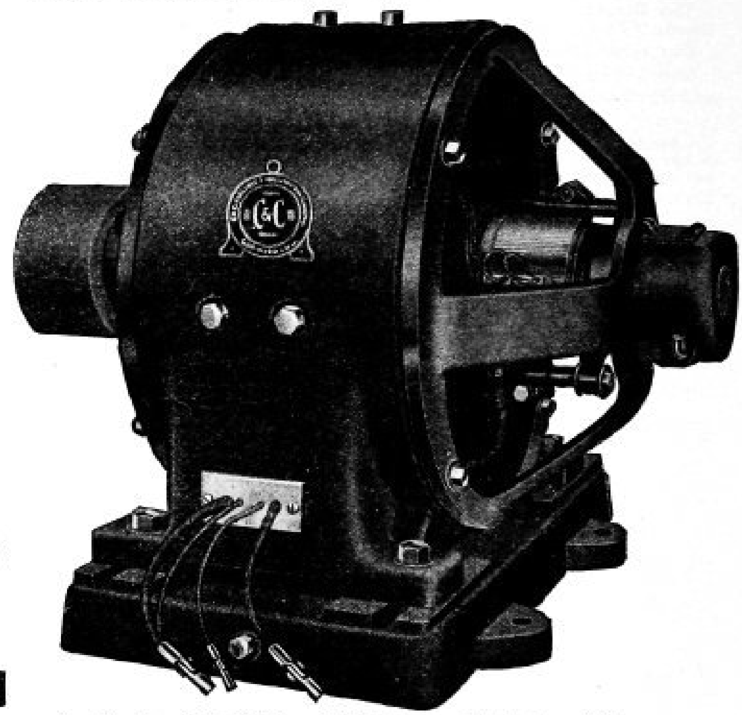


Fig. 1.—C & C Type I. B. Motor, with Universal Base

ufacturing Comapny, of Garwood, N. J., has developed a new line of type IB bi-polar motors in ratings up to 10 horsepower in either the shunt or compound wound with interpoles. For driving machine tools and other industrial machinery the characteristics of the shunt wound

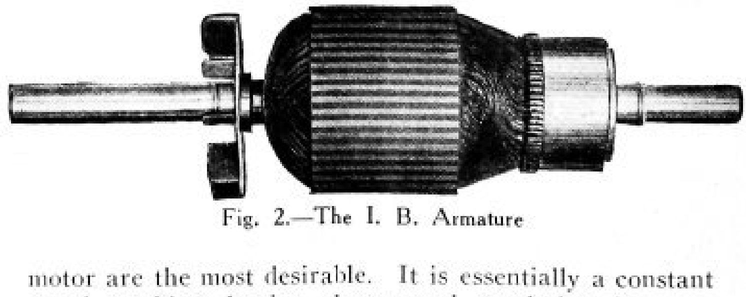


Fig. 2.—The I. B. Armature

motor are the most desirable. It is essentially a constant speed machine, having close speed regulation from no load to full load, and is recommended for all purposes where the torque required for starting and accelerating does not greatly exceed full load torque. The compound wound motor is desirable for drives where the starting torque is much heavier than the full load torque. This motor starts at a much heavier load than the shunt wound motor, and any degree of compounding can be furnished to meet conditions. Adjustment of the speed is obtained in both cases by either armature or field control.

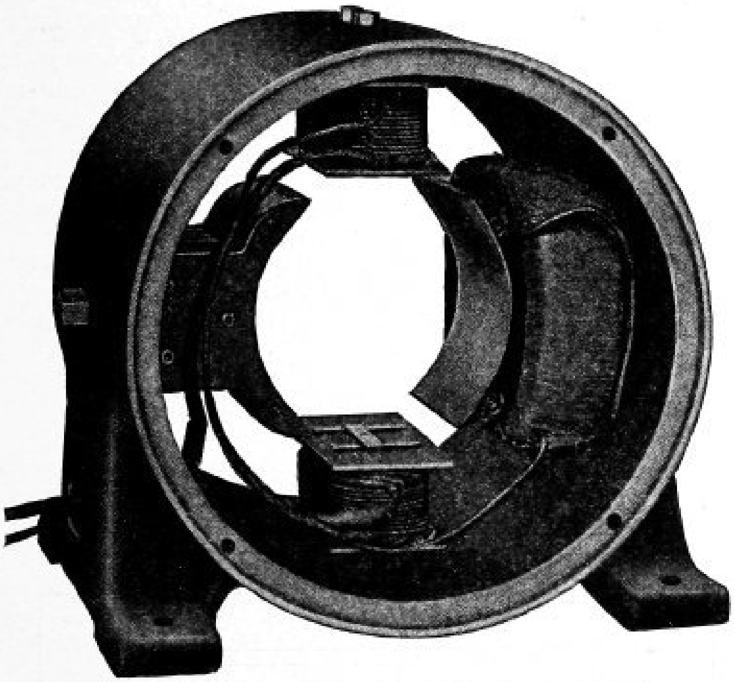


Fig. 3.—Main Frame, with Field and Commutating Poles

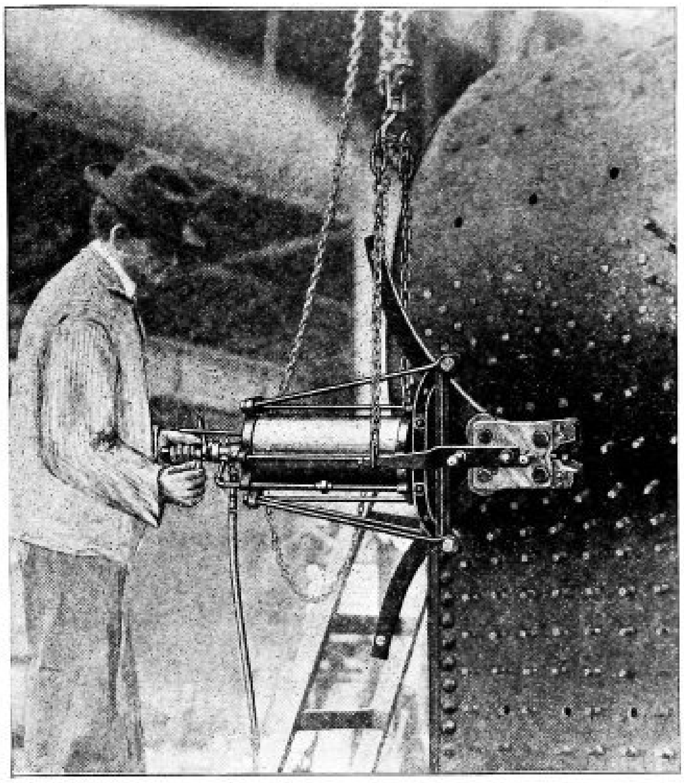
The new line of motors is furnished in the open type, or with perforated or totally enclosing covers for protection against dust, metal chips, dampness, etc. For belt drive the motors can be furnished with either a universal slide rail base or a belt tightner idler pulley.

Helwig Pneumatic Staybolt Clipper

In view of the discussion at the recent Master Boiler Makers' Convention, regarding the advantages of cutting off staybolt ends with oxy-acetylene, over the old methods of nippers and chisels, the Helwig Manufacturing Company, St. Paul, Minn., has furnished us with the following information regarding the advantages of the pneumatic staybolt cutting device which they manufacture for this purpose, and which has proved a most useful and economical boiler shop tool.

The Helwig Clipper is compactly built. Size B has a capacity up to 1¼ inches and weighs but 170 pounds, and size A has a capacity up to 1½ inches and weighs but 210 pounds. The machine consumes about 3½ cubic feet of air for each cut and is capable of cutting off bolts at the average rate of thirteen per minute. No skilled labor is required to operate the device, consequently the labor cost is only from 20 to 25 cents an hour. The clipper is designed to cut the face of the bolt square, of the proper length for riveting, without shock to the bolt or injury to the sheet, and leaves the bolt just as tight in the sheet as when just put in.

In renewing a firebox, the holes are tapped and all staybolts screwed in. The clipper is not put to work until one side of the box is ready for it. Then the machine is quickly suspended from a light boiler crane, and while the cutting is being rapidly done the men are getting the other side of the box ready for cutting. While the machine is in operation, other workmen are not prevented from doing work on the same part of the boiler, whereas with the oxy-acetylene torch, with its intense heat, other men are prevented from working on the firebox while the cutting is going on.



Helwig Pneumatic Staybolt Clipper in Action

The machine can be operated rapidly, as it is readily and quickly moved from one bolt to the next, rapidly adjusted to the bolt, and a quarter turn of the throttle cuts off the bolt. The clipper has small inserted knives which are readily replaced at small cost.

PERSONAL

M. M. McCallister, inspector of building shops at Schenectady, N. Y., and Lima, Ohio, for the New York Central Railroad, has been appointed boiler expert of the American Flexible Bolt Company, with headquarters at Pittsburgh, Pa. Mr. McCallister was born at Curleysville, Pa., and began his business career as the first apprentice on the Pittsburgh & Lake Erie. When he left that road he was made field erector of the James P. Witherow Company, of New Castle, Pa., manufacturers of the Heine boilers. From this position he went with the American Bridge & Iron Company in charge of the Roanoke, Va., shops, and later to the Norfolk & Western as assistant foreman of shops at Roanoke. He was next appointed assistant superintendent of the Richmond shops of the Richmond Locomotive Works, now a part of the American Locomotive Company. From here he left to become foreman boiler maker of the Lake Shore & Michigan Southern at Collinwood, Ohio. He was next appointed superintendent of the Erie City Iron Works, at Erie, Pa., leaving this position later to go as superintendent of John Brennen & Co., at Detroit, Mich., who manufacture stationary and marine boilers. He was next appointed superintendent of the Weil Boiler Company, with headquarters at Indianapolis, Ind., and while here he designed and put on the market the Weil smokeless boiler, which has since proven a great success. From this position he went with the New York Central, which he now leaves to become boiler expert of the American Flexible Bolt Company.

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.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

NOTE.—A criticism has been made on the factors stated in May's issue for the shearing strength of rivets and tensile strength of plate. One reader pointed out the advisability of quoting the A. S. M. E. Code * values, since it is claimed that eventually these values will be standard for the United States. In the future, unless called for, the A. S. M. E. Code values will be quoted in all calculations for finding the strength of boiler parts.

In the solution given for finding the efficiency of the single riveted lap joint, the note "drill for ¾-inch rivet" should have read, drill for ¾-inch the driven size of rivet. One-sixteenth inch clearance is usually allowed between the diameter of rivets and diameter of holes, which allows the rivets to be inserted into the holes to better advantage, and also permits the rivets to upset their entire length and fill the holes when properly driven.

* A. S. M. E. code is the American Society of Mechanical Engineers' code.

Finding the Center of Flanged Round Heads

Q.—I would like to learn of a good method for finding the center of circular tube sheets after they are flanged. LAYEROUT.

A.—The solution in Fig. 1 illustrates quite clearly a method that gives very close results. With the use of a pair of trammel points and with them set to a radius greater than one-half the diameter of the head, describe an arc inside the head from any point as 1. Hold one leg

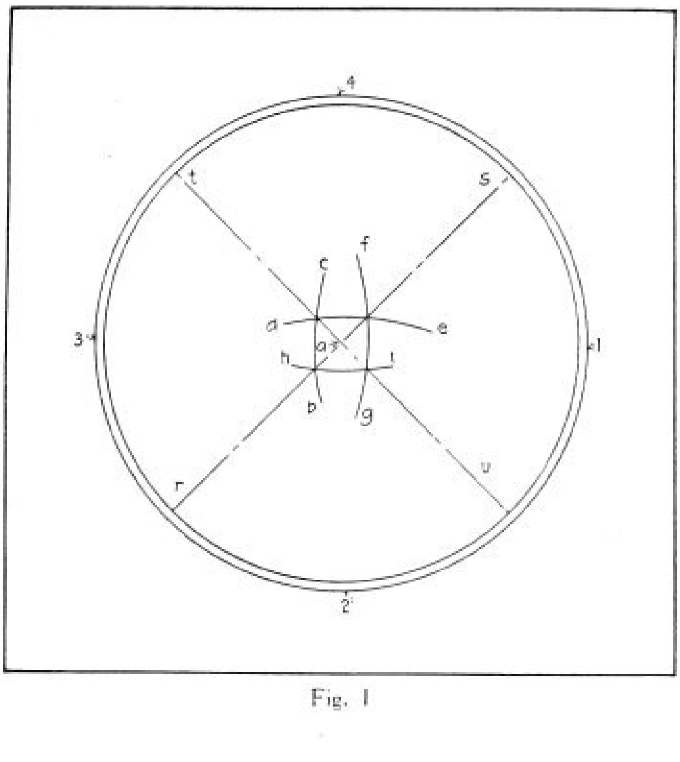


Fig. 1

of the trammels firmly against the outer part of the flange. When drawing the arms, shift the position of the trammels to position 2, which is about one-fourth the circumference of the head from point 1, as near as can be judged by eye. Describe the arc, *d-e*. From points 3 and 4 describe arcs respectively as *f-g* and *h-i*. Draw in the diagonals, *r-s* and *t-u*. A perpendicular to either of these diagonals, as *t-u* to *r-s*, divides the head in four equal parts or quadrants. By using the lines *t-u* and *r-s* as center lines from which to locate the position of tubes and rivet centers for diagonal stays accurate work can be had.

To Square Up Boiler Plate

Q.—How are large boiler sheets squared or trued up for laying out the location of the rivet holes, etc.? APPRENTICE.

A.—The method shown in Fig. 2 demonstrates a practical way of doing such work. Let *a-b* represent one outside edge of the sheet, measure in from it the required distance allowed for lap, then draw the line *c-d*. Find the

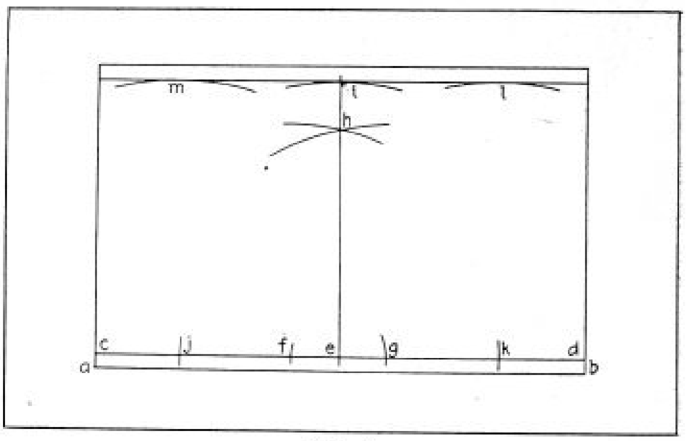


Fig. 2

center of line *c-d* at *e*, and with *e* as a center describe arcs *f* and *g* with the same radius. With *f* and *g* as centers and with the trammel points set to a length greater than one-half the width of the sheet, describe arcs intersecting as at point *h*. Through *e* and *h* draw a straight line with a straight edge. Upon line *e-h* lay off the width of the required section of the boiler locating point *i*. With the trammels set equal to *e-i* and from points located on line *c-d*, as *j* and *k*, draw arcs *l* and *m*. Through *i* and tangent to arcs *l* and *m* draw a straight line, which, if correctly done, will be parallel with line *c-d*. The required length of the sheet should be laid off from the center line, *e-i*.

Camber of Tapered Sheet

Q.—Kindly show method of figuring *camber* in a sheet of very large diameter. Assume a course of ½-inch plate in a tank about 100 feet in diameter, as shown in sketch. The course to be about 4 or 5 feet in width and plates about 10 feet or 12 feet in length. J. T. D.

A.—To bring out clearly the correspondent's problem, it is essential to distort in the drawings the relationship between the diameters at top and bottom of the course, and also the patterns as illustrated in the figures. The dimensions of the two neutral diameters and the slant height of the object being given in Fig. 3, it is required as shown in Fig. 4 to find first the length of the base *bc* of the triangle *abc*, which is found by subtracting one-half the diameter of the upper base from one-half the diameter of the lower base.

Then 600¼ — 599¾ = ½ inch, the difference in the length of the radii for the two bases.

Next find the length of the radius, or, in other words, the slant height of the cone, of which the frustrum *abde* is

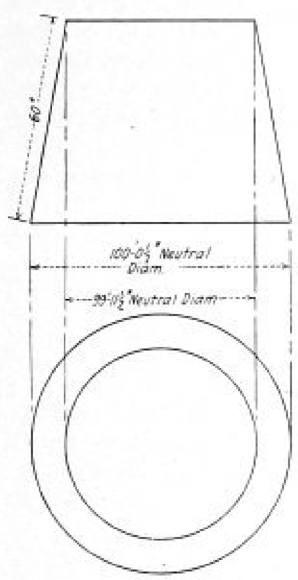


Fig. 3

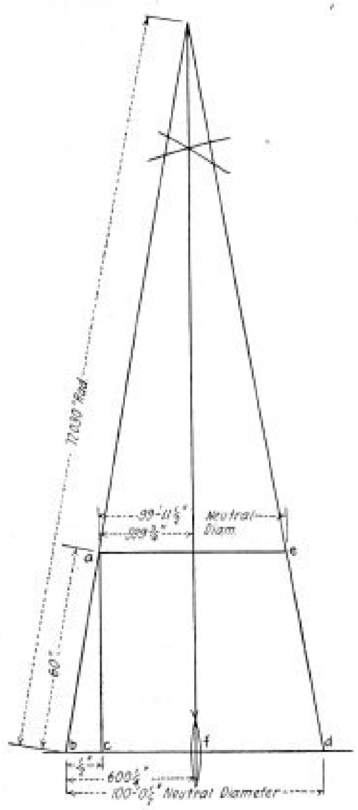


Fig. 4

a part, which may be done by proportion in finding the ratio of certain dimensions as follows:

It is evident that the slope *ab* is to the base *bc* as the slant height of the cone is to the base distance *bf*. Substituting the values given we have 60 : ½ :: *x* : 600¼, in which *x* equals the slant height of cone. Then

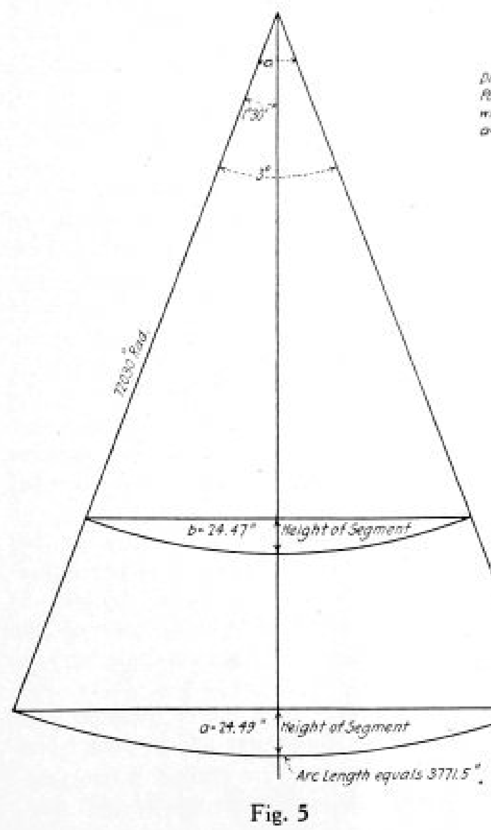


Fig. 5

$$x = \frac{60 \times 600\frac{1}{4}}{\frac{1}{2}} = 72{,}030 \text{ inches radius, or slant height of cone.}$$

The circumference of the lower base along the neutral layer of plate equals 1,200½ × 3.1416 = 3,771.5 inches.

To proceed further, it is necessary to find the number of radians in the angle *a*, Fig. 5, which equals 3,771.5 ÷ 72,030 = .05236 radian. 1 radian = 57.3 degrees. The number of degrees in .05236 radian equals 57.3 × .05236 = 3 degrees. Angle *b* equals one-half of angle *a* equals 3 ÷ 2 = 1 degree 30 minutes. Versed sine = 1 — cos. 1 degree 30 minutes = 1 — .99966 = .00034. Height of segment Fig. 5 equals 72,030 × .00034 = 24.49 inches, which is the distance between the chord that subtends the arc or camber line shown in the figure.

As the example calls for plate sections either 10 or 12 feet in length, it is required to find the height of segment in a much shorter length. This cannot be done according to the method just given for the entire circumference of the base, as, owing to the ratio of the shorter arc length to the radius, or slope of the cone, the angle found is so small that calculations, if employed, involve higher mathematics. A practical solution that does not vary much from the accurate method can be used. The solution is as follows:

Square one-half the arc length and divide by the diameter of the circle, the result equals versed sine. (It is more commonly called the height of segment.) In the form of a formula, we have,

$$\frac{\frac{1}{2} \text{ arc length squared}}{\text{Diameter of circle}} = \text{height of segment.}$$

Consider the tank to be made up of 28 sections. Then 3,771.5 ÷ 28 = 134 11/16 inches length of one section at the lower base. Applying the approximate rule given to find the height of segment, 134 11/16 ÷ 2 = 67.345 inches.

Radius of circle equals 72,030.

Diameter of circle equals 72,030 × 2 = 144,060.

$$\frac{67.345^2}{144{,}060} = \frac{67.345 \times 67.345}{144{,}060} = 1/32 \text{ inch, height of segment.}$$

Fig. 6. The following approximate method may be em-

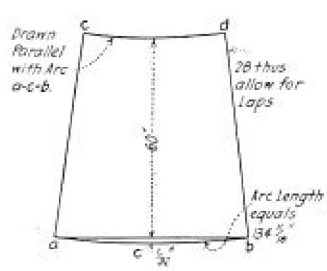


Fig. 6

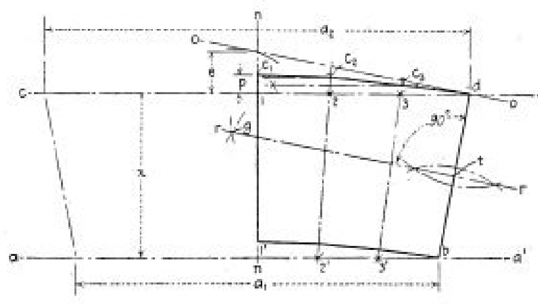


Fig 7

ployed in laying out the pattern for frustums of cones having a slight taper:

The first step in the solution is to lay off the center line *n-n* (Fig. 7.) Then at right angles to this line draw the lines *c-d* and *a-b*, making the distance *c-d* equal in length to the circumference around the large end of the frustum, and the distance *a-b* equal to the circumference around the small end. The distance *x* is equal to the slant height of the cone. Bisect the line *b-d* into two equal parts as shown at (*t*) with the use of a pair of large compasses or trammels. With *b* and *d* centers, describe arcs to intersect as shown at *g*. Through points g and *t* draw the line *r-r*. Then with the trammels or compasses set to the distance *t-d*, and using point *g* as a center draw an arc above the line *c-d*. Tangent to this arc and through point *d* draw the line *o-o*. This line should run parallel with *r-r*. To determine the camber line for the ends of the pattern, it is necessary to divide the stretchout lines *c-d* and *a-b* into an equal number of spaces, in this example half of the pattern is shown developed. The other half being the same, it will be completed in the same manner. The distance between points *l-d* and *l'-b* is divided into three equal parts. Connect 2-2' and 3-3' and extend these lines indefinitely. Next lay off 4/9 of the distance *e* shown at the top of the drawing, which is equal to the distance *p*. With the dividers set equal to the distance *p*, describe an arc from point 1 as a center. Divide this arc into the same number of equal parts shown in half the pattern. At right angles to the line *n-n* and through the points located on the arc, draw lines to intersect as shown at c_2 and c_3, thus locating the required points which lie on the camber or curved line for the pattern at the top of the object. To find the camber line for the large end, set the dividers equal in length to the distance *d* to *b*, and from points c_1, c_2, c_3, lay off the distance on the radial lines. A curved line traced through these points gives the approximate camber line for the large end of the pattern. The required stretchout of the pattern after the curved lines for the upper and lower bases have been found, may be laid off with the use of the traveling wheel, which is a circular graduated measuring wheel. The allowance for lap and the location of rivet holes are to be made to meet the requirements.

Method of Inspecting a Tubular Boiler

Q.—Being a subscriber for your journal, will you please tell me how to proceed in making an inspection of a tubular boiler? R. T.

A.—In making a complete examination of the boiler there must be made an *external* and *internal* inspection. Every part of the boiler should be thrown open as far as can be done, so the inspector can get at each section and ascertain the conditions. The outside examination consists of determining the conditions by ocular inspection and *hammer tests*. The seams should be cleaned by the use of a wire brush, then look for fire cracks, leaks, loose and burned rivet heads. Mark the damaged parts found directly on the boiler. If there are indications of corrosion, find the extent of such parts so effected by boring into the plate. Examine the boiler supports, settings, etc., also the heads for cracks and leaky flues. Inspect the condition of the boiler next to the fire for blisters and bulges, also the steam dome, mud drum fittings and other accessories for any defects in their construction and operation. Examine the furnace brick lining, bridge wall, combustion chamber at the back of the furnace, the uptakes, grate bars and their supports. Note the condition of the blow-off pipe, which, if exposed to the gases, without protection may deteriorate. Usually a sheet iron sleeve is installed over the exposed part of the pipe for protection against the hot gases.

The inside or internal inspection is then made. All sediment which collects at the bottom of the boiler should be removed, also as much of the scale along the seams and surface of the boiler as possible. Look for pitting and corrosion in the shell plates, heads, flues, especially along the seams. Examine the laps in the seams for grooving and cracks. Note the condition of the braces, especially at the angle between the palm and body of the braces; at this place the braces are liable to crack from the stresses set up, due to contraction and expansion of the boiler when in operation. If the inside of the shell surfaces are found pitted or corroded, find the thickness of the plate so affected by drilling several small holes. Then measure the thickness of the plate, after which the holes are plugged by first threading or tapping out the holes and installing plugs.

A memorandum should be made by making a sketch of the boiler and noting upon the sketch the location of each damaged part, and the extent of the repairs needed to insure the safe operation of the boiler. After the proper repairs are made, boiler laws usually require a hydrostatic test to be made before placing the boiler in service. This test should not be made at too high a pressure, as it is possible to strain the boiler plate beyond its elastic limit.

In cases where the plate or stays are found wasted away, their strength may be ascertained according to the regular rules applied in boiler design. A wasted plate, if very thin, should be removed and a patch properly fitted. Where a thin spot is found and conditions warrant the operation of the boiler by a reduction in pressure, the allowable pressure may be found by proportion. According to the following, it is evident that the original thickness of the boiler plate is to the original working pressure as the thickness of the wasted plate is to the allowable reduced pressure.

From the following formula the allowable pressure may be determined:

When a = original working pressure,
b = original thickness of plate,
c = thickness of wasted plate,
x = allowable reduced pressure.

$$\text{Then } x = \frac{a \times c}{b}$$

Consider, for example, a boiler subjected to a working pressure of 140 pounds per square inch. The original plate thickness equals ½ inch. A thin spot is found being wasted away to a uniform thickness of ⅜ inch. What pressure may be allowed on the boiler?

Substituting values in the problem, we have,

$$x = \frac{140 \times 3/8}{1/2} = 105 \text{ pounds allowable pressure.}$$

Steam Space in Boiler

Q.—I should like to know the formula for calculating the necessary steam space to allow when designing a boiler. I want to design a firebox heating boiler carrying 15 pounds pressure, the boiler to have 804 square feet of heating surface; 22 square feet of grate area; capacity of steam, 8,000 feet, water 13,000 feet.

(1) What is the ratio of cubic feet of steam space in shell to square foot of heating surface?

(2) How many feet of heating surface would you figure to the horsepower in this type of boiler?

(3) Would any of the water space be considered in this ratio?

(4) Is there any chance of the steam condensing in the top of a boiler with direct and return tubes? V. M. D.

A.—(1) The cubic contents allowed for steam space depends upon the purpose for which the steam is employed. Steam supplied to steam engines should be of sufficient volume to supply the engine intermittently from 20 to 25 seconds. For heating purposes, the steam flows steadily and need not necessarily be dry, hence a smaller steam space is permissible. Usually the size of steam space is based upon the cubic contents of the boiler, for ordinary designs the space may range from ¼ to ⅓ the cubic contents of the boiler, the remainder being water space. There is no mathematical rule for finding the size of steam space, according to the ratio of cubic feet of steam space to the square feet of heating surface.

(2) The ratio of heating surface to horsepower for this type of boiler is about 14 to 18 square feet per horsepower. This is of course indefinite for rating boilers, as with the same heating surface different boilers of the same type may under different conditions produce varying quantities of steam.

(3) No. The heating surface of a boiler includes only the surfaces of the plates and flues that are in direct contact with the fire and hot gases.

(4) I do not think so.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Formula for the Camber or Versed Sine of a Tapered Sheet

In the December, 1915, issue of THE BOILER MAKER I noticed an article by Mr. D. Viders on "The Camber or Versed Sine." The formula which he gives is not good in all cases. The only place a layerout could use it would be where there was only a small taper as having the outside of the small course the same diameter as the inside of the large course. I would like to submit the following formula, which can be used for all cases.

Formula:

$$\frac{\left(\frac{L-S}{4}\right) \times (L \div 2)}{l}$$

$L =$ large circumference.
$S =$ small circumference.
$l =$ length of course center to center rivets.

Example: We have a taper course 81 inches inside of large end and 75 inches inside of small end and the plate ½ inch thick. We will first find the necessary circumferences for the stretchout.

Circumference of large end $= 81.5 \times 3.1416 = 256$ inches.
Circumference of small end $= 75.5 \times 3.1416 = 237\frac{1}{4}$ inches.
$l = 41\frac{1}{4}$ inches.

Substitute in the formula, we have

$$\frac{\left(\frac{256 - 237.25}{4}\right) \times (256 \div 2)}{41.25}$$

or

$$\frac{4.6875 \times 128}{41.25} = 14\frac{1}{2} \text{ inches camber.}$$

Hoping this may be of some use to layerouts.

WILLIAM F. BRADY.

Buffalo, N. Y.

Questions for Boiler Makers

The following list of suggestive questions came to the writer recently and I believe that answers from experienced boiler makers would prove interesting reading for subscribers to this journal:

1. Explain in detail how to test a boiler after being overhauled.
2. Explain how to locate and remove a leaky tube in a watertube boiler.
3. How are the holes in the tube sheets prepared for the reception of tubes to be expanded.
4. Explain the construction of a furnace of a Scotch boiler, how it is secured to the boiler and how furnaces may be removed and replaced.
5. Explain how to cut and replace the front cross box on a Babcock & Wilcox boiler.
6. Explain the formation of blisters sometimes encountered in the headers and cross boxes of Babcock & Wilcox boilers.
7. Describe in detail how to clean the water side of a watertube boiler.
8. What are the principal causes for leaky rivets?
9. Why are tube ends in watertube boilers flared?
10. Explain how you would put a patch on an irregular surface of a boiler shell.
11. What are the principal causes for leaky tubes?
12. What is a retarder?
13. Why are ferrules placed in the ends of tubes in Scotch boilers?
14. Describe the various methods of making longitudinal seams in boiler shells and tanks.
15. Describe the principal power tools used in a boiler shop.
16. How are plates annealed after flanging?
17. How are tube sheets laid out, drilled and reamed?
18. How are the ends of a metal tank or boiler joined to the shell?
19. What is meant by welding? What metals can be welded? Explain the process of flanging boiler plates.
20. Explain how a butt strap joint is set up for riveting.
21. What is calking and how are seams prepared for calking?
22. What are the causes of cracked tube plates?
23. How are they repaired?
24. How is a leaky tube plugged in a Scotch boiler? In a watertube boiler?
25. Carefully explain the process of expanding tubes, giving various defects in the processes that are sometimes met with.
26. Make up a bill of material to replace an evaporator shell, giving general dimensions.

Scranton, Pa. CHARLES J. MASON.

[Editor's Note: Readers of THE BOILER MAKER are invited to answer any or all of the above questions. All answers published will be paid for at regular rates.]

Locomotive Boilers and Their Improvements

I have read with a great deal of interest and pleasure, in the June issue of your valuable paper, the full proceedings and reports of committees of the Master Boiler Makers' Association, held in Cleveland, Ohio, of which I am a member, and especially the remarks of Mr. Pratt, of the C. & N. W. R. R., "that the general consensus of opinions of thinkers in the railroad world to-day is, that the greatest opportunity is in the improvement of locomotive boilers," which I heartily indorse.

This brings me back to the troubles in locomotive boilers sketched on the blackboard by the boiler makers at the convention held at Buffalo in 1905, when I was asked by them to take a hand in trying to get rid of the troubles referred to. I well remember my answer, "that it was a hard problem from the fact that I considered that no particular part could be fixed that would benefit the boiler as built, and any one who thought so would surely get left." The only way, in my opinion, to eradicate the difficulties was to reconstruct it as a whole, and I also remember two years later at the Cleveland convention presenting my plans.

Consolidation engine boilers were built after my testing out a series of formations for fireboxes and tube plates. My diagnosis proved out in practice to have balanced the stresses produced by expansion and contraction. Tube and mud ring leakage was reduced and the raising of crown over flue sheets was dispensed with. I also note, which is very pleasant to me to read, the boiler makers' explanations about trying different improvements, all of which are embodied in my construction and which can only be satisfactory when used in connection with the *new complete construction.*

I believe in fair play, and when once the boilers are given it they will become standard. There is no other way by which the present form of locomotive boiler can be changed to be made flexible and at the same time made stronger that I have seen or know of up to date.

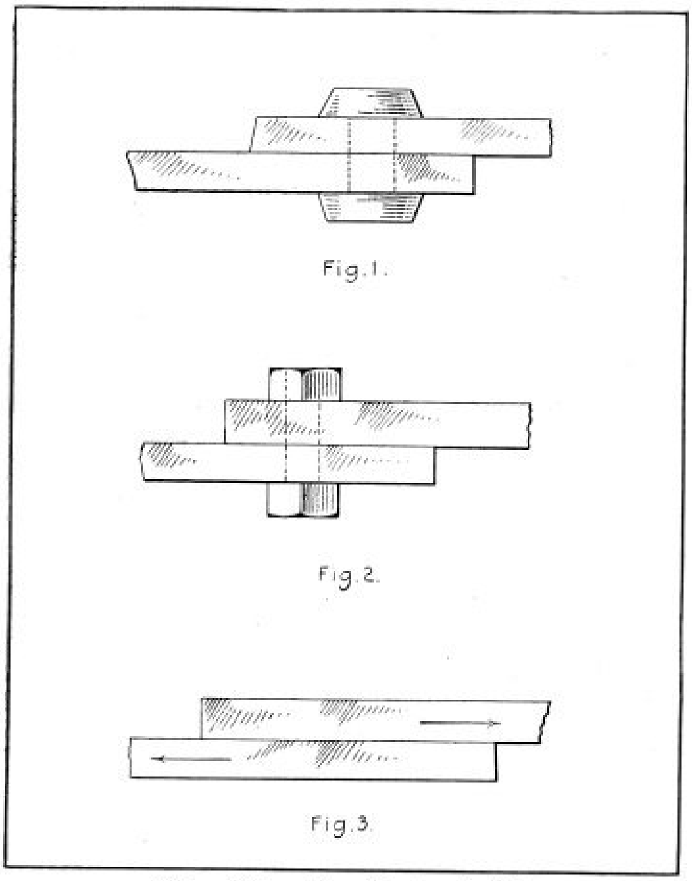
I regret not being able to attend the convention to meet a number of my old friends the boiler makers, for I will always remember and appreciate the pleasant times I had talking with them about their efforts.

WM. H. WOOD,
Media, Pa. Mechanical and Constructing Engineer.

Rivets Versus Bolts

Which will hold the most in tension, a rivet or a bolt?

The above question with rough sketches was sent to me with the request that I send my answer to THE BOILER MAKER. Fig. 1 shows a rivet in single shear. Fig. 2 shows a bolt in single shear, and Fig. 3 shows direction of



Plates Fastened by Rivets and Bolts

pressure. Under certain circumstances there is no doubt that a bolt of a given size and quality would have the same holding power as that of a rivet of the same size and quality, provided that the holes in the plate for the bolt were made for a driving fit and that the pressure of tension was anything other than steam pressure.

Now, suppose we were going to fit dome braces on a crown barrel boiler, the top of the brace to lay flat against the side of the dome. The brace either bolted or riveted would then be in tension. Now, who of my readers would want to bolt his braces even if they were a driving fit other than in case of emergency. Although the tensile strength of the bolt holding the brace would be equal to rivets of the same size and quality, the holding capacity of the nut is not equal to that of the head of a well driven rivet.

Again, a patch bolt may hold and give entire satisfaction so long as it is possible to keep it tight, but I should feel more satisfied with rivets in the same place.

We know that crown bar bolts hold and give entire satisfaction under favorable conditions, but a crown bar bolt screwed into the crown sheet and riveted over is more reliable under all conditions, for while the bolts thus applied are in tension they are not in single or double shear. Both bolts will hold equally well until subjected to some unusual strain, such as that caused by low water; then we find that the bolt held tight by friction—that is, a large bolt driven into a small hole—starts giving trouble by leaking, and as a general rule never stops until removed, while the bolt that is screwed into the crown sheets and riveted over can generally be made tight again.

It is the practice of some shops to apply soft patches to boilers, but all things considered, I think it is a pernicious practice and should never be resorted to unless in the case of the greatest emergency, for again it is not a question of the holding power of the bolt, but that of the nut, and patches so applied should be riveted up as soon as possible. There are places on a locomotive where a bolt will hold far better than a rivet, as, for instance, the bolt that holds the boiler to the saddle of the engine, and several other places around the framework.

It is quite possible that a close-fitting bolt properly fitted in strips of plate put into a testing machine and drawn may show the same, or nearly the same, resistance as that of similar strips of plate riveted, and could best be determined by some firm having a testing machine making the experiment. Personally, I believe in the rivet and that well driven.

I should like very much to have the experience of other readers of this magazine upon this question, for I think that questions of this kind should be thoroughly discussed, for there are many men who cannot see the difference between a bolt and a rivet, and no doubt my friend has met with cases of this kind from his anxiety to have the question brought to the notice of the readers of THE BOILER MAKER. FLEX IBLE.

Braced and Stayed Surfaces—A Handy Chart Based on the A. S. M. E. Boiler Code Formula

This chart is based on the A. S. M. E. boiler code committee formulas found in Paragraph 199 of their report. The formula is

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

where P = maximum allowable working pressure, pounds per square inch;

t = thickness of plate in sixteenths of an inch;

p = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches. (The transactions show this as "capital P," which I assume to be a typographical error.)

C = 112 for stays screwed through plates not over 7/10 inch thick, with ends riveted over;

C = 120 for stays screwed through plates over 7/16 inch thick, with ends riveted over;

C = 135 for stays screwed through plates and fitted with single nuts outside of plate;

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

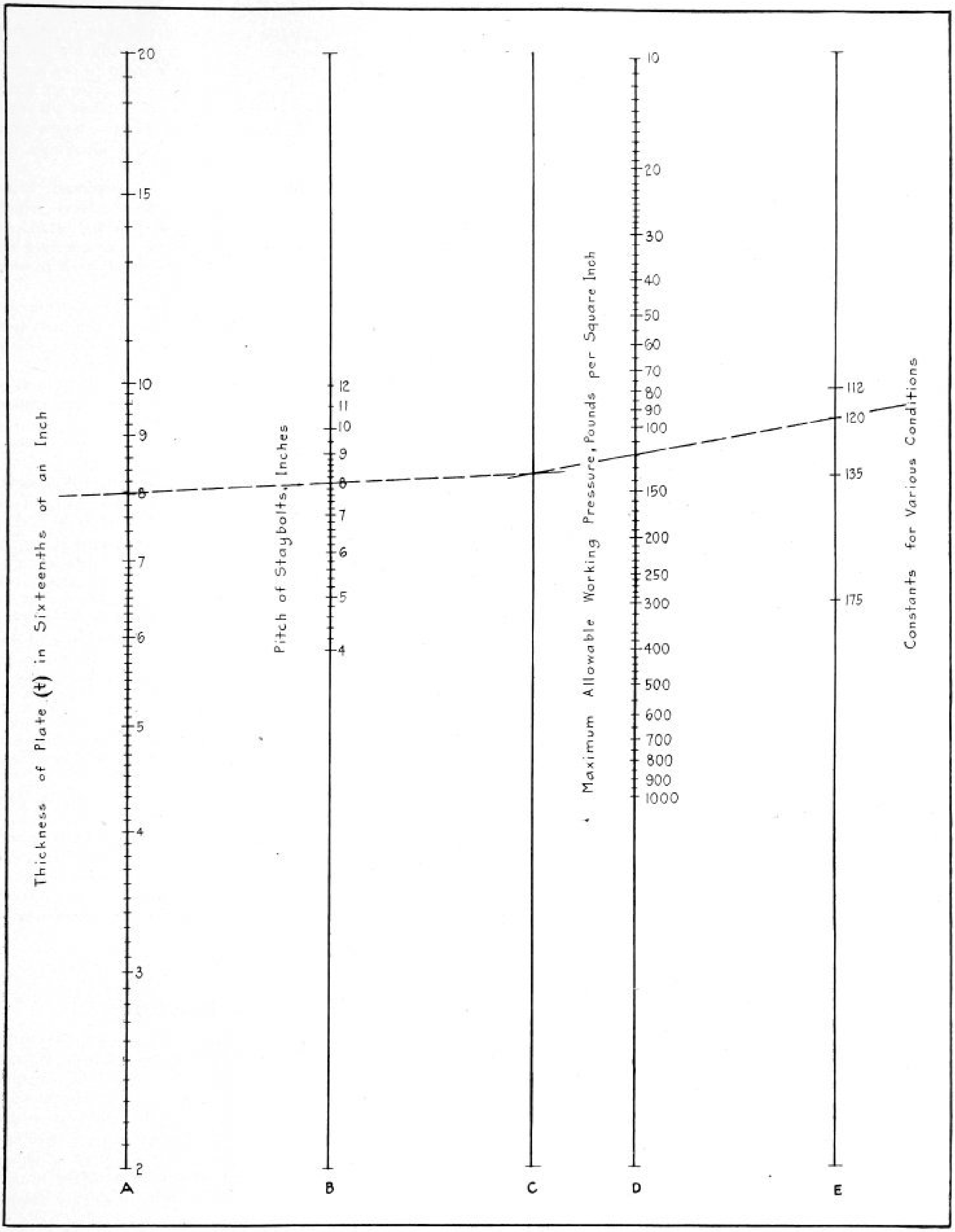


Chart for Determining Thickness of Plate, Pitch of Stays and Safe Working Pressure for Flat-Stayed Surfaces

For example, what pressure is the maximum allowable where $t = \frac{1}{2}$ inch (eight sixteenths), and $p = 8$ inches, the stays being screwed through the plates with ends riveted over (or where $C = 120$)?

The dotted lines drawn across the chart show how it is done. From 8 (column A) pass through 8 (column B) and locate the intersection with column C. Then, from that point of intersection run over to 120 (column E) and the maximum allowable pressure is immediately found in column D to be 120 pounds per square inch.

The chart can be used in various ways for finding any one of the dimensions where the others are known. Thus any value in column A can be found, knowing B, D and E. Or E can be found knowing A, B or D, and so on. It is an all around useful chart and will prove to be handy when used in conjunction with the code directions.

A straight edge merely has to be laid across the chart twice and the problem is solved. Or a thread stretched tautly across will serve just as well.

New York. N. G. NEAR.

Removal and Application of Flues*

BY G. F. PROUT†

In describing the details of the removal and application of flues in a locomotive boiler, and estimating the cost of the same, we will take a Class G-7 boiler, which we are the most familiar with. The average G-7 boiler has 363 tubes, and should be .125 × 2 inches × 14 feet 9 inches. In removing these flues we cut away the flue bead, which operation is performed by one boiler maker in three hours' time at a cost of $1.24, the rate being $.4126 per hour. At the same time the beads are being removed the flues are being cut in front with shop-made flue cutter, operated with a No. 2 pneumatic motor. This operation requires 2½ hours for one high-rate helper, .2882 per hour and one low-rate helper at .2182, or $1.27. The flues are then conveyed to the flue rattlers, taking four helpers three hours each at .2182 per hour, or $2.62. The flues are distributed between two rattlers and cleaned dry in 10 hours, the flue rattler receiving 15 cents per hour, or $1.50. After the flues are cleaned they are cut off preparatory to welding them. This necessitates using one high-rate helper five hours at .2882, amounting to $1.44 and one low-rate helper five hours at .2182, amounting to $1.09. The flues are then turned over to the blacksmith shop for welding.

After the flues are removed from the boiler, the flue sheets are examined and necessary repairs made. If needed, the sheets are straightened at an average cost of $2.32 per boiler. In taking the lengths of the tubes before applying (which is nothing more than getting the length of the water space, horizontally between flue sheets) requires one hour for high-rate helper at .2882, and one low-rate helper at .2182. Good care should be taken so as not to have over five lengths at the most, for if more lengths than this should develop flue sheets should be re-straightened, as it is very evident that the sheet went back to the old position after removing (strong backs) or vice versa. After getting the length of the flues on measuring stick, we are ready to cut them off to length. This operation requires longer time than cutting them preparatory to welding them. It is necessary to allow at least one-half inch on length to give sufficient stock on each end and to insure a standard bead. These flues are cut at this time in six hours by using a high-rate helper at .2882 per hour, or $1.73, and one low-rate helper at .2182 per hour, or $1.31. After the flues are out of the boiler the flue ends remaining in front sheet are removed and the flue holes in both back and front sheet are cleaned of all foreign substance in ten hours by one high-rate helper at .2882, or $2.88. Copper ferrules are then applied by boiler maker with sectional expanders in five hours at .4126, or $2.06. I find that by using sectional expanders with the same reach as thickness of flue sheet it is much cheaper and makes a much better job in the end than by the old method of driving liner with hammer, after having stretched same, and then rolling the life out of the copper, after which they invariably had to be pinned or belled over on inside in one operation; the shoulder on prosser clinching liner on inside. We are now ready for the application of the flues. The flues are brought to the engine and put in boiler with one boiler maker at .4126 per hour, one high-rate helper at .2882 per hour, and two low-rate helpers at .2182 per hour each. A total of five hours' time at a cost of $5.69. We are now in a position to set the flues.

We first pin the flues with long-stroke, pneumatic hammer with tool in same especially made for this work, which is operated by one boiler maker who received .4126 per hour, and one boiler maker apprentice, who received 17 cents per hour, requiring three hours' time, or a cost of $1.74

The flues are then belled (or lipped over), requiring one hour's time with the same gang, but using a different tool in the pneumatic hammer, at a cost of 58 cents. This operation has been performed in fifteen minutes.

The flues are then expanded and prossered. The sectional expander, which is called the prosser, was named after the man who invented same. This operation requires the same gang with the same tools four hours to complete at a cost of $2.33.

We then give the flues a light rolling with roll expanders and pneumatic motor, operated by the same gang. This work is usually done in 1½ hours at a cost of 87 cents; this operation is done many times in forty minutes.

The flues are now ready to bead, which work is completed by one boiler maker in eight hours at .4126, at a cost of $3.30. (This work has been done in five hours.)

While these operations are being performed in the firebox, one high-rate helper is working the front end of the flues. If the steam pipes have been removed the front end can be completed in nine hours at .2882 per hour, or a total cost of $2.59.

First, the sheet is braced in the shape of a wheel with eight spokes running out from the hub. These flues are completed to keep flues from creeping or the sheet from moving either way.

Second, copper ferrules are then applied around the flues if needed.

Fourth, flues are rolled hard with self-feeding rolls and pneumatic motor. As the flues are usually the last work to be completed on boiler, we are now ready for test.

The total cost of labor for the removal and application of locomotive boiler tube-flues on Class G-7 engines is $37.09.

* *Railway and Locomotive Engineering.*

† Foreman Boiler Maker, Chesapeake & Ohio Railway, Covington, Ky.

Hydraulic Riveting

A query has recently appeared in a railway paper regarding hydraulic riveting pressures necessary to drive a certain size rivet so they would be tight after the pressure is released from the rivet. As THE BOILER MAKER is a paper of wider circulation than any other publication devoted to the vocation of which this specialty is involved and as it is read and studied by the majority of boiler tradesmen, of which a certain percent is assigned to this particular kind of work daily or occasionally, I submit the following regarding this important subject:

There are three classes of riveting. The first and most important is a rivet driven in boilers or reservoirs, or any other vessel subjected to pressure; the second is a rivet driven in tanks or any other vessel designed to retain any liquid not under pressure except that due to its own weight; the third is a rivet driven in all miscellaneous work not being subjected to pressure nor to hold any form of fluid from leakage.

The following rule will govern the ascertaining of pressures required to drive rivets hydraulicly:

d = diameter of rivet.
c = constant, 150,000 for boiler or first-class work.
c^1 = constant, 112,500 for tank or second-class work.
c^2 = constant, 75,000 for miscellaneous or third-class work.
P = pressure required in pounds.
P^1 = pressure required in tons.

SOLUTION

For First-Class Work

$$\frac{d^2 \times .7854 \times c}{2{,}000} = P^1$$

For Second-Class Work

$$\frac{d^2 \times .7854 \times c^1}{2{,}000} = P^1$$

For Third-Class Work

$$\frac{d^2 \times .7854 \times c^2}{2{,}000} = P^1$$

EXAMPLE

For 1⅛-Inch Rivet in Boiler or First-Class Work

1.125 = d or diameter of rivet.
1.125

5625
2250
1125
1125

1.265625 = d^2 or diameter squared
.7854

5062500
6328125
10125000
8859375

.9940218750 = area of 1⅛-inch rivet
150000

49701093750000
994021875

149,103.281250000 = P or pressure in pounds.
2,000) 149,103.28 (74.55 = P^1, or pressure in tons
140 00

9 103
8 000

1 1032
1 0000

1 0328
1 0000

The following table will govern the determining of pressures required to drive rivets hydraulicly:

POWER TO DRIVE RIVETS HOT

Size *Inches*	Miscellaneous Work *Tons*	Tank Work *Tons*	Boiler Work *Tons*
½	9	15	20
⅝	12	18	25
¾	15	22	33
⅞	22	30	45
1	30	45	60
1⅛	38	60	75
1¼	45	70	100
1½	60	85	125
1¾	75	100	150

The above table is based on a rivet passing through only two thicknesses of plate, which, together, generally exceed the diameter of rivet by half the thickness of the plate, if any.

As the thickness of the plate increases, the power must also increase approximately in proportion to the square root of the increase of thickness of plate, thus: If the total thickness of the plate is four times the diameter of the rivet, it will require twice the power given in the above table in order to thoroughly fill the whole area of the rivet hole and insure perfect work. Double the thickness of plate would increase the necessary power about 40 percent.

It takes about four or five times as much power or even more, according to tensile strength of material, to drive rivets cold as to drive them hot. Thus, a machine that will drive ¾-inch steel rivets hot will drive ⅜-inch steel rivets cold. It is not essential practice in boiler shops to drive rivets cold beyond ½ inch in diameter, and that would be only in miscellaneous or third-class work.

Meadville, Pa. TAD. TULIN.

Originality

"Do you know how to design a conical connection with a cylindrical breeching?" I was asked.

"Yes," I answered.

"Have you ever done anything like it?" he came back.

"No; not exactly like it, but similar."

"Well, then, how do you know you can do it? Have you ever studied descriptive geometry? Have you been thoroughly drilled in boiler design? Who was your professor?" These questions were hurled at me so quickly that I couldn't answer them between times. The chief draftsman, you see, thought he "had" me.

I settled the whole thing by saying, "Let me *show* you that I can do it."

I got busy and just "thought" a while, making rough sketches on a piece of paper. I had never done it before, had never studied descriptive geometry, had never gone to college, and didn't even have much "book learnin'" on the subject of boilers outside of THE BOILER MAKER. In that publication, though, I had noticed that most of the processes were the result of plain common sense, and that almost any man mechanically inclined who knew anything about cones and cylinders and sheet metal at all should have originality enough to work out a layout without any assistance whatever.

By and by the method "came to me" and I started laying 'er out on the board.

The chief draftsman came around once in a while, looked at my work and shook his head. He didn't say anything, because I was using a method with which he wasn't familiar at all. He had never seen it anywhere before, and neither had I. It was original.

The finished job came out just as the chief had expected. He "judged" it was right, because he had had experiences with such designs before and he knew just what the thing should look like. However, he didn't check it over himself. He had me instruct a checker as to my method and it was "up to the checker" whether or not my method was correct. The checker found it to be correct and congratulated me on my method. "Where did you get it?" he asked. "Out of my head," said I. He didn't speak the word, but his look had the appearance of "Liar."

That is the way it is with too many of us. We think that the other fellow's method is the method we should use. We haven't enough confidence in ourselves.

I believe in using the "best" method always, but am not averse to inventing methods of my own when I know from experience that the results will be correct and that I am not going at it in a roundabout way.

New York. N. G. NEAR.

Selected Boiler Patents

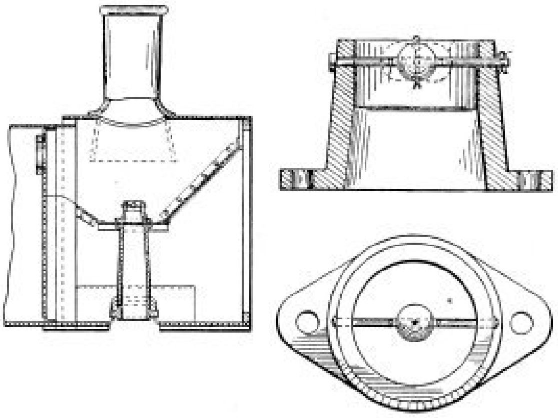
Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,
Millerton, N. Y.

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

1,176,935. EXHAUST-NOZZLE TIP FOR LOCOMOTIVES. CHARLES D. WALDEN AND MORTIMER H. ROGERS, OF NORFOLK, VA.

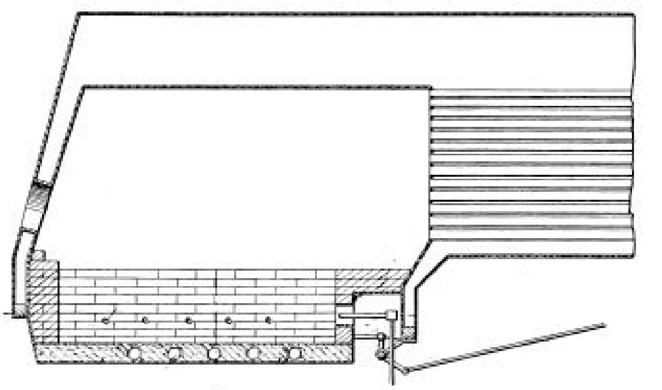
Claim.—A device in combination with an exhaust nozzle tip, a spherical laterally adjustable deflector or spreader for the products of combustion and having a diameter smaller than that of the said tip,



supporting means for said spherical spreader or deflector, and locking means on said spreader adapted to place the same in any position upon said supporting means.

1,177,067. LIQUID-FUEL-BURNING FURNACE. CHARLES VAN AMBURGH, OF TACOMA, WASH.

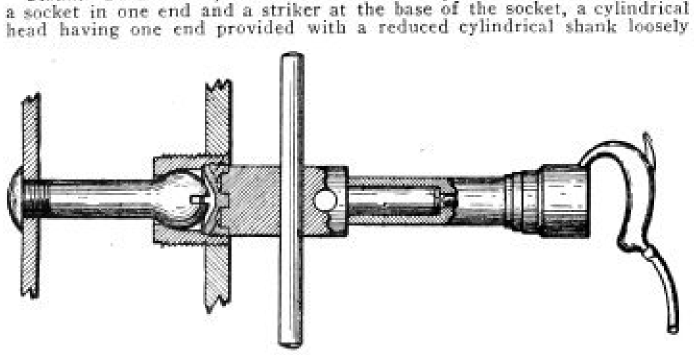
Claim 3.—A furnace firebox having a plurality of horizontal passages formed in its bottom and opening through the sides of the furnace and having outlets extending upwardly from the horizontal pas-



sages through the upper surface of the bottom, said firebox having other passages in its side walls opening into the firebox, sliding dampers at the sides of the furnace for closing the horizontal passages and the passages in the side walls of the furnace, and means for operating both dampers simultaneously. Four claims.

1,164,561. PNEUMATIC WRENCH FOR APPLYING AND REMOVING FLUSH CAPS FOR FLEXIBLE STAYS. CHARLES P. WHELAN, OF SYRACUSE, N. Y.

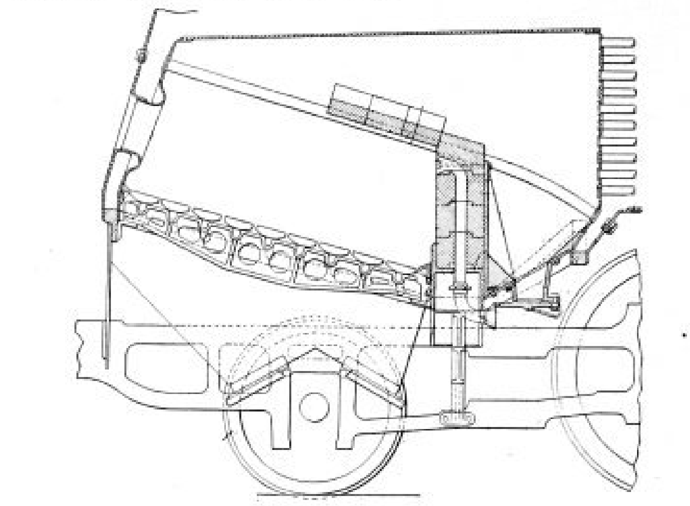
Claim.—In a device, the combination of a pneumatic hammer having a socket in one end and a striker at the base of the socket, a cylindrical head having one end provided with a reduced cylindrical shank loosely



fitted in said socket to turn therein relatively to the hammer and having its inner end in striking coaction with the striker of the hammer, said head having its opposite end provided with means for engaging and turning the cap and its intermediate portion provided with a diametrical opening and a handle-bar inserted in said opening for turning the head relatively to the hammer and while the hammer is in action upon the shank.

1,177,313. LOCOMOTIVE. FREDERICK F. GAINES, OF SAVANNAH, GA., ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

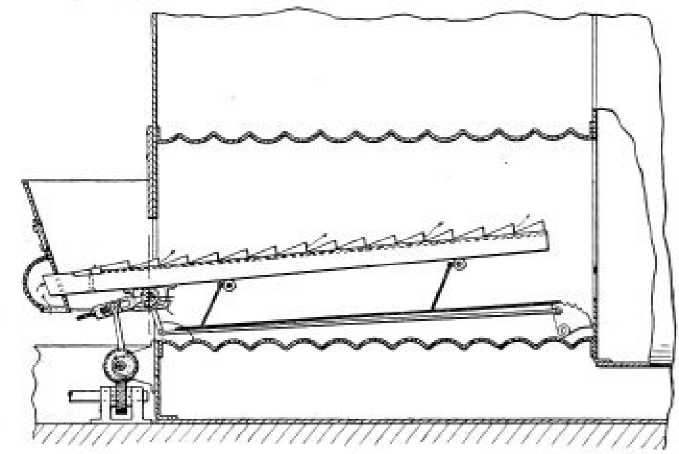
Claim 1.—In a locomotive the combination with the rear drivers, of a firebox the forward end of which is positioned above the drivers, the lower side edges of the firebox being inclined downwardly from the



forward end to a point spaced therefrom, a cross wall rising within the firebox at this point, a normally tight closure for the space between the wall and the front end of the firebox, and a grate closing the lower part of the firebox between the wall and the rear end of the firebox. Five claims.

1,180,737. AUTOMATIC FURNACE STOKER. ELIAS REES, OF DETROIT, MICH.

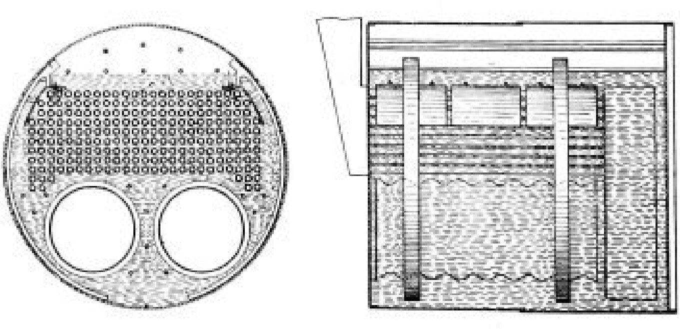
Claim 1.—In an automatic stoker, the combination of a plurality of vibratory bars, a furnace in which the same are contained, an ash



and clinker propeller located below and at the rear end of said bars and comprising an oscillated segment of a cylinder provided with teeth for propelling the ashes and clinkers down the slideway. Seven claims.

1,166,539. BOILER ATTACHMENT. ALFRED A. OLSON, OF RIVERSIDE, ILL.

Claim 1.—The combination of a Scotch marine type of boiler, of a baffle plate attached to the outermost tubes therein, causing the heated



water around the tubes to flow inwardly and upwardly within the boiler, and the water adjacent the shell to flow downwardly to the bottom thereof. Six claims.

1,174,182. COMBINATION WATER-TUBE AND FIRE-TUBE BOILER. WILLIAM ROHRBACHER, OF ERIE, PA.

Claim 1.—In a combined water-tube and fire-tube boiler, a top drum and a bottom drum, a tubular member connecting the drums, a cylindrical baffle wall supported at its lower end on the lower drum and spaced at its upper end from the upper drum, water tubes connecting said drums and spaced outwardly of the baffle wall, and fire tubes extending through the bottom drum and communicating at their upper ends with the chamber afforded by the baffle wall. Seven claims.

THE BOILER MAKER

AUGUST, 1916

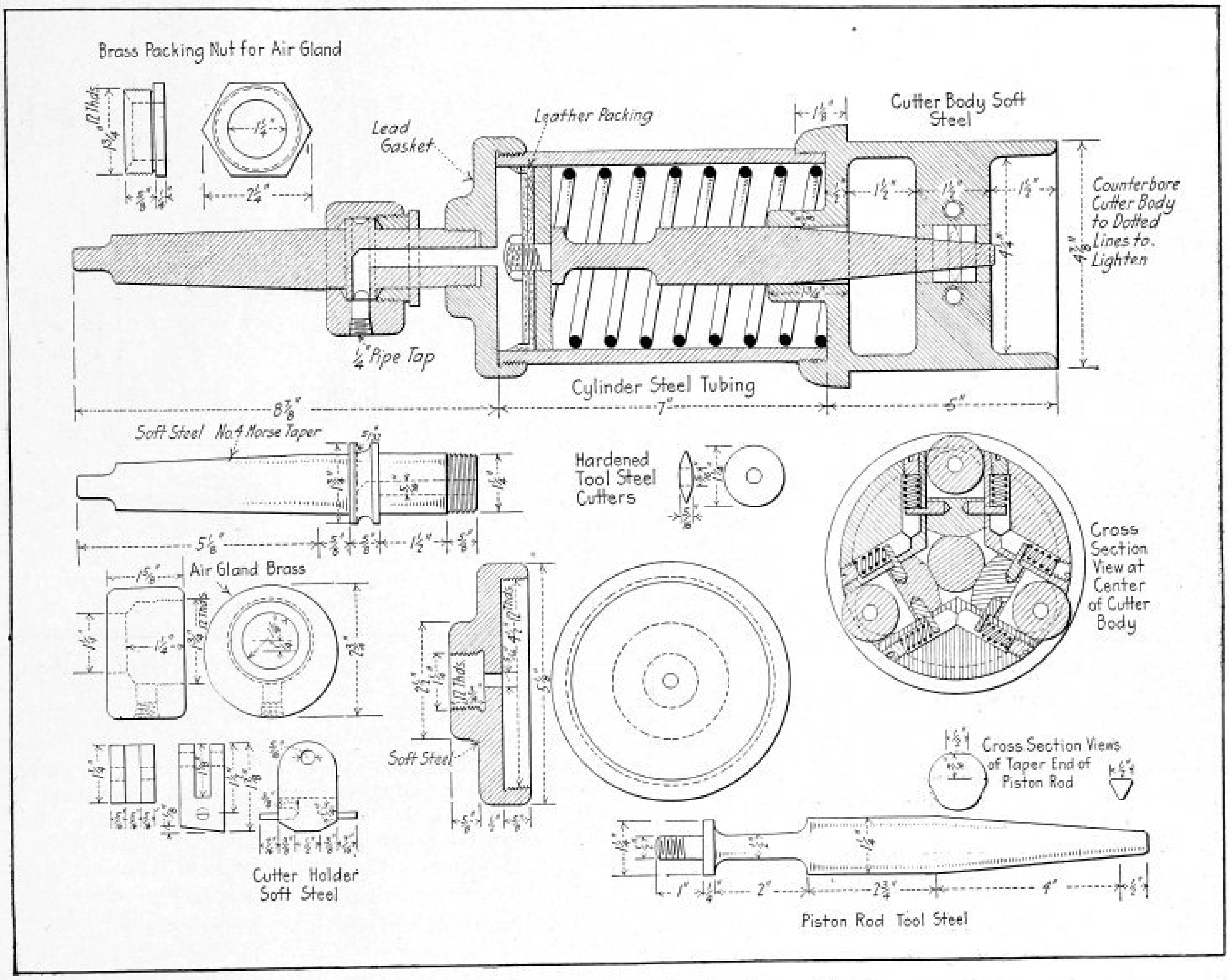


Fig. 1.—Pneumatic Flue Cutter for Superheater Flues

Boiler Shop Tools

Useful Appliances for Practical Application in the Shop

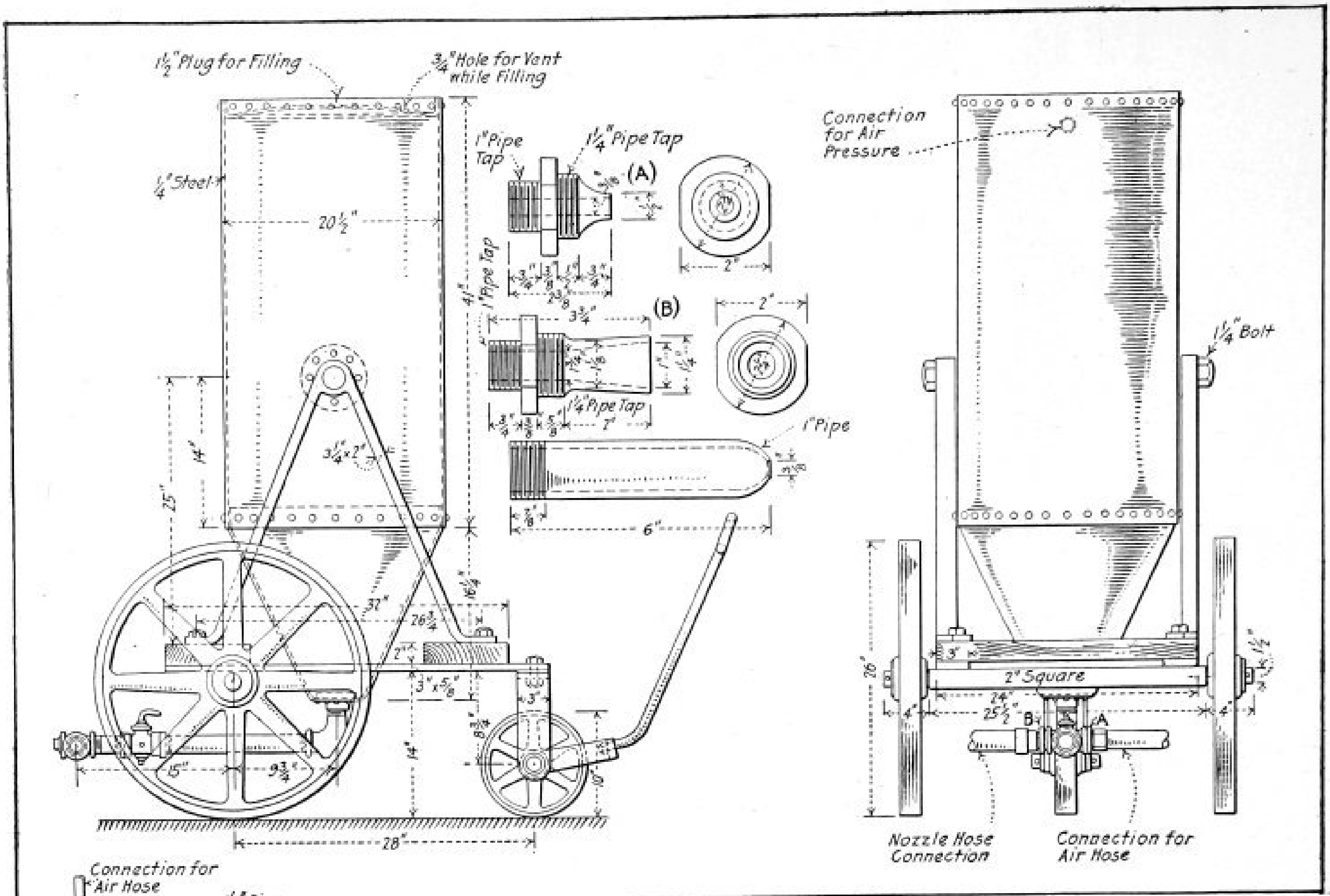
BY C. E. LESTER

The accompanying sketches, with a brief exposition of their purposes, may prove of value to some who are in need of such tools, inasmuch as they are associated with problems in modern boiler work and may be depended upon to do successful work if constructed to the drawings.

The sketch of a pneumatic flue cutter shows a tool in common use for cutting off superheater tubes in the front end.

The cutting of these tubes requires considerable power, and it has been found that a good close quarter motor gives the best service by rigging it up with two "L" bars stuck in the small flues and a plank across to shove the feed screw into, to keep the motor from working off the shank of the tool.

The air for operating the piston is taken from the motor air supply at a point in the handle of the motor by cutting in between the motor and the handle valve and carrying the air to the piston by a pipe line to the opening in the tool shank. Common pipe fittings are unsatisfactory, as the vibration breaks them off. Substantial fittings and an



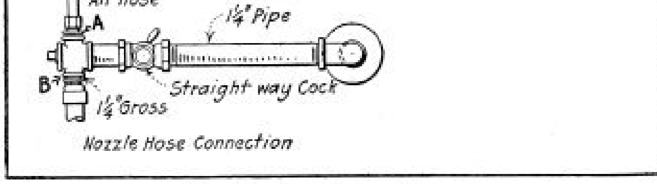


Fig. 2.—Sand Blast Apparatus

annealed copper pipe give the best service. Superheater flues can be cut at the rate of about 12 per hour with 90 pounds of air with this tool. This includes all rigging up.

The sand blast has proven most satisfactory, inasmuch as it does not interfere with the usual method of flue setting and the welding operation need not be delayed beyond the next succeeding operation after the flues are set, barring the thirty minutes necessary to set up the machine and blast the sheet. A first class cleaning is assured in that length of time and the flues may be welded while the boiler is being prepared for test. A screen or curtain should be placed over the smoke box to prevent the flying atoms of sand getting in machinery bearings.

Scaling the interior of locomotive boilers was, until a few years ago, not given the serious consideration it now is, and was frequently passed up altogether. The Interstate Commerce Commission requirements, that boilers be kept free from scale, now make scaling imperative when the flues are out of the boilers.

Scaling Tool

The scaling of a boiler is a dirty, tiresome job at its best. The old method of chopping the scale off with a cross-faced, double-bitted axe or cutter was a tedious, unsatisfactory method, and has been superseded by air tools. I understand there are patented articles on the market for this purpose, but for a "home-made" affair the tool illustrated with the "cross-hatched" face gives very good service. The tool is used with a moderately strong

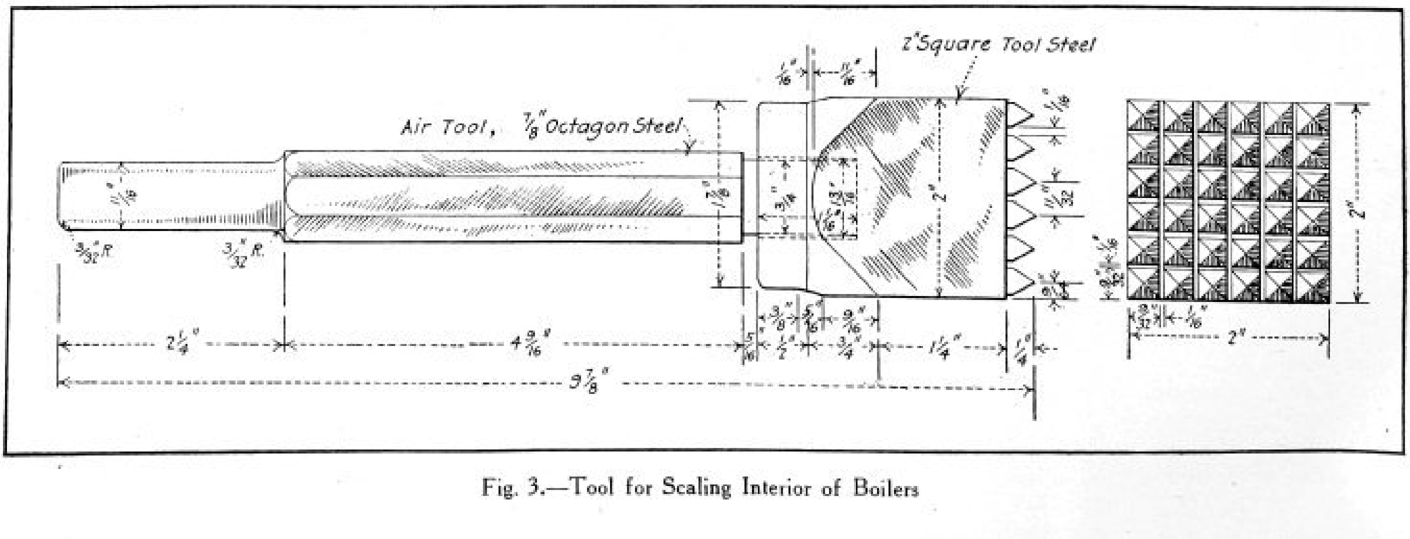


Fig. 3.—Tool for Scaling Interior of Boilers

chipping hammer with the air supply cut down a little and the cutting points not too sharp to avoid the cutting and roughing of the sheet as much as possible.

The operators should be equipped with dust mask to cover the mouth and nose to keep the dust from the lungs. When the boiler is completed, a coat of metallic paint will defer actions of the different mineral salts.

The electric welding of flues is now standard on many roads, and it has been necessary to provide ways and means of cleaning the oil from the flues and sheet in order to procure successful welds. The use of soap instead of oil on the flue tools has been used, as also has firing up the boiler before welding. Both of these methods have drawbacks not found in sand blasting.

Design and Upkeep of Locomotive Boilers*

Numerous Improvements Show that the Boiler Takes Precedence Over Any Other Part of the Locomotive in Railway Work

The modern locomotive being called upon to maintain high speed, with heavy and increasing train loads, and to meet greater demands for steam, the design and maintenance of boilers would seem to take precedence over any other part of the locomotive. That locomotive designers are aware of this was evident from the various means by which a number of roads are endeavoring to meet these conditions.

Among the many devices tending to show the efforts in this direction may be mentioned a firebox composed of sectional U-shaped plates, with similar wrapper sheet construction, riveted together, which eliminates staybolts; another firebox which consists of squared water tubes, expanded into water and steam drums at the top and a water leg at the bottom eliminating staybolts on the sides of firebox; a corrugated firebox; also the several types of watertube locomotive boilers; devices to improve the circulation around the firebox; various forms and adaptations of combustion chambers and brick arches, and the almost universal adoption of superheaters.

Combustion Chambers

The most generally adopted improvement in fireboxes appears to be the use of combustion chambers, either of the ordinary type or of special construction, having a bridge wall with air inlets. In some cases the adoption of combustion chambers has been due to a desire to avoid excessively long flues, while others have considered that the construction is desirable from its being inducive to longer flame travel, increasing firebox temperatures on account of the more complete combustion obtained. The increase in the ratio of firebox volume and grate area is held to be beneficial, producing better steaming boilers, while the improved combustion has the effect of eliminating black smoke. It does not appear that the maintenance and repair of combustion chambers are greater than is the case with the ordinary construction, while the life of the flues is greatly increased by their use.

There appeared to be little experimental data on the relative evaporative performance of boilers with or without combustion chambers. The firebox design being recognized as of paramount importance, there has been a general trend toward wider water spaces, about 4½ to 5 inches for the sides and 5½ to 6 inches at the front, being representative practice. Firebox door flanges have been given considerable attention, the majority of opinion favoring flanging the sheets toward each other; the joint in many cases being welded, with beneficial results, from the elimination of rivets, with their tendency to collect mud. Some state that the welded method is cheaper than the riveted joint. Cross braces are used as a matter of necessity on Belpaire fireboxes and boilers with flattened surfaces, and to some extent on crown bar boilers.

Staying Front End of Crown Sheet

The use of flexible staybolts, instead of tee bars and sling stays, to support the front end of the firebox has become quite general, and the results have been satisfactory. In order to obtain proper bearing for flexible radial stays which are at a sharp angle with the wrapper sheet, one road reported having pressed out bosses in the sheet, while another road builds up bosses by autogenous welding. The results, giving sufficient full threads through the sheets for the bolts, have been very satisfactory. Regarding venting crown sheet in case of low water, two roads report that on coal-burning locomotives they omit the button heads on four front transverse rows of stays. Another reported omitting button heads on the sixth, seventh, eighth and ninth rows back from the back flue sheets for the same purpose. The majority, however, do not make any allowance for this contingency.

Regarding the relative value of firebox and tube heating surface, there appeared to be little data derived from tests. However, the accepted value assigned to firebox and flue heating surface, respectively, on basis of evapotive capacity averages about 6 to 1, with special designs of firebox claiming a ratio as high as 12 to 1. The most effective ratio of firebox volume to grate area seems to be approximately from 5.5 or 6 to 1 for bituminous coal and 4.5 to 4.85 to 1 for anthracite coal.

Long Flues Not Favored

The use of long flues is not favored, for, while the total evaporative capacity of the boiler may be increased by their use, the rate of evaporation per unit area of heating surface is lower, and discounts the theoretical increase in capacity. In this connection tests show conclusively that there is a great variation in the evaporative value of the boiler tube, about one-half of the heat being transmitted in the first quarter of the tube length. It appears that a proportion of tube length to diameter of 100 times the inside diameter is most satisfactory. Longer tubes do not require any greater spacing than reasonably short tubes. The addition of superheaters is quite general and superheaters are likely to be used on all new equipment, with the possible exception of some few roads which are not certain about switch engines. The ratio of superheating surface to total saturated heating surface seems to vary from .198 to .29, the average for modern power being about .27 to .29 for boilers with combustion chambers and from .20 to .22 for boilers without combustion chambers.

*From report presented before the American Railway Master Mechanics' Association, June, 1916.

In a general way it may be deduced that in modern practice the built-up type of dome is being generally abandoned in favor of one-piece pressed-steel domes. In regard to the elimination of boiler seams, no general effort has been made, although one member reports satisfactory results from combining the throat sheet and bottom half of last course. In almost all cases firebox sheets, as well as wrapper sheets, are made in one piece. There does not appear to be any development along the lines of welding circumferential seams. The support of the back end of the boiler above frames seems to be satisfactorily met by either vertical expansion plates or by expansion shoes.

Autogenous Welding

The most interesting feature brought out by the committee in connection with boiler maintenance is the wide adoption of autogenous welding. The welding of flues into flue sheets, of firebox seams, and the application of patches varying in size from small crack and pitting repair plates to half side sheets and back heads, mark a radical and economical means of handling what has heretofore been a difficult and expensive problem. Both electric and acetylene welding processes have been used, but we are unable to determine which method gives the best results, as it seems to be largely a matter of opinion. Firebox seams have been welded successfully, one road reporting 14 engines by the electric process, while another road reports three engines with all seams welded by the acetylene process. Several roads report having side sheet seams welded, with little or no trouble experienced. Occasionally it has been necessary to reweld a seam, on account of opening up.

Among the other uses to which the electric and oxy-acetylene processes have been put is in cutting off old smoke boxes, burning off staybolts, instead of nicking and breaking them, and to loosen the caps on flexible staybolts to permit of easy removal without damaging threads. The autogenous processes of welding have recently been used to quite an extent for patching in fireboxes. Some of the replies indicate that welding can be done at about 40 percent of the cost of riveting; others report very little difference in cost. The methods of patching are still an experiment on most roads; others are reporting satisfactory results. The methods preferred seem to be a matter of opinion; the patches are of all shapes and sizes; some are welding by lapping the plates, others by beveling the patch and plate and filling in the groove, and others report patches are being boxed out or bulged with a corrugation for expansion; but from the replies it is impossible to draw a conclusion as to the best way or method. Fire-door openings have also been replaced by welding with success.

Cracks in Flue Sheet Welded

The practice of welding cracks in the knuckle of flue sheet is quite extensively used, in most cases the welding being done on both sides of sheet. Two roads cut out the crack and weld in a patch, but in the majority of cases the crack is filled up without patching. While some roads report welding in half side sheets and half back heads, with satisfactory results, the practice has not yet become general. One reports welding brick arch studs on side sheets of firebox, with success, but no welding-in of arch tubes has been reported.

The methods of safe-ending superheater flues, as reported, are rather uniform, the usual way being to cut off at the small end, scarf, apply safe end, and weld in flue welding machine. A few roads report that they have welded safe ends by the electric or oxy-acetylene process. In this method, after scarfing, the flue and safe ends are separated about 1/8 inch and the opening filled up, rotating the flue during the process. It seems to be accepted practice to avoid the use of more than one weld in a superheater flue at a time, which is accomplished by increasing the length of safe ends in successive applications, the old weld being cut off and a longer safe end used. Few roads weld safe ends to the enlarged portions of the flues. Results are in most cases reported as being satisfactory.

The usual practice in setting tubes appears to be, for the back end, to insert a copper ferrule in the hole, then roll, expand and bead the flue, after which the joint is cleaned and welded lightly on the edge of the bead. One road reports that copper ferrules are not used, nor flue beaded, but welded in by the electric process, which is indicated to be the most generally used in this class of work. Flues in the front flue sheet are not welded, but rolled, and about 10 percent beaded.

Rebuilding Old Locomotives

While a few roads are rebuilding old locomotives and converting consolidation types to Mikados, and Prairie types to Pacific types, there is no general trend in this direction. Many roads are applying superheaters to their more modern types of saturated engines, and in some cases at the same time eliminate old styles of staying, bracing, etc. The application of combustion chambers, brick arches and outside valve gear has been reported by several members. On engines having cylinders smaller than 20 inches diameter it has not, as a rule, been considered advisable to apply superheaters.

In view of the development of the locomotive, it is the opinion of the committee that the ratios of 1897, being unsuitable, should be superseded by a method of calculation which will meet the variable conditions imposed by modern practice. The reports indicate a wide departure from the recommended practice of 1897. Ratio of grate area in square feet to volume of two cylinders in cubic feet, for simple passenger or freight locomotives, should not be less than: four for large anthracite coal; nine for small anthracite coal, and three for bituminous coal. From the replies received, for modern power these ratios have been increased 23 percent.

Proportions of Heating Space

The ratio of heating surface in square feet to grate area in square feet, for simple passenger and freight locomotives, should not be less than: 40 for large anthracite coal; 20 for small anthracite coal, and 60 for bituminous coal. From the replies received, for modern power these ratios have been increased 28 percent.

The ratio of heating surface in square feet to volume of two cylinders in cubic feet, for simple passenger or freight locomotives, should not be less than: 180 for large anthracite coal; 200 for small anthracite coal, and 200 for bituminous coal. From the replies received, these ratios for modern power have been increased 34 percent.

Boiler compounds are good if a proper selection is made. There can no more be a universal boiler compound that there can be a universal solvent.

It is not often remembered that there is a very great loss in handling hard or anthracite coal, and it has been estimated that as high as 2 percent in weight is lost in filling large bins. Too little attention has been paid to this serious loss.

Prevention of Corrosion in Pipe*

Causes of Corrosion—Solution of Iron an Electrochemical Reaction—De-aeration of Water Increases Life of Pipe

BY F. N. SPELLER

Casual observation will show very marked differences in the degree of corrosion of pipe in service. For instance, hot water heating systems and sprinkler systems show practically no deterioration in service after twenty-five years, while low-pressure steam returns sometimes give trouble after fifteen years' service or less. Galvanized pipe in hot water supply systems, where the water is heated under pressure, lasts from about five years upwards, depending on the temperature and quality of the water and volume of flow. The last-named condition is so severe on iron and steel pipe that many are compelled to use brass pipe, at a cost approximately ten times that of galvanized pipe. These few instances are the extremes, but are surely suggestive when we consider that in pipe carrying ordinary water under some conditions there is no apparent deterioration in a generation; whereas in other cases, the same grade of pipe is seriously damaged in a very few years. A few illustrations of the present condition of old sprinkler lines after long service are shown in Figs. 1-4.

Some years ago, when steel pipe was comparatively unknown and not fully developed, it was natural to question this material, but comparisons of the modern wrought iron and steel pipe in the same lines in service have shown beyond any question that where corrosion is found one material suffers on the average as much as the other. Some references to practical comparisons of the life of various wrought pipe carrying water will be found in a

* A paper presented at the annual meeting of the American Society of Heating and Ventilating Engineers, January, 1916.

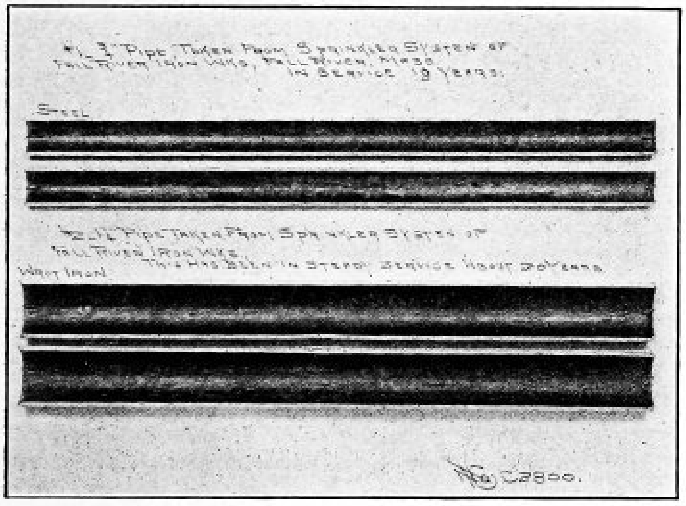


Fig. 1.—Pipe from Sprinkler System

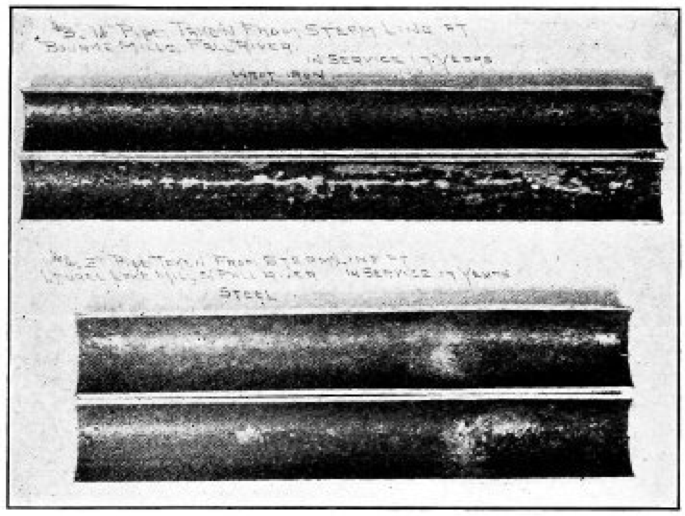


Fig. 2.—Pipe from Steam Line

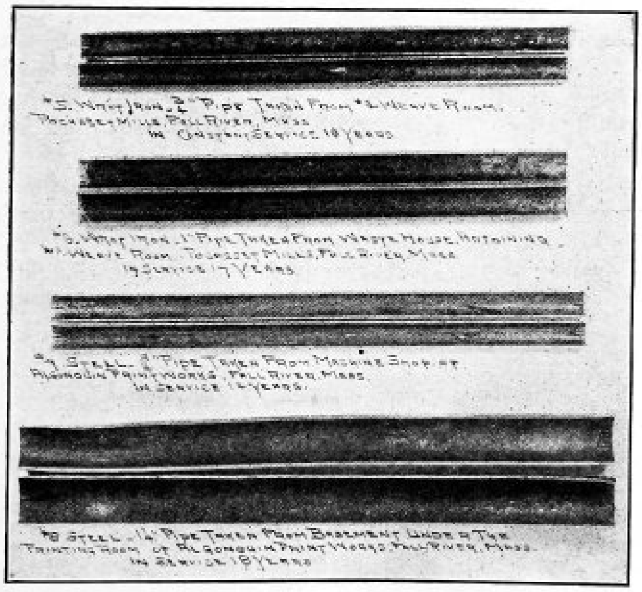


Fig. 3.—Iron and Steel Pipe from Shops

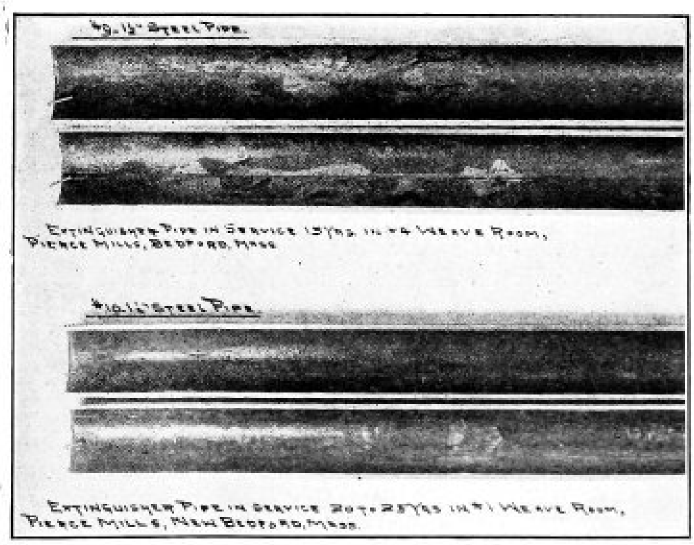


Fig. 4.—Sections of Steel Pipe from Extinguisher Lines after from 15 to 25 Years' Service

paper by L. C. Wilson entitled "Wrought Iron or Steel Pipes?" which appeared in *The Engineering Magazine*, November, 1915.

It has been the custom of the writer to keep several service tests under way continuously for the past few years. In every case the co-operation of some local engineer or organization is sought under whose immediate direction the test is conducted. One of the most recent to be completed may be described as an example of the method pursued in conducting such tests. This test was made in the Pennsylvania Building, Philadelphia, Pa., Mr. Munsey, engineer. Four standard grades of pipe of well-known manufacture were selected and four pieces of each taken at random and coupled together alternately so that the hot water passed through each sample at the same temperature.

DETAILS OF TESTS

Date installed—October 27, 1913.

Date removed—November 20, 1915.

Location—Hot water return line, Pennsylvania Building, Philadelphia.

Temperature of water—175 degrees Fahr. average.

Amount of water—5,000 gallons per day for 600 days.

Method of installation—In form of box coil.

CORROSION MEASUREMENTS

			Depth of Pitting in Inches	
Lot	Material	Sample Number	Average of 10 Deepest Pits in Each Piece	Deepest Pit
A	Steel	1	.068	.094
A	Steel	2	.087	.124
A	Steel	3	.045	.050
A	Steel	4	.063	.074
B	Steel	5	.079	.104
B	Steel	6	.056	.094
B	Steel	7	.054	.065
B	Steel	8	.070	.081
C	Iron	9	.065	.073
C	Iron	10	.072	.097
C	Iron	11	.078	.105
C	Iron	12	.077	.080
D	Iron	13	.055	.075
D	Iron	14	.067	.112
D	Iron	15	.067	.078
D	Iron	16	.073	.090
A	Steel	General Average	.066	.085
B	Steel	General Average	.067	.086
C	Iron	General Average	.073	.089
D	Iron	General Average	.066	.088

A résumé of a large number of these service tests compiled from several sources is given in Table I.

Inasmuch as both materials have been found to fail in about the same time under the same conditions, and as both have shown practically no deterioration after many years under other conditions, it would seem that with a correct understanding of the fundamental causes of corrosion a practical solution of this problem should be possible. The author has devoted a considerable portion of his time for the past ten years to a study of the factors governing corrosion of pipe in service, and is writing this paper in order to open up a more general discussion of preventive measures.

The inside of pipe is subject to peculiar conditions not to be compared with external corrosion, and the inside surface is particularly vulnerable in that protective coatings are difficult to apply, therefore more liable to be defective.

Consider for a moment the situation in a hot water heating system and a hot water supply system where the temperature of the water is about the same. It is evident that the water alone is not responsible for the results observed, but rather something brought in with the water. The hot water heating lines have started to rust and then the action has apparently stopped, while in hot water supply lines the action is continuous and rapid; so much so that if the pipe does not fail by leaking it may be plugged up tight with reddish hydroxide of iron. The only way to account for this accumulation of oxide of iron is through the oxygen in solution in the cold feed water, amounting to 6 to 10 cubic centimeters per liter, according to the temperature and quality of the water. This very small percentage of oxygen is apparently the measure of the destructive power of the water and accounts for the fact that a limited volume of water has no serious action on iron, whereas when this water is renewed continually, especially when heated, the results are liable to be most disastrous. It will be useful to consider the mechanism of corrosion before discussing ways and means for preventing this action.

All water supplies carry more or less foreign matter in solution. What are usually considered the purest natural water supplies are generally saturated with oxygen and carbonic acid, which cause such waters to be very corrosive, particularly when heated. Iron in all its forms is soluble in water to the amount of a few parts per million, depending on its composition and that of the water. In this treatise, in referring to water in connection with corrosion, it will be understood to include domestic supplies of the usual degree of purity. Chemically pure water does not occur in nature, and therefore may be omitted from consideration.

The phenomenon of solution is now generally explained as an electrochemical reaction. When pieces of zinc and copper are connected together and suspended in water, a current of electricity starts to flow through the water from the zinc to the copper. The zinc is termed the anode and the copper the cathode. While the current flows the zinc goes into solution, the amount dissolved being proportional to the current according to Faraday's Law.

If we replace the zinc with a piece of iron, a current flows in the same direction and iron will be found in solution. Suppose we now replace the copper with another piece of iron. A small current of electricity will still flow, but not necessarily in the same direction, this depending upon the relative surface condition of the two pieces of iron.

It is this small current flowing between one piece of iron and another under water which causes iron to enter solution, and this is now recognized as the *initial reaction of corrosion*. Solution is hastened by carbonic acid and mineral salts in solution, as these make the water a better electrolyte. However, it has been proved that iron will dissolve to some extent in the purest water that has yet been made. If the iron is exposed to nothing but water this reaction will soon cease, due to the accumulation of hydrogen at the cathode causing polarization; and this is what actually happens in practice in hot water heating and other systems in which the water and consequently the supply of free oxygen is not renewed. On the other hand, when oxygen is present it combines with the hydrogen, depolarizing the surface of the iron and thus causing solution of the iron to continue. Oxygen enters further into the reaction by combining with the ferrous hydroxide to form insoluble ferric hydroxide, generally known as rust. With an unlimited supply of water and oxygen, corrosion will continue until the iron is all converted into the form of ferric hydroxide.

So far most of the authorities are agreed as to the cause of corrosion, although there has been considerable scientific argument as to whether a trace of carbonic acid (CO_2) is necessary or not for the solution of iron. For all practical purposes we can let this question rest and combine the acid and electrolytic theories into one, as outlined above, which affords the best explanation of the observed facts available at this time.

Ever since the electrochemical theory of corrosion was

TABLE I.—SUMMARY OF RESULTS OF INVESTIGATIONS OF THE CORROSION OF IRON AND STEEL IN ACTUAL SERVICE.

No	Date	Locality	Length of Time Pipe Lines Were Installed	Character of Service	Authority	Number of Cases on Record	Average of Deepest Pits		References for Details and Remarks
							Wrought Iron	Steel	
1	1910	New York city bathhouses.	3 yrs. and over	Hot water supply service.	Prof. Ira H. Woolson, Columbia University.	89 samples secured, of which 17 are wrought iron and the remainder steel.	EQUAL 100%	100%	Eng. News, Dec. 3, 1910, p. 630; N. T. C. Bulletin No. 2. This was a test of iron and steel pipe in actual service continued to destruction.
2	1910	Frick Coke Co. power plants.	6 mos. to 7½-8 yrs., varying with the comparisons secured.	Boiler feed water lines.	Research Laboratory National Tube Co.	21 lots comprising 52 samples, of which 26 are iron and 26 steel.	.112″ 100%	.108″* 96%*	Eng. Review, April, 1911; N. T. C. Bulletin No. 3; Amer. Soc. Heating & Ventilating Engrs., 1911. Pipe samples secured from lines in actual use. In 22 cases of adjacent iron and steel pipes in same lines, 13 comparisons favor steel and 9 iron.
3	1911	Cresson (Pa.) coal fields.	6 mos. to 10 yrs., varying with the comparisons secured.	Hot and cold water boiler feed lines; pump discharge lines.	Research Laboratory National Tube Co.	9 comparisons of iron and steel found together.	.100″ 100%	.085″* 85%*	Pipe samples secured from lines in actual use. In 9 cases of adjacent iron and steel pipes found in the same lines, 4 comparisons favor steel and 2 iron; in 3 cases the steel and iron are equally corroded.
4	1911	Allegheny General Hospital.	Between 7 and 8 years.	Hot water supply service.	Research Laboratory National Tube Co.	69 samples from hot water lines, 42 wrought iron and 27 steel.	.105″ 100%	.105″* 100%*	Conditions those of actual service, and pipe was tested to destruction. In 13 cases of adjacent iron and steel pipes found in same lines, 7 cases favor steel and 6 iron.
5	1911	New Eng and Investigation.	2 yrs. to 17 yrs. varying with the comparisons secured. Average 9 yrs	Hot and cold water, live and exhaust steam, brine, boiler blowoff lines, etc.	Dr. W. H. Walker, Director Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology.	54 comparisons of iron and steel found together, in hot water and steam lines.	.069″ 100%	.063″* 91%*	Eng. News, Dec. 21, 1911; Jour. of New England Water Wks. Assn. Jan., 1912. Actual service conditions. In 54 cases of adjacent iron and steel pipes found in same line, 20 favor steel and 18 iron, 9 show no differnce in corrosion and 7 no corrosion at all.
6	1913	New York City Hotel Investigation.	6 to 10 years.	Hot water supply and steam return lines.	Dr. Wm. Campbell, Columbia University, co-operating with Research Laboratory N. T. Co.	From 60 samples 9 comparisons of iron and steel were found.	.095″ 100%	.067″ 70.5%	Conditions those of actual service, pipe used to destruction. The iron samples failed in 20 spots; the steel failed in 2 places; due to pitting.

NOTE.—Depth of pitting in wrought iron samples considered as 100% in all cases. * Calculated from the deepest pit in each sample.

proposed by Whitney in 1903 there has been a division of opinion as to the cause of the difference of potential observed between two pieces of iron. The majority at first assumed that this was due to variation in composition of the metal, and the manufacture of iron of a high degree of purity in the open hearth furnace was heralded with great expectations as to durability. So far, after several years of trial, it has not been found that such iron is so well adapted for the manufacture of pipe as the grade of soft weldable steel now generally used for this purpose.

In the year 1904 the writer started a study of the potential differences as found on the surface of iron of various compositions, and has invariably found just as much difference in potential on the surface of very pure iron as on steel or wrought iron of ordinary commercial quality. Subsequent observations, covering several years of service with pure iron, open hearth and Bessemer steel and wrought iron of the quality required for the manufacture of wrought pipe, have confirmed the conclusion expressed by the writer after his earlier experiments; viz., that composition has very little to do with the rate of corrosion of these metals under water. It should be remembered, however, that conditions underground or inside pipe lines are not the same as when exposed to the atmosphere, so that these conclusions do not apply to materials subjected directly to atmospheric conditions, such as metal roofing, which is another problem.

The tests and experiments referred to indicate that differences in finish and density of the material, particularly the character of the mill scale and how firmly it is attached, usually determine where corrosion starts and how it proceeds. The difference of potential due to surface influences was found to be many times greater than that due to variations in composition in the ordinary run of steel, and predominated over all other influences in nearly every case. These conclusions were tested in the most critical manner, and have since been borne out by service tests of several years' duration.

Among the surface influences which directed the course of corrosion it was found that rust, when once formed, was nearly as potent as mill scale in its effect on corrosion. Some recent work by Mr. James Aston, M. E. of the U. S. Bureau of Mines, confirms these conclusions, but goes further in showing that the influence of rust in some cases is to render the metal underneath the rust anodic. As the mill scale is always the cathode, there is every reason to believe that we may have in certain places on the surface nearly double the difference of potential which was expected and this without reference to the actual composition of the iron or variations thereof. Everything seems to point to this explanation of the cause of pitting as being the true one. Under some conditions of service in water lines or boilers it frequently happens that the tubes, which prove to be of a high standard of quality as regards chemical composition, structure and physical properties of the metal, have rapidly pitted through in places.

The difference of potential and the current which thereby flowed from the exposed places to the firmly attached mill scale, especially after the exposed metal becomes covered with rust, affords a satisfactory explanation of the rapid pitting observed in such cases.

The current flowing between these two points on the surface of a piece of iron is very difficult to measure accurately; however, we have frequently observed currents as high as one milli-ampere flowing between steel electrodes in McKeesport city water, one plate being clean and the other covered with mill scale. The following are some typical readings between plates of the same area made with a milli-ammeter having an internal resistance of eight ohms: Electrolyte McKeesport city water.

Submerged Area of Plate in Sq. In.	Current in Milli-amperes	Current Divided by the Square Root of the Area of Plate	Distance Between Plates
0.155	.07	.18	1"
0.338	.10	.16	1"
1.643	.25	.20	1"
3.875	.48	.24	1"
16.430	.98	.24	1"
0.062	.06-.09	...	1/8"
0.342	.14-.18	...	1/8"
16.430	2.02	...	1/8"

Material of Plates—Clean, soft steel plate free from scale (positive). Same with light coating of mill scale (negative). Plug of pipe steel (positive). Similar area on skelp with light mill scale (negative).

It might seem at first that these currents are too small to cause serious damage. A rough calculation based on these experiments will indicate the ultimate result from such currents acting continuously with certain submerged areas of electrodes:

One ampere acting for six months will dissolve 10 pounds of iron, or a plate 12 by 12 by 1/4 inches thick.

One milli-ampere acting for six months will dissolve .144 square inch of this plate, making a hole about 7/16 inch in diameter by 1/4 inch deep.

One-tenth milli-ampere acting for sixty months will perforate this plate with a hole of the same size.

This rate of pitting is not so far different from that experienced under some conditions of service.

The remedy seems to lie in the elimination of dissolved oxygen from water before use. This may be accomplished in practice in at least two ways:

1. By allowing the hot water to come to rest for a few minutes under greatly reduced pressure. As no reliable data could be found on the amount of oxygen retained in solution in water at various temperatures and pressures, a series of experiments was run to determine these constants. The results are given in Fig. 5. Evidently the

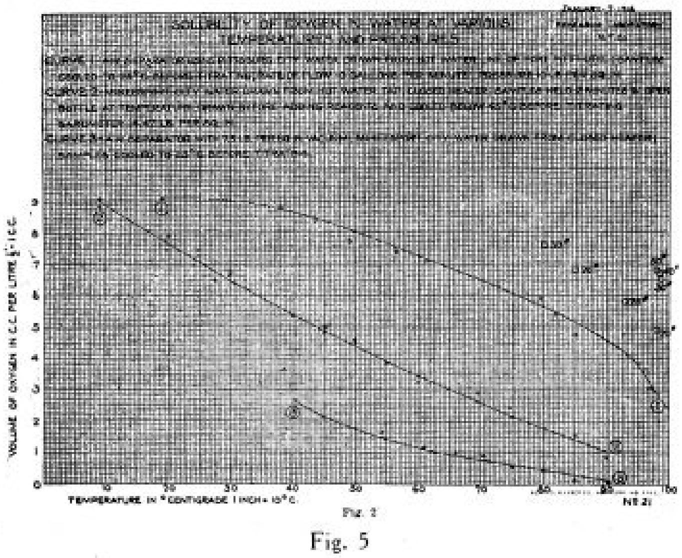


Fig. 5

pressure must be reduced below normal or the temperature raised nearly to the boiling point with the water at atmospheric pressure to get proper separation of oxygen and other gases.

In order to test this out on a practical scale the hot water supply system of the Mellon Institute of the University of Pittsburgh was altered so as to operate in part as an open system under atmospheric pressure or partial vacuum. As there has been some delay in getting the preparatory work completed, results of this trial will have to be deferred for a supplementary paper.

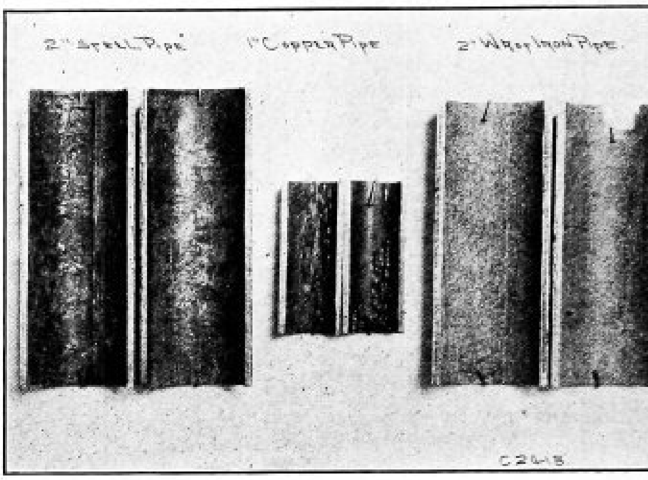


Fig. 6

Fig. 6 is a photograph of some 2-inch wrought iron and steel pipe (galvanized) after thirteen years in the Columbia Baths, Atlantic City, N. J.—an "open" heating system. The small pipe in the same picture shows the condition of some copper pipe used under the same conditions in a "closed" heating system for only six months. At the Columbia Baths the salt water was heated to about 180 degrees Fahr. in an open tank from which it was run by gravity to the system. This pipe was in continuous use during the season for this period. The galvanized pipe was practically as good as new, showing that even salt water is practically harmless when de-aerated to this extent.

2. An alternative method of reducing corrosion in water lines by satisfying or "fixing" the free oxygen was tried out by the writer several years ago, using clean iron turnings. It was found difficult to get the scrap free from oil, and after rusting had progressed for some time there was a tendency for the mass to cake together and so impede the flow. By using sheet iron, so formed as to provide a large number of channels with about 1/4 inch clear passage through which the hot water slowly percolates, we expect that these difficulties will be overcome. Some determinations of the rate at which the free oxygen is removed from water by this system are given in Fig. 7. The rate of rusting varies with the surface condition of the plates, becoming more rapid as the surface is covered with a good coating of oxide. The speed of rusting is 50 percent more rapid at 110 pounds per square inch pressure than at atmospheric pressure, and of course the time required to "fix" the free oxygen of the water varies with the amount of surface of metal exposed per cubic foot and other conditions which are liable to vary. For these reasons the results given in Fig. 7 are only relatively correct for the conditions stated.

On this principle, two small plants have been equipped to carry out this method of treatment in practice. These systems were installed at places where considerable trouble has already been developed through the clogging and corrosion of galvanized pipes.

These plants, which have only been operating a short time, show a reduction of oxygen contents from 8 to 9 cubic centimeters per liter to 0.1 to 1 cubic centimeters per liter, according to the rate of flow and temperature. At present it seems desirable to design the plant so that the oxygen contents will be less than 1 cubic centimeter per liter at all times, at which point corrosion seems to be reduced to a negligible amount. Some more definite data on this point will be available after these plants have been in operation for several months. The indications are that the rate of rusting of the plates, and hence the efficiency of the apparatus, will increase with time. Water should be in contact with the plates for at least ten minutes.

Similarly, the corrosion of low-pressure steam lines will be found to depend principally on the amount of oxygen

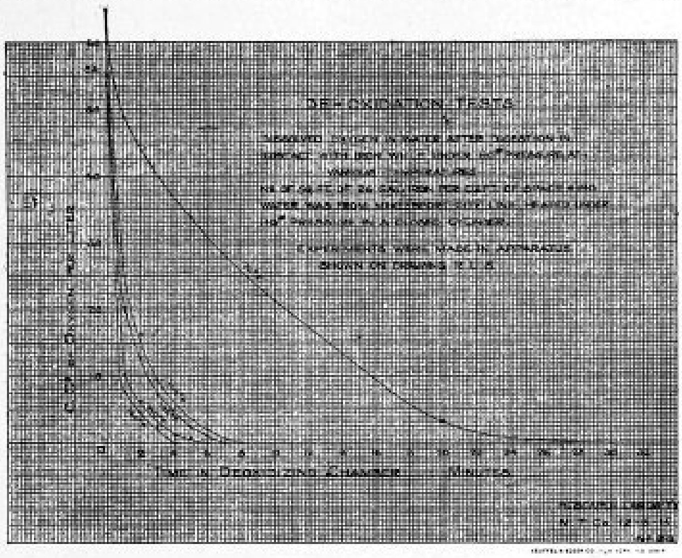


Fig. 7

which finds access to the system. The return lines naturally suffer the most and are usually the first to show failure. Condensed water when freed from oxygen in solution is harmless, and will not even tarnish bright iron after months of exposure; but this water, on account of its great purity, has greater capacity for solution of oxygen than the average natural water, and is therefore apt to be very corrosive when aerated. This may be prevented in large measure by using an open feed water heater and keeping the water over 185 degrees Fahr.

In some cases the surface of the pipe may be protected with a film of oil deposited from the steam. The writer's attention was recently called to the satisfactory results obtained in some buildings using exhaust steam which on investigation was accounted for by the thin film of oil found on the inside of these pipes. This was such an interesting matter that we made some tests in the research laboratory on long lines of new pipe and found that mineral lubricating oil, when dropped into a pipe carrying steam under pressure at the rate of two drops per minute, was carried forward in a fine state of division and in a few minutes was found condensed in a uniform film in the pipe about 160 feet from the lubricator. While this simple means of protection would perhaps be objectionable in some cases, there are many steam heating systems where the oil could do no harm and might result in considerably prolonging the life of the lines. Of course, nothing but a good grade of mineral lubricating oil should be used, and the supply should be regulated by a reliable sight feed lubricator.

Drying kilns and greenhouses use annually a very large amount of pipe for steam heating, and under certain conditions are subject to rather rapid deterioration from inside corrosion due to the large amount of water condensed in the returns. A case of this kind was investigated by the writer last summer, where corrosion had developed on the low temperature end of the system due to oxygen brought in with the feed water. The same plant had been operating for fifteen years without trouble, using an open hot well kept at high temperature. Due to enlarged demands on the system certain changes were made by which the temperature of the water from the hot well, from which the feed pumps drew their supply, was reduced below 120 degrees Fahr. At this temperature the amount of oxygen in solution is about three and one-half times the amount found in water at 180 degrees Fahr., most of which was of course absorbed in the water of condensation in the returns, making possible the corrosion of the pipe. A higher temperature in the hot well and the use of a lubricator were recommended.

Summarizing very approximately, the influence of various factors on corrosion, it appears from the experience we have at present that developments in the metallurgy and manufacture of steel pipe promise to add 50 or perhaps 100 percent to the life of pipe compared with the service obtained under like conditions ten or twelve years ago. However, it appears well within the bounds of possibility to predict that de-aeration of the water, through the use of plants designed with this end in view, should at moderate expense increase the life of some piping systems four or five times.

Such a possibility of conservation of material is surely worthy of careful consideration by heating engineers and architects.

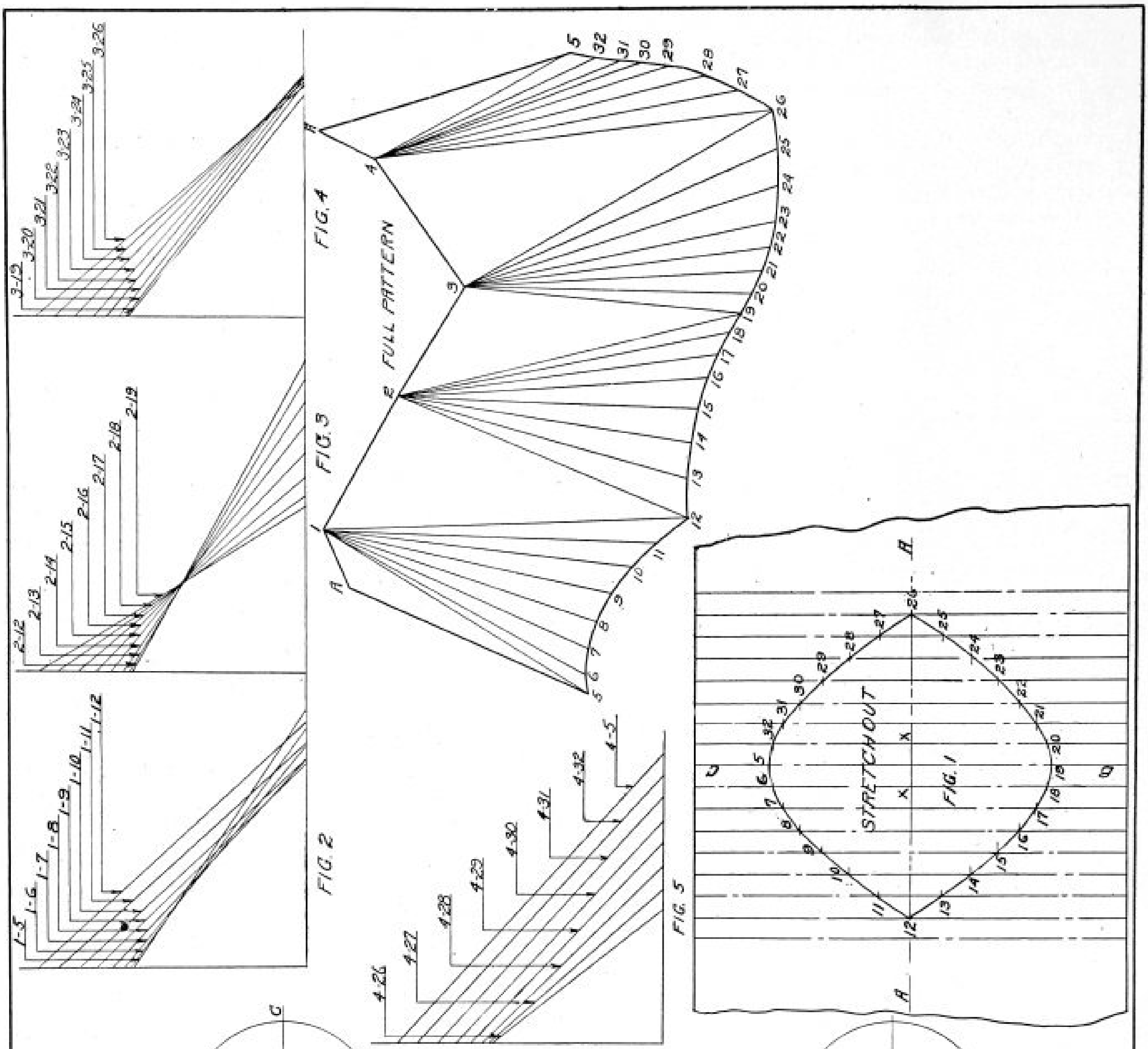
"Safety First" on the Railroads*

Over twenty-five years ago the number of men killed and injured in railroad service began to attract the attention of the public, and movements were started by the employees to obtain the passage of laws for the promotion of safety for railroad men. Strong opposition was encountered from sources where support for the movement might reasonably have been expected, and it was only after a number of years spent in the work and after a number of laws had been passed and enforced to an extent which proved that it not only was a protection to their employees, but it was actually cheaper to protect employees than it was to pay for their injuries, that the movement was actively taken up by the railroad companies under the slogan of "Safety First."

It will perhaps surprise most of you to know that the records of the Interstate Commerce Commission show that during the last twenty-five years 223,721 persons were killed and 2,184,339 injured in railroad accidents, and that before the slogan "Safety First" was ever heard more than 1,000,000 railroad employees had been killed or injured in their daily work.

Do not understand me as criticising the Safety First movement. Far from it. The movement, belated as it was on the part of the railroads, is welcome. Where it is sincerely observed it is a boon to both the railroads and their employees, and is doing much to prevent accidents. As one railroad which is a pioneer and one of the most consistent advocates of the safety movement puts it, "It takes less time to prevent an accident than it does to report one."

* From an address by Mr. Frank McManamy, chief locomotive boiler inspector, Interstate Commerce Commission, before the Master Boiler Makers' convention.



Development of Patterns of Double Off-set Transition Piece

Layout of Double Off-Set Transition Piece

Plans and Development of Patterns by Triangulation of Unusual Piece of Sheet Metal Work

BY R. J. HETTENBAUGH

This is an odd-looking design and looks rather difficult, but if the instructions are followed closely you will have little difficulty in laying out this design.

On the line *B C* lay out the plan and end view of a round drum and space the end view in a number of equal parts. Next scribe the half-circle on the line *A-A* equal to the length of the elliptical hole in the top. Divide this into the same number of parts as was used in the end view and project the points to the plan parallel to the line *A-A*. Also project all points in the end view to plan parallel to the line *B-C*. The points of intersection will form the elliptical hole in the top of the pipe as shown by the little crosses.

Next lay out the rectangular top and number the points as shown *A*, 1, 2, 3 and 4. Connect the points in top with those in the ellipse completing the plan. Scribe the center lines *B-B* at right angles to the line *B-C* and *a-a* parallel to the line *B-C*. On these lines lay out the side elevation and end view as shown. Project all points in the end view of the plan to the end view of the side elevation and thence to the side elevation parallel to the line *a-a* as shown. Project all points in the half-circle to the side elevation and the points of intersection with the lines from the end view will form the joint line of the two pieces. Erect the top line of the piece and connect the points *A*, 1, 2, 3, and 4 with the points in the base.

The next step will be to form the stretch-out which is shown in Fig. 1. First draw the center line *A-A*, which will be the center line of a rectangle equal in length to the circumference of the drum. The ends have been cut off in this case to eliminate space. Find the center of this rectangle and scribe the line *B-C*. Step off seven points on each side of this line equal to one of the spaces in the end view and scribe the lines parallel to the line *B-C*. Take half the distance between the points 5 and 19 in the half-circle (which is half the length of the ellipse). Set one point of the dividers on the center line *A-A* and scribe an arc across the line *B-C* at 5 and 19. Now set the dividers equal to half the distance between the points 6 and 18 and with one point on the center line at *X* scribe arcs to cross this line at 11 and 27, and with the dividers the same size set one point at *X* on the opposite side of the center line and scribe arcs at points 13 and 25. In like manner take all the points on both sides of the center line *B-C* forming the hole in the drum. The distance between these points as 5, 6-6, 7-7, 8, etc., will be the true length around the base of the pattern, which will be explained later.

The next step will be to form the construction triangles shown in Figs. 2, 3, 4 and 5. Take the distance between the points *A*-5 in the plan and place it on the horizontal line in Fig. 2. This will be the base of the first construction triangle. Now take the height on the center line *A-A* in the side elevation from point *Y* to the line 5-19 and place this on the perpendicular line of Fig. 2. This will be the height of the first construction triangle. Take the distance across these two points and it will give the hypothenuse or true length of the line *A*-5.

The next triangle will be found in the same manner. Take the length of line 1-5 in the plan and place it on the base line of Fig. 1. Now take the height from point *X* on the center line of the side elevation to line 6-20 and place this on the perpendicular line of Fig. 2. The distance across these two points will be the true length of line 1-5. As all other lines are found in the same manner I will not explain each one in detail.

After all the triangles are found the pattern must be formed, and this is done by piecing the construction triangles together. Take the true length of line *A*-5 in Fig. 1, place it at any convenient place on the sheet and with point *A* as a center scribe an arc equal to the distance between points *A* and 1 in the plan. Now take the true length of line 1-5 and with point 5 as a center scribe an arc to cross the one just taken from point *A*. The point of intersection will form point 1. With point 1 as a center scribe an arc equal to the true length of line 1-6. With point 5 as a center scribe an arc equal to the distance between points 5 and 6 in the stretchout to cross the one just taken from point 1 and the point of intersection will form point 6.

Proceed in like manner with lines 1-7, 1-8, 1-9, 1-10, 1-11 and 1-12, taking the lines from Fig. 1 and the distance between points from the corresponding points in the stretchout. Now with point 1 as a center scribe an arc equal to the distance between the points 1 and 2 in the plan. Now take the length of line 2-12 in Fig. 2 and with point 12 as a center scribe an arc to cross the one just taken from point 1. The point of intersection will form point 2. Proceed in this matter until all the points are found completing the full pattern.

Lap Welded and Seamless Boiler Tube Specifications

Lap welded and seamless boiler tubes for merchant and marine service shall be made of good quality soft steel, rolled from solid ingots. Sufficient crop shall be cut from the ends to insure sound material. The permissible variation in weight is 5 percent above or below the calculated weight. Tubes shall have a reasonably smooth surface and be free from injurious pits, laminations, cracks, blisters, or imperfect welds; they shall also be free from kinks, bends and buckles, signs of unequal contraction in cooling or injury during manufacture. The thickness of the walls shall not vary more than 10 percent above or below the gage specified, except at the weld, where 0.015 inch extra thickness will be allowed. Tubes shall not vary more than ½ percent either way from being round or true to the mean outside diameter, except in the smaller sizes, where a variation of 0.015 inch will be accepted. Tubes shall not be shorter than the length ordered nor more than 0.125 inch longer.

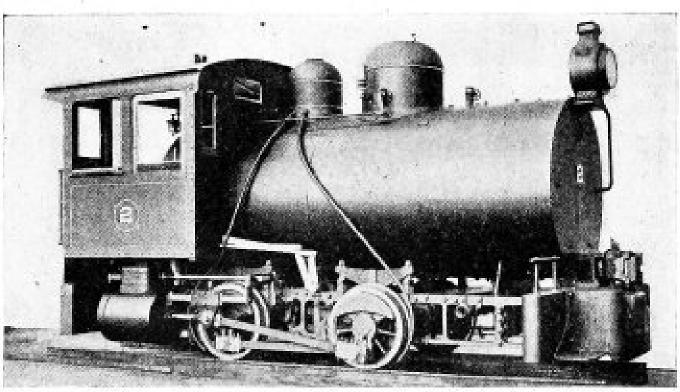
Flattening Test.—A section 3 inches long shall stand hammering flat cold until the inside walls are within three times the thickness of the material without cracking at the bend or elsewhere. In case of lap welded tubes for marine work, the bend at one side shall be made in the weld. For marine purposes on lap welded tubes 4 inches and smaller, and on all sizes of seamless tubes, a flange ⅜ inch wide shall be bent over at right angles to the body of the tube without showing cracks or opening at the weld. Each lap welded tube shall be subjected by the manufacturer to an internal hydrostatic pressure for the respective sizes and gage as given and agreed upon. All seamless boiler tubes are tested to 1,000 pounds per square inch.

In addition to the foregoing tests, each tube when inserted in the boiler must stand expanding and flanging where required without cracking or opening at the weld. Tubes that fail in this way must be returned to the manufacturer. A certificate of test shall be furnished the purchaser of each lot of tubes for marine service, describing the kind of material from which they are made, and that the tubes have been tested and have met all the requirements described by the Board of Supervising Inspectors, Department of Commerce, Steamboat Inspection Service. —*National Tube Company.*

Fireless Locomotive

A new fireless locomotive recently placed in service by the Ohio Wood Preserving Company, at Orrville, O., was developed at Pittsburg, Pa., at the locomotive works of the H. K. Porter Company. While this is a type of locomotive not generally used in this country, it is largely utilized in Germany. It has cylinders 17 inches diameter by 16 inches stroke, four 30-inch driving wheels, and weighs 43,500 pounds in working order.

In place of the ordinary boiler, this locomotive has a large tank having a capacity of 250 cubic feet. Just behind the front bumper there is a coupling which extends out beyond the frame. The locomotive is connected with a stationary boiler at this point, and water and steam from the high pressure stationary plant is allowed to enter the storage tank through this connection. The tank, in this case, was built for 180 pounds pressure, and when about



New Fireless Locomotive

four-fifths full of hot water and the pressure equalized with the stationary boiler, there is about 150 to 160 pounds pressure. By using a locomotive of this type all danger from fires, caused by sparks from the smokestack or from the ashpan, are eliminated, as there is no fire connected with the locomotive at any time.

Under the conditions at the Ohio Wood Preserving plant, this locomotive will run from three-quarters of an hour to one hour on a charge, and can be recharged in about ten minutes. The locomotive can be stopped and left without an engineer when not in use. It is apparent that there is no danger from low water, and consequently no danger of an explosion.

It may be mentioned that inside of the tank is a coil of perforated piping whose function it is to thoroughly heat the full body of water to the required temperature, and as quickly as possible. Special care is taken in the lagging and jacketing of the tank, cylinders, steam chests and piping, so as to conserve as much heat as possible. The elimination of the firebox does away not only with the dangers from low water, but also eliminates all tubes and staybolt troubles.

The locomotive shown in the photograph has a height limit of 10 feet, is 8 feet 6 inches wide, and 16 feet 6 inches long over bumpers, with a driving wheel base of 5 feet, and is, therefore, able to negotiate curves with a radius as low as 50 feet. In order to get the steam as dry as possible, and therefore to have as much efficiency as possible, the regulation steam dome, with the throttle near the top of it, is applied, and a sand box with two pipes on each side for sanding four wheels going in either direction is also furnished. The exhaust from the cylinders goes up through pipes which extend through the roof of the cab.

Powdered Fuel*

The use of powdered fuel in manufacturing plants has proved quite successful and has passed beyond the experimental stage after years of experimental and development work. Apparatus has been perfected for the drying and pulverizing of coal. The problems to be encountered in the use of powdered fuel in locomotives are more serious, on account of the necessity for storage of powdered fuel and the limited restrictions of space available on a locomotive. The first aplication of such a device for burning powdered fuel on a steam locomotive was made about a year ago, and special apparatus had to be designed, tested, improved and perfected to make it adaptable to locomotive practice, therefore discouragement should not be felt because in so short a time there are not a large number of locomotives in regular service burning powdered fuel.

The members of this association know the great difference in the burning of run-of-mine coal from different sections of this country, and even different mines in the same section; therefore they will readily appreciate at least that similar difficulties must be encountered and overcome in burning in powdered form the same coals containing various amounts of moisture, ash, etc., besides the added process of actually pulverizing the fuel.

It is easily within the memory of all as to the difficulties at first experienced in the burning of oil in the limited confines of a locomotive firebox, and the apparatus used successfully; therefore to-day it would hardly be recognizable to the early designers and experimenters therein. Perhaps most would agree to-day that but for the difficulty in obtaining fuel oil, and its excessive cost, the use thereof would be much greater than it is; nor is the end of increased cost of oil in sight, since methods have been devised for producing gasoline therefrom; hence it is believed that the perfection of apparatus for burning powdered fuel with equal advantage offers an acceptable substitute, and on account of the greater supply of coal and its less cost, particularly the smaller sizes, many of which at present are entirely wasted, the field for the use of powdered fuel would appear to be much more extensive.

The results to be obtained from successful use of pulverized fuel in locomotives may be briefly summarized as follows: Operation free from smoke, cinders and sparks; ready maintenance of full boiler pressure, increased boiler efficiency, decreased fuel cost, saving of manual labor in stoking, elimination of grates, as well as ash pit delays and expense.

*From report presented before American Railway Master Mechanics' Association, June, 1916.

Chisels*

BY HENRY FOWLER†

Very considerable attention has been given to the composition and treatment of tool-steel used in machine tools, but the three implements of the hand worker—the file, the chisel and the hammer—have been comparatively neglected. The author is aware of the work recently done in testing the former of these, and knows that there is little need of improvement with the last named, but believes that the chisel has not received the systematic attention its importance deserves. A close examination of the new and used chisels in the shop, over which he had control, confirmed that view, and the result was an effort to induce the Alloys Research Committee of the Institution to take up the matter. For various reasons this was not successful, and so the matter has been dealt with individually.

The material usually employed for chisels is not bought to specification, but a well-known and tried brand purchased. In the Chief Mechanical Engineer's Department of the Midland Railway, after considerable experiment, it was decided to order chisel steel to the following specifications: "Carbon, 0.75 percent to 0.85 percent, the other constituents being normal." This gives a complete analysis as follows:

	Percent
Carbon	0.75-0.85
Manganese	0.30
Silicon	0.10
Sulphur	0.025
Phosphorus	0.025

It is perhaps interesting to note that the analysis of a chisel which had given excellent service was as follows:

	Percent
Carbon	0.75
Manganese	0.38
Silicon	0.16
Sulphur	0.028
Phosphorus	0.026

The heat treatment this chisel received is unknown.

At the same time that chisel steel was standardized the form of the chisels themselves was revised, and a standard chart of these as used in the locomotive shops drawn up. Figs. 1 to 10 show the most important forms of these, which are made to stock orders in the smithy and forwarded to the heat treatment room, where the hardening and tempering is carried out on batches of 50. A standard system of treatment is employed here which to a very large extent does away with the personal element. Since the chemical composition is more or less constant, the chief variant is the section which causes the temperatures to be varied slightly. The chisels are carefully heated in a gas-fired furnace to a temperature of from 730 to 740 degrees C. (1346-1364 degrees F.), according to section. In practice the chisel, Fig. 1, is heated to 730 degrees C., chisel, Fig. 2, to 735 degrees C. (1355 degrees F.), and a 1-inch half round chisel to 740 degrees C., because of their varying increasing thickness of section at the points.

Upon attaining this steady temperature, the chisels are quenched to a depth of ⅜ inch to ½ inch from the point in water, and then the whole chisel immersed and cooled off in a tank containing linseed oil. This oil tank is cooled by being immersed in a cold water tank through which water is constantly circulated. After this treatment, the chisels have a dead hard point and a tough or sorbitic shaft. They are then tempered or the point "let down." This is done by immersing them in another oil bath which has been raised to about 215 degrees C. (419 degrees F.). The first result is of course to drop the temperature of the oil, which is gradually raised to its initial point. On approaching this temperature the chisels are taken out about every 2 degrees C. rise and tested with a file, and at a point between 215 degrees C. and 220 degrees C. (428 degrees F.) it is found that the desired temperature has been reached, the chisels are removed, cleaned in sawdust, and allowed to cool in an iron tray.

A question which naturally will be asked is whether comparative tests of these chisels with those bought and treated by the old rule-of-thumb methods have been made.

FIG. 1.—*Heavy Brass Work.*

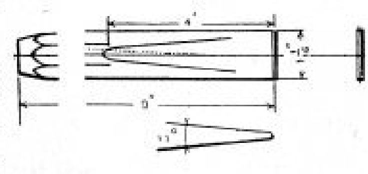


FIG. 2.—*Heavy Iron and Steel Castings.*

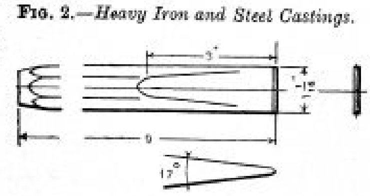


FIG. 3.—*Cylinder Repairs.* (Right Hand.)

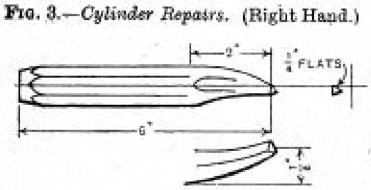


FIG. 4.—*Side Tool.* (Right Hand.)

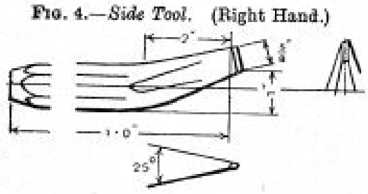


FIG. 5.—*Square Nose.*

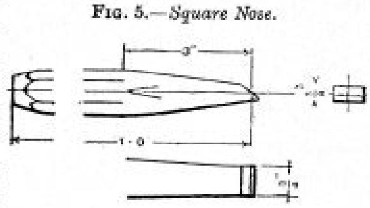


FIG. 6.—*Diamond Point for Jagging, etc.*

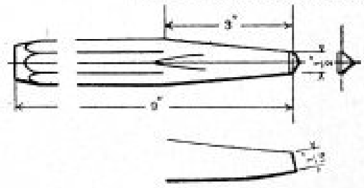


FIG. 7.—*Long Cross Cut.*

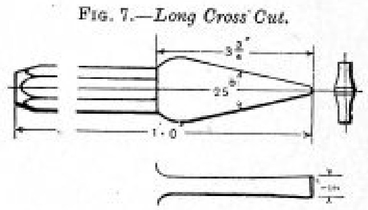


FIG. 8.—*Round Nose.*

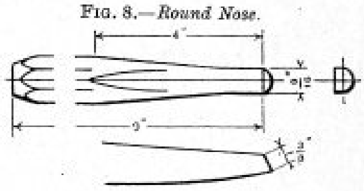


FIG. 9.—*Gouge Tool.*

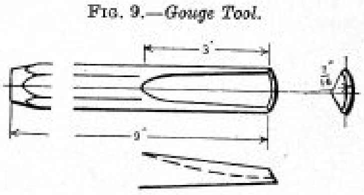
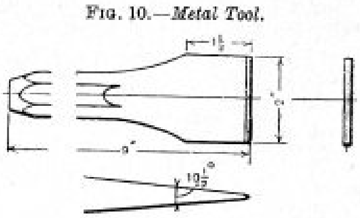


FIG. 10.—*Metal Tool.*



It must be admitted that the author knows of no method of carrying out such tests mechanically, other than that of hardness by the Brinell or Scleroscope method, while any ordinary test depends so largely upon the dexterity of the operator. The universal opinion of foremen and those using the chisels of the advantages of the ones receiving the standard treatment set out has, however, convinced the author of the improvement made.

The author is aware that questions may be raised as to why the chisels have not been normalized at about 900 degrees C. (1652 degrees F.) after forging and before hardening. This matter had attention when the question was first dealt with, but at that time there were no facilities for carrying out this work. These have since been provided for in connection with certain other work, but although chisels have been normalized in the manner mentioned, no advantage has been found in carrying this out.

*Paper read before the Institution of Mechanical Engineers, London, Eng., February 18, 1916.

†Chief mechanical engineer, Midland Railway, Derby, Eng.

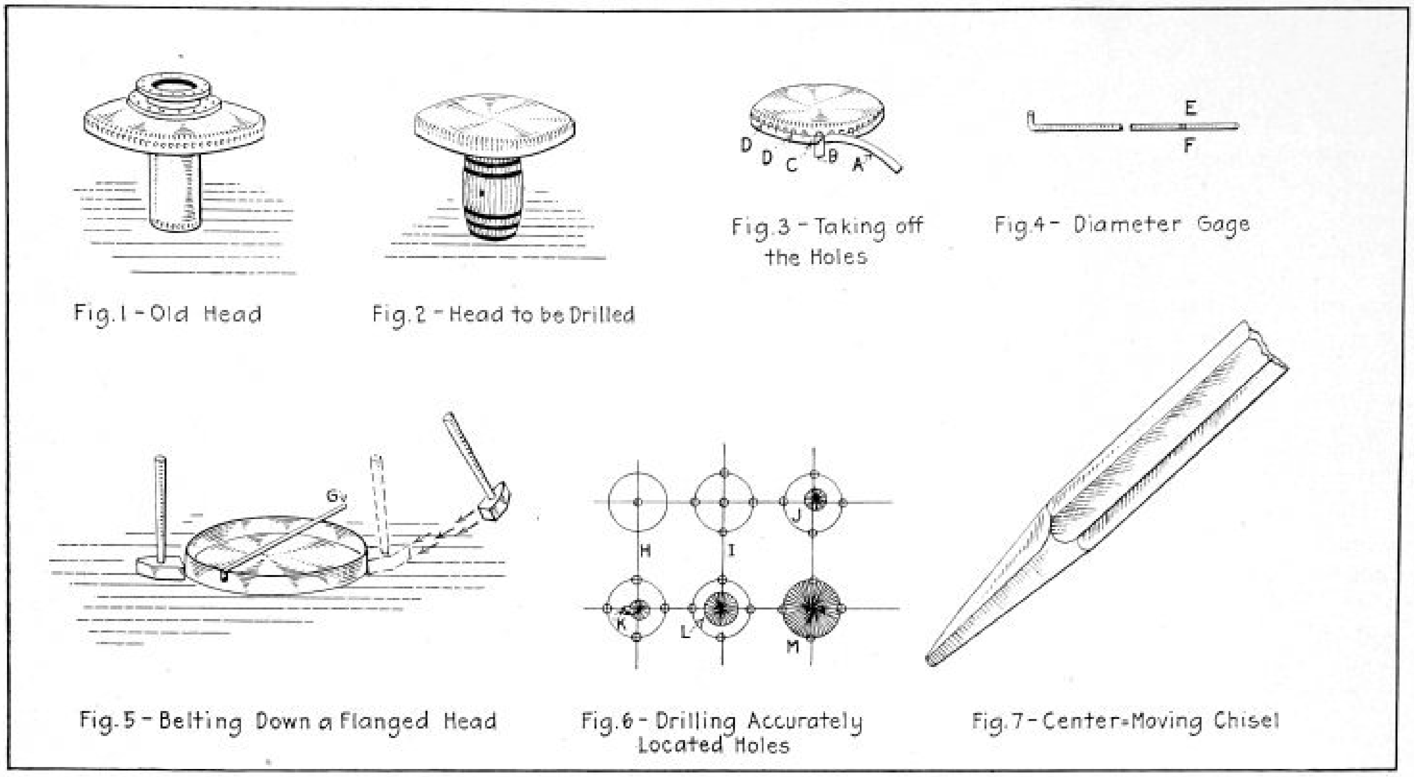


Fig. 1—Old Head
Fig. 2—Head to be Drilled
Fig. 3—Taking off the Holes
Fig. 4—Diameter Gage
Fig. 5—Belting Down a Flanged Head
Fig. 6—Drilling Accurately Located Holes
Fig. 7—Center-Moving Chisel

Shaping Up a Duplicate Head and Locating the Rivet Holes

Duplicating a Bumped-Up Head: Drilling Accurately Located Holes

Over-Size Head Fitted to Tank—Method of Transferring and Drilling the Rivet Holes

BY JAMES FRANCIS

"Henry, that 36-inch old head has just come in from the oil works. Didn't you flange a new head for them the other day? A 36-inch bumped-up head which is to be drilled for rivets, same as the one which just came in?"

"Yes, that new head has been ready for several days. You said to leave it until the old head came in."

"Yes, Henry, that's right. But here's the new head. Get it marked and drilled as soon as you can."

"All right; it will do all right to level the old head and plumb down, won't it?"

"What's that, Henry?"

"Won't it bring the holes near enough if I level the new head, place the old one on top of it, then with a spirit level plumb down from each rivet hole in the old head and mark beside the level for the new holes in the new head?"

"I should be a little afraid of that method, Henry, for this job at least. If the new head should be a bit too large or too small, there would be trouble."

"The new head ought to be the right diameter, for I made it just as you gave me the figures—36 inches in diameter."

"Those are the figures they 'phoned me, Henry. If the head is 36 inches and is not the right size, then it is somebody's fault besides ours."

"Wish I had a traverse wheel same as the carriage-smiths have. That tool would be handy on this job."

"Never mind the traverse wheel, Henry. Get a piece of that thin strap iron. There's a coil of it hanging over the layerout's bench. Here! Don't try to lay out those holes with the head on the floor. Put the head up on something. There must be a lot of the 'primal man' in a boiler maker because he is apt to work each job on the ground when he could do the work easier and quicker if he would only put the work on something so he did not have to spend time and energy in stooping down so much. Have your helper bring in a short piece of smoke stack or a barrel and put the old head and the new one each on something which will bring them up to a good, easy working level, same as shown by Figs. 1 and 2.

"That's the thing, Henry. Now you can work easily and quickly. Now put the thin strap of iron around the head just above the bottom of the flange and bring the top of the strip level and fair with the middle of the rivet holes. Fasten the thin strip of iron (or steel) with a small screw clamp as shown by Fig. 3, at *B*, the strip of band steel being shown at *A*. Sharpen your bit of soapstone and carefully mark where the underneath end of the strip comes, as indicated at *C*, then carefully mark the center of each rivet hole as at *D D*, etc., Fig. 3."

"It's all marked, and marked pretty close, too."

"That's good, Henry. Now remove the screw clamp, take off the thin iron strip, place it around the new head and clamp it fast, the same as before. See that the strip is even and as far from the heel of the flange as it was when on the old head. See that the inner end of the measuring strip comes even with the mark *C*, Fig. 3, and then—

What's that you say? The mark *C* doesn't come even with the inner end? Is 1½ inches short? Well, how's that?"

"Suppose the blamed head is too big. That's all the reason I can see for it. Here, I'll put the rule on it. It measures exactly 36 inches, as close as I can measure, so the head is just as you told me to make it."

"Measure the old head, Henry. What's that? Thirty-five and one-half inches? Well, that's where the trouble is. Pshaw! I ought to have thought of that when they gave the order for a head to a 36-inch tank. Yes, there it is, stencilled on the head, just where the maker put it '36 x 8.' A tank 8 feet long and 36 inches in diameter. Well, that's one on me for not thinking of it."

"Thinking of what, Mr. Francis? I don't see where you are to blame They said 36 inches, and the tank is only 35½ inches. That lets you out."

Diameter of Head Too Large

"No, it don't let me out, not a bit of it. I should have remembered that a 36-inch tank would never be larger than 36 inches, especially when furnished on contract as this one was; therefore that tank is 36 inches diameter OUTSIDE, and as the shell is ¼ inch thick, the head is of course 35½ inches in diameter, and fits into the shell all right. See?"

"Yes, confound it, I 'see,' but what are we going to do about it? Make a new head?"

"No, Henry. That head was made outside, you know, so we can't afford a new one, even if our customer would stand for the delay in getting another one. Just take that head over to the flange forge, Henry, and 'bump down' the diameter half an inch."

"Shall I hammer the flange all around, or take it all off of one side?"

"It will be all right to take it all off one side for this job, and if it be any easier you may do so. But, first better make make a gage, as shown by Fig. 4. Get a piece of ½-inch round rod and bend one end over square, as shown by Fig. 4, then make two marks on the rod with your soapstone marker. One of the marks, that at *E*, is the diameter of the old head. The mark *F* shows the diameter of the new head, and there is just one-half of an inch between these two marks."

"Say, we haven't got any form for a 35½-inch head; the nearest one which we have is only 34½ inches in diameter, and that is just half an inch too small."

"Never mind that, Henry. The 34½-inch form is good enough, and you could do this little job without any form at all."

"Yes, but how would I get the flange straight and squared up, if I didn't have a form to true it up on?"

Working Without a Form

"Do it with your eye and a sledge, Henry. The boiler maker, if he be any good at all, is an artist, the same as a painter of pictures or a sculptor. He sees in the sheet of steel or in the clay just what he wants to make, and goes about building the thing which is before his mental or spiritual vision. Now, then, if your eye is of any use to you, you can hammer that flange square and even, after you get the head belted down to the required diameter, just as well as the sculptor can chisel out the figure which he sees in the rock."

"Yes, but do you suppose I can get the flange true enough with the sledge, and no form to true it up on?"

"True nothing, Henry. If you can't do this job, you are N. G. as a boiler maker, and I will give it to the rivet boy to fix up. He'll tackle it, or anything else he can get hold of. That boy will be some boiler maker bye and bye, let me tell you! And now, Henry, wake up "already vunce," as my old German boss used to say. Throw that head on the fire and heat as large a segment as you can. Then put the head on the floor as shown by Fig. 5, have your helper hold against the flange with the biggest sledge or dolly he can lay hands on, while you belt in the opposite side of the head, taking care that your sledge blows come in line with the web of the bumped-up head.

"If you are careful to strike just right, the web of the head will be bent over a trifle, and upset a bit, so that the flange is driven inward, at the same time remaining as square as if it were being driven against the body of a flanging form. But if you strike too high, the flange will be bent inward. If you strike too low, the head will be upset and the flange given a cone-shape, and it will be a homely looking thing."

"Couldn't the flange be trued up afterward against the 34½-inch form?"

"Yes, it could; but if you don't keep the flange square while belting it down, you won't be able to tell when the head is small enough. You should make frequent use of the gage described above and shown by Fig. 4. This gage is shown in use at *G*, Fig. 5, and by its use on a straight, square flange, you are able to tell when the head has been made small enough."

Truing Up the Flange

"Say, how is this thing worked? If I belt down the flange where the sledge is shown in operation, until the head is small enough, then I will have to use some kind of an estimate in belting the rest of the flange, for I can't belt it in until it shows to the second mark (*E*, Fig. 4), for if I do the head won't be round any more. I will have to belt down about half way, around both ways, in Fig. 5, from where the sledge is doing business in Fig. 5."

"Well, you can do that, can't you? Just work in the flange a little less, as you work around the head, until you get to where the hold-on sledge is placed, and there you don't have to do anything. And this side of the head being done as closely as possible by the eye; then, after one side is done you can finish the other side of the head to the measuring gage and get it about as you want it. And, Henry, before you leave the head, just slip the measuring strip around it and see if it just reaches the mark you made, fair with the under end when the strip was clamped to the old head. This is the supreme test and you will work away at the new head until the flange is square, true to the eye, and just fits the measuring strip."

"Say, I know what to do after that, all right. I will slip the measure upon the flange, place one edge the proper distance from the heel of the flange, then mark right around beside the measuring strip. Then I will transfer each river center mark, drive a center punch into the point where each mark passes the line which was marked along the measuring strip."

"And, Henry, if you want to have the holes in the flange made very accurately like those in the old head, you must take certain precautions when the holes are drilled. If you put the point of the drill into the center punch holes and drill away, there is no certainty that the holes will follow the punch marks accurately. Mind, I say, when the holes are required to be very accurate and to register within 1-32 inch. You can drill and drift, or you can push a reamer through after the new head is in position in the tank shell, but if you wish to drill some very accurately located holes, then proceed as shown by Fig. 6. With the dividers strike little circles around the center punch marks."

"What are those circles for, Mr. Francis?"

"They are to guide the drill, Henry. Drills frequently run in one direction or another when started from a center punch mark, and without the circle. After the center mark has been drilled out, there would be no way of telling whether the drill was cutting fair, or whether it had dodged to one side or the other. But make the circles, shown at *H* and *I*, Fig. 6, and you can see whether or not the drill is cutting fair with the center punch mark."

"What are those little holes for shown in sketch *I*, Fig. 6?"

"Those, Henry, are center punch holes, placed there to enable the circle *H* to be seen easier than if it were not for the four center punch marks *I*. When there are chips and drill cuttings to be cleaned away, the small circles will aid greatly in locating the circle *H*, and when the drill has cut the circle nearly away, as in sketch *M*, portions of the four punch marks remain as witnesses of the fact that the hole has been drilled fair with the center mark."

"O ho! So that's the way of it, eh? I have seen machinists doing that stunt, but I didn't know what they were doing it for."

"Then why didn't you find out? I tell you, Henry, if we see a trick or kink in use, we should go after it, for if a kink is good for one man it is valuable for us, so we should not let it get past us. Go for each and every kink, trick and dodge you see. Then you can use those which you need and keep the others in the back of your head until you need 'em. And I never yet caught a kink which did not prove useful some time or other!"

"Guess I'll do that, Mr. Francis; it sounds pretty good to me. But what is that off-center hole in sketch *J*, Fig. 6?"

Locating the Rivet Holes

"Oh! That is where the point of the drill 'run' to one side when a hole was started. Now, then, had this been one of the holes in the new head, see where it would have gone? Far to one side. What makes a drill do that? Well, several things. The metal may not have been placed level under the drill or there may have been a side pull upon it which made the drill crowd away. At any rate the trouble is there and it must be corrected, if the hole is to be made where it was laid out."

"How can a hole be changed when it has started same as at *J*?"

"Sketch K shows how to 'bring the hole back' fair with the circle again. With a small cold chisel cut a groove on the side of the hole toward which it is desired to draw the drill hole. The width and depth of this groove must be according to the distance it is desired to 'draw' the drill. Experience alone can teach a man how large a groove to cut. But if it be not cut large enough the first time, you can make another groove after the drill has cut all the first groove out. But make sure that the point only of the drill is cutting. You can draw a drill while the point only is working, but you can't do anything after the body of the drill has entered the metal. Therefore be careful to look at the hole just as soon as the point of the drill has located itself, as in sketch *J*.

"What is to be done if the groove brings the drill over too far?"

"Do just the same. Cut another groove on the side of the hole toward which it is desired to draw the drill and proceed as before, but be very careful to get the drill to working central, as shown by sketch L, before the body of the drill gets to work. Then it will be too late."

"Well, I don't see what good the four center punch holes do. Can you show me that?"

"Yes, Henry. Look a sketch M. There the drill has been centered accurately and has just cut out to the line of the circle, which you can't see any more, or at least which you can't distinguish from the edge of the drill hole. Now, then, the center punch marks have been half removed also and there is nothing left of them but the little half-circles shown. But as these half-circles are each and all perfect and exactly upon the edge of the drill hole, we know by that fact that the drill has cut fair with the center punch mark and fair with the little circle which was described around the punch mark. Therefore the four outside punch marks remain as witnesses to the fact that the hole has been drilled just where it was marked."

"What kind of a chisel is best for 'moving drill holes'?"

"Almost any chisel, Henry, with which you can cut a shallow groove in one side of the drill-point hole. Fig. 7 shows a good tool for this purpose."

"Why wouldn't that be a good scheme to use when drilling holes in fittings?"

"It sure would, Henry, and it is used for that and for many other purposes also."

"By hang, I'm going to try it out next time I drill holes. But say, Mr. Francis, I wish you would tell me of a good way to build up a fire when we have got to weld boiler tubes. Our tube-heating fire gets out of shape so quickly that a whole lot of time is lost in mending the fire frequently. Isn't there some way of making a fire stay in shape?"

"I'll tell you my way next time I see you, Henry. That method will hold for two or three hours without having to mend the fire."

A Theory of the Corrosion of Steel

Two theories have been advanced to account for the actual corrosion of iron, says Leslie Aitchison, of Sheffield, England, in a paper, "The Theory of the Corrosion of Steel," presented at the annual meeting of the Iron and Steel Institute in London, May 4, 1916. In a large number of experiments the material employed has been pure, or nearly pure, iron, and in most cases the interest has centered around the attack upon this of pure water. At the present time the question is an open one as to the actual details of the corrosion under these conditions. Most workers have left the theory of the corrosion of steel, which is a material of much greater complexity of structure than iron, rather well alone.

The complex structure of steels, composed as they are almost invariably of carbides embedded in a matrix of some carbon-free materials, renders it almost certain that the action going on in a steel during its corrosion is a galvanic one. The large number of galvanic couples present in an ordinary sample of steel can be well imagined, and these couples will consist of the carbide on the one hand and the ferrite or solid solution on the other. This postulates at once that one of the two constituents will be anodic in its action and the other cathodic.

The intensity of the galvanic action between the two constituents will depend, other things being equal, upon the potential difference between the two constituents with respect to the corrosive liquid which is in contact with the steel. The carbides in all steels, although of varying chemical composition, will be likely to be possessed of very similar electrical properties, and hence it appears reasonable to assume that the electrolytic solution pressure of all the carbides will be the same, or nearly so.

On the other hand, the solid solution, which may range from practically pure iron to an alloy containing many percentages of a second element, will be a material of

very varying electrical properties. As a result the electrolytic solution pressure of this constituent will change very considerably from steel to steel, and will in consequence produce a considerable variation in the potential difference existing between the constituents of the steel. Thus the corrosion of the steel should vary a great deal with changes of composition.

The three pieces of evidence—the microscopic, the analytical by sulphuric acid, and the effect upon the corrosion—may be taken as conclusive in proving that the carbides act throughout as cathodes. The rest of the material then becomes the anode in the various galvanic couples present in the material. This residue of the steel is practically always solid solution. In the case of ferrite the solution is extremely dilute, sufficiently so for the ferrite to be termed pure iron, while in other cases there may be as much as 12 or 15 percent of a second element.

The author drew the following conclusions:

That the corrosion of a steel takes place purely by the action of the ferrite or the solid solution.

That the action upon pure ferrite may be due entirely to the potential difference set up in consequence of the different solution pressures of the grains of the metal and the inter-granular cement, it being probable that this latter is possessed of a greater electromotive force.

That the percentage of the third element added to iron and carbon in steels must be sufficiently great to produce a fairly high percentage in the solid solution, if there is to be any beneficial effect from the use of this element.

That the electromotive force of the solid solution with respect to the corrosive liquid is the deciding factor in the corrosion of a steel.

That the pearlite in a steel does not corrode as a whole, but as a mixture of ferrite and cementite, the disappearance of the latter being due to mechanical and not to chemical action.

That carbides are not decomposed by ordinary corrosive agents, and that they act merely as cathodes to the anode of the ferrite or solid solution.

Treating Feed Water for Locomotive Boilers*

Internal Treatment of the Boiler—Methods of Boiler Washing—Prevention of Foaming

So far as the writer is aware, the first use of a semi-internal treatment or, in fact, the first attempt to treat bad boiler feed water on any large railway, which attempt later led to general use of the treatment on that road, was initiated on the Chicago, Milwaukee & St. Paul in 1879. A machinist at the North Milwaukee shops compounded soda ash, tannin extract and sorghum and used the combination in a few boilers with fairly good results. Later this material was mixed at Milwaukee and shipped to different division terminals.

By 1890 it had been discovered that the commercial soda ash alone did all that the compound medicine had been doing, and it was thereafter shipped, without mixing, for general application to the tender tanks.

In those days enginemen had the same prejudices that many of them evidence to-day, varying in effect as their prerogatives were not so limited. They objected to soda ash, in that they could not see its benefit, and it caused foaming. The result was that the required amount for a trip had to be placed in the tenders at the terminal, and this large dose frequently did cause more than imaginary foaming.

Some of the engineers took readily to the new order and consistently carried out instructions, with the result that their boilers required far less maintenance expense and the foaming bugbear lost in importance.

Still, down through the years to the present time, the objections to this method of using soda ash have held good; and with the advent of larger power and pooled engines, the only incentive which the enginemen had, to use soda ash in furtherance of his selfish interests has disappeared. Close supervision can only slightly better the conditions, not cure them. Moreover, he who would supervise the consistent use of soda ash must be prepared to offset the evil tendency to foam, given the water in the boiler by this system. He must blow out the concentrated water and replace it by raw water from the tank. This can be done systematically or spasmodically, but it must be done if water heavy in incrustating solids is to be kept within bounds after complete treatment. Either method of blowing costs coal and reduces boiler efficiency. Water which has been raised to the temperature of steam at a pressure of 200 pounds is pretty valuable material, and its heat units should be used in the cylinders, not used to paint the right-of-way fences.

What is more natural than that we turn to a method of treatment which, while removing from the engine crew all responsiblity and knowledge in the matter, still produces far better results than does this method, in the fondest dreams of the soda ash enthusiast; which does not cause foaming, and which costs less than other methods.

INTERNAL TREATMENT

By the term "internal treatment" we mean a treatment applied to the boiler direct. Since the boiler must be opened at stated intervals for washouts or, in unusual cases, for running repairs, the application of a treatment placed directly in the boiler may be done at the periods when the boiler is opened for washouts or for repairs.

Since any chemical reaction incident to the use of such a treatment must take place as rapidly as the reagents are brought in touch with their chemical affinities, and since the locomotives will probably operate on the average of ten days between washout periods, it is evident that something other than ordinary chemical reaction must be depended upon for satisfactory results by this method.

The use of mercury has been made practical by a process in its treatment which involves heating and the separation of raw mercury into fine particles, and the addition of a carrying compound which has a primary chemical action in the boilers. It is necessary, however, for the reason just given, to depend on the mechanical action of the mercury, which is a peculiar one, and one which deserves explanation.

It is noted that the boilers which have been treated by

* Concluded from the July issue.

this method are coated, so far as their heating surfaces are concerned, with a black film, sometimes designated as an amalgam, but more properly simply as a "film." This film, however, does not form except the old adhering scale has first been thrown down, by the very process incident to the formation of the film.

The surface film on the heating surface is formed only while under pressure and subject to heat. An oxidization of the mercury which, in connetcion with the iron, cleaned by emulsified kerosene used in the preparation, and in the presence of a powerful alkali salt, forms this film under scale which may have accumluated, forcing it off by expansive action.

This surface coating furnishes a protection against either acid or galvanic action. It appears to stand a sulphuric acid test perfectly, and for this reason pitting troubles are reduced.

This material is put up in stick form about sixteen to eighteen inches long and one inch square, and weighing about one pound each, and is placed in the boilers through the washout plugs after the locomotives have been washed, making it a roundhouse proposition instead of being looked after by the engine crews, thus involving the services of one man for perhaps 150 engines rather than those of 150 enginemen.

The carrying composition, after the boilers have been filld up, gradually dissolves, liberating the infinitesimal particles of mercury, too insufficient in mass to be much affected by gravity. These are carried into circulation all over the boiler until a lodgment is effected, probably in some broken edge of a piece of scale. Naturally every section of broken edge of scale on the boiler plate or tubes is somewhat loose, possibly owing to superior expansion of metal, and is to some extent free from the plate and tubes. Into this crevice a particle or many particles are hurled by the force of circulation, and mechanical exfoliation of the scale is effected. As soon as a particle has been hurled or has insinuated itself into the broken edge, the sudden expansion of the mercury, due to the superior heat of the plate or tube, may have something to do with detaching the hard deposit. Also the fact that the water following the mercury, and meeting the greater heat through the superior conductivity of the mercury, is put into such a rapid state of ebullition that the globules of steam rapidly arise, may have something to do with the detaching of the scale, or it may be the concerted action of both the mercury and water.

We have now come to an important feature connected with the use of this treatment. This is the important matter of making possible a reduction in frequency of boiler washouts. Its effect upon the sludge and mud is to make it very slippery and fine in character, thus robbing the mud of its power to stick to the heating surface and bake, which often causes a mud-burn. This change in character of the mud is very important, as it also makes it possible to blow out of the blow-off cocks a very much greater amount of solid matter than formerly. It will be readily seen that, under these circumstances, as frequent washouts as formerly are not needed, the reduction being from 50 percent on some roads, to as high as 80 percent on others. Since boiler washing is responsible for a considerable amount of upkeep expense on locomotives, besides the valuable time it requires, this represents a very considerable saving. In fact, the cost of this treatment is being saved, and more than saved, on the majority of engines now under treatment, by the reduction in the number of times engines are washed per month. This is a very important fact, and it will be seen that if the cost of this treatment can be saved by a safe reduction in the number of washouts, all the other savings resulting from its use—greater boiler efficiency, less staybolt and flue leakage, longer firebox and flue life, greater reliability of the power, etc.—are clear profit.

Boiler Washing

I do not feel that we should pass over this subject without brief discussion of boiler washing methods. One of the results of the early direction of attention to methods of combating bad water conditions was the discovery that close adherence to carefully conceived rules in the washing of boilers would do wonders in reducing maintenance cost as well as fuel bills.

In the case of the Milwaukee, above referred to, one of the engineers, from those who sought to improve conditions, was selected to direct others in the means by which he had won success on his engine. In the course of events he commenced to get interested in the washing, and was eventually able to interest Mr. Barr and later Mr. Manchester in experimentation with nozzles, boiler plugs, etc.

His success attracted the attention of the American Railway Master Mechanics' Association, and a committee was appointed to look into the matter, with the result that Milwaukee methods were recommended as standard, practically as they had been worked out.

Regardless of whether there is any treatment, boilers must be washed more or less frequently. A thorough job done according to a proper system costs little or no more than a haphazard one, and the good results of the former are too evident for argument.

Boilers are washed more or less frequently as conditions require. On a great many roads the mileage which can be made between washouts is determined solely by the conditions of the water with respect to foaming. In most cases, in such localities, the obviation of foaming troubles automatically reduces the washouts by half or even more.

Foaming

If foaming is caused by concentration of soda ash used as a treatment by itself, or contained in some proprietary compound, then the logical thing to do is to change the treatment. It might be stated parenthetically, the mercury treatment above mentioned does not cause foaming.

If the foaming is caused by suspended matter in the water as taken from its sources, then a good anti-foaming compound is a great economy. It blankets the water in the boiler, holding it down under surprisingly severe conditions. It is easy to handle, and its use is a matter of great interest to enginemen, as it reduces their troubles instantaneously.

There is no deleterious after effects, such as is the case with crude oil. After it has performed its function it disappears from the boiler to the last particle.

An anti-foaming compound should be mixed with the water in the tender tanks, not fed through the injector direct. The proportions required then can be maintained and the most efficient service secured; whereas direct feeding is sure to result in larger quantities being used and inconsistent results being obtained.

Anti-foaming compound should be checked out to engine crews in the same manner as is customary with valve oil. There is no good reason for the indiscriminate handling sometimes found. A minimum figure is obtained by test, and then the allowance should be made slightly larger than this figure to meet unusual conditions.

If its use is systematic, there is a simplicity about the treatment which has its appeal. There is never any difficulty in getting engine crews to use anti-foaming compound, but there is sometimes difficulty in keeping the men from using too much. This does no harm to the boilers, but it increases the expense of treatment, and there is every incentive for close allowance in this compound that there is in the use of any other class of supplies.

It is now the object of the manufacturers to assist in every way possible to reduce to the absolute minimum the amounts of compound used, not to send its representatives forth to increase the amounts used for the sole purpose of incresing sales. Good business policy directs that sales be developed by extension of the use where needed, with the assistance of the records obtained for good, consistent, economical service performed.

John Snares a Decagon

Explanation of Method for Laying Out a Ten-Sided Screen Head

BY JAMES F. HOBART

"Mr. Hobart, will you show me how to lay out a ten-sided sand screen head? The shop has orders for a lot of them to be sent to a machine shop nearby and they have been having trouble in laying off the right shape. The layerout struck a circle right on the sheet, then laid down a diameter and stepped off half the circumference five times with the dividers. Then he scratched lines connecting the five points and went around the other half of the circle same way. Isn't there some way of doing the trick without guessing at the spacing and stepping around the half-circle three or four times until the dividers have been set just right?"

"Yes, John, there are several ways of laying off a ten-sided figure inside a circle, but for time spent you can't beat the half-circle spacing business, not even a little bit. Why, your layerout would have the head all marked out in that manner before you got ready to make a single mark if you went at the problem scientifically by geometry and figures."

"Yes, that may be so, Mr. Hobart, but I'd just like to have the 'know how' of the matter so as to be able to do the stunt when it's necessary. And besides I want to know so as to be able to talk with that confounded professor. He was in the shop again the other day, and I asked him how to lay out a ten-sided figure, and what do you think he told me? He made this sketch, Fig. 1, gave it to me and said:

"'To inscribe a regular decagon in the given circle, draw the radius *OC* and divide it in extreme and mean ratio, so that *OC* shall be to *OS* as *OS* is to *SC*. From *C* as a center with a radius equal to *OS* describe an arc intersecting the circumference at *B* and draw *BC*, which is the side of the regular decagon required.'

"Now, what in all creation did the scientific gink mean by that? I wanted to know how to lay out a ten-sided sand screen head, not a 'decagon.' What is that, anyway?"

"It's just what you asked for, John, a ten-sided figure."

"Well, I should think they might find a decent name for it and not call it by that tongue-twister. Where did they get such a name, anyway?"

"The name is all right, John. They got it from the Greek—dekka, ten, and gonia, corner. And I don't see that it is any worse than the names of other figures which you use every day, as, for instance—octagon, eight-sided, and hexagon, six-sided."

"Yes, but those are everyday words, not Greek things like decagon."

"Oh, yes, they are, John. Octagon comes from two dead languages, 'Octa,' the Latin word for eight, and the same Greek gonia, for corners, meaning eight-cornered, while decagon means ten-cornered. I don't see why the latter is a bit worse than the former. And then there is 'hexagon,' or 'hex,' as you call it in the shop. That comes from the dead languages also. And it is a regular grandchild, for it came to us through two languages, from the Latin 'hexanonum,' which in turn came down from the Greek 'hexagonus,' being made up from 'hex,' six, and the same 'gonia' again. And, John, this Greek word 'gonia,' meaning corner or angle, came, so we are told, from the Greek word 'gonu,' which means a knee. Some stunt, those words and where they came from, isn't it? And it's pretty interesting chasing them up when once you get started after them. But now you see that 'decagon' isn't even half as bad as 'hexagon' and 'octagon,' so why shouldn't it be used instead of ten-sided'?"

"Well, suppose there isn't any good reason? Guess we are apt to be scared by words which we don't understand. That word 'decagon' seems all right after you know about it, but what in all creation did the professor mean when he told me to 'draw the radius *OC* and divide it in extreme and mean ratio'?"

"Let's see that sketch, John, the one the professor gave you. Oh! Here it is, Fig. 1. Now, John, let's carry this right through according to the work you are doing in the shop. How large are the heads you are to make for the sand screens?"

"They are in several sizes, 48-inch to 72-inch. Take the 72-inch one first, that will give a radius of 36 inches."

"All right, then the radius *OC* will be 36 inches, and we will divide it 'in extreme and mean ratio.'"

"Say! Back up, right there. Any ratio is 'mean' enough and 'extreme' enough, I'll admit, but where does it come in here? I thought we had to have two or four numbers in order to get a ratio. Where can it come in with a single line 36 inches long?"

"We'll divide the line into two parts, John. Here! Just look at Fig. 2. That shows the proportion business. There is the line *OC*, 36 inches long, and we want to divide it at *S* so the parts from *S* to *O* and from *S* to *C* will be in a certain ratio to each other and to the whole length of the line."

"Then we will have three things to get a ratio with?"

"Yes, John, I see it now. We have got to cut *OC* at *S*, and we want to locate point *S* so that the three lengths of line will be in a certain ratio to each other."

"Say, I don't get this three-part ratio business yet. If we have 4 and 2, the ratio will be $4 \div 2 = 2$, won't it?

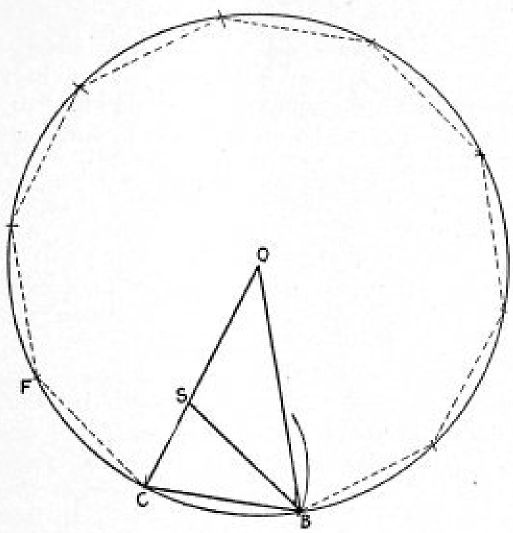


Fig. 1—The Professor's Sketch

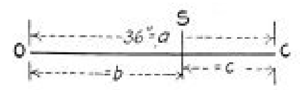


Fig. 2—Extreme and Mean Ratio

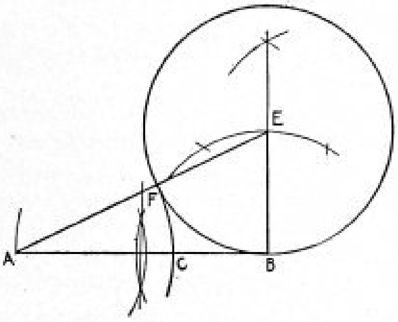


Fig. 3—Finding the Extreme and Mean Ratio

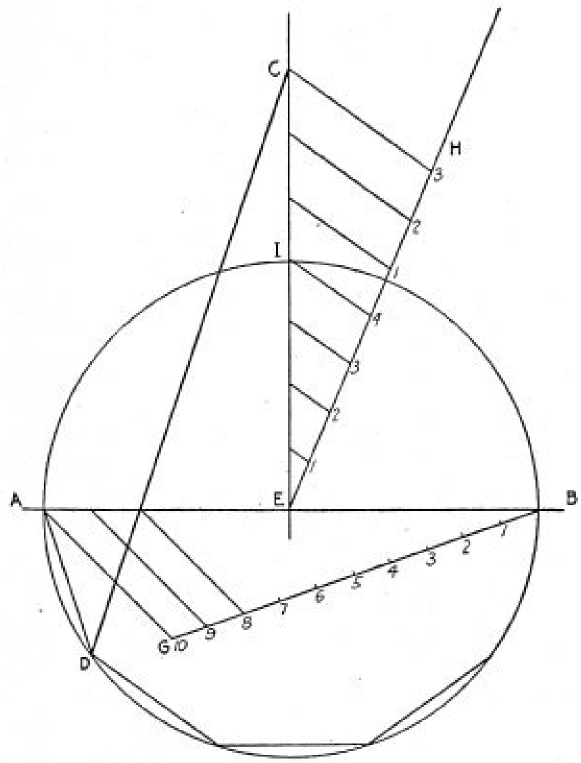


Fig. 4—To Draw a Figure with any Number of Sides

Diagrams for Laying Out Ten-Sided Figure

Now, if we have another number, say 6, and want to use the same ratio then we say $6 \div 2 = 3$. Then we can say, as 4 is to 2, so is 6 to 3, and there we have a ratio business. But I don't see how we are going to strike a ratio between three numbers—or three lines, either."

"Good for you, John. There are times when you do act almost human, and this is one of the times. Now take that 2 and 4 of yours. For convenience we will turn them around say the ratio of 2 to 4 is ½. Now, then, with a ratio of ½, what is the number which has that ratio with 4? 'Eight,' you say? To be sure; and, now, why haven't we got just what we want, a ratio between three numbers, when we say as 2 is to 4 so is 4 to 8? Just put it right into a regular proportion, using the signs, and say, $2:4::4:8$. Isn't that straight?"

"Reckon it is. There don't seem anything the matter with it—$4 \times 4 = 16$, and $16 \div 2 = 8$, so it proves up all right."

"Good, John. Now what is to hinder us from cutting line *OC* in two, making three parts or lengths, counting the whole line as one part, and cutting the two lengths at *S* so as to form an 'extreme and mean ratio,' same as we with with 2, 4 and 8?"

"That will be all right if we can do it, but I don't see just yet how we are going to get a strangle hold on the business."

"Let's take a look at Fig. 2, John. There is the 36-inch line, *OC*, which we want to divide into two parts at *S*, and the problem is to locate *S* so the two parts will fill the bill. Now let's use a little algebra. You aren't afraid of algebra, are you, John?"

"N-n-o. I guess not, if 'tain't too ragged."

"Ragged—that's good. Red rag, I suppose too, and you, John, are a 'bully boy,' and so there is the red rag and the bull when you and algebra get into the same field! But 'buck up.' I won't be very hard with the algebra and you may learn something. Now let's throw away that 36 on the *OC* line and call it '*a*' instead. Then we will call the length of *OS* '*b*' and length of *CS* '*c*.' Here we have got the three lengths of line, with no figures to bother us, so let's make up the ratio and see how it looks. We will say:

$$(1) \quad c : b :: b : a$$

And that is all there is to the matter. Now we will try and find out where to cut line *a* to make *b* and *c* parts of it."

"That isn't hard. Why, it's easy!"

"So is all algebra, John, when you understand it—much easier than arithmetic, for you only handle some letters, instead of dividing and multiplying a bushel or so of figures. But let's get after *b* and *c*. Fig. 3 shows a little stunt for finding the extreme and mean ratio without knowing how long the line is, or anything else about it."

"Phew! that's going some!"

"Just lay down the line *OC*, John, between *A* and *B*, Fig. 3. Next find the middle of this line. The work is there in light lines, so you can see them. After you have found the middle of *AB*, take its half length in the compasses and lay it off from *B* to *A*. It will be necessary first to erect the perpendicular from *B*, and the light lines show this work also. Then with the compasses at *E* draw the circle *EFB* as shown."

"That circle has a diameter equal to the length of line *AB* or *OC*?"

"Yes, John, it has. Next draw the line from *E* to *A* and with the compasses placed at *A* open them until the other leg just touches the circumference of the circle at *F*. Then draw the arc *FC* and where it cuts line *AB*, at *C*, will be the place to cut line *AB* or *C* to secure the extreme and mean proportion we are after."

"Is line *AC*, Fig. 3, same as line *OS*, Fig. 1?"

"Yes, John, you can place the compasses right on *O*, lay down *S* and go ahead, but really you don't have to do even that. The distance in the dividers, *AF*, *AC*, or *OS*, is the distance *BC*, Fig. 1, or the length of one side of a ten-sided figure, and you can use that distance at once and with it step around the circle in Fig. 1, provided you have laid down line *AB*, Fig. 3, same length as *OC*, Fig. 1."

"Well, I'll be drilled and riveted if that isn't a caper across lots for fair. Got the whole thing laid off and haven't had to make a single figure. No matter how large or how small the head, it can be done that way by means of a dozen lines and no figuring, measuring or calculating to be done. But I wonder if the work is accurate?"

"Test it out, John. Of course, you must be careful to place the dividers right on the mark when you are laying off the several distances, but if the work be accurately done, it will come right every time."

"That's fine. And say, I can do the Fig. 3 stunt right on line *OC* in Fig. 1, can't I? That will save making sketch 3 and also prevent possible errors in transferring the length of line *OC* to *AB*, Fig. 3, and, Mr. Hobart, isn't there some way of actually calculating the lengths of lines *b* and *c*, Fig. 2?"

"To be sure there is, John, but it will run right into a little algebra, and I don't want you or the other boys throwing fits until the boiler shop resembles a Spanish bull fight!"

"Oh, no. We won't do that! If you will show me how to figure those lines, I'll make all the other boys 'get out and get under' until they can work the problem as well as I can."

"All right, John. Remember you're to blame if the boys kick at the 'crazy letters and drunken signs.' Go back a bit and pick up that equation we found. The one marked (1), which was $c : b :: b : a$. Now work both ends against the middle and it will become—

$$(2) \quad ca = b^2$$

"But in order to solve this equation, we have got to get rid of all the letters but one, so we will try to find the proper values of *a* and *c*, and put them into the equation in place of those letters. By looking at Fig. 2, we can find a couple of different values for some of the letters. We find that

$$(3) \quad a = 36$$

And we also find that

$$(4) \quad c = 36 - b$$

"Now put these values of *a* and *c* into equation (2) and we find that

$$(5) \quad 36\,(36 - b) = b^2$$

or, $$(6) \quad 1296 - 36b = b^2$$

"Transpose this, and get

$$(7) \quad b^2 + 36b = 1296$$

"Next, we must add enough to both sides of this equation—completing the square, they call it—so we can extract the square root of both sides of the equation and get rid of the second power, or 'square' of *b*. Completing the square in this instance may be done by adding to both members of the equation the square of one-half the coefficient of *b*. That coefficient is 36, one-half of it is 18, and 18 × 18 is 324, which we will add to both members of equation, making it read as follows:

$$(8) \quad b^2 + 36b + 324 = 1620$$

Extracting square root,

$$(9) \quad b + 18 = 40.2491$$

or, $$(10) \quad b = 22.2491$$

But $$(4) \quad c = 36 - b$$

therefore $$(11) \quad c = 36 - 22.2491$$

and $$(12) \quad c = 13.7509$$

"It may be well to call *b* and *c*, respectively, 22.25 and 13.75. To prove this multiply *b* by itself and divide by *a* and we obtain 22.25 × 22.25 = 495.0625, and dividing this by 13.15 we obtain 36.004, which shows the answer to be correct to a very small fraction of an inch, which was due to the incomplete division which we did not carry out to the limit, also to the assuming of even quarters of an inch in the results obtained. Still, the answer is close enough for our purpose."

"Well, say, these algebra gymnastics are all to the good, aren't they? Wish we could twist arithmetic problems around that way!"

"That's where algebra has the advantage, John. In arithmetic you have to perform the actual operations as you come to them, but in algebra you can keep the letters, twist them around to suit convenience, then perhaps get rid of most of them—eliminate they call it—and only have to determine the actual value of one letter in order to solve the problem and then get the values of the other letters from some of the equations same as we did in this example."

"Well, say, geometry and algebra do make some team, don't they?"

"They do, John, for sure. And when you hitch trigonometry up in the same team, then you've got something which can't be beat. Geometry, trigonometry, algebra and 'horse sense' certainly make one of the finest teams the mechanic ever put into the shop. It makes old arithmetic look like thirty cents and 'gets there' before the arithmetic horse gets fairly well started."

"Well, that ten-sided layout is sure some stunt. Wonder if you can do any other sided figures with it?"

"Yes, John, by omitting every other side, you can lay out a 'pentagon, a five-sided figure, and by bisecting each side you can lay out figures with twenty, forty, eighty sides, etc."

"It would be rather convenient, wouldn't it, to have one method by means of which you could lay out any sided figure you wanted, from three up to three thousand, if you wanted that many?"

"I'll give you a method for doing that, John, if you would like it, and then you will be ready for anything from a triangle to a circle."

"You can give me that, Mr. Hobart? Well, shoot it P D Q and I'll get outside of it instantly."

"Here it is in Fig. 4. Draw the circle to the required diameter, then draw the starting diameter *AB*, and on it lay off as many equal spaces from *A* to *B* as there are to be sides in the polygon. Space off the random line *B D* along the edge of a rule, marking even spaces, 1, 2, 3, etc., then place a pair of triangles so *A* and *G* are connected.

(*Continued on page* 263.)

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

Boiler makers, shipbuilders and manufacturers of steel plate for marine boilers have united in a movement to secure modifications in the rules of the United States Steamboat Inspection Service relating to the physical requirements, marking and other details involved in the manufacture of materials for steam boiler construction. Representatives of several of the largest boiler plate manufacturers, forming a committee of the Association of American Steel Manufacturers, have drawn up some suggestions approved by the shipbuilders for the consideration of the supervising inspector general of the Board of Supervising Inspectors.

One point raised is that the rules of the Board of Supervising Inspectors when applied to marine boiler plates over 1¾ inches thick do not lend themselves to workable conditions under the best manufacturing practice; and while the rules can be met in cases of plates up to 1⅜ inches thick, they interpose difficulties which interfere with deliveries.

Another suggestion made is that the minimum elongation in 8 inches, expressed in percent, shall be equivalent to 1,400,000 divided by the tensile strength, with a deduction of ½ percent from the specified percentage for each increase of ⅛ inch in thickness over ¾ inch, to a minimum of 17 percent. The specification of the Steel Manufacturers' Association makes elongation percentage equivalent to 1,450,000 divided by the tensile strength and the minimum for the thicker plates 20 percent. It is also suggested that definite requirements for the reduction of area should be eliminated, though results of this test may be recorded.

In order to facilitate inspection and delivery of plates at the various manufacturing plants, it is suggested that the tensile strength stamped on the plate shall be the minimum of the range specified on the order rather than the actual for each plate. These modifications are in no way detrimental to the quality of the material used, but on the other hand they provide means for overcoming difficulties which interfere with the rapid completion of the work and prompt deliveries. For this reason some agreement should be reached to make the marine boiler plate requirements more easily attained.

Safety engineering for the purpose of reducing the danger of accidents to persons not only while at work, but at other times, has made rapid strides in the past few years Not only is this one of the most commendable movements for social welfare that has been inaugurated in recent years, but the general interest which has been taken in the subject means much for the future of the people of the United States both in the decrease of suffering and in the reduction of economic waste. An important possible development in this connection is pointed out by the Travelers' Insurance Company. Hitherto it has been the tendency to place the entire obligation for accidents on the factory owner, the driver of the vehicle or the operator of the railroad, who are supposed to assume not only the responsibility for the safety of their appliances but the liability for the careless and thoughtless acts of others who come in contact with these appliances. Employees and others must be protected against the hazards of machinery and in addition against their own thoughtless acts. If the safety campaign can be carried on so as to produce equally good results on the part of individuals as well as of corporations, the savings will be tremendous.

Plans are being made for the continuance of the work of the American Uniform Boiler Law Society in promoting the universal adoption of the A. S. M. E. Boiler Code throughout the United States. The results of the work of this society during the past year have been very beneficial. Wide publicity for the boiler code has been gained throughout the United States; as a matter of fact, there is hardly a section of the country where the boiler code has not been vigorously brought to public attention and its advantages outlined.

The strongest efforts of the Uniform Boiler Law Society during the coming year will be concentrated on the States of Connecticut, Michigan, Illinois, Minnesota, Texas, Missouri, Tennessee, Louisiana and New York. The work of this society was well supported financially last year, but the larger scope which the society will cover this year will require funds at least equal to the amount placed at their disposal last year, and probably more. This work deserves the hearty support of every boiler manufacturer as well as of engineers and boiler users.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Vulcan Soot Cleaners

For installation on boilers of the Babcock & Wilcox type with substantially horizontal tubes and vertical baffling, the fundamental principle of the Vulcan soot cleaners, manufactured by the Vulcan Soot Cleaner Company, of Du Bois, Pa., consists in directing powerful steam jets along the diagonal paths at about 60 degrees to the horizontal, as shown in Fig. 1. The cleaner element is mounted on bearings and rotated by a chain and sprocket wheel outside the setting, so that jets of steam discharged from the nozzles arranged longitudinally of the elements are caused to sweep through a wide arc, concentrating their cleaning and scouring action successively on each portion of the tube surface. In the illustration the element has been rotated in the direction of the arrow through 90 degrees of its total travel space of 180 degrees. Sections of the tubes marked *A-A* are being cleaned, and parts *B* are still to be cleaned when further rotation of the element will concentrate the scouring force of the steam jets upon them.

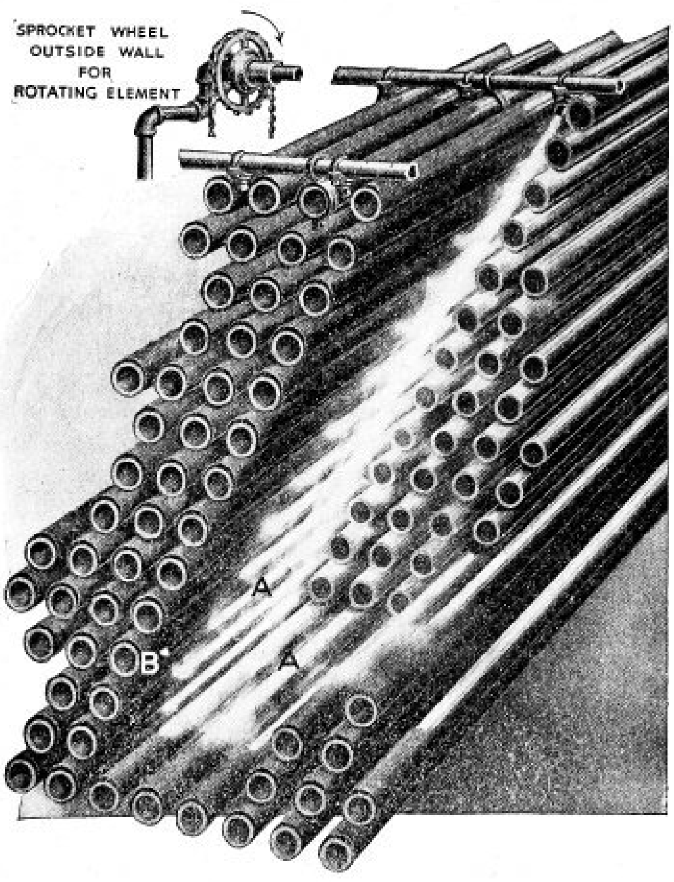


Fig. 1.—The Vulcan Principle of Cleaning Boilers of the B. & W. Type

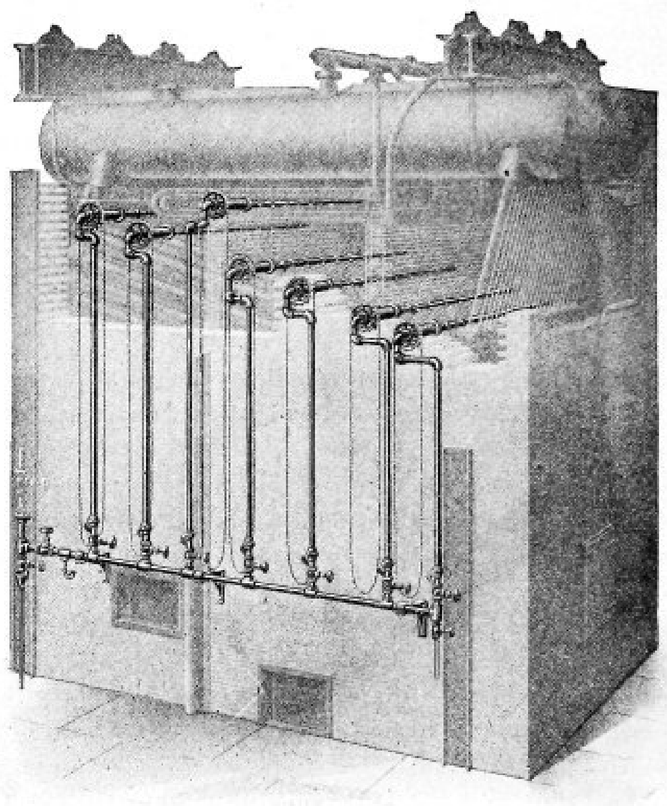


Fig. 2.—B. & W. Boiler and Superheater Equipped with Vulcan Soot Cleaner

The complete installation on a Babcock & Wilcox type boiler is shown in Fig. 2, where the location of the elements for each of the passes, and also for the superheater, are such as to insure concentration of steam-gas currents set up by the discharge of steam from the nozzles on all parts of the heat absorbing surface.

A main steam header is installed along the length of the boiler, with risers and valves for each element, as shown. Operation of the cleaner consists in opening the valves on each riser in rotation, commencing at the left. Cleaning every six or eight hours is generally the best practice.

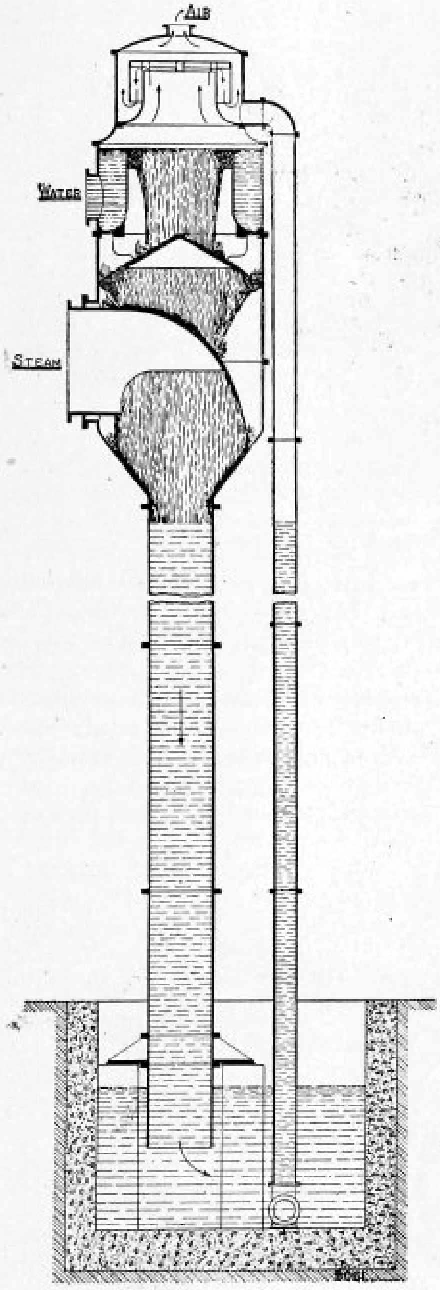
Two important features of Vulcan soot cleaners are the anti-corrosion air relief valves and the tell-tale drain valve, the former located on each of the risers and the latter on the main steam header.

Early in the development of the Vulcan soot cleaner it was found that its future existence as a practical and commercial proposition was seriously threatened by the internal corrosion of the ouside valves and piping.

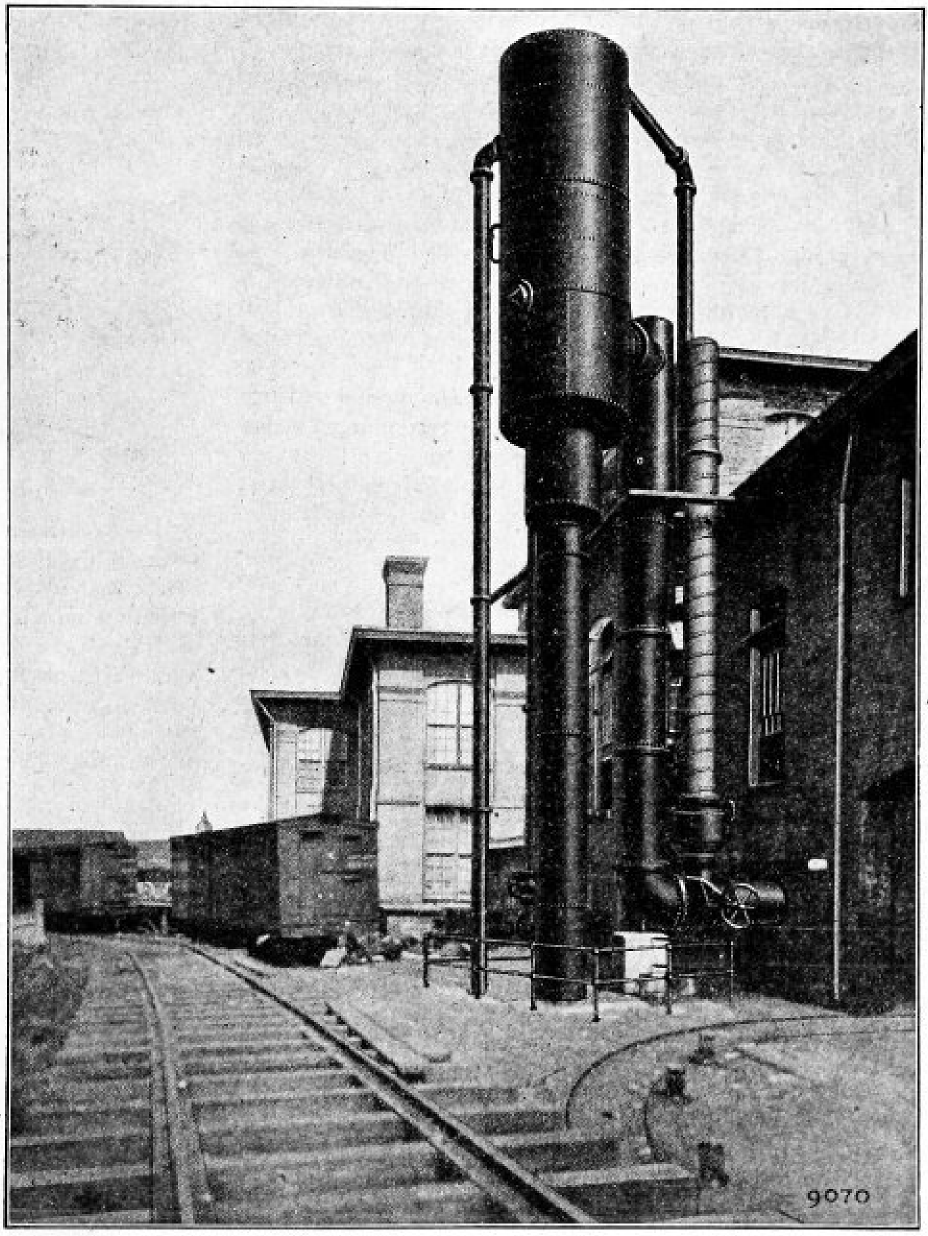
The trouble was caused as follows: Upon closing one of the operating valves the steam contained in the riser condensed, forming a partial vacuum, and as the piping was closed to the atmosphere, the pressure balance could only be restored by the piping being filled with the sulphur-laden furnace gases. The sulphur dioxide in these gases entered into combination with the moisture on the inner walls of the pipes, forming sulphuric acid, the presence of which caused serious erosion of the metal.

Once the cause of trouble was discovered it was very simply corrected by the use of small automatic ball-check valves on all risers from the main header (see Fig. 2). When the steam valve on any riser is closed the ball-check instantly falls away from its seat, opening a minute orifice, through which sufficient air is admitted to restore the balance of pressure within the riser and prevent the entrance of furnace gases.

The automatic tell-tale drain valve is similar in construction to the air relief valve, but considerably larger. Its function is immediately to discharge and indicate any small amount of water which may lead into the header from the steam connection. This prevents the header gradually becoming filled up with condensate which would be blown into the boiler when the cleaner was next operated.



Cross Section Beyer Barometric Condenser



Installation of Beyer Barometric Condenser

Vulcan soot cleaners are in service on practically all types of watertube boilers, on economizers, garbage destructor boilers, waste heat boilers and on oil fired boilers, also on firetube, Manning and Scotch marine boilers.

Beyer Barometric Condenser

The Ingersoll-Rand Company, of New York, is now offering to the trade complete steam condensing plants for all service conditions. This equipment includes the Beyer barometric condenser, for which the company has secured the patent rights, Imperial duplex and Ingersoll-Rogler straight line, reciprocating, dry vacuum pumps and, where required, Cameron simplex and centrifugal pumps.

The Beyer barometric condenser is of the counter-current type, in which air and cooling water flow in opposite directions. The steam inlet is at the bottom of the condensing vessel, the water inlet above and the air removal opening at the top. The sheets of cooling water overflowing the pool at the inlet point meet the entering steam. The two are brought into intimate contact by conical baffle plates assisting the water to absorb to its full capacity the latent heat of the steam. The non-condensible air liberated in the condensing action rises through the falling water to the removal point at the top, being cooled to practically the temperature of the incoming water. It is also to be noted that ample opportunity is given for the removal of the air content of the water before it mixes with the steam. This, the manufacturer points out, not only facilitates the mixing process but permits the removal of air and vapor at a comparatively low temperature—a distinct advantage, as the reduced volume saves in vacuum pumpage horsepower.

The steam inlet is of large diameter to secure low velocity and is hooded in such a way as to discharge the steam into the center of the condensing vessel. The air removal opening is also of ample area and is protracted by a self-draining baffle and trap. This, it is said, positively prevents water being carried over into the vacuum pump.

The hot waste water is discharged through the self-draining tail pipe. This pipe straddles the hot well and rigidly supports the condenser.

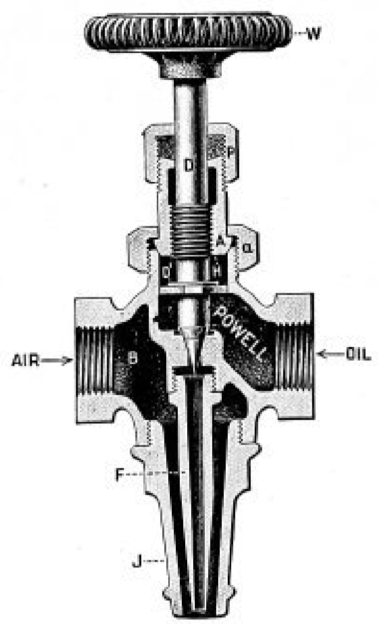
The Imperial and Ingersoll-Rogler vacuum pumps are of the manufacturer's standard type. They are high-speed reciprocating machines, wholly enclosed, automatically lubricated and are said to effect a floor space saving approximating 50 percent over the more common slower speed vacuum pumps.

When a water pump is required to elevate cooling water to the condenser head Cameron pumps are provided. These may be either reciprocating or centrifugal as desired. The Ingersoll-Rand Company, however, emphasizes the fact that where the level of the cold well is of sufficient height above the hot well the condenser will lift its own cooling water, dispensing entirely with a water pump.

The manufacturer in presenting this equipment brings out the point that the vacuum and water pumps, being independently operated, can be regulated to suit varying water temperatures and conditions, and that this plant, in addition to its efficiency in general service, is admirably adapted for duty as a central condensing unit.

Powell Oil Burner Valve

The William Powell Company, Cincinnati, Ohio, has placed on the market the oil burner valve illustrated, which is the result of special tests for proportioning the oil tubes and air nozzle so as to produce the maximum



Cross Section of Oil Burner Valve

amount of heat with the minimum amount of oil and air. The stem is machined with a needle point and fine thread, permitting a close regulation of oil. The oil tube has a long, taper point, adapted for the close control and economy of oil, while the air nozzle is of heavy construction, especially proportioned to meet the general conditions as a spray or atomizing transmitter. It is claimed that the free and unobstructed passage of the oil will not clog or interfere with the proper flow, and can be used in connection with compressed air, blowers, fan-blast or steam.

Q M S Cold Metal Sawing Machine

In the Q M S cold metal sawing machine, illustrated, which has recently been placed on the market by the Vulcan Engineering Sales Company, Chicago, Ill., the saw and gear arbor are of hammered open-hearth .60 carbon steel. The teeth are cut from the solid, and being stag-

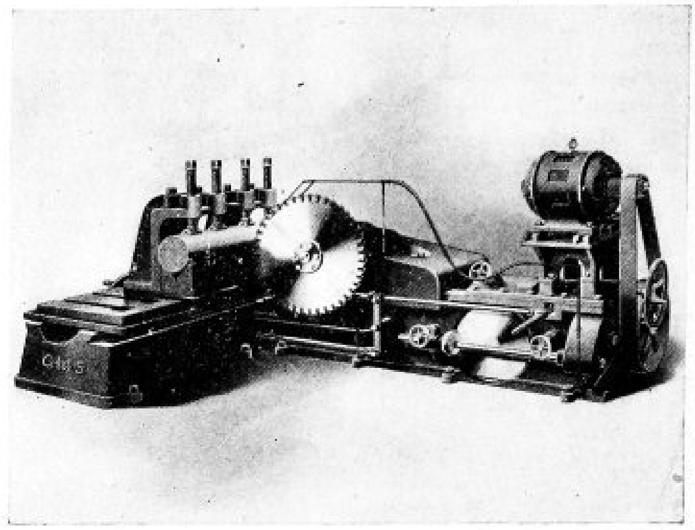


Fig. 1.—Q. M. S. Cold Metal Saw

gered, back lash and resultant clatter of the saw blade are reduced to a minimum. The main drive is through a worm and worm wheel, both encased and run in grease. Roller bearings take the end thrust of the worm. The carriage is of box section, with full-length bearing and hand adjustment, automatic stop and quick power turn. Feed is accomplished by a combination of a friction disk and gears, providing a range of from 5/16 to 2½ inches per minute. The peripheral speed change is instantaneous,

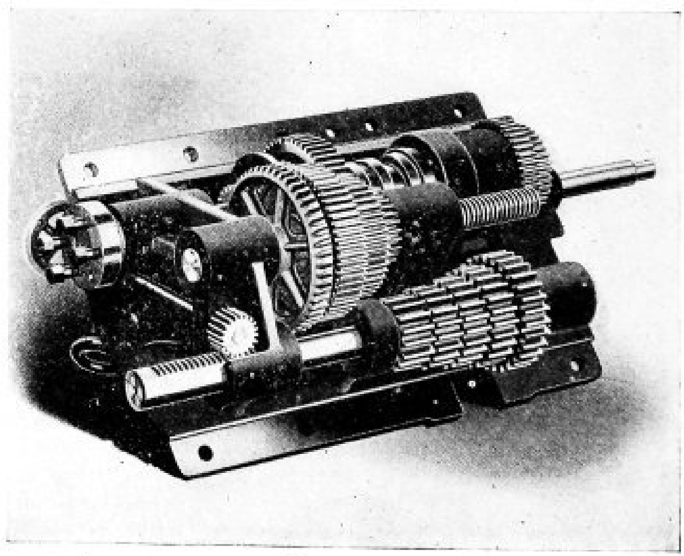


Fig. 2.—Gearing

being arranged to run at either 30 and 50 or 40 and 60 feet per minute as desired. All the gears run in oil, and the internal bearings are lubricated by oil pipes leading to the exterior of the machine.

OBITUARY

John H. Allen died at his summer home, Kattskill Bay, Lake George, N. Y., on July 22. For the last 15 years Mr. Allen has been president of the John F. Allen Company, 370-372 Gerard avenue, New York City, widely known as makers of the original "Allen" riveting machines.

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.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Steel for Steam Boilers

Q.—(1)—What reasons are given for the superiority of firebox steel over flange steel in boiler construction? (2) Where should firebox steel be employed in boiler construction? (3) Does it permit of a higher rate of heat transmission or is it more durable than flange steel? (4) Is it easier worked into shape? (5) Why is it more expensive than flange steel? (6) What are the various grades of steel most commonly used in boiler construction? C. J.

A.—(1) *Firebox* steel, due to the methods employed in its manufacture, is more *homogeneous* than iron, or *flanged steel.* On account of its greater degree of *homogeneity* than flange steel, it withstands to better advantage the severe strain and shocks resulting from the sudden changes in the firebox temperature and action of the fire, during firing. The boiler code of the American Society of Mechanical Engineers for firebox steel requires a test for homogeneity. The object of this test is to show if the seams or layers of the plate are properly welded up and free from blow holes or cavities due to gas bubbles in the ingot and that no waste or foreign matter is interposed. If firebox plate is not uniform in its physical properties, or if it has blow holes, cavities, etc., the action of the fire and the chemicals in the water will cause it to deteriorate rapidly.

(2) Firebox steel, as the name implies, is used for fireboxes and furnaces, which are subjected to great heat and shock.

(3) More durable than flange steel as already explained.

(4) If flange steel has a higher phosphorous content than firebox steel, it is easier worked or shaped in to form by flanging.

(5) Owing to the processes involved in the manufacture of firebox steel to insure homogeneity it costs more to make it than flange steel.

(6) Extra soft steel, firebox steel and flange steel, latter two steels being employed for boiler parts and the soft or mild steel for rivets, braces, staybolts and flues.

Radian

Q.—In looking over the April issue of THE BOILER MAKER I find an article entitled "Camber or Versed Sine," signed by J. L. W. Will you be so kind as to inform me through the medium of THE BOILER MAKER how to compute the 57.3 degrees, or one *radian*? P. H.

A.—From "Wentworth's Plane and Solid Geometry" the following is given which explains clearly the trigonometric functions on angular measure.

As lengths are measured in terms of various conventional units, as the *foot, meter,* etc., so different units for measuring angles are employed, or have been proposed.

In the *common* or *sexagesimal** system the circumference of a circle is divided into 360 equal parts. The angle at the center subtended by each of these parts is taken as the unit angle and is called a *degree.* The degree is subdivided into 60 *minutes* and the minute into 60 *seconds.* A right angle is equal to 90 degrees.

In the circular system an arc of a circle is laid off equal in length to the radius. The angle at the center subtended by this arc is taken as the unit angle and is called a *radian.*

The number of radians in 360 degrees is equal to the number of times the length of the radius is contained in the circumference. It is proved in geometry that this number is 2π ($\pi = 3.1416$) for all circles; therefore the radian is the same angle in all circles. Since the circumference of a circle is 2π times the radius,

$$2\pi \text{ radians} = 360 \text{ degrees, and } \pi \text{ radians} = 180 \text{ degrees;}$$

Therefore,

$$1 \text{ radian} = \frac{180}{\pi} = \frac{180}{3.1416} = 57 \text{ degrees } 17 \text{ minutes } 45 \text{ seconds.}$$

and

$$1 \text{ degree} = \frac{\pi}{180} \text{ radian} = 0.017453 \text{ radian.}$$

By the last two equations the measure of an angle can be changed from radians to degrees or from degrees to radians. Thus,

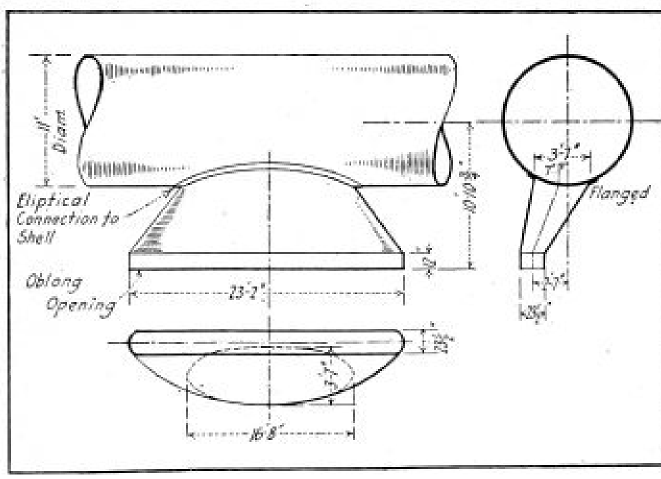
$$2 \text{ radians} = 2 \times \frac{180}{\pi} = 2 \times (57^\circ\ 17'\ 45'') = 114^\circ\ 35'\ 30''.$$

[NOTE.—The circular system came into use early in the last century. It is found more convenient in the higher mathematics, where the radians are simply expressed as numbers. Thus the angle π means π radians, and the angle 3 means 3 radians. On the introduction of the metric system of weights and measures at the close of the last century it was proposed to divide the right angle into 100 equal parts called grades, which were to be taken as units. The grade was subdivided into 100 *minutes* and the minute into 100 *seconds.* This *French* or *centesimal* system, however, never came into actual use.]

*The sexagesimal system was invented by the early Babylonian astronomers in conformity with their year of 360 days.

Layout of an Oblong Tapering Connection

Q.—I am required to develop an object, tapering from an oblong to an elliptical opening, where it intersects a cylinder as illustrated in accompanying sketches. Will you please show how the pattern for the irregular shaped object is developed? Also give the layout for the opening in the pattern of the cylinder. RAY C.



Sketches of Object to be Developed

A.—A general idea of what the shape of the object is like and how it is to be joined to the cylinder may be seen from the pictorial drawing Fig. 1. The main dimensions are indicated thereon so that no difficulty should be had in reading properly the plan and elevation views, Fig. 2. Owing to the size of piece *A,* it will be necessary to make

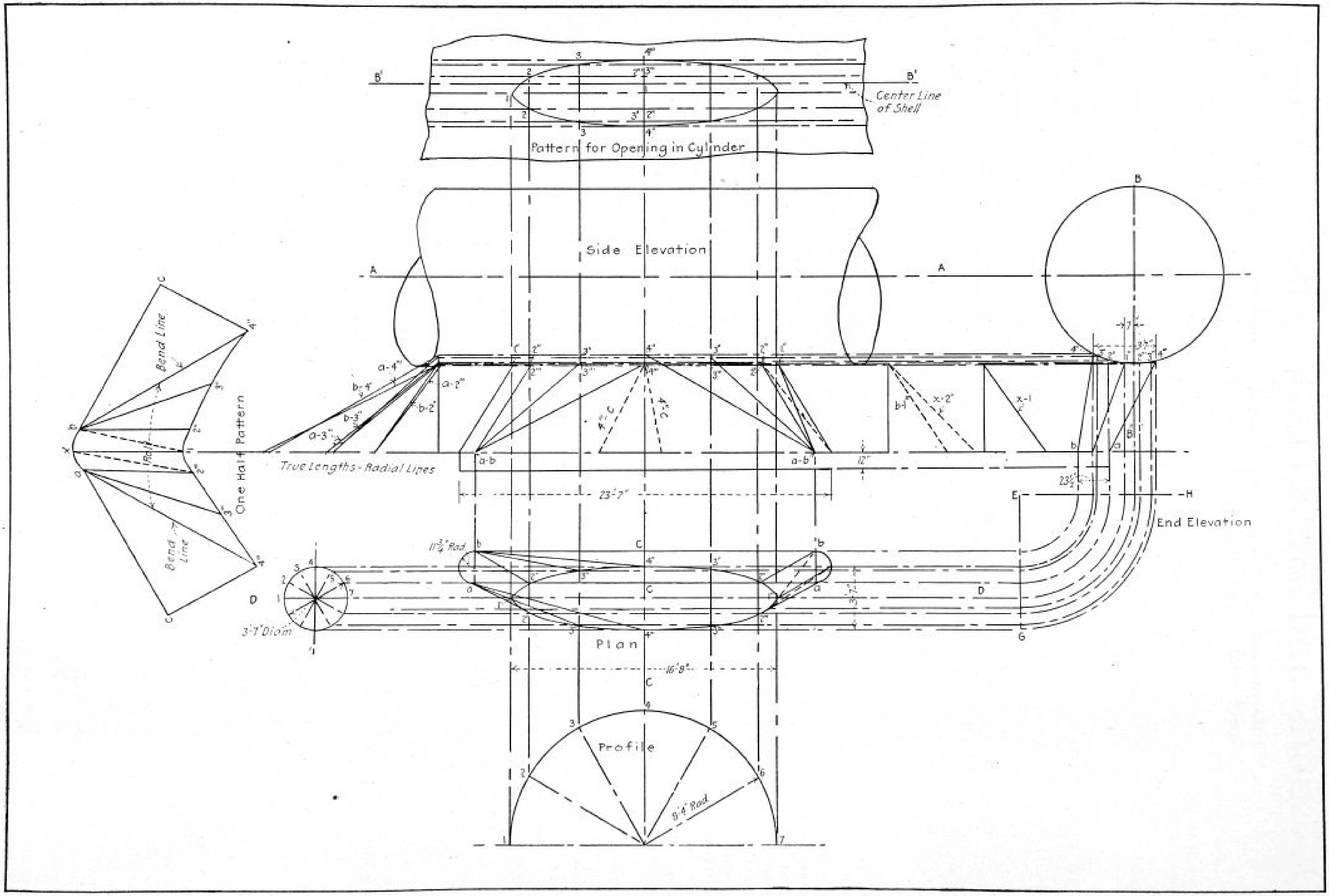


Fig. 2.—Construction Lines and Patterns

it out of several sheets of metal, but the purpose here is to show how the miter between the transition piece *A* and cylinder *B* is determined and the other data essential for the development of their patterns.

Construction.—First draw the horizontal axis *AA* of the cylinder Fig. 2, and vertical axis *CC*. Lay off from *AA* the distance 10 feet 10¾ inches upon line *CC*, to locate the position of the oblong opening. Make its length 23 feet 2 inches. There is a strip of metal 12 inches wide that joins the object *A*, but as it is straight throughout its entire length, no development is needed for laying off its pattern. To the right of the side view, draw the end view, locating the view of *A* according to the dimensions shown. Next establish the plan view, which in this case requires a layout of the elliptical opening for the object *A* where it joins the cylinder. The major axis of the ellipse is 16 feet 8 inches long and the smaller or minor axis is

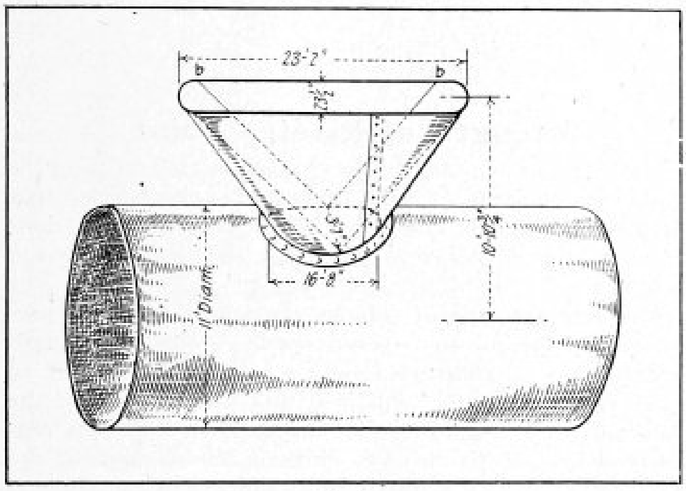


Fig. 1

3 feet 7 inches long. Upon the line *CC* locate a convenient center, from which describe a semi-circle with a radius equal to half the length of the major axis 16 feet 8 inches. Upon *DD* draw a circle 3 feet 7 inches in diameter, and divide it into a number of equal parts. Do likewise with the semi-circle as shown. Develop the ellipse by drawing the vertical lines from points 1, 2, 3, 4, etc., from the semi-circle, and the horizontal lines from the corresponding points of the circle, thus locating the points 1', 2'', 3'', 4'', 2''', 3''', 4''', etc. Through points draw in the outline the ellipse.

For convenience in drawing the plan view, two axes *EH* and *EG* may be drawn, about which the points on the end view may be revolved to the plan or vice versa, thus affording a means by which each step may be readily followed without confusion. The use of these axes will be understood from the drawing. The oblong opening is next drawn in position. Its center is 2 feet 7 inches from the center *BB*, shown in the end view. The ends are rounded off with a radius equal to ½ the width which is 23½ inches. From point *a* draw radial lines to the points 1', 2''', 3''', 4'''; from *b* draw lines to 2'', 3'', 4''. Before the true length of these radial lines can be found it is required to lay off the triangles used for obtaining their true lengths. It is well in this case to develop the miter in the side view before explaining the construction of these triangles. The miter is found by extending the vertical lines used in developing the ellipse, plan view. Then draw the horizontal lines from the corresponding points located in the side view to intersect the verticals as at 1', 2'', 3'', 4'', 2''', 3''', 4'''.

Construction of Triangles.—Extend the base line from points *a* and *b* in the side view. Perpendicular to the base erect a line upon which is to be located the heights of the different points as 2'', 3'', 4'' 2''', etc., above it. This may be done by extending the horizontal lines from these points as shown. Transfer from plan, the distances *a*-2''', *a*-3''', *a*-4''', *b*-2'', *b*-3'', *b*-4'', and locate them as shown to the left of the side elevation. Connect the bases with their corresponding heights which establishes the true lengths of these radial lines. The end sections of the transition piece taper from a semicircular shape to an elliptical one at the miter line. Owing to their shape, which is the same for both ends, it is necessary to divide its outline in the plan and elevation into a number of triangles. As the drawing is made to a very small scale, only a few triangles are used, but for very close work more are needed. However, the ones given and as they are applied in the construction will bring out the principle. To avoid confusion the end section shown to the right in the plan is divided up as mentioned, and the true lengths of lines are indicated to the right of the side view.

Development of Opening in the Pattern for the Cylinder.—Draw the line *B' B'* and locate the point 1 from it equal in distance to the arc length between point 1 and the center line *BB* of the end view. Then from point 1 lay off the distance 1-2'', 2''-3'', 3''-4'', etc., equal to the corresponding arc lengths between these points of the end view. Erect the verticals from the points in the side elevation to intersect as shown at 1-2-3-4, etc. The arc lengths between these points are to be used in laying off a part of the pattern as described further on.

Layout of Pattern.—Only one-half of the pattern is represented. As it would be made in a number of sections, the layerout would develop its entire outline and then break it where the seams should come. In this case it is broken through the center, as from 4'' to *c* for one side, and 4''' to *c* for the opposite side. The true lengths of the distance between points 4''-*c* and 4'''-*c* are shown in the side view. Draw a straight line and upon it lay off the length *x*-1 of the triangles. From point *x* in the pattern, and with the arc length *x*-*b* of the plan, draw two arcs. With *b*-1 of the triangles as a radius and point 1 as a center in the pattern, draw an arc intersecting at point *b*. With *x* as a center and *x*-2''' of the triangles as a radius, draw an arc locating point 2 in the pattern. Continue in this way, using the triangles for the true developers and the spaces in the opening of the shell until the pattern is complete.

When a patch has to be put on with a patch bolt, one way to proceed in order to get a first class job is as follows: Cut the patch to size required and burr the edges. Locate and center punch for the holes and drill them tapping size, not the body size of the bolt. Lay the piece on the boiler and drill one hole, using the drilled patch as a template. Then tap the single hole in the boiler, open out the hole in patch to body size used to locate the single hole and countersink it. Put the patch back and make it fast to the boiler by means of a single patch bolt, screwing it up good and solid. Now drill all the other patch bolt holes in the boiler from the drilled patch. Remove patch and tap all the holes in the boiler. Open out the patch holes to body size and countersink them. Care should be taken in countersinking to have the countersink leave a smooth, concentric cut, otherwise the cone-shaped head of the bolt will not fit snugly and much calking will have to be resorted to. It is well to have the holes in the patch a little larger than body size. This system will be found to take less time than the usual method and will give better results.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

A Case of Carelessness

Recently the writer received a call to repair a boiler at a manufacturing plant. Upon arrival at the plant we found a Heine watertube boiler with eighty-seven 3½-inch by 16-foot tubes. The night fireman had opened the blow-off valve to blow off his boiler, but had forgotten to close it, consequently all the water ran out of the boiler. With a hot coal fire on the grates, the result was about 6 feet of burnt-out tubes, including about one-third of the total number of tubes directly over the grates. The other tubes were also badly burned and bent. Some were melted together so that they had to be taken out in clusters of three and four. The bottom half of the steam drum was burned and warped to such an extent that it had to be renewed the entire length and the staybolts had to be riveted and calked.

As there was only one other small tubular boiler at the plant, they were unable to run the plant by steam power, and were obliged to install a dynamo until the burnt out boiler was repaired. We were obliged to work on the job night and day in order to avoid delays.

A safety alarm fusible plug was attached to the boiler, but it has failed to operate. As these plugs do not melt under 90 pounds pressure, this fact shows that the boiler pressure was below that point. It was fortunate that the fireman did not discover his mistake sooner; for if he had started his feed pump there would have been a disastrous explosion.

A fireman has no business to leave his blow-off valve when blowing off his boiler. W. F. M.

Which is the Best Boiler Maker?

Mr. G. Lacey in the May issue selects Wright over Jimmie O'Connor as a man to keep when it comes to a matter of a lay off or to hire preferably if a man is wanted in your boiler shop. I take just the opposite view, as O'Connor possesses the great advantage of being a better workman.

Now, as a proprietor of a boiler shop I hire workmen to do work and not to answer questions concerning tank capacities, strengths, strains, etc. Such questions should not be put to boiler makers, according to my notion.

As O'Connor was a skilled boiler maker, of course he knew at once from the thickness of the plates and size of the rivets whether he was working on a high pressure boiler, a tank or a smoke stack. He was, in fact, according to his description, an ideal boiler maker. I have seen such men. They have always been scarce and always will be. I have seen one or two men like Wright; and while I like to see a man who studies, a little learning is sometimes a dangerous thing, and a man like Wright can cause trouble at times by answering questions, as the following illustrates:

The proprietor of a large establishment (not a practical man) asked the foreman in charge of a gang of boiler makers if a feed water heater would save money, and was told by the foreman that it surely would. Then he asked how big a one he would have to put on the boiler that was being erected, and the foreman figured it out, and the proprietor ordered a feed water heater. When it had arrived the superintendent of the place wanted to know why the proprietor had ordered it for that particular boiler, and was told that it was because it would save money, but it took the superintendent an hour to show the proprietor that while a feed water heater was a good thing in many places, in this case the water came from a lot of steam vats to a hot well at a temperature of a little over 200 degrees, therefore a feed water heater was in this case useless.

No, Mr. Editor, I want Jimmie O'Connor, and I consider him a much better man for the boiler trade than Mr. Wright. JOHN BROWN.

Providence, R. I.

Strength of Riveted Joint

The "Questions for Readers to Answer," on page 82 of the March issue of THE BOILER MAKER, indicate that "Inquisitive" is not satisfied with the short explanations given in text-books regarding the strength of riveted joints.

Although the type of joint is not mentioned, it is presumed that the questions refer to a butt joint of standard design, such as illustrated in Fig. 2, and in answer to question "1" it can be explained that the strength of the plate along the line of rivets, marked A in Fig. 2, is represented by $P\text{-}d \times t \times TS$, which is the strength of the metal after the hole is removed, in which P is the pitch of the rivets, d the diameter of the rivet hole, t the thickness of the shell plate and TS is the tensile strength of the steel.

The strength of the metal along line of rivets marked B is represented by $P - 2d \times t \times TS$, so it can be readily seen that the difference in the strength of the plate along lines A and B is due to the extra rivet hole along the line B, as indicated by the arrow.

Of course, this difference in strength is equal to the diameter of the rivet hole multiplied by the thickness, and then by the tensile strength of the plate, but should the seam fail along the line B it will be necessary for the rivets in line A to fail also by shearing, or by the heads pulling off and the shanks pulling out of the holes. In well-proportioned work there is little probability of the failure of the rivets other than by shearing, so the strength of each rivet along line A would be found by multiplying the area of the driven rivet by 44,000 pounds, if steel rivets were used.

It will be seen that while the strength of the plate along the rivet line B has been decreased by the removal of the metal for the additional rivet holes, the failure of the joint would also involve the shearing of the rivets along line A, therefore the relative efficiency of the joints along the line of rivets A and along the line of rivets B depends upon the strength of the metal removed in forming the additional rivet hole, and the shearing strength of the rivet along line A, which may be expressed formulatively as follows:

$$d \times t \times TS = A \times SS, \text{ or}$$

$$d \times t \times 60{,}000 = d^2 \times .7854 \times 44{,}000, \text{ which gives,}$$

when solved,

$$\frac{d}{t} = 1.75 \text{ — approximately.}$$

So if the diameter of the rivet hole is 1-75/100 times the thickness of the plate used, the strength of the joint will be less along the rivet line *A* than along line *B*.

Fig. 1 shows a cross section of the quadruple riveted joint shown in Fig. 2, while Fig. 3 shows the manner in which the rivets on one side of the joint would fail by shearing.

It will be seen that the rivets in the outer rows, marked *A* and *B* in Fig. 2, would shear at but one place, while the rivets in the inner rows, marked *C* and *D* in Fig. 2, which, passing through both butt straps and the plate, would shear at two places. From this illustration it can be understood that the rivets in rows *A* and *B* are in single shear, while those in rows *C* and *D* are in double shear.

The question of what to do with a pitted boiler is one which causes a great deal of worry to the builders, owners

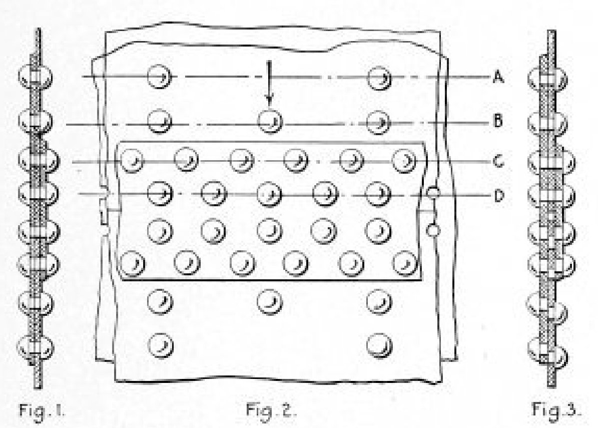


Diagram of Quadruple Riveted Joint

and inspectors, and the phrase "sightly pitted" is susceptible of a wide range in meaning, but if it were understood as meaning but four or five pitted spots, the strength of the boiler would not be materially impaired, providing, of course, the action which results in pitting is eliminated.

The safe working pressure of a boiler is based upon the strength of the longitudinal joints, so that unless pitting has affected the joints, or reduced the strength of other parts of the boiler until they are weaker than the joint, the factor of safety will not be disturbed.

Assuming that the longitudinal seams of the boiler are of the quadruple riveted butt joint type having an efficiency of approximately 94 percent, the other parts of the boiler may be weakened 6 percent before they are as weak as the seam, and should the longitudinal seams be of the double riveted lap joint type, having an efficiency of approximately 70 percent, the other parts of the boiler may be weakened 30 percent before the factor of safety is lowered.

Of course the extent to which the boiler built with any other type of seams may be weakened before its safety is affected can be determined by subtracting the efficiency of the seam from 100 percent.

Those acquainted with boiler inspection will understand that a 30 percent deterioration of the shell plates would be so pronounced as to alarm both the inspector and operator, in spite of the fact their logic might convince them that the boiler could be safely operated.

Pitting of the shell plates of a boiler may be retarded, if not entirely eliminated, by thoroughly cleaning the affected parts and coating them with a skin-like layer of flake graphite. No doubt the action will continue elsewhere, but those parts may then be treated and the effects of the action so decreased that it will not be of serious importance. It may be necessary to renew the coating of graphite from time to time, which would require but a few moments' work.

Bumped Head.

Gray Hairs—What Shall We Do with Them?

In my youth I worked very close to a large puddling mill, and have often heard the question asked, What becomes of the old puddlers? The usual answer was that they turned into gray horses.

The trade of puddling, now almost forgotten, is a hard one, and one that requires great strength in the working of the iron and to withstand the intense heat thrown off by the furnace. The strain upon the system of men engaged at this trade is so severe that their lives are usually short, and the man who works at it until he is an old man must have a constitution of iron. For this reason many men not yet in middle life have been compelled to throw up the job, and seek something lighter, after their health has been broken down and they have become totally unfit for anything that requires strength and activity. If the man has been thrifty he may have a little bank account to fall back upon, but if he has been improvident he turns into a gray horse and is forgotten.

Now the trade of boiler making is a very hard one, and can be generally classed as a parallel case with that of puddling. The boiler maker does not, as a rule, stand the heat that the puddler does, only at times, say when there is a leaky seam at the bottom of an oil still and rivets are to be changed, while the bricks are still red hot and the soles of your shoes shrivel up, or when a broken grate bar has to be removed close up to the flue sheet under the brick arch. That is the time that the strength and vitality are sapped out of the body of the unfortunate man employed to do the job.

There are lots of situations in which the boiler maker gets his share of heat. Go to any roundhouse, look at the men who have followed hot work for any length of time, and what do you see? A man not yet in middle life with hair turning gray, stooped shoulders, lopsided and often crippled with rheumatism—in fact, an old man before he is past his prime. Now, I think it would be a fair question to ask, What becomes of our old boiler makers?

Those of our readers who will give it a passing thought will be surprised to know that many men well known to them have passed out of their lives because they have found work at something lighter than boiler making. The writer knows four young men, good mechanics, who are to-day locomotive engineers, having left the trade while yet there was time for them to get something better to do at which they can work until they are old and gray, and many years beyond the time that they could hold their own in the boiler shop.

The age limit of 45 years, at which some of our large firms and railway companies have set the mark for employing men, and this only temporary, is working a hardship among men that are over that age. In fact, to secure a permanent job, in many shops you must secure a job before the age of 35. If by chance you are hired after attaining the age of 45, it will be for one year only, when you are laid off, and should there be a rush of work they hire you again from time to time.

Now, is there any wonder that men with such conditions staring them in the face look out for work at something where those conditions do not exist?

Again, a man goes to work for a firm at the age of 35, works for 10 or 15 years faithfully, giving the best there is in him. There is a change in the management, his services are no longer required, he is removed to make room for a friend of someone higher up. Past the age limit, with a nice crop of gray hair, he is cast adrift. What are his chances of getting another job? Mighty slim, for now he is 45 years old or more, with gray hair. He goes from shop to shop, asking for work, and one glance at his head is enough for the average foreman, who are generally too busy to pay any further attention to the gray-haired man.

A case of this kind occurred here not long ago. A gray head made the rounds of the shops, being refused work right along. This going around was kept up for some considerable time, until one of the foremen, who had noticed the man calling so often, got interested in the man to the extent that he asked the man if he knew the reason why he could not get work. The man replied that it was a mystery to him, so the foreman told him it was his gray hair. "Well!" exclaimed the man, "if that is the only reason, I will soon have work." Returning home, he called upon his barber and asked him if he could dye his hair. He was told it could be done. In a week's time the dyeing process was finished and he started out to get a job. Calling at one of the shops where he had been turned down repeatedly, he struck a job. His appearance was so much changed that he was not recognized.

The uncertainty of work at any shop to-day is surprising, and it not only reaches the common boiler maker, but the layerout and the foreman as well. Here is a case in point: A young man started with a firm, then in its infancy, worked hard and helped to build up the firm until the capacity of the shop had reached about 400 percent of what it was when he first went with them. In fact, he had grown old and gray in their service. His prospects were good for ending his days with them, but one day the Grim Reaper called the manager away, then there was a change. The old foreman went on his vacation, as he had done many times before. At its expiration he returned to the shop to take up his duties, when he was met by the manager and told that there was a man in his place (put there clandestinely in his absence). Now, my readers, did any of you ever hear of anything so mean? I think not. I am glad to say that the firm did not forget the old veteran, but pensioned him. Talking to him recently, he told the writer that he was just beginning to know what living was.

Another case of a foreman being discharged (and by the same manager but at another works) for some trifling affair. This man had grown old and gray with this company. At the time of his discharge there was a very large order in the shop, and the work was being done on the reputation of the company, without any inspector. Knowing this, the discharged foreman wrote to the people getting the boilers for the job of inspecting, which he got, and I am told that there were lively doings in that shop for some time.

At one time a man well on in years, and gray, asked the writer for work, saying he was a locomotive boiler maker. He was put to work putting in corner plugs, a job that he ought to have been able to do easily. Seeing that the job was too much for him, he was taken to one side from the other men and talked to, when it came out that he had left a good, easy job at C—— on account of some little family trouble, but that the job still held good. He was given an order for his time, and persuaded to go home before it was too late.

Many cases of men being discharged after years of faithful service, when they have become entirely unfit and unprepared to go out into the world and begin life over again, are known to the writer. I think that is one of the greatest mistakes ever made, to discharge or discard a man because his hair is gray. Many men are gray at 25, so that gray hair is no guide for any foreman or manager to go by, and there are men at 60 and 65 with white hair who are physically fit for anything. The weight of responsibility resting on the foreman or manager who discharges a man on account of gray hair alone must be something terrible. The foreman, at least, is not sure of his job, but the manager is generally safe for five years.

I have often heard it said by men that they would get out of the trade if they could get a job that would pay them as much as boiler making. I am well aware that there are shops that take care of their old men and provide easy jobs for them. The arduous nature of the work is such that, like the puddler, all men cannot stand it, and have to look out for something easy. Unlike the pattern maker, the machinist or carpenter, who can work at the bench until they are 75 years old, the boiler maker who reaches that age is a very rare bird. I have seen a few of them. They were sorry sights to look at. To the foreman boiler maker I would say: "My friend, if you are a young man, with life just staring you in the face, and you have men old and gray working under you, treat them kindly, be considerate, give them a smile or a word of cheer in passing. Remember that you are traveling over the same road that they have already trod; you are losing nothing by doing so. And remember, above all, that your job is just as uncertain as the men under you." The intelligent boiler maker at 60, with his years of experience, should be an acquisition to any shop, a man that any foreman ought to be proud of, to whom he could go for many a little pointer, and feel no shame in doing so.

I trust that the day is not far distant when the age limit and the physical examination, and above all the abominable practice of taking the finger prints of shop men, will be done away with, that the gray-haired man will be considered in hiring and discharging men, for there is no good reason why a boiler maker should turn into a gray horse. He has learned a trade that to-day is second to none, where the greatest skill and the best judgment possible must be brought forth. All things considered, the man of 60, with his gray hair, should be as valuable to his employer as the man of 25 years. FLEX IBLE.

Pittsburgh, Pa.

The Old-Time Boiler Makers

In reading Mr. Roberts' article in this May issue of THE BOILER MAKER, I am surprised when he says a foreman boiler maker of over 20 years ago was not the best in those days. I don't know where he got his experience. I know that from 40 to 60 years ago the foreman had to know his business from A to Z if he wanted to hold his job. I mean he had served his time from rivet boy up.

In those days he had no layer-out. That is, in most shops I have known them to do the laying out, and he had to be careful whether the pitch came 2⅛ or 8½ inches. It was the practice then (that is, when rivets were driven by hand) if a riveter was wanted to advertise for a riveter or calker. If a foreman was wanted a boiler maker was advertised for.

Nowadays the foreman gets blue prints from the office and gives them to the layer-out, probably the only boiler maker in the shop, for you cannot possibly call the man at the rolls a boiler maker, or the man that punches the sheets, or the one who manipulates the bull, or the one who holds the gun. These are handy men, and the majority of them will know as much about a boiler as a hog about his great-grandfather.

The foremen of to-day probably will have a technical education, although not all of them, as some may have worked their way up. Men know what they are up against, but one with only a theoretical knowledge is not in it very deep. Mr. Roberts says near the end of his piece: "If we proceed to the well-arranged shop of to-day you will find a very fine class of well trained workmen who have studied out triangulation and all the modern methods of laying out, whereas 20 years ago it was all by rule of thumb." Somebody must have been "stuffing" him, don't you think?

Now, I do not think there is much change in rules for getting the stresses or strains on boilers. They had to be built to carry so much pressure, if it was only 14 pounds to the square inch. The tensile strength of the metal was on the sheets as it is to-day, and the formulas for getting the strength of seams, staybolts, etc., 60 or 70 years ago were the same as to-day.

Now, if Mr. Roberts had only seen some of the boilers built 50 or 60 years ago, I do not think he would have had such a poor opinion of the old-time boiler maker. I am sorry to say he is not the only one that has run the old fellows down, and they are the very ones that have made all the improvement in boiler making that is on deck to-day.

Let us see what some of the differences are. The shop of to-day has a force of draftsmen to make drawings of the boiler, with all dimensions given, distance and size of rivets marked. The boiler maker of 30 or 40 or more years ago had a sketch of the boiler wanted. He had to calculate the distance of holes apart so as to come up to government rules for the pressure needed.

Of course, there were no such pressures, neither were there as thick plates or as large rivets. If there had been, they could not have been used, as very few shops had steam or hydraulic riveters 50 years ago. About the heaviest plates were 5/16 or 3/8 inch, used for shells, 1/2 inch for heads and not over 48 inches at that in one sheet.

Fifty years ago I have seen firebox boilers made of 1/2-inch iron for shells and 3/8-inch heads tested to 150 pounds by firing them up to get the pressure on.

I have seen boilers in the oil region of Pennsylvania where no one could tell how much steam was being carried, as over 100 pounds of scrap steel was hung on the end of the safety-valve lever with the ball belonging to it. Still, according to a lot of would-be scientific boiler makers, the old fellows who built them were boobs. I have seen boilers made of 5/16-inch iron shell and 3/8-inch heads 8 feet diameter with two fireboxes carrying 150 pounds of steam—in bad weather, too—on the lakes.

John Cook.

John Snares a Decagon

(*Concluded from page 252.*)

Draw the parallel lines *G*-10, *G*-9, *G*-8. Only *G*-8, the second space from *A*, will be needed. Next erect the perpendicular *E I*, and produce it upward to *C*. To find this point, divide the radius *E I* into four equal parts by running the random line *E H* and drawing lines parallel to 4 *I*. Draw three lines, same spacing, outside of the circle. The third line will locate point *C*, through which draw the diagonal *C D*, passing through *A B* at the second point from *A*. Connect points *A* and *D* and the line between them will be one side of the required polygon—in this, a decagon, or ten-sided figure. The remaining sides may be found by spacing around the circumference with the distance *A D* in the dividers, or several of the points may be found in the circumference by carrying the points in line *B G* to diameter *A B*, and then throwing diagonals through these points on *A B* to the circumference. Alternate points on line *A B* will give points on circumference *A D B*."

"By the big dolly bar, that one surely is a 'peach.' Say, I like it better than the way the professor gave me. I'll put that where the dogs won't carry it off, you bet. And say, Mr. Hobart, what stunt are you going to give me next time? I would like to be wise to it, and I would make the boys work like all get out!"

"What would you like, John? Just write to the editor of The Boiler Maker, tell him what you want, and he will see that I get your word. Some of the stunts you have been working were asked by somebody in the shop, and I just like to tackle any of the problems you boys are interested in. Don't be bashful. Send in your questions and I'll do the best I can with 'em."

Scientific Management and Labor

A REVIEW BY L. C. MARSHALL*

Efficiency of some sort has always been the key to business success and general welfare. Most employers will agree that inefficient labor and lack of interest, ambition and good will on the part of the workers are the greatest present obstructions to increased and improved output, the lowering of productive costs, and wage advances. It is evident, then, that if further rapid advance is to be made toward the goal of efficiency, the labor aspect of the matter must receive more careful attention. Something must be done to secure better preliminary training of workers; more efficient methods of selecting and hiring must be devised; better means must be found for discovering the quality and aptitudes of the men so that they may be more surely and quickly fitted into the work which they are best able to do; better methods for shop instruction and training must be created; direct means must be evolved for stimulating interest and effort; the suspicions of the workers toward their employers must be removed, and some way must be found for overcoming the general opposition of organized labor to improved processes and methods and their present attitude toward limitation of output.

It is apparent that problems of this nature cannot be solved by theorists. They must be worked out in the shop. It is of the greatest importance, therefore, that we should know what the most advanced employers are trying to do with respect to these matters; what they have succeeded in accomplishing; where and why they have failed; what the objections of the workers are to the advanced methods which are being introduced, and just why they are moved to adopt their peculiar attitudes and policies in opposition to them.

A book has just appeared from the press of D. Appleton & Co., which goes far toward giving a practical answer to these questions. It is called "Scientific Management and Labor," and summarizes the results of a broad and thorough study, extending over a year, of shops where advanced methods are in process of application. This study was made by three men well qualified for the work—Robert F. Hoxie, of Chicago, who has been engaged for many years in the investigation of labor problems; Robert G. Valentine, of Boston, industrial counselor and expert on employing management, and John P. Frey, of

*Dean of the College of Commerce and Administration, University of Chicago.

Cincinnati, labor expert, and editor of the *International Molders' Journal.*

The book begins with a careful analysis of the claims of scientific managers relative to labor and labor methods, the objections of organized labor to scientific management, and the possible benefits of scientific management to labor. In the body of the text it presents a great number of interesting and valuable suggestions and criticisms based on the actual methods employed in the shops studied and the results achieved. These cover: The installation of the systems; functional foremanship, as it affects labor; the selection and hiring of workmen; adaptation, instruction and training of workers; time study and task setting, their purposes, methods and results; methods of payment and their operation; the protection of the workers from over-exertion and exhaustion; the methods of advancement and promotion, discipline and discharge employed, the resulting labor turnover, etc. It gives also the results of the investigation with respect to the general relationships of employers and workers in scientific management shops, and the general effects of the systems on labor, together with labor's attitude toward them and the causes involved. In the appendix a full statement is made of the vital points at issue between scientific management and organized labor, and an analysis of the fundamental and specific facts which are required as a basis of judgment with regard to the labor standards of any shop, and the means necessary to raise them.

While the book is no manual of technique, the employer who is concerned to know what labor problems are likely to be involved, and what difficulties encountered, in the installation of advanced management systems; how these problems and difficulties are being met and with what success; what underlies the opposition of labor and what is involved in overcoming this opposition, or who wishes to rate his own shop with reference to advanced management labor methods will find in this volume much food for thought.

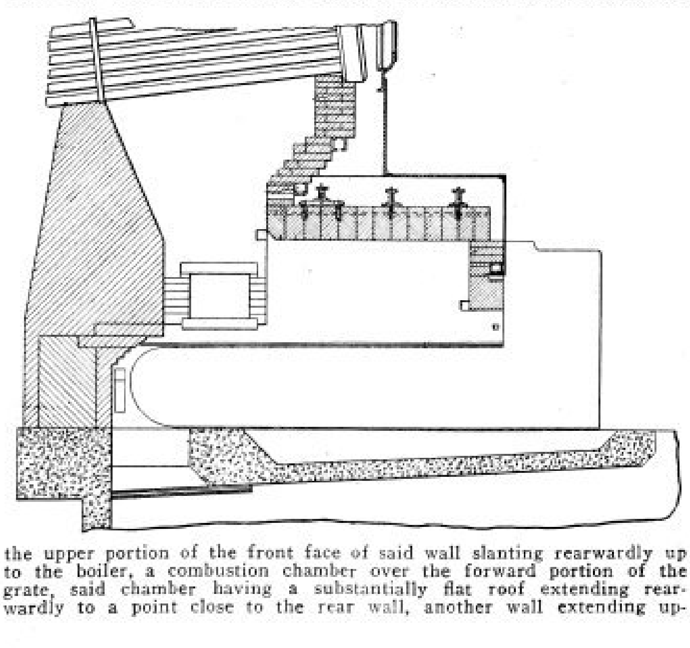
Selected Boiler Patents

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

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

1,179,084. BOILER FURNACE. WILLIAM M. DUNCAN, OF ALTON, ILL.

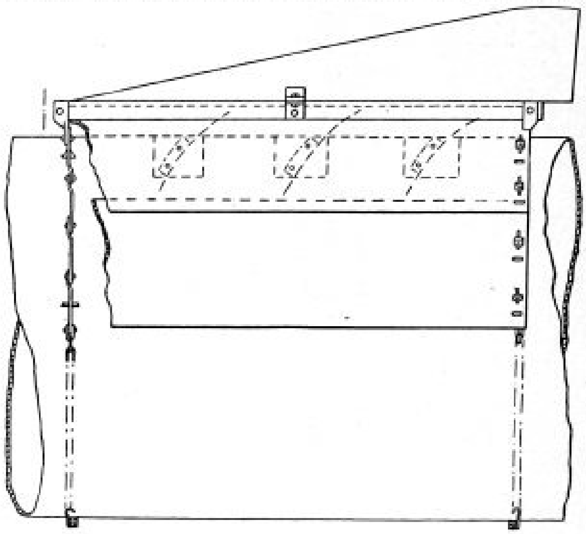
Claim.—In a boiler furnace, the combination with the grate, of a rear wall extending upwardly adjacent to the rear end of the grate,



the upper portion of the front face of said wall slanting rearwardly up to the boiler, a combustion chamber over the forward portion of the grate, said chamber having a substantially flat roof extending rearwardly to a point close to the rear wall, another wall extending upwardly from the roof of the combustion chamber and sloping forwardly into contact with the front end of the boiler, and a wall closing the upper portion of the front end of the combustion chamber, the roof of the combustion chamber lying substantially parallel with the grate, whereby there is provided over the front portion of the grate a combustion chamber of substantially uniform cross section communicating in its rear portion with an expansion chamber of larger horizontal section in its upper portion than in its lower portion.

1,179,141. APPARATUS FOR PROMOTING CIRCULATION IN STEAM BOILERS. HARRY SCHOFIELD AND CECIL HOWARD SEDGWICK, OF LONDON, ENGLAND, ASSIGNORS OF ONE-THIRD TO OLIVER PRESCOTT MACFARLANE, ONE-THIRD TO SIDNEY JOHN ROSS, AND ONE-THIRD TO SAID HARRY SCHOFIELD, ALL OF LONDON, ENGLAND.

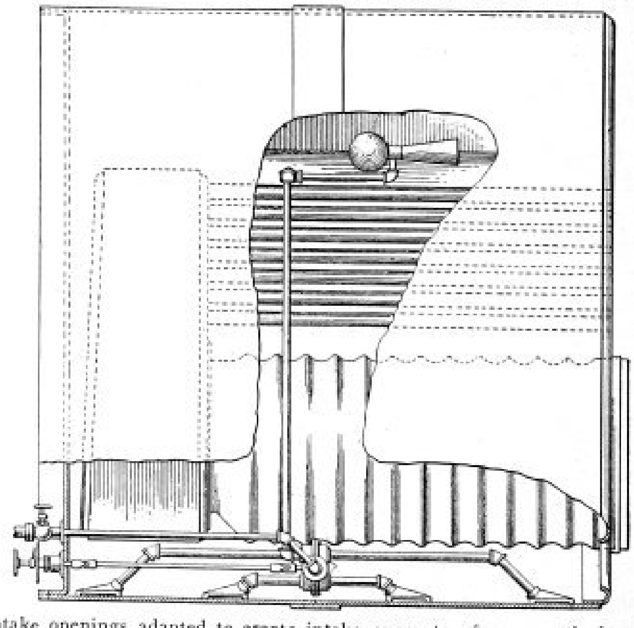
Claim 1.—In a saddle-shaped circulating arrangement for application to steam boiler flues, the combination of a saddle formed in sections provided with sets of holes; flexible and partly annular false flanges



formed of link plates hinged together; lateral projections on said link plates for enabling them to keep upright on their edges relatively to the wall of the flue, without interfering with the access of water to the latter; a chain and yoke connected to the end links for securing the said flanges around the flue; projecting loops on said links adapted to be passed through the holes in the saddle sections; and wedge devices fitting in said loops for positively connecting the said saddle with the link plates without the manipulation of bolts or screws, substantially as described. Two claims.

1,163,687. BLOW-OFF FOR BOILERS. GEORGE PURVIS, OF DEROIT, MICHIGAN.

Claim 1.—A blow-off for boilers comprising suction members, each having an open base and margins that form with a surface to be cleaned,



intake openings adapted to create intake currents of comparatively wide extent beyond the confines of the member proper on the surface to be cleaned, an outlet conduit, and means for selectively throwing any suction member into communication with the outlet, the suction members being fixed in relation to a boiler to which they are applied and being held in such relation to each other that the areas affected thereby are contiguous. Eight claims.

1,167,982. AUTOMATIC STOKER. ALFRED COTTON, OF NEWARK, N. J.

Claim 1.—An automatic stoker, comprising a horizontally swinging shovel, a tension means for moving said shovel through its fuel-throwing movement, and means for varying the tension on the shovel by successive throws to vary the velocity of the shovel movement and the longitudinal distribution of the fuel, said means also arying the inner limit of the shovel movement to vary the lateral or sidewise distribution of the fuel. Forty-five claims.

THE BOILER MAKER

SEPTEMBER, 1916

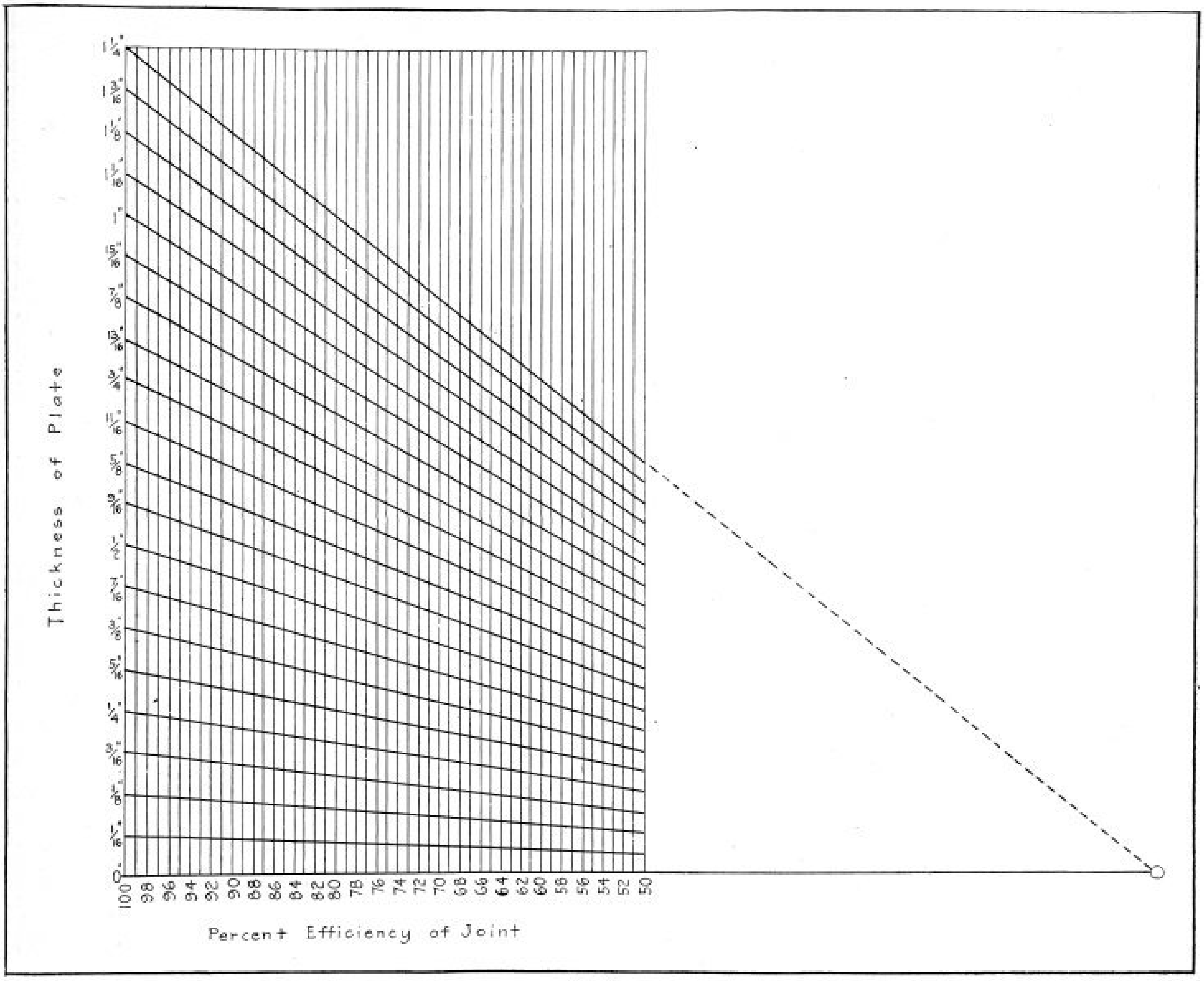


Fig. 1

The Graphic Determination of Working Pressure of Boiler Shells

Use of Chart for Finding Allowable Pressure on Boiler or Thickness of Shell Plate

BY JOHN S. WATTS

The accompanying chart, Fig. 2, can be used to determine the working pressure, the thickness of plate, efficiency of joint and factor of safety being known, or if any of these are known the others can be determined by inspection.

For example, we will suppose we require the working pressure of a boiler, the shell plate being 11/16-inch thick, with a longitudinal joint having an efficiency of 82 percent, and using a factor of safety of 4½, the diameter of the boiler being 8 feet.

The method of procedure is as follows: Trace down the diagonal line marked 11/16 inch on left-hand side of the diagram until it intersects the vertical line for 82 percent efficiency. From this point of intersection draw a hori-

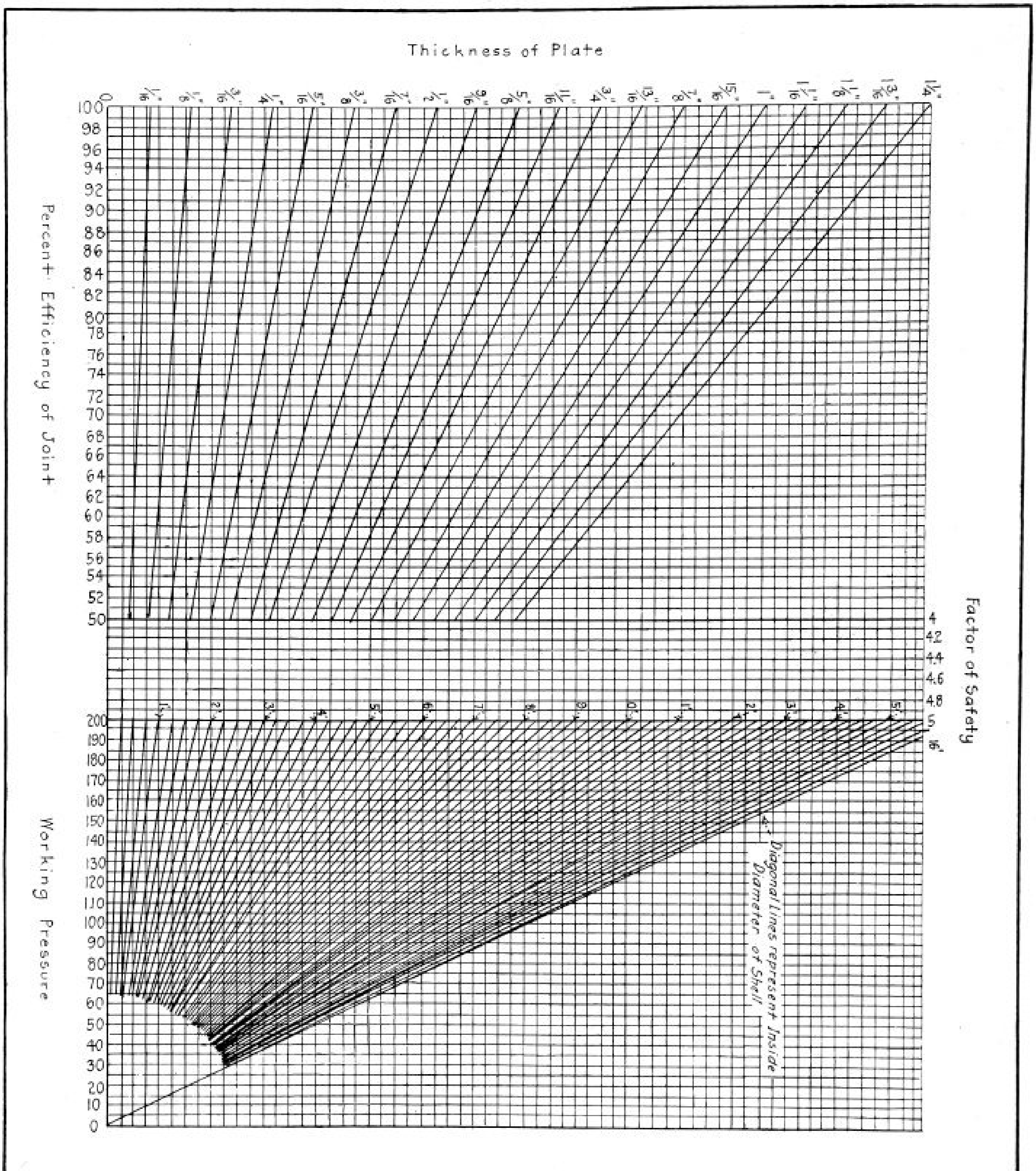


Fig. 2.—Chart for Determining Working Pressure of Boiler Shell Plates, Taking 60,000 Pounds Tensile Strength of Plates

zontal line to the vertical line marked 50; from this point draw a diagonal line to meet the bottom right hand corner of the diagram, and from where this line intersects the factor of safety line marked 4.5 draw a horizontal line to meet the diagonal line marked 8 feet, then the working pressure will be found by the vertical line from this last point, which gives us 155 + pounds as our answer. Where the factor of safety is 4, the horizontal line will be drawn straight across from where the thickness of plate line intersects the efficiency line, to the diagonal line representing the diameter.

The process can be reversed when the working pressure is given and thickness of plate required. In this case, of course, we start from the intersection of the 155 pounds pressure line with the 8-foot diagonal line and draw a horizontal line to the 4.5 factor of safety line, then produce a line from the lower right hand corner of chart through this point onto the line marked 50, and then from the new point on line 50 draw a horizontal line across the left hand part of the diagram. This line will show that we have the choice of any of the following thicknesses of plates at the percentages of joint found vertically below the intersections of this line with the diagonal lines, viz: ⅝-inch at 89 percent, 11/16-inch at 81 percent, ¾-inch at 74 percent, 13/16-inch at 68 percent, ⅞-inch at 63 percent, 15/16-inch at 59 percent, and 1-inch at 55 percent, or 1 1/16-inch at 52 percent.

It is obvious that in reading off percentages of efficien-

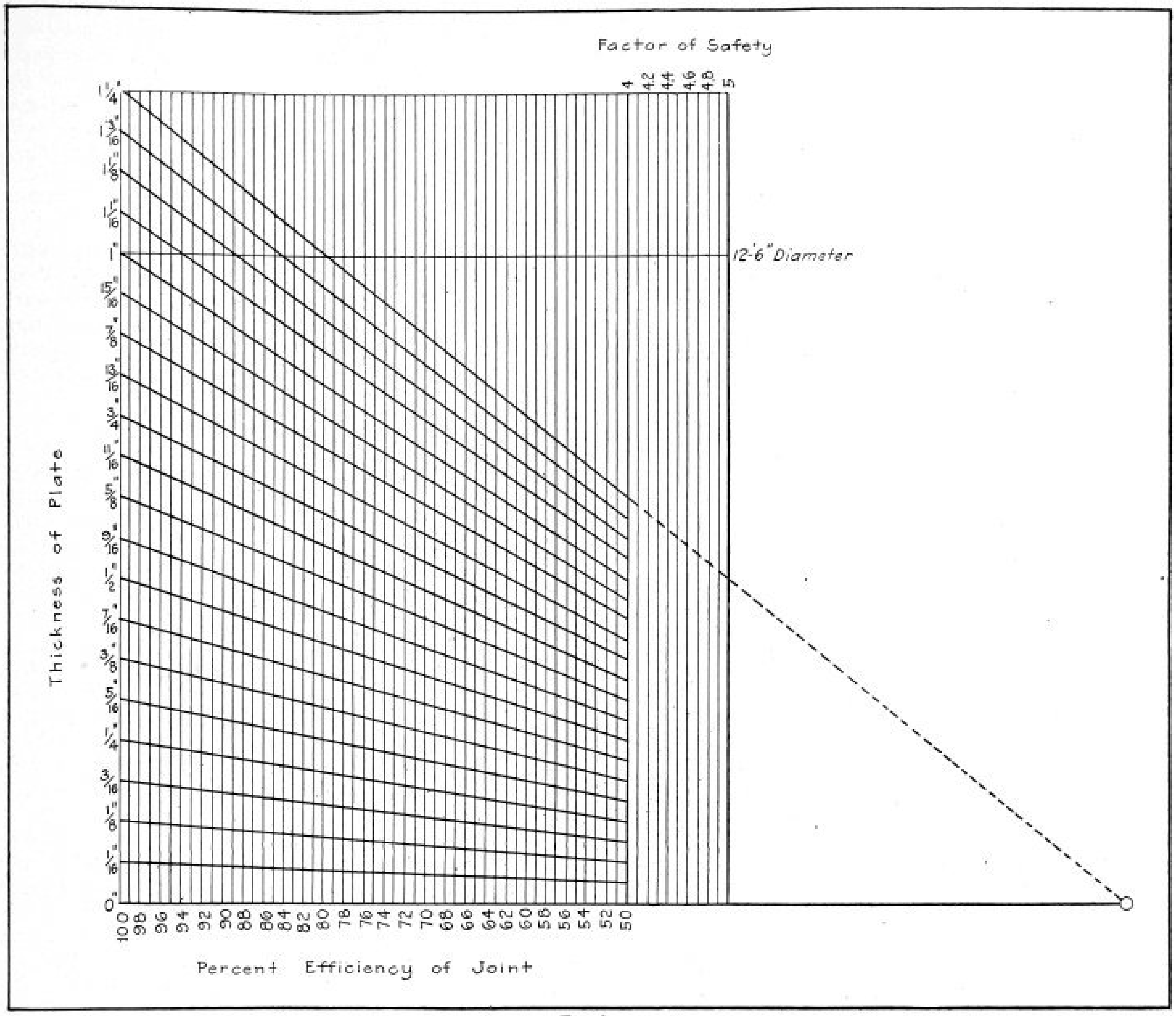


Fig. 3

cies required the nearest larger must always be taken, and in finding pressures allowable the nearest smaller.

An explanation of the reasoning of the method of constructing this chart may be of interest, and will serve also as a proof of its accuracy, and is therefore given below.

First we lay off the thicknesses of the plates on a vertical line to any scale; in this case we choose six times the actual size (see Fig. 1), and making the base line of the triangle any convenient length containing 100 units, say 1 unit = 3/32 inch, which gives a total length of base line of 100 × 3/32 = 9⅜ inches. Next draw vertical lines and number the points from 50 to 100. Draw diagonal lines joining the points on the vertical line to the right hand corner of triangle, and as no riveted joints will be used with less than 50 percent efficiency we can stop these lines at the vertical line marked 50. It is apparent that the height of any diagonal line at any of the vertical lines is in that proportion or percentage of the height at line 100, that the vertical line is numbered. As the sectional area of the plate is in direct proportion to the thickness, these vertical heights are in direct proportion to the net sectional area of the plate at their respective percentages of efficiency and obviously also in proportion to the net tensile breaking strength of the plate at the joint.

We must now take account of another variable, namely, the factor of safety, and this we do as shown in Fig. 3, which is really Fig. 1 carried a step farther. We now draw vertical lines up from the division points 40 to 50 on the base line, and mark these points 4.1, 4.2, etc., up to 5, these figures being the respective factors of safety represented by these vertical lines. It will be seen that as the length of the base line from perpendicular *F S*-4 is 50 units and from *F S*-5 is 40 units, the height of the vertical lines at the diagonal lines are in the inverse proportion to their numbers, i. e., line 4 is to line 5 as 5 is to 4, and the length of the lines between 4 and 5 diminish by one-tenth of the difference between 5 and 4. Now taking the point on line 4 to represent the net breaking tensile strength of the joint, as shown in the last paragraph and Fig. 1, we go another step and call this same length the net safe load on the joint at a factor of safety of 4, to which, of course, this length is also proportional. Now, if we draw a line from the point on line *F S*-4 to the bottom right hand corner of chart and mark where it intersects the factor of safety line (in example 4.5) chosen, the height of this point is proportional to the net safe load on the joint at that factor of safety. This is in turn in proportion to the diameter when the pressure is constant, and to the pressure when the diameter is constant.

The next step completes the diagram, so we return now to Fig. 2, where the line *F S*-5 is taken to lay off the points for the diameters on, and the remainder of the base line to represent the pressures. The part of the base line from line $F S$-5 to the right contains 40 units, and we will take a unit to represent 5 pounds pressure, making a total of 200 pounds at line $F S$-5. We now erect vertical lines from these 40 points and number them 5, 10, etc., up to 200 at line $F S$-5.

Having made line $F S$-5 to represent 200 pounds pressure and having shown that the heights of the points found are in proportion to the diameter, we need only fix one point on the diameter scale on $F S$-5 and then divide up for the other points. For simplicity we will take a 1-inch plate with 100 percent efficiency, factor of safety of 4, and, of course, 200 pounds pressure, which gives:

$$\text{Diameter} = \frac{60{,}000 \times 2 \times T \times \%}{W\ P \times F\ S}$$

$$= \frac{60{,}000 \times 2 \times 1 \times .100}{200 \times 4}$$

$$= 150 \text{ inches} = 12 \text{ feet } 6 \text{ inches.}$$

So, by drawing a horizontal line from the 1-inch point on the vertical line of thickness of plates, at 100 percent efficienty, to line $F S$-5, we fix the point for 12 feet 6 inches diameter (see Fig. 3), we can now take the height from base line to this point as 12 feet 6 inches and divide up as shown on Fig. 2, giving points representing additions of 3 inches in diameter. Now by drawing diagonal lines from each of these points to the right hand corner of the triangle we have the diameter lines falling in inverse proportion to the numbers representing the pressures on the vertical ines, or, in other words, the diameter is nearer the base line at the low pressures than at the high, in the same proportion that the corresponding thickness of plate lines are. The diameters, of course, become smaller the greater the pressure. The horizontal lines crossing the diagram are only for convenience in carrying the points across.

This chart has been worked out for a tensile strength of plate of 60,000 pounds, but can be used for other strengths by multiplying the actual working pressure by the actual tensile strength and dividing by 60,000, using the result as the working pressure. Or, if 55,000 pounds is the actual tensile strength, each division on the diameter line will represent 2¾ inches instead of 3 inches; for example, 10 feet diameter would be 9 feet 2 inches diameter, and so on.

Government and Business*

BY EDWARD N. HURLEY†

Co-operation and industrial preparedness are the most important questions before the business men of the country to-day. The country needs at this particular time the co-operation of a strong national organization with energy and good judgment, which has the entire confidence of the Government and of the banking and business world.

A wrong feeling has existed in this country as to the proper relations between government and business. Even when I went to Washington I had the feeling that business men did not want to co-operate with the Government, but I learned very quickly that they are all eager to co-operate and willing to do everything in their power that the Government desires.

We are talking a great deal these days about mobilizing our industries. We have been floundering about for many years with no definite plan; in fact, the first step has hardly been taken toward solving our industrial problems and *toward* attaining the result which we all know is absolutely necessary. Co-operation requires the interest and good will of both sides. Business men are anxious to co-operate with our Government. It is now the duty of the Government to lend its active constructive aid, *and it is the earnest desire of the Federal Trade Commission to do everything in its power to help foster American industries.*

Federal Trade Commission and Definite Steps Forward

The Federal Trade Commission is endeavoring to-day to work out a comprehensive, constructive solution of our business *problems.* We have tken definite steps toward getting at the real facts of industry from manufacturers. Within a few months we hope to be able to give manufacturers first-hand detailed information about their business.

Cost Accounting

A preliminary study of industry generally, made by the Federal Trade Commission, has revealed the fact that only a very small percentage of the manufacturers of the country make any charge for depreciation of building plant equipment, or seasonable merchandise, and that their products were priced and their profits determined before reckoning *this* vital and important item.

Depreciation

The Trade Commission is urging on every business man the absolute necessity of making proper provision for depreciation and doing it monthly, or at least quarterly. I think I can safely say that no accounting system will receive the endorsement of the Commission unless it does provide for the inclusion of this most important item of cost.

Statistics show that the percentage of business men who do not provide for depreciation is very large, running over 50 percent, and this is one of the causes *that has a great influence* on the business death rate. Nearly every man is perfectly willing to include in his cost all items for which he pays out actual money, but he is inclined to overlook those which do not require a visible outlay, and depreciation is one of these which unquestionably exists. Many manufacturers and merchants do not charge *any* depreciation and give as a reason that they keep their plant and stock in first class condition. This is one of the most erroneous ideas in business to-day. Every machine, building and apparatus, as well as seasonable merchandise, *like every man,* has a certain period of life, and no matter how much care is taken or how much medicine you give the man, death is bound to come.

If the Federal Trade Commission does nothing more than arouse the American business man to the fact that depreciation does exist, that it is an element of cost, and that he should put it into cost, the time will have been well spent and business generally will have received a benefit.

Uniformity in Accounting Methods

The subject of more uniformity in cost finding is at present receiving the careful consideration of many manufaturers and trade associations. A number of trade associations are in this way achieving marked success in strengthening their industries. It is being demonstrated that knowledge of cost determined by a uniform practice can improve trade conditions to a remarkable degree. By a uniform practice I mean a common classification of costs, both manufacturing and selling, a uniform method of providing for depreciation with rates more or less standardized. Where this condition exists, production statistics which are comparable and which will inform

* Extracts from address before the Associated Advertising Clubs of the World, at Philadelphia, June 29.
† Vice-chairman, Federal Trade Commission, Washington, D. C.

and guide the whole industry are obtainable. Manufacturers and merchants can then talk the same language and will be in a position to profit by each other's experience, to conduct their plants more efficiently, *and to establish prices more intelligently.*

DANGERS OF LACK OF ADEQUATE ACCOUNTING METHODS

For example take two manufacturers, say Jones and Brown. They are in the same line of business and bank with the *same banker.* Jones keeps an accurate cost accounting system, charges off liberally for depreciation on his buildings, machinery, etc. He charges his jigs, tools, dies and patterns against the cost of operation every month, or at least every quarter. His overhead is distributed equally and fairly. He quotes a fair price on his product and his customers recognize that they are getting value received. He has a large bank account and is considered a conservative and substantial business man. *Brown,* his competitor, on the contrary, does not keep a cost accounting system, does not charge off for depreciation except a small amount at the end of each year. Brown maintains that his buildings and machinery are very near as good as they were ten years ago. He charges his jigs, tools, dies and patterns to capital account and considers them valuable assets. He figures that he has been *quite liberal* when charging off 10 percent for depreciation *on these items at the end* of the year. He is a heavy borrower at the bank and *the banker* is probably loaning him the money *that Jones,* his competitor, has on deposit. This furnishes Brown working capital *to do what?* To continue to run his business in a *slip-shod, slovenly manner,* to cut prices and ruin the industry in which they are *both engaged.*

Ignorant competition is most dangerous to the development and success of our country. The Clayton Act and the Federal Trade Commission Act have no control over this menace. It is estimated that 90 percent of the manufacturers and merchants in Germany know absolutely what their goods cost to manufacture and sell. If you compare our figures, which show, according to estimates, that only 10 percent of our manufacturers and merchants know what it costs to manufacture and sell their products, *you have the answer* as to why Germany has been so successful in developing such a high standard of efficiency in manufacturing and distributing their products, *not only in Germany* but in the markets of the world.

It is a fact, well understood among business men, that the general demoralization in a large number of industries has been caused by firms who cut prices, not knowing what their goods actually cost to manufacture; the cost of selling also, which is equally important, is almost wholly lost sight of. Are the officers of the companies and firms who are cutting prices right and left, irrespective of their costs, *fair to their customers, stockholders, or competitors?*

Quality and service are becoming greater in the field of merchandising. Long after the price of a product is forgotten the *quality of that product is remembered.*

ACCOUNTING ESSENTIAL TO PROGRESS

Government has complained about business. Business men have complained of the attitude of the Government toward business. Whatever justification there may have been in the past for such complaints, to-day there is a better understanding between Government and business. Since better business methods usually begin with better methods of cost accounting, scientific cost keeping becomes in a very definite sense the basis of our prosperity. The Government, through the Federal Trade Commission, by recommending the subject of costs to the business men of the country at this time, and offering to aid in the actual development of proper cost systems, is endeavoring to do a constructive piece of work which is of the greatest importance. *The problems of credit and finance,* of foreign trade and unfair methods of competition, *and of labor and capital*—all will begin to solve themselves once the subject of costs receives on every hand the attention it rightfully deserves.

Novel Oil Tank Car

A unique oil tank car was recently placed in service by the Riverside Oil Company, of Sistersville, W. Va., for the shipment of light petroleum products, such as the higher gravity gasolines, naphtha and benzine. This metal housing is applied with three or four inches air space between the housing and the tank. It may be stated that it is provided with an ordinary tank-car tank and the entire car is otherwise not different from the standard tank car. The heavy steel anchor is used to prevent the tank from shifting. Many of the tank cars built in the past were constructed with oak head blocks at each end

Tank Car, With Metal Housing

of the tank to hold same in position. This method of preventing the tank from shifting has proved unsatisfactory and particularly bad if used on a car housed.

It is pointed out that the object of the housing is to cut down the evaporation of the loading. The exterior surface of a tank loaded with such liquids as gasoline is always cold, and the housing protects the tank from the rays of the sun. At the same time and also because the housing is painted a light color, the heat of the sun is reflected. The Riverside Oil Company and the James B. Berry Son's Company, of Oil City, have been using these cars extensively for two or three years, and have demonstrated that the housing is very beneficial in reducing loss by evaporation, on account of the rise of temperature, which takes place when an ordinary bare tank is exposed to the heat of the sun in the summer time.

As to the efficiency of this housing, it practically eliminates the outrages which are experienced by the ordinary tank car in similar service. The housing consists of corrugated galvanized sheets, which extend from the top of running board over the tank to a similar position of angles and supports, so as to withstand service conditions and be strong enough to allow a man to stand or walk upon the top of the tank.

The idea of a safety valve is to have its outlet area great enough to relieve the steam pressure and to keep on relieving it. If the steam is being made faster than the safety valve will relieve it, the pressure will accumulate and the boiler may explode in spite of the safety valve blowing off.

Patterns for a Hopper

Layout of Patterns for an Ore Hopper —Explanation of Construction Lines

BY GEORGE A. JONES

In the upper right hand corner of the drawing marked "General Arrangement" are shown the drawings for an ore hopper. There are no dimensions on this drawing, but it is taken from a general erection print.

To lay out the patterns for such a job, first erect the horizontal *A-C* of indefinite length. For the center line of the plan make the distance *A-C* the radius of the top section of the hopper and strike out a semicircle. Draw the vertical line *B-B* of indefinite length. At right angles to *B-B* draw the lines *B-D* of the required length, then erect the line *D-D*. To the right of the plan erect another view of the plan shown turned half way around and call it the front plan.

As the hopper is the same in every respect each side of the center line, only one half is needed. Below the plan and the front plan erect the line *T-T* parallel with the line *A-C* of the plans. Extend the line *D-D* of the plan down to the side elevation and erect the heights of the different sections as *R-K′-D-U*. Parallel with the line *U-R* draw the line *O-P* and parallel with the line *T-T* draw the lines *D-B-C* and *K′-K-S* and the lines *T-C* and *C-R*. This is the outline of the side elevation.

To the right of the side elevation erect the vertical center line *T-R*. Extend the line *D-C* of the side elevation over to the front elevation and locate the line *D′-D*, the required width of the hopper at this section. Erect the vertical line *O-B′*. From *B′* a portion of the top section of the hopper is to be cut away to a slope of 45 degrees, so draw *B′-4′* at 45 degrees and erect the vertical line *D-H* of the conical section, which is also cut away.

As the back of the cone is a 45-degree taper, lay out the line *H-K* at 45 degrees. As the lines *S-K′-R* are at right angles from the front elevation, the front of the bottom section of the hopper will be a semi-circle of the same radius as *K-S*, so in the side elevation from the point *K* erect a line *K-N* parallel with the line *R-S* and through *N* draw the horizontal line to the center line of the front elevation and locate the point *N′* and draw the radius *N′-R* and the vertical line *K-N*. This completes the outlines of the front elevation.

Division of Surfaces

In the front elevation extend the line *H-D-4′*, which is the flat portion of the cone, and the top section upward to the front plan and locate the line 4-*E*. Also locate the line 4-*E* in the plan. Now with the dividers step off 9 equal spaces in the plan from *B-C* and number the first 4 spaces *B*-1-2-3-4. From these points draw lines to the center *A*, and from these same points drop vertical lines down to the horizontal line *D-B-C* of the side elevation. Number them *B*-1-2-3-4. Now extend the line *O-B-K* to the line *R-C* and locate point *P*, the apex of the cone. Draw lines from the base line *D-B-C* of the cone and through the points 1-2-3-4 to the apex *P*. In the front plan from *B* to 4 on the circle lay out four equal spaces and number them 1-2-3-4. From these points drop vertical lines to the line *B′4′* of the front elevation and number them *B′*1′-2′-3′-4′. Extend horizontal lines from these points over to the side elevation to similarly numbered lines and locate points *B′*1′-2′-3′-4′. Draw a curved line through these points and through *B′-F*. This will be the line of intersection for the top section of the hopper and the bent side plates.

Now in the plan where the line *E*-4, which represents the side plate, crosses the radial lines drawn from the center *A* to the circle locate points 1″-2″-3″ and drop vertical lines from these points down to the side elevation on to similarly numbered lines drawn from the base line of the cone to the apex and locate points 1″-2″-3″. Now draw the curve through the points B″-1″-2″-3″-4 and the straight line *B″-F′*. This will be the line of intersection between the side plate and the cone.

Now draw the horizontal lines from *B″*-1″-2″-3″ over to the line *C-R* and locate the points *B*°-1°-2°-3°. From the points *B″*-1″-2″-3″ erect vertical lines up to the line *D-B-C* and locate the points *a-b-c*. We can now lay out the patterns for all the plates.

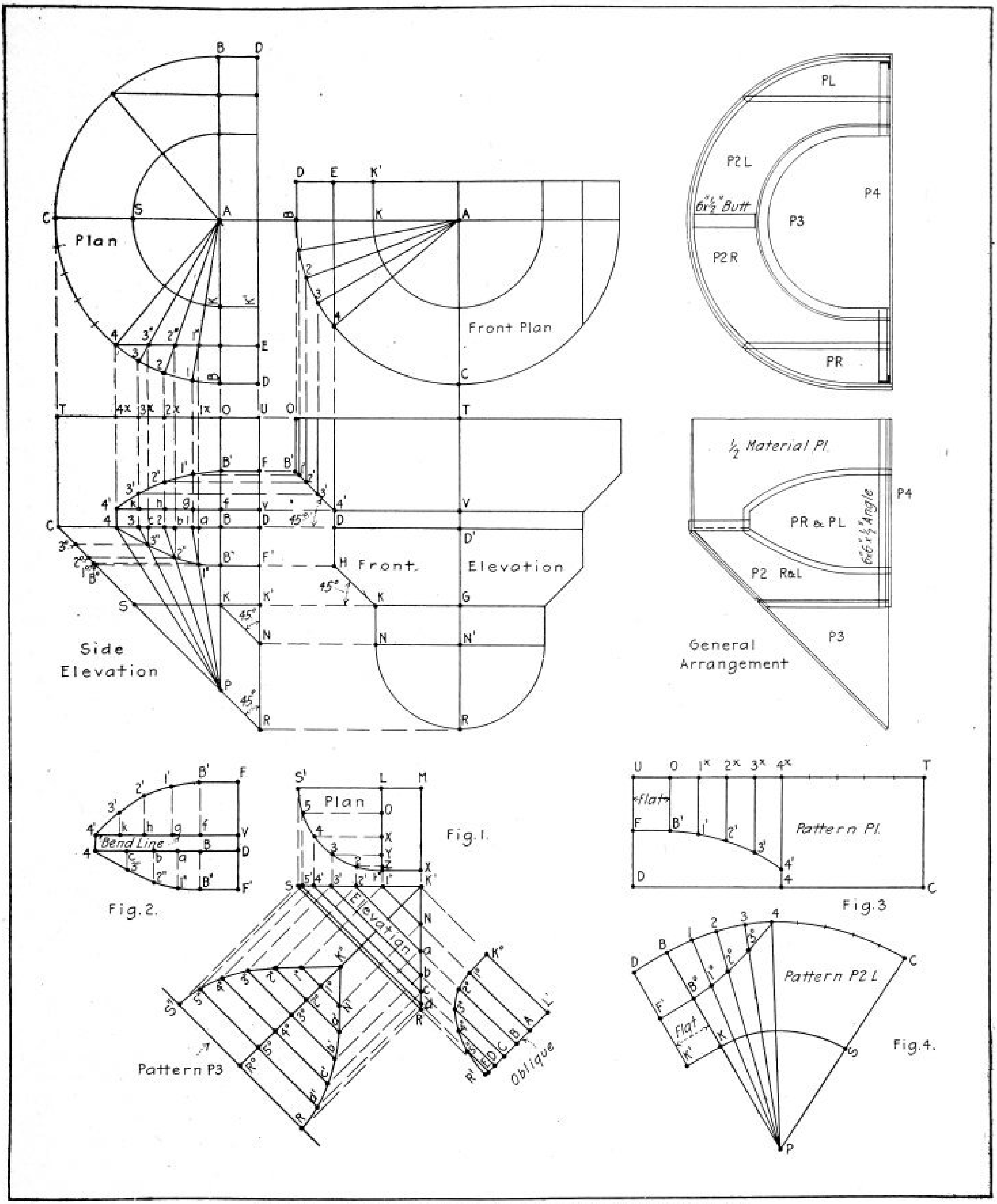
Laying Out the Patterns

In Fig. 3 erect the horizontal lines *D*-4-*C* and *U*-4ˣ-*T* the required distance apart, making *O* to *T* one-fourth of the circumference. Make the flat part *O-U* the same as the flat part in the plans or elevation. Square up the plate and draw lines *T-C* and *U-D*. From *O* to *T* lay out nine equal spaces the same as in the plans and number the first four spaces *O*-1ˣ-2ˣ-3ˣ-4. Through these points drop vertical lines. Take the lengths of these lines from the side elevation as *O* to *B′*-1ˣ to 1′-2ˣ to 2′-3ˣ to 3′-4ˣ to 4′, and transfer them to Fig. 3 on their proper lines, then draw the curve through these points. This portion on the bottom of the curve is cut out.

This completes one-half of the pattern. The other half is exactly the same. No laps are required on this pattern.

We will now lay out the pattern for plate *P* 2 *L* at Fig. 4. Set the trammels to *P-C* and *P-S* of the side elevation and draw the two curves in Fig. 4, making *B-C* one-fourth the circumference around the curve. At right angles to line *B-K* draw lines *B-D* and *K-K′* equal to *B-D* of the plan. Then draw line *D-K′*. From *B* to *C* lay out nine equal spaces and draw lines to the apex *P*. Number the first five lines as *B*-1-2-3-4. In the side elevation take the lengths of *P* to *B*°-1°-2°-3° and transfer them to similarly numbered lines in Fig. 4 and locate points *B*°-1°-2°-3°. Draw a curve through this point and draw the line *F′-B*° at right angles to line *B-K*. The outer portion around this curve is punched out. Allow for flanging around the curve from *C* to 4. No lap is required on this pattern. As line *C-S* is the center of the butt joint, turn this pattern over and mark one off.

Now take pattern for plate *P R* and *P L*. At Fig. 2 draw the line *D*-4 equal in length to *D*-4 of the side elevation and parallel to *D*-4 draw the horizontal line *V*-4′. Make *D-V* equal *D-V* of the front elevation. Draw the vertical line 4-4′ and extend line *V-D* above and below the two horizontal lines. Now in the side elevation at points of intersection between the cone and side plates as 1″-2″-3″ erect vertical lines to the base line of the cone *B-C* and locate points *a-b-c*. Now transfer the spaces *D-B-a-b-c*-4 of the side elevation to Fig. 2 as shown and locate simi-



General Arrangement Plans and Development of Patterns for Hopper

larly lettered points from *D* to 4. Through these points drop vertical lines downward. Take the length of line *D-F′*, *B-B″*, *a*-1″, *b*-2″ and *c*-3″ of the side elevation and transfer them to similarly lettered lines in Fig. 2. Draw a curve through the points 4-3″-2″-1″-*B″* and *F′*. This curve is the flange line.

Now take the spaces *V-f-g-h-k* and 4′ of the side elevation and transfer them to the line *V*-4′, Fig. 2, and letter them the same. Through these points erect vertical lines upward. As the side plate is bent to 45 degrees on the line *V*-4′, Fig. 2, the lengths of the vertical lines just drawn will be obtained from the front elevation. So take the distance 4′-*B′* and transfer it, Fig. 2, as *f*-B′ and 4′-1′ front elevation to Fig. 2 and *g*-1′ and so forth till all the lengths have been transferred to the pattern Fig. 2. Draw the curve through points 4′-3′-2′-1′-*B′*-*F*. This curve will be the flange line.

Allowance for flanging is made all around the pattern, except on the front *F* to *F*1 which connects on to the angle iron. There will be two required of this type.

We will now lay out the bottom section *P* 3, which is the discharge end of the hopper. At Fig. 1 is shown a plan and elevation, also an oblique view. The elevation is exactly the same as the side elevation shown and lettered *S-K'-N* and *R*. Draw the horizontal *S'-M* above the elevation, Fig. 1, and project the vertical lines *K'-R* up to the plan and draw the vertical line *M-X*.

Take the radius *K-S* or *K-G* from the front or side elevation and set it down in Fig. 1 as *S'* to *L*. Through *L* drop a vertical line to the plan and locate 1'. On the line *K'-S* about the center *L* strike a circle and from *X* draw a horizontal line over to the vertical line drawn through *L* and locate point 1.

With the dividers step off on the circle from 1 to *S'* five equal spaces and number them 1-2-3-4-5-*S'*. Through these points draw horizontal lines over to the line *L-I* and locate points *O-X-Y and Z* and vertical lines down to the elevation and locate points 1'-2'-3'-4'-5' on the line *K'-S*. Through these points and parallel with the line *S-R* draw lines to the line *K'R* and locate points *N-a-b-c-d*.

As this section of the hopper is a true circle on the top of *K'-S* and the front *K'-R*, another view is necessary that will show the shape to which it will be rolled and from which the length can be obtained. So extend the line *S-R* and locate *R'* at right angles to this line. Draw the line *R'-L'*. Extend the lines just drawn as 1'-*N* and 2'*a* and so forth of the elevation to the line *R'-L'* and locate points *A-B-C-D-E*. Now take the distance *L* to 1 of the plan and transfer it to the oblique view as *L'* to *K*° and *A* to 1° and draw line *K'* to 1°. Transfer *L-Z* of the plan to *B*-2°, *L-Y* of the plan to *C*-3°, *L-X* of the plan to *D*-4° and *L-O* of the plan to *E*-5°. Now draw a neat curve through the points 1°-2°-3°-4°-5°-*R'*, and this will be the shape of this section of the hopper on a line at right angles to *S-R* and through *K'* of the elevation. From this view the lengths will be obtained for laying out the pattern for the plate.

Now extend this line drawn through *K'* and locate *R*°. Take the lengths measured around the curve of the spaces *R'* to *K*° and transfer them to line *R°-K'*, starting at *R*°, and locate points 5°-4°-3°-2°-1°-*K''*. Through these points at right angles to line *R°-K''* draw lines as shown. At right angles to *S-R* of the elevation and through points of intersection extend lines to similarly numbered lines in the pattern and locate the numbered and lettered points as shown. Draw a curve through these points and allow enough material around the outside of the pattern from *K''* to *S''* for flanging. This completes half the pattern.

Modern Superheater and Its Performance*

Current Practice in the Use of Superheated Steam on Locomotive Boilers—Causes for Loss of Efficiency in Superheaters

BY S. S. RIEGEL†

Steam in its uses on a locomotive passes through such great ranges of changes, and the conditions are so exacting, that any device, to serve the purposes as a satisfactory superheater, must meet the changing circumstances with a reasonable degree of satisfaction. This in American practice has led to the selection of a superheater generally known as the fire-tube type. It is most in favor, and for its simplicity of design has brought relatively little increase in maintenance cost, while it has produced from 20 to 30 percent more power per unit of weight, permitting the utilization of this additional power as an economy in train operation.

As there are now over 16,000 superheaters of this type in service in the United States and Canada, it may be called standard equipment on American railroads, and from its general use it is not necessary to go into great detail in describing it or its results, these being well known.

As a result of imperfections in material, methods of manufacture and improper supports in the smokebox, some of the earlier headers were not able to withstand the severe service, particularly the internal stresses, due to the rapid heat transfer, and cracks developed between the unit seats in the lower faces of the headers. This was overcome by a later design, providing free movement of the several parts—the loose finger design, now coming into favored use. This is a through bolt header, providing air spaces between the walls of the saturated and superheated steam compartments, to allow for expansion and contraction and avoid a too rapid heat transfer. This relieves the header of the severe internal stresses imposed on the headers of original design.

Another recent improvement in the American superheater is the re-design of the superheater unit, by the substitution of a welded return bend for the old cast steel form. This new bend is produced by welding the ends of the units together, through an ingenious combination of machine forging and acetylene welding. The torpedo shaped ends which result offer minimum resistance to the passage of gases through the large flues and maintain liberal cross sectional area for the free flow of steam through the units. From a mechanical standpoint the welded end is superior to the cast steel return bend unit, since it eliminates the threaded joints and reduces the possibility of those failures. The unit troubles which are avoided by the new construction are the leakages at the threaded connections between the unit tubes and the cast steel return bends, and the fractures of the tubes at these points from the weakening of the metal by the cutting of the threads.

No general change in the design or practice of operating superheater dampers has been made, although several railroads have made extensive experiments in an effort to do away with dampers, but the results obtained seem to indicate that the dampers still are necessary for continued successful operation. It would seem that with a moderate amount of superheat, by design or conditions of operation, the damper may be made unnecessary, but with the use of high superheat it cannot safely be dispensed with, and a good recommendation would be to use it, except in special cases. If the damper operates properly, it is not a hindrance in any case.

The maintenance of a permanently tight connection be-

* Abstract of paper read before the Central Railway Club, Buffalo, N. Y., May, 1916.

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tween the unit and header depends largely on the use of proper header bolts, which cannot be stretched beyond their elastic limits when tightened. The importance of this is appreciated when we know that an average man, tightening a bolt with a 36-inch wrench, may set up a tensile stress in the bolt of over 50,000 pounds per square inch. To provide a sufficient margin of safety these bolts should be made of a material with an elastic limit of about 70,000 pounds, and an ultimate strength of over 100,000 pounds per square inch. One of the superheater companies, laying particular stress on this important matter, has produced a bolt of this material. The use of inferior material in header bolts is sure to result in leaky ball joint connections between the unit and header.

While the economy of a superheater in coal and water is so thoroughly recognized that it now requires little elaboration, there are certain relations between these savings and the resultant increased power output of the superheater locomotive which are sufficiently fundamental to warrant discussion, however well they may be understood. That the increased power of the superheater locomotive is made possible by the water economy of the engine is self-evident, since the superheater means a decreased amount of water per drawbar horsepower developed, while the evaporative capacity of the boiler remains the same. The superheater, therefore, means more power output for every pound of water used by the engine. To utilize the maximum power developed by the superheater, larger cylinders should be used than would be possible on a saturated engine of the same size. This may readily be seen when we remember that a saturated engine gives a maximum power output at from 40 to 45 percent cut-off. If, however, a superheater is installed in this locomotive, givng 25 to 35 percent more steam available at the critical point, the cut-off for maximum power output must be increased from 45 to possibly 70 percent. This increase in cut-off results in less efficiency, due to the impossibility of getting full expansion out of the steam. Increasing the size of the cylinders, by an amount equal to or proportionate to the greater steam volume available, makes it possible to get the same power at a shorter cut-off, thus utilizing the full benefit of the superheat, as well as better expansion in the cylinders.

The conversion of existing locomotives to superheaters is a problem which must be governed by local conditions, and for which no uniform or standard rule can be fixed. The cost of conversion and results to be obtained must be be taken into account in each case. In general the modernizing of existing engines by the application of superheaters has permitted such power to keep pace with increased demands, as by the change of wood to steel equipment, the use of heavier trains, or in the meeting of more exacting service.

A study of pull-speed curves will show the power developed by a saturated engine decreasing rapidly after a speed of 15 miles per hour is reached, and the superheater, sustaining a higher power for a considerable period beyond this, as expressed in tractive effort and draw-bar horsepower. In such cases the gain by superheating the engine may be considered as a purchase of power output. This increased power output is obtained at relatively low cost per unit of tractive effort, as compared with the purchase of superheater-equipped new power. The application of superheaters to existing locomotives has been a very interesting feature of recent locomotive development. During the year 1915, out of 3,667 superheaters applied in the United States and Canada, more than 2,000 were used on old engines, and as a matter of fact locomotives are to-day superheated which would not have been considered three years ago.

It is worthy of note that superheaters are being more generally applied to both new and existing yard engines. This is comparatively of recent development, as it was formerly thought impossible to obtain a sufficient gain in yard service engines to warrant superheating. It is generally supposed that there is not much necessity to superheat switch engines, but engines so equipped handle more cars between longer periods of coaling and taking of water, and do their work more quickly, so it would seem the superheater is properly adaptable to engines in switching service. There are now nearly 900 superheater switch engines in service in the United States, and the railroads which have operated them are ordering more, which is evidence that the results obtained must be satisfactory.

While the superheater has been selected with great care, it has not been free from troubles, but it is pleasing to state that, as we become more familiar with the use of the device, the troubles are growing considerably less. The principal causes of the troubles are due: First, to differences in temperature expansions. Second, to lack of sustained or proper supports by liberal sized bands, and supporting rests, to avoid vibrations and prevent wearing holes in the flues. Third, use of improper materials for joint bolts, or bolts severely overstrained in the application of the units. Fourth, construction or use of improper materials for return bends. Fifth, abuse of the device by improper handling.

The following causes of loss of efficiency occur:

Dirty Surfaces.—The superheater should be accessible for easy cleaning, as in the roundhouse care of the superheater it is very important to have the flues and superheater surfaces blown clean of ashy deposits.

Leakages of Steam.—At all indications of leaks hydrostatic tests should be applied, as it is very necessary to keep the superheater free from leaks.

Improper Damper Adjustments.—Unless the dampers are so adjusted that they can open properly under automatic control, proper flow of gases through the superheater tubes is not secured, and a great loss in efficiency is thereby sustained.

Maintenance of a Proper Water Level.—A too high water level in the boiler causes the steam to carry much water over into the superheater. This may be due also to dirty water conditions, and it would appear that maximum superheat cannot be obtained except under clean water conditions, and insistence on the engineman carrying his water at the proper levels, generally as low as safe operating conditions will warrant, is necessary.

Improper Firing.—Firing must be very carefully done, as, when a fire is too thin, excess air will result in the cooling of the superheater tubes, and a heavy and smoky fire will smudge them and interfere with obtaining high superheat temperatures.

It is not sufficient to have lubricators which work uniformly, but drifting steam must be used under automatic control. Results without drifting steam are generally unsatisfactory. This manifests itself in carbonization of the lubricants, excessive wear of surfaces, broken packing rings, and high wear and destruction of rod packings. With drifting steam, and preferably on piston valve engines, some by-pass valve arrangement should be used, as then these conditions are generally overcome and a condition bordering on saturated steam operation can be obtained. With the solution of this problem high superheat temperature, with its greater economies, is obtainable.

It would appear that no perceptible saving is realized with less than 100 degrees of superheat, while over this the savings increase rapidly. The reason for this is that superheated steam cannot be depended upon to be dry below 570 degrees F. terminal temperatures, and as long as any suspended vapor is contained in the superheated steam, condensation will speedily follow. From this it is apparent we must come to the use of higher degrees of superheat. To get this we may need more superheat units, and may have to adopt some more efficient way of superheating, and with it may come types requiring longer boilers, with increased diameters, and longer lengths of flues.

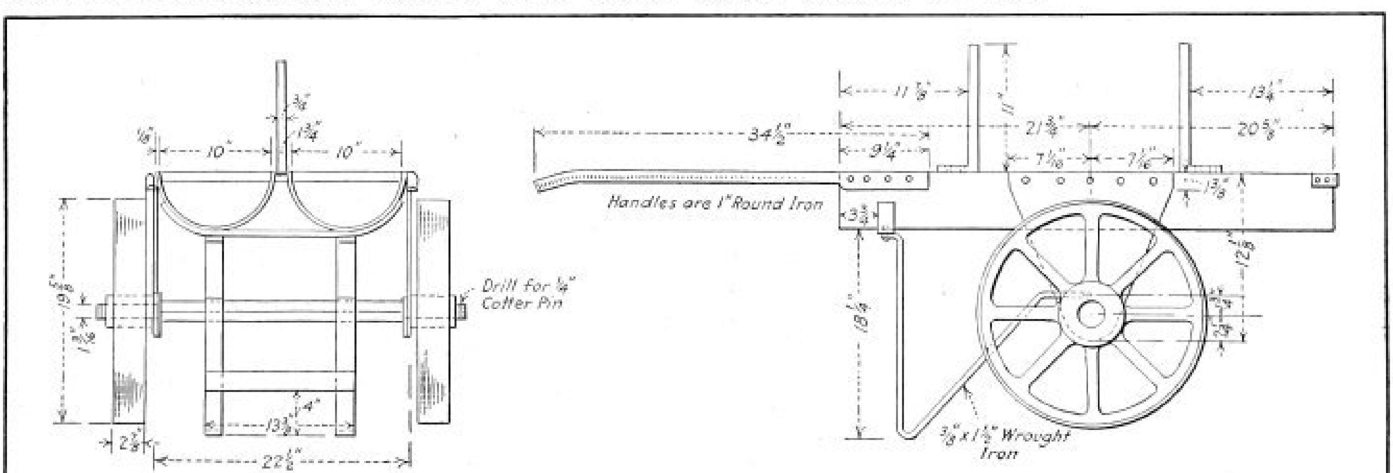
The superheater in its present form is very sensitive. Perhaps, as we understand it in its present state of development, it may be too sensitive, but with proper handling and maintenance it is giving very satisfactory results. But it is very important from its extreme sensitiveness that the throttle valve should be opened gradually at starting and kept in such a position that there is a pressure drop at the steam chest of from five to seven pounds below the boiler pressure, as unless this is done we cannot be sure of getting dry steam delivery into the cylinders.

For the proper determination of the amount of superheat in the steam the use of some instrument like the pyrometer is necessary when the more reliable records are required, although, generally speaking, it is not necessary to know when a proper degree of superheat is obtained with the normal operation of the engine. This instrument, from general experience, would seem too complicated for roundhouse care and severe locomotive service when continuously used, but for short tests it serves the purpose very well. There is, however, need for a better and more reliable instrument,

Wagon for Hauling Oxy-Acetylene Tanks

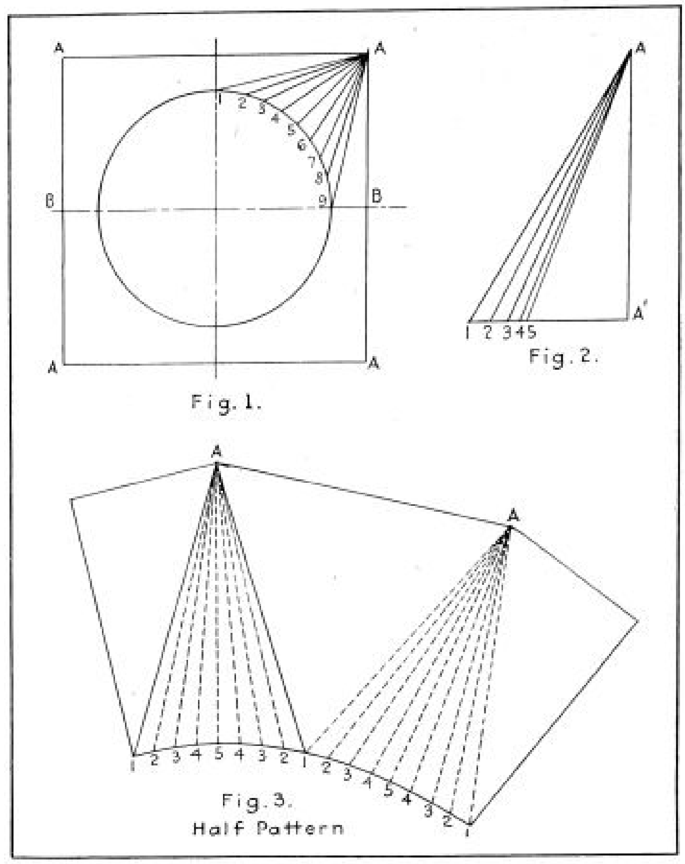
The accompanying illustration shows a wagon on which oxy-acetylene tanks are hauled at the Newark shops of the Baltimore and Ohio Railroad. This has proved to be a very handy wagon, and no doubt the readers of THE BOILER MAKER will be interested to learn the details of its construction, as shown in the drawing.

Newark, Ohio. E. H. RITTER,
Foreman the Baltimore and Ohio System.



Wagon Used for Hauling Oxy-Acetylene Tanks at the B. & O. R. R. Shops, Newark, Ohio

Boilers in Pennsylvania carrying over 15 pounds per square inch steam pressure will hereafter be thoroughly inspected every year under operating conditions.



Patterns for Transition Piece

Layout of Conical Section Square on the Bottom and Round on the Top

In the accompanying illustration is shown the method of developing a pipe that is round on the top and square on the bottom with the square having the greatest area.

First lay out a full-sized top view, as shown in Fig. 1. Next divide the circle into any number of spaces; in this case 8. Then lay out Fig. 2.

The distance from *A* to *A'*, Fig. 2, will be equal to the height of the conical section, and the distances from *A'* to 1, 2, 3, 4 and 5 will equal the distances from *A* to 1, *A* to 2, *A* to 3, etc., of Fig. 1.

Next lay out the point *A* in the pattern, and from there draw a line equal to the length of line *A*-5. Then take the distance 5-4, Fig. 1, and lay it out on Fig. 3, and so on, as shown. The pattern shown is made for a butt joint, but if a lap seam is wanted the lap must be added.

Paterson, N. J. JOHN ZINGA.

Recent Developments in Locomotive Boilers*

Use of the Superheater and Brick Arch—Film Feed Water Heaters—Mechanical Stoking—Business Questions

The past year has witnessed the almost universal use of the superheater and brick arch, but the refinements of the former are only just commencing. The high temperatures of steam have brought into more extended use the force feed lubricator, a custom quite general in European locomotive practice, and it would not be inappropriate for this association to have a committee whose duty it would be to keep in touch with the developments therein, collect data and make yearly reports.

There is evidenced a halt in the strife for larger and still more powerful locomotives of the articulated type, and yet the perfection of the mechanical stoker has increased the human limitations therein so that some cause other than the stoking of the boiler must be sought as the reason. Perhaps the articulated locomotive was only the means to an end which may now be accomplished in other ways.

The development of the film feed water heater and the possibility of passing 60,000 pounds of water per hour through such a device of size small enough to be made practicable on a locomotive gives rise to the belief that a marked economy may be effected thereby; for it has been demonstrated that an increase of every 11 degrees in temperature will represent an economy of 1 percent. The boiler being the limiting feature of the modern locomotive, no pains or expense should be spared to effect its improvement, and it is in that line that the greatest advancement in the art of locomotive engineering is to be expected.

Through the limitation of clearances the boiler is bound to be the controlling factor in the development of the steam locomotive, and while we should produce the maximum hauling capacity per unit of total weight at the minimum cost per pound of draw bar pull, consideration must also be given to the problem of bringing about a greater heat value per cubic foot of the limited firebox volume. Then by the direct means of higher boiler pressure, increased efficiency of evaporating surfaces, more perfect combustion, more uniform firebox temperature and steam pressure, improved circulation, feed water heated by gases and waste steam, higher superheat, systems of compounding in one or more cylinders to reduce back pressure, we will be able to place steam on a parity with electric operation.

In his address a year ago your president referred to the experimental work then being done in the use of pulverized fuel, in order not only to utilize the smaller sizes and lower grades of coal and lignite, but to insure more even firebox temperatures, more uniform steam pressure and to lessen the fireman's work on large locomotives. During the past year further applications of this method of stoking and burning solid fuels have been made, the Chicago & Northwestern Railway having equipped one of their existing superheated Atlantic type passenger locomotives, which is now and has been for some time performing service between Chicago and Milwaukee on some of the fastest regular schedules in the world. The Delaware & Hudson Company have recently purchased, so equipped, a new consolidation locomotive which is one of the largest of that type. The Missouri, Kansas & Texas Railway is now equipping a 10-wheel passenger locomotive for burning powdered fuel, and several other applications are in progress. Up to the present time various grades of bituminous coal, lignite, and a mixture of bituminous and anthracite coal have been used successfully in these experimental locomotives. The results obtained from the use of pulverized fuel in locomotive service may be briefly summarized: Cinderless, sparkless and smokeless operation; maintenance of maximum boiler pressure at all times without loss at the safety valves; increased boiler efficiency due to the high temperatures obtained; saving in fuel; the elimination of arduous labor on the art of the fireman and of delays and expense at the ash pit.

It seems now quite probable that the public demand for the elimination of the smoke, cinders and sparks, the desirability of giving a value to what is now a waste product of mining, the growing scarcity of fuel oil, and the prohibitive cost of briquetting will, in combination with this method of increasing the effectiveness of steam boiler operation, afford as great an opportunity for lessening the cost of conducting steam railway transportation as has the use of superheated steam.

The improvement of old locomotives by the application of superheaters, brick arches, improved valve gear and other modern apparatus, and even rebuilding with larger boilers and these appliances, is still going on. All these refinements, as well as the substitution of heavy new power and the retirement of old smaller locomotives, have had and will continue to exert a marked influence toward the decreased cost of conducting transportation, for which often too little credit is given the mechanical department, whereas it should be borne in mind that these changes continually produce an increase in the charges to maintenance of equipment for which the mechanical officers of railways are held directly responsible, particularly so when the unit of measurement used is the cost per locomotive mile.

One of the most vital questions for us to-day is the standing of the motive power officer with respect to business questions. Does this department have a knowledge of its costs in order to show what it gets for a dollar and to check waste and extravagance? On most roads the cost of doing a given piece of repair work at different shops varies so widely as to suggest lack of appreciation of the value of keeping of costs on a reliable basis. Every motive power superintendent should know the cost of his department and the effect of his work upon the earnings of the road. If motive power officers and their managers would take the time to investigate the careful methods of obtaining costs in commercial manufacturing institutions they would readily see the value of similar data to a railroad. No such commercial institution could hope to succeed without such accurate information. By it they can show conclusively the commercial advantages of discarding obsolete machinery in old and inadequate buildings and installing new machinery in new buildings with all the modern facilities for cheap and quick output. It has been years since this association has had a paper on shop layouts, and yet we have among our

*Extracts from address by E. W. Pratt (assistant superintendent of motive power, Chicago & Northwestern Railway), president of the American Railway Master Mechanics' Association, presented at the forty-ninth annual convention of the Master Mechanics' Association.

membership experts in that line, and I would suggest a paper thereon for another convention.

Railroading is the largest industry in this country except farming, yet it is not to be doubted that other manufacturing plants of less magnitude spend far more money for shops, tools and machinery. How frequently do you find manufacturing establishments with their buildings, tools and equipment 30 or 40 years old? Yet this is not at all unusual for a railroad shop or roundhouse, where often you will find not even sufficient expenditure on machinery to offset its depreciation. Why should we not obtain the necessary data and present it in such a way as to force attention and action? Perhaps by improved facilities the cost of repairs to locomotives could be kept from advancing in leaps and bounds. Every railroad with numerous shops should have standard practice cards to insure uniformity at all shops, and, where the facilities are inadequate to produce finished material at a reasonable cost, this work should be concentrated in one or more of the larger shops and the material distributed from there ready for use or nearly so.

One of the progressive features of this association is their recent increase of standards and specifications. If this work be continued and amplified and generally followed by the members it would result in vast economies as compared with a specification wherein every item is a specialty. Every motive power officer should exert his influence in the direction of more rational methods of adopting new designs. Too much of this work is done over night. A road is to have a new freight engine, perhaps a new type—a sample engine ought to be built and run for some time on the road before purchasing a large number. Too often there is less time in the design of the intricate details of a locomotive than in that of a new freight car, where a sample car is first built and tried out.

So many changes have taken place in the locomotive since this association tested out and promulgated its standard front end arrangement that I cannot but feel that something should be done with respect to modifying the same in connection with superheat. Easier lines of draft should be provided for, similar to European practice, thereby permitting of the use of a greatly increased size of nozzle and consequent decrease of cylinder back pressure.

Specifications Relating to Boiler Steel

The steel boiler tube specifications have been extended to include tests for superheater pipes and the table of standard weights has been changed. A new diameter, 1⅞ inches, has been added and two new thicknesses of pipe wall, and the weights are given in three decimal places. The table is here reproduced, together with a table for small superheater pipes, which is new.

In the specifications for boiler and firebox steel, besides the tables of permissible weight and thickness variations already referred to, it is also required that hereafter the tension test specimen is to be taken longitudinally from the bottom and the bend test specimen transversely from the middle of the top of the finished rolled material. In present practice both are taken longitudinally from the bottom. The bend test specimen is to be tested cold only, omitting the quench-bend test, and the requirements as to cold bend are now that the specimen of material for 1 inch or under in thickness shall bend around a pin the diameter of which is equal to the thickness of the specimen; and for material over 1 inch in thickness, around a pin the diameter of which is equal to twice the thickness of the specimen.

Match marking of test coupons has also been provided for as follows:

"(*b*) When specified on the order, plates shall be match marked as defined in Paragraph (*c*), so that test specimens representing them may be identified. When more than one plate is sheared from a single slab or ingot, each shall be match marked so that they may all be identified with the test specimen representing them.

"(*c*) Each match mark shall consist of two overlapping circles each not less than 1½ inches in diameter, placed upon the shear lines, made by separate impressions of a single-circle steel die.

"(*d*) Match-marked coupons shall match with the sheets represented and only those which match properly shall be accepted."

It is cheaper to cary a few extra grate bars than to wait for them to be cast and have poor firing and "cuss words" from the firemen.

There are any number of flue cleaners on the market. All seem pretty good, with some better than others, but the main thing is to use whatever flue cleaner you happen to have often.

It is wise to start up and run new boilers for a little while before covering them with any insulating material, as leaks may then be easily detected and calked without marring the covering, thereby saving much annoyance.

The hinges and latch of a boiler front door should be oiled from time to time. It is rare, however, that this is done; it makes the door handle easier, and if the oil burns off there is something the matter with the boiler setting and it should be looked after.

WEIGHTS OF LAP-WELDED AND SEAMLESS STEEL BOILER TUBES, INCLUDING SAFE ENDS, ARCH TUBES AND LARGER BOILER PLATES

Thickness, In.	Nearest B. w. g. or Fraction	Weight, Pounds Per Foot of Length. Outside Diameter, Inches: 1¾	1⅞	2	2¼	2½	3	3½	4	4½	5	5¼	5⅜	5½	6
0.095	13	1.679	1.806	1.932	2.186	2.440	.....	.....	.....	.....	.....	.....	.....	.....	.....
0.110	12	1.926	2.073	2.220	2.514	2.807	3.395	.....	.....	.....	.....	.....	.....	.....	.....
0.125	11	2.169	2.336	2.503	2.836	3.170	3.838	4.505	.....	.....	.....	.....	.....	.....	.....
0.135	10	2.328	2.508	2.688	3.049	3.409	4.130	4.851	5.572	.....	.....	.....	.....	.....	.....
0.150	9	2.560	.....	2.960	3.360	3.760	4.565	5.366	6.167	6.968	7.769	8.170	8.370	8.570	9.370
0.156	5/32	.....	.....	.....	.....	.....	4.745	5.579	6.414	7.248	8.083	8.500	8.708	8.917	.....
0.165	8	.....	.....	.....	.....	4.110	4.995	5.877	6.758	7.639	8.520	8.960	9.181	9.401	10.282
0.180	7	.....	.....	.....	.....	4.460	5.421	6.382	7.343	8.304	9.266	9.746	9.987	10.227	11.188
0.187	3/16	.....	.....	.....	.....	.....	5.632	6.633	7.634	8.635	9.637	10.137	10.388	10.638	11.639

Small Superheater Pipes—Seamless Only

Thickness, In.	Nearest B. w. g. or Fraction	Weight, Pound Per Foot of Length. Outside Diameter, Inches: ⅝	11/16	¾	13/16	⅞	15/16	1	1¼	1⅜	1 7/16	1½	1⅝
0.095	13	0.5375	0.6012	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
0.109	12	.....	.....	0.7462	0.8190	.....	.....	.....	.....	.....	.....	.....	.....
0.120	11	.....	.....	.....	.....	0.9676	1.0480	1.280	.....	.....	.....	.....	.....
0.135	10	.....	.....	.....	.....	.....	.....	.....	1.6100	1.7900	1.8800	1.9700	2.1500
0.150	9	.....	.....	.....	.....	.....	.....	.....	1.7600	1.9600	2.0600	2.1600	2.3600
0.156	5/32	.....	.....	.....	.....	.....	.....	.....	1.9100	2.1300	2.2400	2.3500	2.5700

Talks to Young Boiler Makers

BY W. D. FORBES

The way that it came about that Mike Donovan started a boiler shop was this: He came to the United States when he was just out of his time. (His name shows where he came from.) He married, and for three years he worked in various boiler shops, and at the end of that time was known as one of the best men at boiler repairs in the locality.

One day he got a job in Andy MacClaren's boiler shop, and for several months he worked there building new boilers; then Andy sent him out on repair work, and he was so clever at it that he was always called for when repairs were needed, with the result that for three solid years Mike had only three Sundays to himself and two entire holidays.

Then he put up a kick. He and Andy had words, and he quit. Mike and his wife were careful, and all this overtime with extra pay had given Mike considerable money, which he had put in the savings bank, on which he was getting 4 percent; so a little loaf after his hard work would not be serious for him.

It was early summer, and Mike started planting beans and stuff in his little back yard, enjoying his rest. He had quit his job on Saturday, and on Thursday the superintendent of the Gail Bleachery drove over to Mike's house and wanted him to come over to his works and do some repairs on the boiler. Mike said no; he was taking a rest, besides he did not want to go into business against MacClaren.

But on Saturday morning the president of the company drove over, and with tears in his eyes begged Mike to come over and repair the boiler. MacClaren's men were all busy, he said, and it would be a serious thing for the Bleachery to shut down. So Mike went over, saw what the trouble was, and agreed to do the repairs on Sunday.

He got through about 3 o'clock and the superintendent told him to send in his bill and it would be paid at once. He did not do this, but went to MacClaren and asked him to send the bill and pay him his regular wages plus overtime. MacClaren was very much pleased, and wanted Mike to come back and work for him. For the next week Mike did a great deal of "mooning," as his wife called it, around the house, and thumbed over and over a little blank book in which he had kept a record of the various repair jobs during the past three years. He started out one morning and first went to the Gails Bleachery.

Mr. Gail, the president, was glad to see him, but wondered at his being in his Sunday clothes, and wanted to know what he could do for him. Mike went right to the point. He said, "I understand that you are going to enlarge your works, and that means that you have got to have more boilers." Mr. Gail admitted this, and replied that he was thinking of getting a bigger boiler very soon. Mike pointed out that it would be better for him to get another one the same size as the one he now had, as it would cost him less than would a larger one, and there was plenty of room in the boiler room for it, and, with a second boiler, neither one would have to be forced, as was the present one. The repairs on the old boiler were mostly due to this forcing, and with two boilers there would always be one in service.

The upshot of the talk was this: Mike was to get the price on the boiler of proper size, together with the cost of piping and erecting and submit the entire figure to Mr. Gail. For the entire week Mike went around to the various mills, with the result that he had fifteen boilers to estimate on. He got prices on these boilers from three different boiler manufacturers, and finally closed contracts for nine of them, and before cold weather set in they were all at work.

Mike worked the game openly. He showed his cards and his profits being moderate, yet fair, all were satisfied. These transactions put a considerable amount of money in Mike's pocket; more, in fact, that the savings bank would let him deposit, so he opened an account with the National Bank. Just then MacClaren sold out and the shop was turned into a tank-making establishment, so Mike bought a piece of property, a little better located than was MacClaren's, put up a pretty good wooden building and hired some of MacClaren's old men and started work.

Now, my young boiler maker friends, you may think this story has nothing much in it. Any one could have "turned the trick" as did Mike. Perhaps they could, but the point is that there are very few men who would have seen the trick to turn, and seeing it proved Mike to be a very long-headed man. Henessey, who had worked with Mike during all the three years of his boiler repairing, and who was in every way just as good a boiler maker as was Mike, did not see it, and is to-day working for him.

It seems really simple enough. All that was done was to put two and two together. If boilers had constantly to be repaired, it was fair to assume that they were being overworked or were getting too old to be serviceable, and it followed, this being the case, that new boilers would have to be bought. Making use of these logical deductions, Mike made money, while Henessey kept on fitting patches.

All this was entirely in the line of Mike's experience and understanding and things went very well with him until he got so busy that he was doing more business than his cash capital would admit of. He could, of course, get some credit, but he had to pay his men every Saturday, and when he could not pay for his rivets, plates, etc., as he agreed, his credit ran down and Mike was in trouble.

One day he was in the office of the president of a works when the bookkeeper came in and told the president that there would be a lot of bills falling due in a few days and he had better borrow $10,000 at the bank to meet them. Mike nearly fell out of his chair, but the president, instead of turning pale and looking wild, simply said: "All right. Just make a sixty-day note and I will endorse it. You can take it down to the bank now and get it discounted."

Mike went out and hung around and waited until the bookkeeper came along. Then he said to him: "How can you, in heaven's name, borrow money at a bank? Will they lend it?"

The bookkeeper laughed and replied: "Donovan, how do you suppose banks make a living?"

Mike shook his head and said he did not know; he thought they just took money in and kept it.

The bookkeeper turned to Mike and said: "Look here, Donovan, these bank people are the biggest bluffers in the world. They want to loan their money, yet they are always trying to convince the man who wishes to borrow that they loan it to them as a great favor. Shucks! Is it a favor to you when the plate mill takes your order for a lot of material? Of course not. That's the way they make their living by selling you steel. When you borrow money at a bank it is a favor to the bank, but they always try to make you think just the opposite. You can bet on it that they will not lend you money unless what you offer as security is all right. They take no risks. Now, all you have got to do if you want to borrow money is to go to the cashier, show a statement of your business; that is, what you owe and what people owe you and what orders you have on hand. He will see what your cash balance in the bank is and what your account amounts to, and he will tell you just how much he will lend you, or if you are shaky he will not lend you anything. But, do not go there with any bluff or feel scared to death because you want to borrow money."

Mike got this idea into his head very shortly. The bank saw at once what the trouble was and did what it is legitimately supposed to do, furnished money on proper security.

I want the young boiler makers to think over this article, as every one of them has as good a chance as had Mike Donovan. The chances may not be just as good as his were, but they will be chances all the same. Whatever a young man does he must have fairness and honesty, know his job and be willing to work hard or he will not have a permanent success.

Convention of Ohio Boiler Inspectors

Boiler Manufacturers and Inspectors From All States Attend the First Convention of Ohio Boiler Inspectors at Columbus

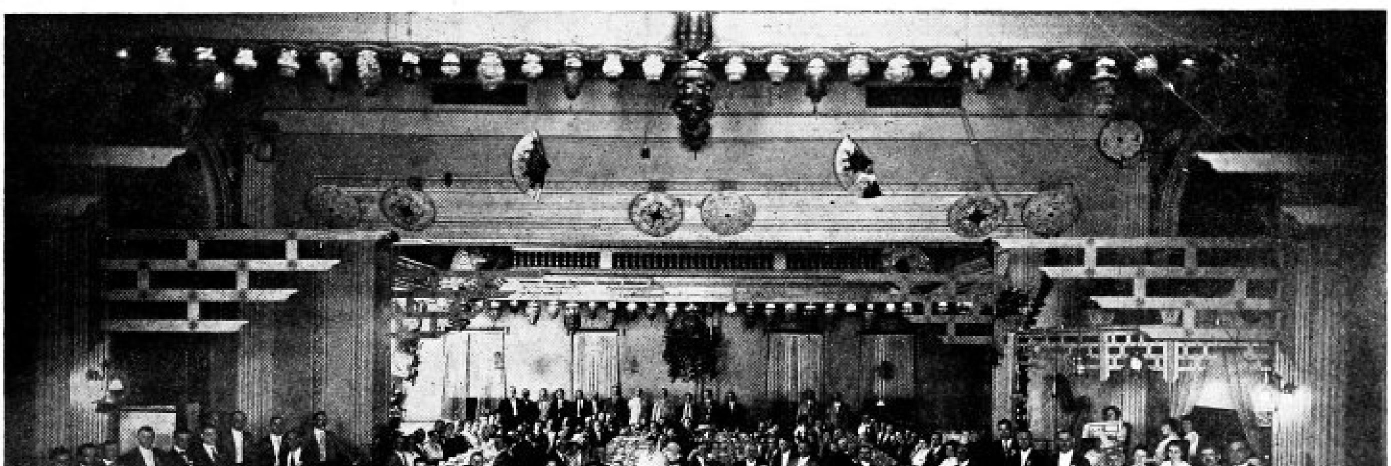
One of the most interesting and unique conventions held in Columbus, Ohio, recently was that of the boiler inspectors employed by the State and by the liability insurance companies, meeting in the House of Representatives on August 17 and 18, and presided over by Mr. J. C. Callery, chief deputy of the Division of Boiler Inspection under the Ohio Industrial Commission.

The principal object of the convention was to further the matter of uniformity, both in the construction of steam boilers and the inspection of boilers in operation throughout the State, and under the immediate supervision of the Ohio Board of Boiler Rules. It is felt that considerable progress was made and great good will come from the meeting, especially in the matter of uniformity and the getting acquainted and discussion along these lines.

Among those persent were Mr. George W. Luck, of the Massachusetts Board of Boiler Rules, and Mr. George A. O'Rourke, of the New York Industrial Commission.

At the first session the address of welcome was delivered by Hon. Wallace D. Yaple, chairman of the Industrial Commission. During his remarks he took occasion to give a short history of steam power, and cited how helpless the industry of the world would be without the steam engine and its necessary corollary, the steam boiler, and especially dwelt upon the importance of the proper inspection of boilers for the safety, not only of the operators of them, but for the general public. He also urged that the matter of uniformity was one of very great importance to be considered, and that whatever was possible to advance its progress should be adopted.

Hon. Percy Tetlow, a former member of the Legislature and member of the Constitutional Convention, now an organizer of the United Mine Workers of Ohio, addressed the convention on: First, Conservation; second, Law Enforcement; in the course of which he took occasion to speak of the enormous waste in the mining of coal and its attendant influence on the cost of power as generated through the steam boiler. The wastage due to the mining methods was placed as high as 40 percent. Mr. Tetlow pleaded that something should be done to secure a greater percent of the coal yet unmined. Speaking of the mining of coal he referred to the enormous loss of life and what had been done to prevent such accidents, and stated that while much has been done, there yet remained much to be



Banquet of Ohio Boiler Inspectors and Guests at Southern Hotel, Columbus, Ohio, August 17 done, and left the thought that it is a duty imposed upon all to do everything in his individual power to prevent loss of life or injury to persons or property through preventable causes.

Mr. H. A. Baumhart, vice-chairman of the Ohio Board of Boiler Rules, gave a history of the insurance of steam boilers and the inspection and protection features connected with the early companies who engaged in this form of insurance. The speaker urged standardization, both as to construction and methods of inspection of boilers, and ventured the conclusion that it was the most important subject before the industry. He also mentioned that Massachusetts was the first State to have compulsory inspection, Ohio following later. The speaker stated that, from his experience, the boiler manufacturers were responding nobly to the changed conditions occasioned by the inspection law, and were assisting in its operation. In closing, he urged the necessity of uniformity, to the end that the life of the people coming in contact with the boilers be better conserved and that property damage be averted, as well as making for progress because of one standard, both in the construction and inspection of steam boilers.

Mr. J. F. Whiteley, of the Fidelity and Casualty Company of New York, at the afternoon session on Thursday gave a very entertaining and instructive address on "Duties of a Boiler Inspector." Going back twenty-six years, Mr. Whiteley gave reminiscences of a time when there were probably not over 100 boiler inspectors in the entire United States, and referred to the present day, when there are more than that number in the one State of Ohio. The old "drop-flue boiler," the "double-decked cylinder boiler" and the "triple-draft Hennessy boiler," he said, are all now happily passed away, for which we can be thankful; and we of the present generation have to be hopeful that the few "misfits" yet remaining are fast disappearing. Continuing, the speaker mentioned the improvement in the workmanship on the present boilers as compared to the methods of drifting the rivet holes until it was possible to force the rivet through, that it was no longer considered possible to set the sheets up loosely and expect the calking tool to cover up the poor work and make the boiler tight, for a while at least; also that "toothpick braces" were out of use in these days of high pressures, and that the use of sledge-hammers to straighten out "kinks" was no longer tolerated. Speaking of reports and what reports indicated, the speaker laid particular emphasis on the fact that the man in the office was able to judge something of the character and ability of the inspector by the manner in which he prepared his reports, and referred particularly to the necessity of having all data correct.

"Necessity of Boiler Inspection Codes" was treated by Mr. Fred R. Low, editor of *Power*. The speaker took particular occasion to impress upon his audience the tremendous power pent up in a boiler, and mentioned something like 163,000,000 foot-pounds of energy in a 72-inch by 18-foot boiler at 150 pounds pressure. The necessity for boiler inspection was apparent, and since different designers design differently, a code of uniform application would be beneficial to both the manufacturers and the users of steam boilers. "A boiler," said the speaker, "knows nothing of geographical or political divisions."

The "Advantages of a Uniform Boiler Inspection Code," by Mr. Thomas E. Durban, chairman American Uniform Boiler Law Society, Erie, Pa., followed along the line of the getting away from present-day difficulties on account of lack of uniformity and the benefits accruing in the future to the time when a standard shall have been adopted by the different States, mentioning some of the incongruities of the present situation, where a boiler may be operated in one State and forbidden in another, yet is no more safe in one or dangerous in the other because of being in that particular State.

Mr. George A. Luck, of Massachusetts, gave a brief talk relating to how the boiler inspection law was applied in his home State, and mentioned some of the difficulties encountered by his Board, especially urging that a uniform code be pushed and adopted by all States at as early a date as possible.

Mr. George A. O'Rourke, of the New York State Industrial Commission, also gave a short talk in respect to his duties in his State and as to progress made.

Short talks were given by different members and considerable discussion of live subjects took place at the close of the prepared papers. On Thursday evening 225 attended a banquet at the Winter Garden of the Southern Hotel.

At the Friday morning session Mr. Victor T. Noonan, director of safety of the Industrial Commission, gave a lengthy address on "Why Not Preparedness Against Accidents?" going into detail as to cause of accidents and the remedying of the same in the way of preventing.

Mr. Frank H. Yeager, of the Ohio Board of Boiler Rules and representing the operating engineers, gave a short talk in which he deplored the present-day tendency of men operating large factories to place a watch in the hand of a man to record the time required in each operation, and expressed the belief that this was the cause of more accidents than was generally credited. The speaker urged the benefits to be derived from proper inspections and mentioned instances illustrating his points.

Mr. P. D. Converse, of the Ohio Brotherhood of Threshermen, addressed the convention and expressed the thought that the time would some when the threshermen would come under the inspection department and have their boilers examined as to safety. The speaker mentioned some of the difficulties in the way, especially referring to the difficulty of finding a time when it would be possible to inspect these boilers and not discommode the farmers, to whom the outfits generally belonged. Between March 1 and June 1, the speaker concluded, was the most propitious time.

Moving pictures showing "From Ore to Finished Pipe" as made in the plants of the National Tube Company were shown and explained by a representative of the company, the convention closing with an address by Gov. Frank B. Willis, in which he complimented them on their attendance, and expressed the thought that much good would come from their meeting.

For the success of this convention very great credit is due to the members of the Ohio Boiler Board, Mr. H. A. Baumhart, Mr. Frank Yeager, Mr. George Kittoe and Mr. Joseph P. Owens, and the convention committee, composed of Mr. W. C. Connelly, president of the D. Connelly Boiler Company, of Cleveland; Mr. W. A. Drake, of the Brownell Company, of Dayton, and Mr. W. J. Hannum, of the Kelly-Springfield Road Roller Company, of Springfield, Ohio.

OBITUARY

James T. Pritchard, master boiler maker of the Georgia, Southern and Florida Railroad, at Macon, Ga., died on August 12 at the home of his daughter, in New York City. For twenty years Mr. Pritchard was foreman boiler maker of the Lehigh Valley Railroad at Sayre, Pa, and for the last five years has been master boiler maker for the Georgia, Southern and Florida Railroad at Macon. The interment took place on August 15 at Scranton, Pa.

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

One of the greatest boosts that the campaign for uniform boiler laws and codes has received in recent months was given by the Ohio Boiler Inspectors' convention at Columbus, Ohio, last month. After some nine months spent in charge of the boiler department of the State of Ohio, Mr. J. C. Callery, chief deputy of the division of boiler inspection, became so impressed with the confusion of the boiler laws and codes existing in Ohio and other States that he felt that if a large number of people interested in boilers and boiler inspection could be brought together for general discussion and comparison of ideas a great amount of good could be accomplished. The hardships and injustice worked against the manufacturers and users of boilers due to the fact that a boiler built in one State cannot be accepted in all other States and that various interpretations of present laws and codes are made by the different inspectors throughout the country, pointed overwhelmingly to the advantages of uniformity in this direction. The very successful convention held and the great number of prominent men participating proved how sound this judgment was.

During the four sessions of the convention complete harmony and good-fellowship prevailed. Everyone was a booster and everyone seemed to approve what the other man said. A brief account of the meeting and what was accomplished is given elsewhere in this issue, and in our next issue a more detailed account of the proceedings and addresses made at the convention will be given. Many resolutions were suggested that the convention idea for the promotion of uniform boiler laws and codes be made a permanent annual occurrence, although none was adopted, as those directly in authority felt that a meeting would be called in the very near future of committees from all the States directly or indirectly interested, including representatives of the American Society of Mechanical Engineers, for the purpose of preparing and adopting a uniform law and code.

More than passing interest has been displayed at recent conventions of the Boiler Manufacturers' Association in the subject of cost accounting. As pointed out by Mr. David J. Champion at the last convention of this association, many manufacturers have a regrettable tendency to underestimate the value of their product, mainly because they fail to realize the actual cost of its production. It is not to be supposed that anyone who has undertaken the manufacture of steam boilers and invested money in a manufacturing plant would be willing to base his figures for the selling price of the finished product solely upon the cost of the material and labor with a fixed margin for profit, but there is every reason to believe that too many manufacturers fail to take proper account of the numerous other items entering into the cost of manufacture and that the methods of cost accounting are far from uniform and are too often misleading.

As pointed out by Mr. Edward N. Hurley, vice-chairman of the United States Federal Trade Commission, in the address on "Government and Business," quoted elsewhere in this issue, since better business methods usually begin with better methods of cost accounting, scientific cost keeping becomes in a very definite sense the basis of our prosperity. The Federal Trade Commission is not only recommending the subject of costs to the business men of the country and offering to aid in the actual development of the proper cost systems, but it is endeavoring by every means within its power to stamp out the evil of ignorant competition, an evil which is most dangerous to the development and success of the country.

When it is realized that only about ten percent of the manufacturers and merchants in the country actually know what it costs to manufacture and sell their products, it is not strange that the general demoralization in a large number of industries has been caused by firms who cut prices and place quantity before quality in their futile endeavors to make a success of their business at the expense of their competitors. That the boiler making industry has suffered from this evil is apparent to everyone familiar with it. The efforts of the members of the Boiler Manufacturers' Association, therefore, to arrive at a mutual understanding as to the methods of cost accounting and the elevation of the standard of competition to a higher level are worthy of the heartiest support and cooperation of the men engaged in the business.

John and Geometry Trisect Lines

Another Practical Application of Geometry—Pointers on the Strength of Riveted Joints

BY JAMES F. HOBART

"Hello, Central! Give me Point 5984! Hello, who is this?"

"Hello! This is Point 5984, Hobart, talking!"

"Oh, hello, Mr. Hobart! Say, are you coming over to the shop soon?"

"Yes, John, I'll be over there this afternoon. Why? What's up?"

"Oh! I'll tell you all about it when you some over, but the sum of the thing is that they want me to divide up some three-cornered plates into three equal sections. They are going to make up a lot of three-cornered shoes for driving piles, and I'm sure up against it to do the trick!"

"All right, John. You are up against the problem of trisecting an angle, and that is something that every 'geometry sharp' is not able to do, try as he may. Well, I'll be over pretty soon. Good bye!"

"Glad you've come over, Mr. Hobart. I am sure some bothered with this job, which is like this: They have got a lot of waste plates, clipped from corners, which they want to make into three-sided shoes for piles, something like Fig. 1. They want to bend the pieces twice, then rivet on an angle clip and let it go, rough like, to keep piles from splitting when driven in hard ground. The sheets look about like Fig. 2. They are square, or nearly square, at *A*, and of various lengths from *A* to *B* or from *A* to *C*, which are equal in all cases."

"Say, John, you are up against it for fair this time. To put the matter in geometry language, you want to 'trisect' the angle *B A C*, and how to trisect an angle (divide it into three equal parts) is something that even geometry has not told me yet how to do."

"Say, is there anything that geometry can't do? I thought that science could juggle anything in any layout!"

"Geometry may be able, John, to trisect an angle, but I have not yet advanced far enough to get initiated into that degree, so I can't dope it out to you. There is a fellow in California, I believe, who advertises that for $3 he will send a method whereby you can trisect an angle, but I have never yet sent him the three plunks. But, John, there is a way of doing your stunt, and there is a pretty neat way of trisecting lines, which may be of value to you some time."

"Show me, Mr. Hobart: I'm here for the goods, and I want all the 'know-how' that is going around when I'm out!"

"All right, John; draw one of your three-cornered plates as at Fig. 3. Let *A B* and *C* represent the corners thereof. Now, with *A* as a center, draw any segment of a circle, as at *D E*; then with the dividers step off the curved line *E D* into three equal spaces, shown at *E G*, *G F* and *F D*. Next draw lines from *A* through *F* and *G*, touching the edge of the plate at *H* and *J*. Then with *A* as a center again, open the dividers until they just reach the edge of the plate at *H* and *J*, and draw the curved line *K J H I*. Then draw the lines *J K* and *H I*, and the problem is finished. It is only necessary to shear off the corners along the lines *H I* and *J K*, bend the plate along lines *A H* and *A J*, and the three-cornered shoe has been formed as required. Of course, the holes for the rivets must be laid out and punched before the sheet is bent up."

"That, sure, gets results, Mr. Hobart, but I rather hoped you would do the stunt by some geometry method which would look more like business than spacing a line with the dividers!"

"Sorry, John, but that's the best I can do in the line with what little I know about geometry. Perhaps the professor could help you out."

"Gee whiz, Mr. Hobart! I got enough of the professor when he handed me out those equations for circles, ellipses, and such things. No more 'professor geometry' in mine. I can get away with your everyday shop geometry, but what the professor hands out is sure a whole lot too rich for my blood!"

"Well, John, I don't see but what you will have to space for awhile yet, but here is a little geometry dope which will come in handy when you want to divide a line into three equal parts without measuring it or without spacing it off. Do you want that?"

"Sure! Let it come right straight off, P. D. Q."

"Then, John, go to it as in Figs. 4, 5 and 6. Fig. 4 shows the line to be trisected. First bisect the line as you were shown how to do in an early talk. Fig. 5 will bring the method to mind again if it has slipped away. Just strike arcs, cutting each other, from *A* and *B*, as centers, and for reasons to be explained later, if possible, let *A B* be used as radius when cutting the arcs. This is not absolutely necessary, as any distance more than one-half the length of *A B* may be taken as radius, but to solve the problem properly, a point *D* must be found equidistant from *A* and *B*, or *A D* and *B D* must equal *A B* for a future operation, as shown by Fig. 6. Therefore it is just as convenient to use distance *A B* as a radius when cutting arcs *C D* as to use any other radius.

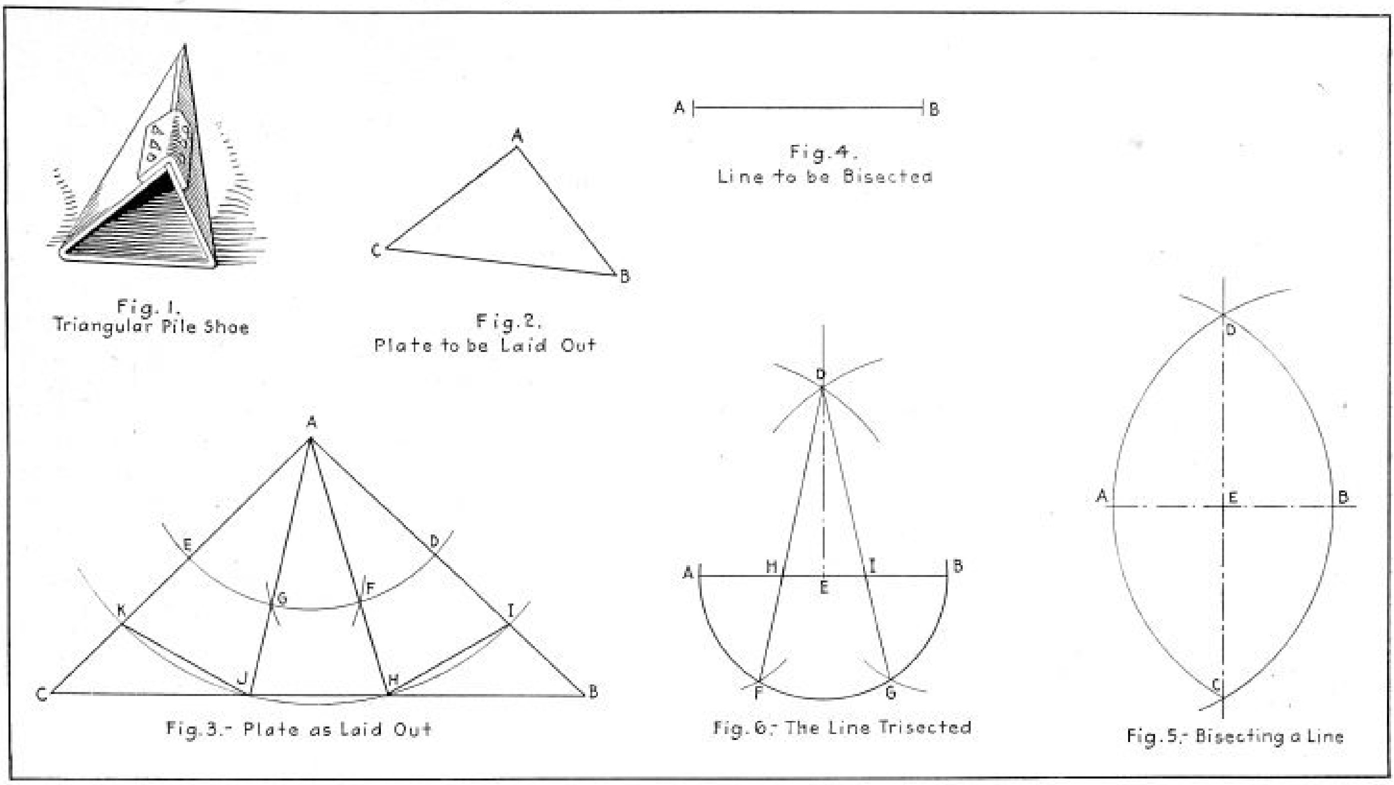
"Having bisected line *A B* and located point *E*, proceed with that point as a center to draw the semi-circle *A F G B*, Fig. 6, and then divide this semi-circle into three equal parts by cutting arcs at *F* and *G*, from points *A* and *B*, with a radius equal to *A E*, or the same as with which the semi-circle was drawn. Do you get me, John?"

"Sure, Mr. Hobart! That is all plain sailing."

"All right, then, John, but be sure to break in when you don't fully understand, will you? That's all right, for I want you to be so dead sure about why these things are done that you will be able to work out ways and means of your own when something similar comes up. Therefore we will get this business down pat before going ahead with something else!"

"Say, Mr. Hobart, I've got the whole thing now! You are going to draw lines from *F* and *G*, Fig. 6, to point *D*, cutting the semi-circle at *F* and *G*, and these points cut line *A B* into three equal parts, sure as I live! Now, how in Sam Hill does it do that? What is the reason for it?"

"Say, John, just let up on the questions a little. When you fire 'em by the broadside it takes a little time to pick them all up and tie on the proper answers. But as to how the line is trisected so exactly is something I will leave for you and the professor to fight out. All I know about it is that it does the business every time. There is a proposition in geometry which shows the how and where of this method, but I am not able to lay hands on it at present, so



Methods of Trisecting Lines and Angles

you will have to tackle the professor if you want to know more about it right away."

"I'll wait, Mr. Hobart! I'm not in half as big a hurry as I would have to be to get me next to the professor about it! Gee, you just bet I ain't!"

"All right, John, let it go at that, but I will tell you that the equilateral triangle and semi-circle business will work as well with four or five equal parts in line *A B* as it does with three. Therefore, you can divide a line into any required number of equal parts by spacing the semi-circle, and then drawing lines to the triangle center as before."

"Say, that's all right, isn't it? But hold on! I don't see how it is much handier, spacing around that semi-circle, than it is to space the line itself and not bother with the semi-circle and lines. Where is the benefit of using the semi-circle?"

"Probably there isn't, when other than three or six divisions are to be made, and possibly five. But these divisions are easily made, for the reason that the radius can be used for the spacing of the semi-circle for the three spaces, and by bisecting one of the three spaces the same radius may be used for the six divisions. By using the method of laying out a pentagon, a five-sided figure, the line may be divided into five equal parts by the use of the semi-circle method, but for seven, nine, eleven spaces the direct spacing of the line would be preferable."

"Thanks, Mr. Hobart. I will work that method all I can until I get it into my head so far that it never can fall out when I'm not looking. But here is a thing or two in regard to those riveted seams we were talking about some time ago, which I don't get quite as clear as I would like to. Now, we found out that each rivet hole cut in the shell of a boiler actually weakened the shell by cutting away metal, and the books say that a single riveted joint is only about .56 the strength of the unpunched sheet. They tell me also that a double-riveted seam has about .76 as much strength as the solid sheet. Now, what I am up against is this: If punching rivet holes weakens the sheet, how can the seam be made stronger by punching another row of holes alongside the first row. I can't get that through my nut! Why is it?"

"That is a blind lead, John, and I don't blame you for getting all tangled up. It is this way, John! If we punched a second row of holes just like the first row the seam would be no stronger. We should punch the holes as far apart as possible and have the edge of the sheet supported well enough to stand the calking, but when we put in two rows of rivets we can space them farther apart than in a single row, for, the rows of rivets being 'staggered,' the second row supports to a great extent the long spaces between the first row of rivets, and the strength of plate section is increased exactly in proportion to the increase in distance between the rivets, viz., from 56 percent to 74 percent, which is a whole lot, all things considered!"

"Do they keep increasing plate strength by spacing the rivets farther and farther apart when they get up to the triple riveted, butt-strap joint?"

"Yes, John, they do that in the joint you mention, but they use other means also. The straps, placed inside and outside the sheets, which are butted together and then fastened with three or four rows of rivets on each side of the butt joint."

"Oh, I see! The straps on either side of the joint take twice as much strain as can be carried by a single riveted seam. The plate section is doubled and strengthened in that way, while the rivets are put in double shear by the straps, and the rivet section increased in that way at the same time that the plate section is increased in strength. But how do they get the plate section up so high? I see that good butt strap, triple riveted seams are given a strength of 86 to 90 percent! How do they get that? The plate has to have rivets close enough together so that the calking will stand, so where does the last 10 percent of joint strength come from?"

"That's right, John. The calking edge *must* be supported, but if you look at a high efficiency joint you will see how cunningly things have been worked to meet all conditions. The calking is taken care of by having a thick, narrow strap on the outside of the joint, where the calking is to be done, and then they put a thinner and wider strap on the inside of the boiler and make this inner strap wide enough to receive one or two extra rows of rivets, but spaced farther apart than the rows which support the calking edges; and one or two rows of rivets are added in this manner, the last row being so far apart from rivet to rivet that the plate section runs up to 86 to 90 percent, as stated above. That is where they get the high efficiency of the triple (or quadruple) riveted, butt strap joint."

"Is there any way, Mr. Hobart, by which the percentage of strength could be increased to 100, so we could use the entire strength of shell?"

"Yes, John. It is possible to obtain 100 percent of strength in a boiler shell, but it must be done by other means than riveting. Each and every time a hole is punched in a sheet, down goes the percentage of strength; therefore it will be necessary to weld the boiler shell in order to obtain full strength, or 100 percent efficiency, of joint or seam."

"How can they weld big boiler shells so as to be sure that the weld is safe and solid?"

"There are two ways, John! One way is by lap welding and then rolling down the joint right in the fire until the sheet is but little thicker than normal. Such a joint will have full, or 100 percent, of strength. In fact, the seam is made the strongest part of the shell by being left thicker, as described above."

"What is the other method, Mr. Hobart? What is it, and how do they do it?"

"The other method of welding boiler shells, John, is by means of the electric arc or by the oxy-acetylene process. By these methods also, the plate is actually melted together and the joint is left thicker and therefore stronger than the rest of the shell, thus full plate strength may be attained in steam boilers. But one word of caution! Boiler shells, when welded by either of the methods noted above should be well annealed before they are built into boilers. There are strains set up in the metal during welding which if not allowed to release themselves by heating the section of shell to a red heat, these strains will usually cause weak spots to develop and repairs soon become necessary—something which does not happen when the welded sections are heated to a red heat and allowed to cool slowly before being placed in a boiler."

"Say, Mr. Hobart; how are such strains set up in metal? There is nothing to show it."

"Just take a bit of plate, John, and hit it a few times hard with a sledge in the same spot while resting dead on something solid like an anvil or a heavy floor plate. Just try it on and tell me what happens."

"Well, I'll be hanged! Why, Mr. Hobart! That bit of plate dished right up like a saucer! What did it?"

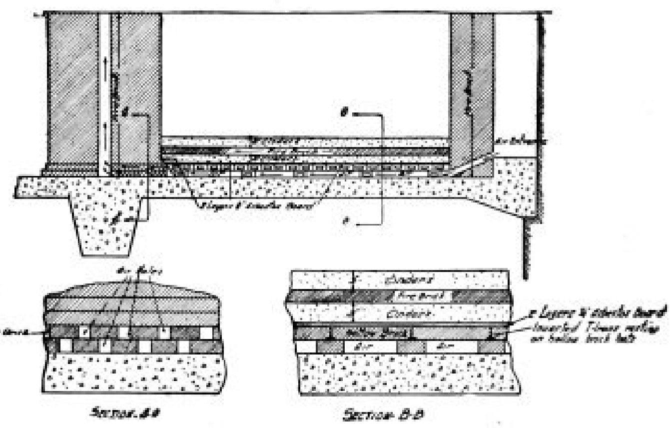
"The hammering, John. You stretched a portion of the bit of plate—made it a little thinner, and to get room to expand the expanding metal just pushed itself sidewise with tremendous force. Now, John, just stop and realize what force was exerted by that little bit of hammering, how it stretched things and made them tear up solid metal to get room for expansion. Again, just stop and consider what happens when there are places like that under stress in a boiler! The local stress is all the time trying to get away, and it actually adds to the internal stress upon the boiler, hence its need of removal by annealing the sections and permitting the strains to disappear while the metal is soft at a high temperature."

"Well, Mr. Hobart, there is a whole lot of 'inside baseball' in this boiler game, isn't there? I never imagined there was so much to it, but you just bet that I'm in the game to stay, and if I don't get a pair of foremen's shoes before I'm 30 it won't be because I didn't try hard enough and study for all I am worth. Much obliged, Mr. Hobart; be over soon again? All right! I'll take care of that. I'm not forgetting any of this dope that I get under my hat. It's mine for keeps!"

How to Insulate Fireboxes on a Concrete Floor

Two new boilers were installed on a reinforced concrete floor, and after being used for a short time cracks were noticed in the concrete. An examination showed that they were caused by the expansion of the concrete on account of excessive heat. A little later a brick wall, which separated the two boilers, had to be taken out because the heat was so intense that the wall started to give way. This wall was 34 inches thick, with outer layers of fire brick and the interior of common brick, and rested directly on the concrete floor. When this wall was torn out the concrete under the wall was found to have begun to dehydrate. On taking up some of the insulation under the fireboxes, which consisted of a one-inch layer of 85 percent magnesia over the concrete, two layers of common brick, and a top layer of fire brick, it was found that neither the common brick nor the fire brick were injured, but the magnesia had become pulverized and the concrete dehydrated on the surface.

Asked to suggest some method of overcoming the difficulty, The Ferro Concrete Construction Company proposed the method shown in the accompanying cross-



section. The method depends for its protection largely on the circulating air space between the fireboxes and the floor, and in the separating wall. Holes were punched through the outer wall to allow the outside air to enter, pass under each boiler and up through the slot in the center wall.

This air space, under the fireboxes, was formed by inverting steel tees, 2½ by 2½ by 5/16 inches, placed the length of a brick apart, these being held above the concrete by hollow brickbats placed under the sections approximately 2 feet apart. The tees were covered by a layer of hollow brick, thus forming a hair space above the brick. The entire surface of this brick was flushed with a sealing of clay, which was covered in turn by two layers of ¼-inch asbestos board. Over the board was placed a 3-inch fill of cinders, another layer of fire brick, and another 3-inch fill of cinders. This construction provided not only a circulating air space, but a dead space formed by the hollow brick. Particular care was taken that no air could get from this ventilating air-space through the insulation into the firebox.

Under the brick wall the air space was formed by placing the two lower layers of brick, as shown in section AA, leaving an air space between each brick. When the wall itself was replaced it was built entirely of fire brick.

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.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Fitting Crown Bars

Q.—(a) I have three Shay engines to put fireboxes in. They are of the crown bar type. Which is the most serviceable way to put on crown bars—to use the taper bolt with copper washer and no threads in crown sheet or to use the threaded bolt with hole tapped out in crown sheet and crown bolt driven up the same as a staybolt?
(b) Do you think it proper to swedge flues cold?
(c) Why do the Lima Locomotive Works drill 2 1-16-inch flue holes in flue sheet, thus requiring thick coppers? H. E. S.

A.—(a) A good method of attaching crown bars to crown sheets in locomotive boilers is shown in Fig. 1. Bars *a* are riveted to the crown sheet with rivets of the

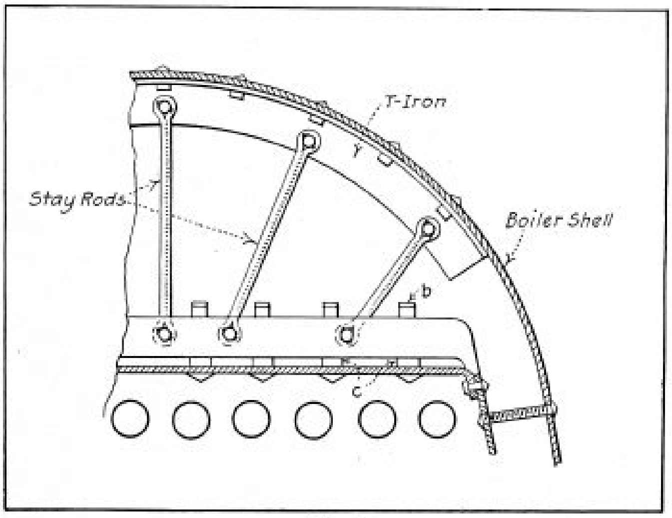


Fig. 1

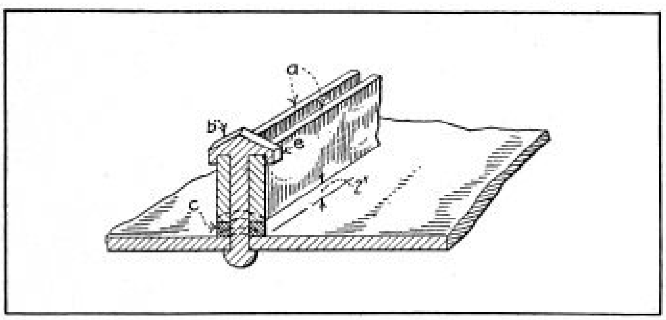


Fig. 2.—Sketch of Rivet and Crownbar Connection

form shown at *b*, Fig. 2. Projections *e* at the top of the rivet rest over the bars *a* and prevent them from spreading apart. Thimbles or distance pieces *c* are placed between the crown sheet and bars *a* and they prevent the sheet from bulging upwards when the rivets are driven. The bars *a* also rest upon the crown sheet as shown in Fig. 3. The ends are shaped to fit the curvature of the flange of the crown sheet, and also to rest upon the inside wrapper sheets. The bars *a* are connected to the boiler shell as shown in Fig. 1, with stay rods pinned to T-irons that are riveted to the shell. These rods are also bolted to the crown bars as illustrated. As to the serviceability of the two methods described in question (a), this is a matter open for discussion to the boiler makers.

(b) *Swaging,* commonly called *swedging,* is the operation of reducing boiler tubes to a smaller diameter at the ends. It is usually done to the smaller sizes of tubes employed in locomotive boilers. The amount of reduction

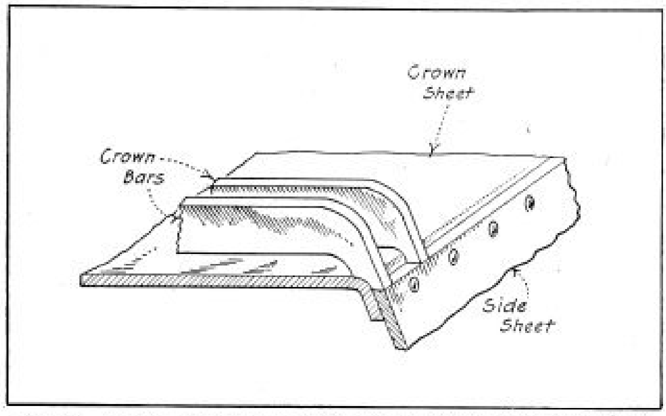


Fig. 3.—Sketch Showing How Crown Bars Rest on Crown Sheet and Side Sheet

in the diameter at the ends of the tubes is made a trifle over two times the thickness of copper ferrule when such liners are used. The tubes should be annealed before subjecting them to the operation of swaging, so as to insure good tube ends free from cracks. Annealing the tube ends softens them, and the operations consist first in heating a length of from 4 to 6 inches from the end to a red heat, then place the heated end upright into a box containing air slacked lime and powdered charcoal. This annealing mixture should be thoroughly mixed.

(c) *Copper ferrules,* owing to their greater expansion than steel or iron when heated, aid in preventing leakage between the tubes and tube sheet. The copper ferrules being very ductile, are easily worked into the small openings in the metal surrounding the boiler tube holes, thereby aiding in producing a tight connection.

Strength of Joint in Channel Iron Bars

Q.—What percent of original strength of channel iron does this joint have? C. B.

A.—To be proficient in handling problems of this kind one must understand the use of properties of sections as employed in structural design work.

To find the percentage of the strength of the channel on *AB* as compared with the combined strength of the plate and channel, it is necessary to determine first the

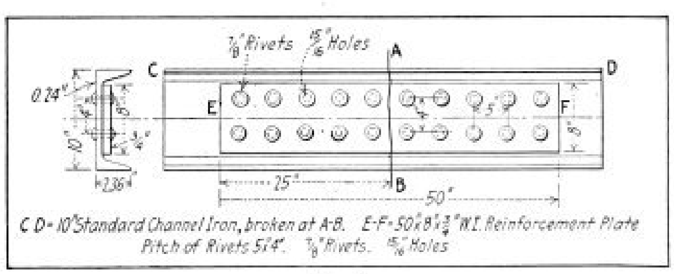


Fig. 1

combined moment of inertia of the plate and channel about its neutral axis *EF*, Fig. 1. Then find the section modulus of the combined members. The ratio of the section modulus of the channel to the combined section modulus equals the percentage of section modulus of the channel.

According to Carnegie's or Cambria's Handbook, the *section modulus* of a 10-inch by 1/4-inch 15-pound channel equals 13.4.

Moment of inertia of the rectangular plate 3/4 inch by 8 inches may be found according to the following formula:

$$\frac{ab^3}{12} = \text{moment of inertia,}$$

in which $a = \frac{3}{4}$ inch.
$b = 8$ inches

Substituting the values in the formula, we have:

$$\frac{\frac{3}{4} \times 8 \times 8 \times 8}{12} = 32, \text{ moment of inertial.}$$

The section modulus is found by dividing the moment of inertia by the greatest distance the outermost fiber of the section is from the neutral axis. In the form of a formula, the rule may be expressed as follows:

$$M = \frac{I}{d}$$

in which M = section modulus,
d = distance of outermost fiber to neutral axis.

The channel is 10 inches deep, neutral axis *EF* is 5 inches from the outermost fibers.

Using the values in the formulas, we have:

$$M = \frac{32}{5} = 6\,2/5, \text{ section modulus of the rectangular plate,}$$

$13.4 + 6\,2/5 = 19.8$, combined section modulus of plate and channel.

$13.4 \div 19.8 = 67.7$ percent of original strength of channel as compared with the combined strength of channel and plate.

The weakest part of the beam is in the sections through the rivets, but as the break is shown along *AB*, the calculations are based on the solid plate section. In determining the strength on plate section through the riveted joints, the same principles are employed as explained. The reduction in section modulus in both plate and channel due to the removal of the metal for the rivet holes must be considered. By splitting the 8-inch plate and placing a strip at the top and bottom of the channel a stronger beam will be secured.

Layout of Firebox Wrapper Sheet

Q.—Please illustrate a complete layout of the pattern for a firebox wrapper sheet as shown on the accompanying sketch. R. C.

A.—The sketch referred to in the request is shown in Fig. 1. The wrapper sheet is of a tapering form with a sloping crown sheet and cut off on an angle at the bottom. A good idea of its shape may be seen in Fig. 2.

The solution of the problem is simple, but requires careful development in order to secure an accurate pattern, as there are a great number of construction lines of considerable length. In all such layout work, where the plate is heavy, always develop the views to the natural dimensions of the plate, so as to insure as nearly as possible the required size of pattern.

Draw an end and profile, Fig. 3, showing a one-half section of the wrapper sheet, then the side view. Divide the curved outlines of the two ends into a series of triangles, number or letter them so as to be able to follow the development of the side view.

From the points *r*, *s*, 1, 2, 3, 4 and *a* project horizontal lines perpendicular to the center line *a-m-n* of the end view to intersect as shown at *a*, *r*, *s*, 1, 2, 3, 4, at the respective ends in the side view. Draw in the solid and dotted lines of construction.

Produce the true lengths of these construction lines by drawing the right-angled triangles shown above the side view. As they are numbered to correspond with those in the end and side views, no trouble should be encountered in determining them. The bases for these triangles are transferred from the end view; for example, the base of the triangle for line *a* to *r* equals the dotted distance between the points *a* to *r* of the end view. The height for this triangle equals the horizontal distance between the points *a* to *r* of the side view.

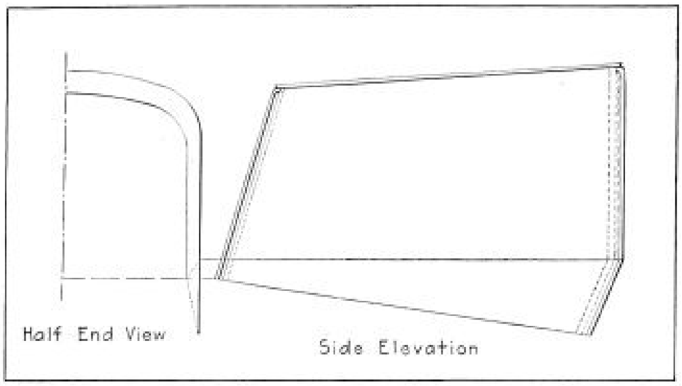


Fig. 1

LAYOUT OF PATTERN.—FIG. 4

First draw the center line *a* to *a* equal to *a* to *a* of the side view taken at the neutral layer of the plate. From point *a* at the bottom, which in this case is the small end of the wrapper, draw arcs equal in length to arc *a-r* of the profile view. With trammels set to equal distances *a-r* of the triangles and from point *a* at the top of the pattern, describe arcs intersecting the arcs previously drawn at *r-r*. Then from point *a* at the top with the compasses set equal in length to the arc *a-s* of the end view, draw arcs. With the trammels set equal to line *r-s* of the triangles and point *a* at the bottom of the pattern, draw arcs intersecting at *s-s*.

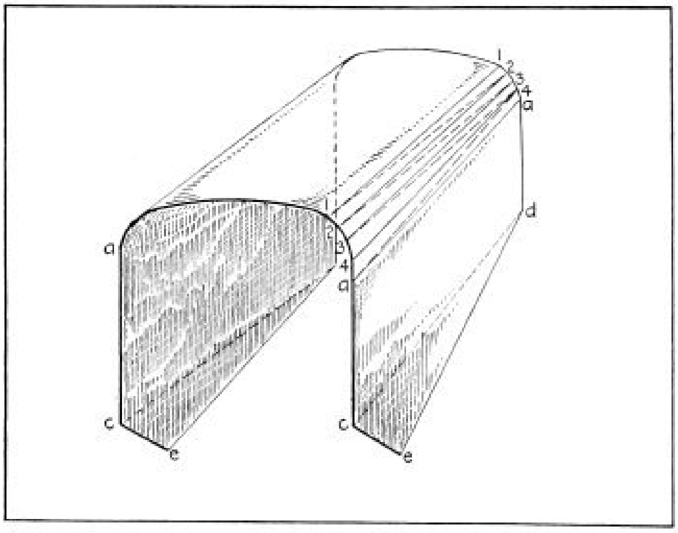
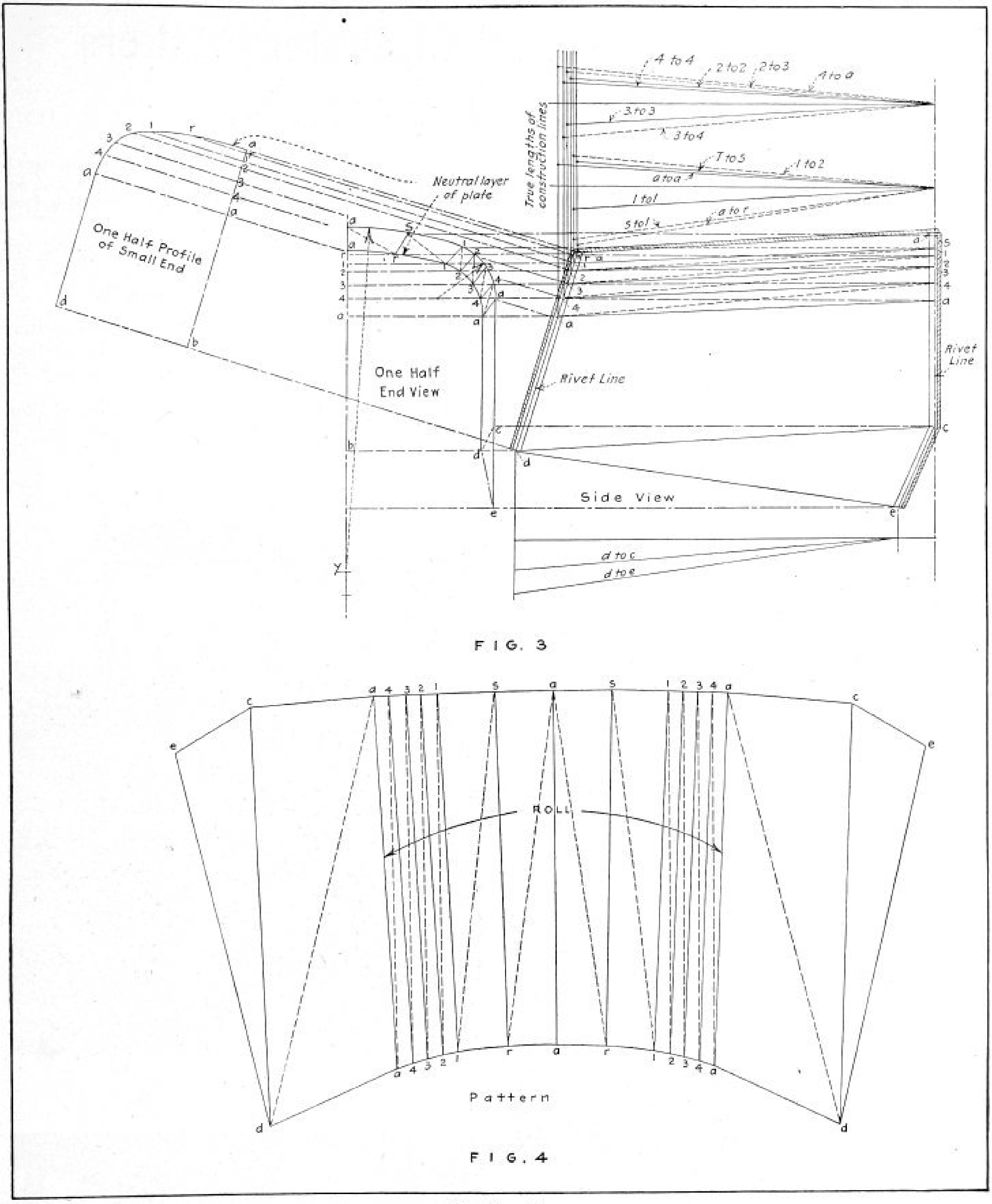


Fig. 2

Continue in this way until points *a-a* are reached. Then use the true lengths of the lines shown from *d* to *c* and *d* to *e* drawn below the side view. The distances *a-c* at the



Figs. 3 and 4

top and *a-d* at the bottom of the pattern are transferred directly from the side view.

The pattern is laid off to the rivet line, where it joins the heads, so allowances for lap must be made.

Question for Readers.—One of our subscribers has recently raised the question of the relative advantages and disadvantages of iron and steel tubes for watertube boilers. Information on this question is sought for the reason that trouble was experienced by the occasional bursting of iron tubes in an oil-fired watertube boiler working about 20 percent overload and using bad feed water containing some salt and possibly some oil. In this case the tubes burst against the grain, and our correspondent wishes to know if steel tubes will stand the strain better than iron tubes and if there would be any difference in the thickness of the tubes if of steel instead of iron, and also if the trouble would be eliminated if good feed water were used?

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Testing a Boiler

Not being a boiler maker by trade, most of the questions to boiler makers in THE BOILER MAKER for July do not interest me greatly, but question No. 1 did, as I have to be constantly present at boiler tests.

First, I insist that the boiler should be thoroughly cleaned and washed out, and I always insist that it be filled from some top opening and that fresh gaskets should be used on all manholes, as it is annoying to see any kind of a leak whatever whether it is important or not in any boiler test.

The boiler should be in such a position that it can be thoroughly inspected all over during the test. A calibrated gage must be supplied. It makes no difference where this is placed, so long as it can be easily observed.

After the boiler is filled and closed up I want about five pounds pumped up on it. Now, as a boiler's normal condition is producing steam when pressure is on it, it must be carrying heated water, and I think it is only proper that the test for leaks and strength should be made under similar conditions; that is, with hot water. I, therefore, have a low fire started so that the boiler will be, so to speak, self tested.

The only thing to remember in carrying out a test in this way is to be careful to have a very slow fire and to provide means for readily relieving the pressure.

Providence, R. I. GEORGE BIGELOW.

Welding Coils by the Oxy-Acetylene Process

Figs. 1 to 3 show the process by which a number of coils were welded by the oxy-acetylene process and rolled cold at the boiler shop of the United Gas Improvement Company at Point Breeze, Philadelphia. Fig. 1 shows a coil of 1½-inch extra heavy pipe 252 feet long, which was first welded into one continuous length and then bent around a cylinder 39 inches in diameter, with a pitch of the coils of 2½ inches. This work required five hours for the welder and helper and one-half hour for the roller.

In Fig. 2 the pipe is 3-inch extra heavy, 135 feet long, which was bent around the same cylinder as that in Fig. 1. but with a 6-inch pitch. This required the same time for welding, but 1½ hours for bending, owing to the greater pitch.

The pipe in Fig. 3 was 2½-inch extra heavy, 227 feet long, bent around a 24-inch cylinder, with a pitch of 3½ inches. This required six hours for welding and 2½ hours for rolling.

All of the coils were subjected to 200 pounds pressure and showed no signs of leaks. A proof that the pipe held its shape is shown in Fig. 2, where threads were cut on the end of the pipe after rolling.

In doing this work care must be exercised not to allow the pipe to come in contact with the bottom rolls. In order to avoid this, a snatch block was rigged from a jib crane in front of the roll, as shown in Fig. 1.

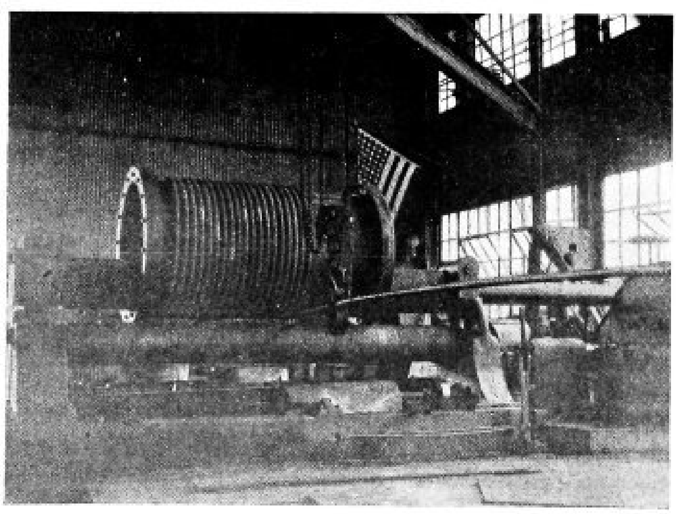


Fig. 1

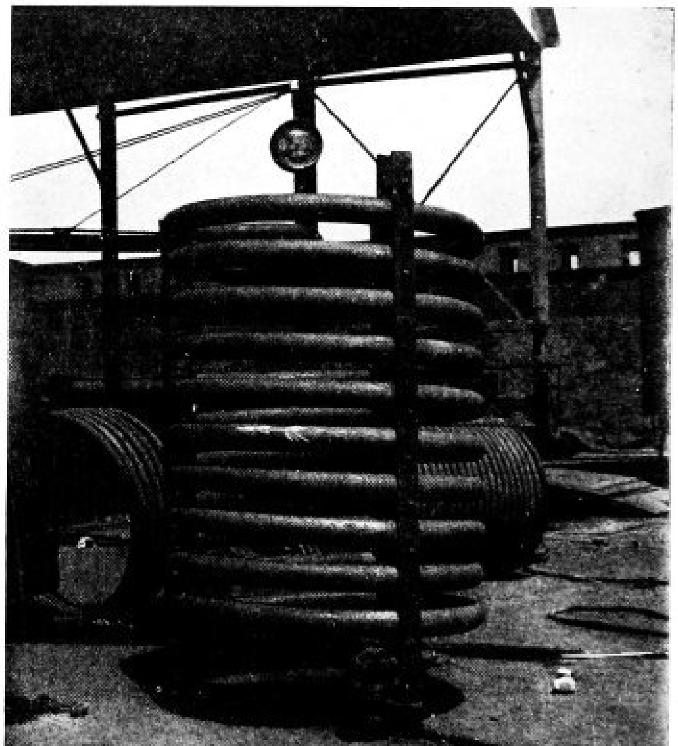


Fig. 2

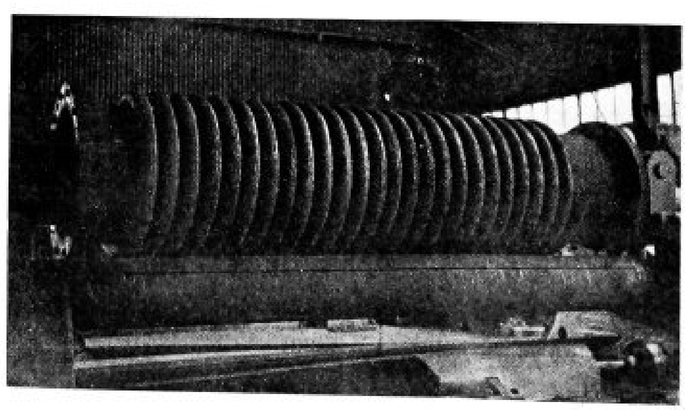


Fig. 3

In the making of cylinders to be used in rolling pipe coils, allowance must be made for the springing of the pipe. The 1½-inch pipe was sprung the diameter of the pipe, the 2½-inch pipe was sprung about one-half the diameter of the pipe, while the 3-inch pipe was sprung about one-third its diameter. J. S.

Answers to "Questions for Boiler Makers"

I saw in your July number a list of questions for boiler makers. I have talked these over with some of my shop mates, and we think it will be very interesting to read the answers. Some of the questions my mates put down as impossible to answer without drawings or more exact information. I will answer what I can of the questions offhand.

Question 9: The ends of the tubes in a watertube boiler are flanged because it was found that if merely expanded they sometimes drew out of the drums.

Question 12: A retarder is a strip of metal, say 3/32 inch thick, twisted into a long spiral which just fits the tube and is usually the length of the tube. Sometimes, however, they are set back quite a distance from the fire end to prevent them from being rapidly destroyed by the excessive heat. Their object is to prevent the heat from passing quickly through the tube, thus giving more time for the tube and the water surrounding it to absorb the heat. If a red-hot cannon ball were carried through a room at the rate of a mile a minute it would raise the temperature a little, but if it were carried through the room at the rate of a mile an hour it would raise the temperature very much more

Question 17: Of course, a blueprint is furnished for laying out any tube sheet, and from this the layer-out lays off the upper row of holes on a line. Parallel to this line he lays off the centers of the lower row of holes horizontally. On the top center line he locates, if there are an odd number of tubes in this row, the middle tube and center punches it. He then steps off with his dividers the centers of the other holes lying to the right and left. He next squares down from the center hole and marks on every other horizontal line the center of the tube hole for that line, center punching where the lines cross. From these central points on the horizontal line he scribes off with his dividers the other centers of the tubes on the tube sheet. He now draws a diagonal line from his first center punch mark in the center of the top line, or No. 1, to the first center punch mark on the third line. To the left or right, as he may choose, of the point directly below his first center punch mark on line No. 1 where this diagonal line cuts the second horizontal line, on No. 2 he makes a center punch mark. By making diagonal lines parallel to this one he will locate the centers of his tube holes on line No. 2. He can prolong these lines to the edge of the tube sheet, and will thereby locate the centers of the holes as they are usually laid out for boiler work. These center punch marks are used to locate the drill or punch, which is of a size to receive the pilot of the flue cutter, or sometimes a spring center cutter is used, but the main thing is after properly locating the centers to have the flue cutters sharp so that they will leave nice, smooth surfaces and plenty of oil should be used.

Question 24: In a Scotch boiler where the tubes are large I have seen slightly tapered plugs used, these being firmly driven in, but I think these are dangerous. It is better to pass a long rod which is threaded at both ends through the tube and draw up tightly with nuts on the rod two plates or washers with a metal gasket under on each and a grummet under the washers of nuts on the rod.

The small tubes of the watertube boilers are made of steel of a quality that will harden and are tapering to the proper diameter of the inside of the tube and then these plugs are threaded with a fine thread about 24 to the inch. Then a half dozen slots are cut at the small end of the plug about ½ inch long, with a 45° milling cutter or any convenient angle, and these cuts are run up about ½ inch. The plugs are then hardened. They are, in fact, a kind of tap, and these plugs are screwed into the leaky tube, a square being milled on the head of the plug for a wrench. Of course, making these plugs is a machinist's job. Care should be taken to have the plugs of such a size that the unflutted part on the plug will fill the tube nicely, otherwise it would leak.

Question 25: In expanding tubes the first thing to be remembered is that the operation is, so to speak, a cold weld, if properly done, and that there is a limit to the expanding of a tube. The tube-sheet hole should be a smooth cut, not all chewed up by the cutter. The surface of the tube should be clean and free from scale, and the tube should just push in easily. The operation of expanding is pushing the metal outward and at the same time revolving the expander. This operation sets up a slight wave of metal in front of each roller, and this metal must be given time to flow or the rollers will hop over the wave and a leaky tube will be the result. In other words, tube expanding must not be done too quickly. The expanders must be kept thoroughly covered with oil and not be allowed to become hot; therefore it is well to have three or four expanders, all kept in oil, for each man.

I leave some of the other questions for a later date.

New Haven, Conn. H. H. WOODWARD.

Gray Hairs—What Shall We Do With Them?

Flex Ible, in your issue of August, page 261, brings up a very interesting question for boiler makers and for those who employ them. The question is one of universal importance to employer and employee. It certainly seems a very strange thing that sensible human beings will employ men by what is on their head rather than for that which may be in it. Gray hairs are generally a mark of advanced years; they do not, however, invariably mark a mental and physical decline which makes for absolute uselessness.

There are two points which should be considered in the article to which I refer. The first is why is an objection raised to a man of forty-five years or more by employers? And the second is, what can be done to give employment to such people as have passed this commercial age dead-line? In the boiler shops which I have known, and I recall them very clearly, there is no question but that there are far fewer gray haired men employed now than there were many years ago. However, I cannot remember any time when there was but a very small percentage of those employed in boiler shops who were gray haired. Yet it is certain that to-day the percentage is smaller than it used to be. It is inhuman to say, perhaps, that if the number of gray haired men employed is few, they can be economically neglected, yet I believe that a careful study will show that not more than 5 percent of applicants for boiler work are over forty-five.

It does not seem to me at all difficult to find the reason why gray haired men are not readily employed. It cannot, of course, be put down to one single thing only, but the main reason is that the enactment of the workmen's compensation laws makes it imperative for employers to employ only those men who are the least likely to be hurt and who, if hurt, more quickly recover. These are, of course, the younger men.

Now, I am a believer in the compensation laws as a general idea. I have examined those of all the States, and they are all immoral and unjust, as they do not take into consideration the neglect of orders or the carelessness of workmen. In New York State, however, drunkenness is a bar to compensation, but drunkenness is one of the most difficult things to prove. Insurance, of course, takes care of the monied responsibility of a firm, but the rate of insurance must be based on the amount of risk run, and if the risk is decreased the premium on insurance will fall. It is therefore a plain business proposition for boiler manufacturers to employ the class of men which will decrease the risk, and this class must be young men. In railroads, where a retirement or pension fund exists, it is manifestly impossible to employ a large percentage of applicants of middle or advanced years.

Now, there is the question of physical endurance. There is much work about a boiler shop where physical endurance counts, but there is a much larger amount where it does not count. It is in repair work that this physical power is of most value; in fact, it is imperative. The outrageous practice of putting men to work in surroundings where the heat is such that work of but very short duration will result in almost complete exhaustion is a condition which is unpardonable in boiler work on shore, but it is another matter when the boiler is afloat, as there the ship might be lost if repairs were delayed until fireboxes and uptakes were cooled off. The older man has experience, and experience is valuable. Proprietors understand this thoroughly, but they fear the risk. In this I think they err too far on the side of safety. With modern appliances for lifting and handling plates, etc., physical effort of an exhausting nature is almost eliminated in boiler shops and there is far more care taken to-day to prevent accidents than formerly.

Having touched on one of the reasons, and I think the main one, why gray-haired boiler makers are given the go-by, what can be done about it? First, the compensation laws can be modified so that negligence, thoughtlessness and disobedience will enter into the matter of compensation. This, I think, would result to the old man's advantage. Second, greater care on the part of the employer through his foreman to put the older man at work where the danger of an accident is very remote. Calking tools, hammers and chisel heads, etc., cannot be so made that the danger of broken flying pieces will not result at times in the loss of an eye or other damage (damages which are as likely to occur to the young man as to the middle aged), but greater care in keeping these tools in prime condition brings the probability of an accident down to a minimum.

There is also another way to help the older men, and that is to have boiler makers know more than they do concerning boilers and their management. If the boiler maker will take the trouble to learn how properly to fire the boiler, look after the feed water and understand the care of pumps, the older man could without much difficulty obtain employment as janitor where boilers are part of the equipment of a building. There they would be valuable, as they are competent to make minor repairs at once, thereby greatly reducing boiler repair bills. I have in the past been more frequently asked to recommend men who were thoroughly competent and trustworthy for such positions than for all other positions put together.

On many occasions I have found men who have been boiler makers who had the other attributes and where they had been employed they had been eminently satisfactory Take such work as laying out, for instance. Beyond pinched fingers or minor possibilities of injury there is no more danger in laying-out work than there is in walking the streets, and here is where experience is of first value. A man cannot always choose what he would like to do, and a real boiler maker does not care to shear or punch plates, no mater what his age, but he certainly can do this work at almost any age provided he has good eyesight and is not decrepit. I think foremen would not be loth to employ grair haired men for this work. It may be a comedown for a boiler maker, but the wages paid are not bad, and are far better than nothing.

To sum up, we should have the compensation laws modified, a more comprehensive view of the trade taken by proprietors and foremen and a greater willingness on the part of boiler makers to take such jobs as they can get in the boiler shop when the relentless hand of time whitens their heads. Further, there should be less inclination on the side of the younger men, who are sure to become old in their turn if they live, to look upon the man of forty-five as an "old fogy."

New London, Conn. W. D. FORBES.

Flue Cutting Machine, with Attachments for Cutting Flues to Required Lengths and Filing Flue Ends

This apparatus was designed with the end in view of reducing the time of cutting flues to required lengths before application, also to cut these flues accurately as to length.

It has been customary for years in taking the length of flues to take the water space of the boiler (horizontally, between front and back flue sheets), plus the thickness of both flue sheets, plus sufficient metal to insure a bead on both ends of the flue. This usually shows from three to five different lengths of flues to each boiler, allowing one-fourth inch difference between lengths, and it is not uncommon for as many as seven different lengths of flues to develop. It is customary to mark these different lengths on a measuring stick, numbering them as Nos. 1, 2, 3, etc. In cutting flues to these lengths, each flue had to be marked separately in accordance with these measurements, and there was no certainty that the flue would be this exact length after cutting.

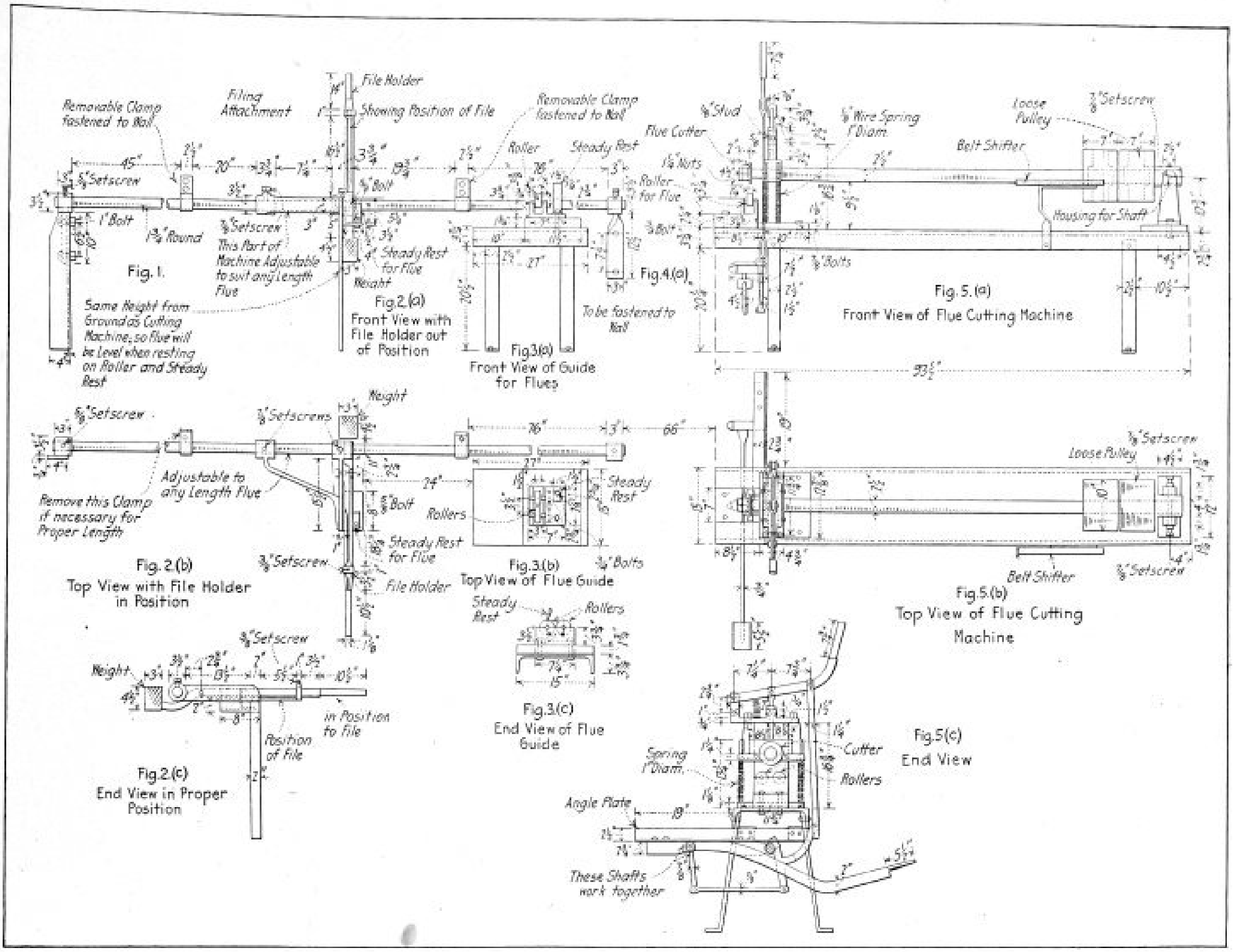
For example, take a boiler with 360 flues, you will find that you have fifty flues of No. 1 length, fifty flues of No. 2 length, and so forth. The gage on the machine is set to the length of the longest flue needed, and all flues required of this length are then cut. The gage is then set to the next longest length of flue, and the required number of flues of this length are cut, this operation being repeated for each length of flue required. While each flue is being cut, the filing attachment of the machine removes any burr on the end of the flue, as well as any scale or foreign matter which may be on the flue end, leaving same in the best condition for application without further treatment.

On the drawing, Fig. 3 illustrates a guide or steady rest, which is necessary to support long flues in the center, in order to secure a true-cut end. This guide is to be lined up with the gage and cutter.

Flues can cut any length required from one foot to the longest wanted by making the gage guide (Fig. 1) of sufficient length.

The cutting end of the machine is operated either by foot or hand, through a system of levers, as shown in Fig. 5. The cutter wheel is made of high-speed steel in order to secure a long life of the cutting edge.

We find that using this machine is a decided improvement over the old method of marking each flue and taking a chance on securing correct lengths. The lever arrange-



Detail Drawing of Flue-Cutting Machine

ment on the cutter is much better and quicker than the old feed screw and results in a great saving of time in preparation of flues for application. We have found that a set of flues can be cut to the required lengths in one-fourth of the time formerly necessary.

GEO. T. PROUT,

Shop Foreman, Chesapeake & Ohio Railway Co. Covington, Ky.

Zinc for Cleaning Boilers

I am, like N. G. Near, surprised to learn that European engineers use zinc for the purpose of boiler cleaning. I was under the impression that zinc was used to prevent corrosion, to take up the galvanic action already existing, not to make it.

I have never seen zinc plates separated by a steel or iron washer. They are usually separated by a few feet of water and hung from the steam space stays. I would suggest that N. G. Near read up what Mr. C. E. Stromeyer says on corrosion, or the book of W. S. Hutton, which is mentioned in your columns.

He says he wants to be sure before he loads up his boiler with zinc. Well, 2½ ounces per square foot of heating surface can hardly be called "loading up." I would also add that little is sure about boiler practice, hence the use of a factor of safety, or, as it has been called, the "measure of our ignorance."

Liverpool, England. T. J. MURPHY.

What are the Principal Causes for Leaky Tubes?

The leaking of tubes in locomotive boilers may be attributed to the length and thickness of the tubes, as they sag when being applied to the boiler, and also to the vibration and momentum of the boiler when in working condition. This movement and vibration is caused by excessive heat or cold that increases or decreases the sag in the longest flue to a considerable extent from the time that the fire is first applied to the boiler until the time the locomotive is in actual service on the road hauling its train. The indications are that under certain conditions of service the sag in the tube is actually straightened out, and under other conditions the sag is increased.

From my own practical experience, when an engine comes in leaking badly it is usually possible to run a piece of good, thick paper between the bead of the flue and the flue sheet at the back end when the engine has been cooled off to a certain extent. As the boiler maker makes the repairs when conditions permit his going into the firebox, the result is that the flues are expanded or rolled in whatever position they happen to be. Working the flues in this manner several times has a tendency to shorten the distance between the flue sheets, resulting in the back flue sheet being pulled towards the shell of the boiler in the greatest zone of leakage. This naturally has a tendency to cause the flues to leak while in service and their condition in this respect becomes worse the longer they are in service.

Chicago, Ill. J. CURTIS.

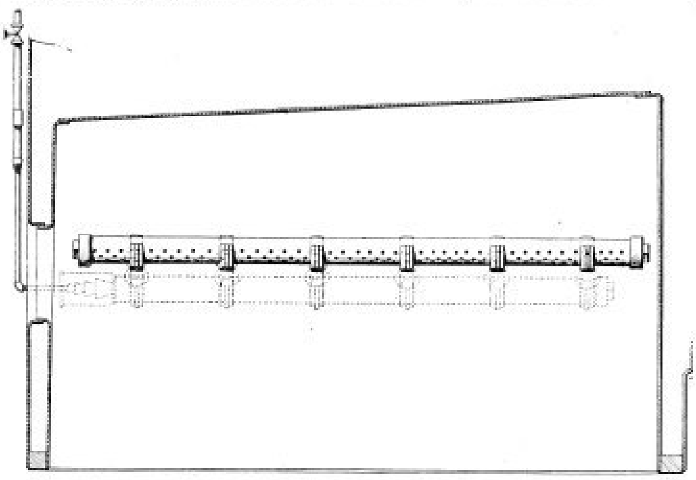
Selected Boiler Patents

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

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

1,164,437. AIR-SUPPLYING ATTACHMENT FOR FURNACES. DAVID T. WILLIAMS, OF PATERSON, NEW JERSEY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DAVID T. MARVEL, JOSIAH MARVEL, AND JOSIAH O. WOLCOTT, COPARTNERS TRADING UNDER THE FIRM-NAME OF MARVEL, MARVEL & WOLCOTT.

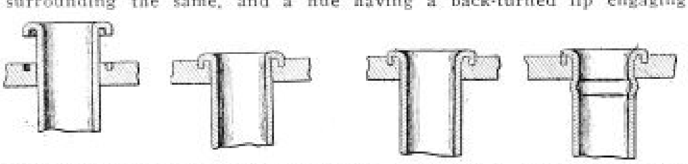
Claim 1.—In combination with the firebox of a furnace, an elongated air receiving chamber, a similar air heating and discharge chamber arranged along the inner side of the firebox adapted to emit air laterally



into the combustion area above the bed of fuel, and a plurality of tubular members constituting communicating passages between the air receiving chamber and the combined air heating and discharge chamber, substantially as described, said tubular members bearing brackets on which one of the chambers is removably supported. Eleven claims.

1,164,577. BOILER-FLUE JOINT. LEWIS W. CRAFT, OF CHICAGO, ILL., ASSIGNOR OF ONE-HALF TO JAMES GODFREY, OF CHICAGO, ILL.

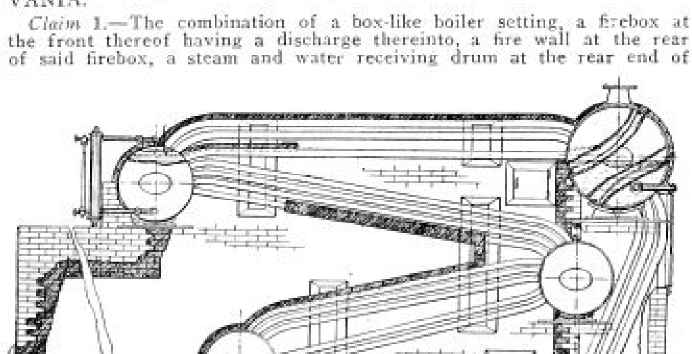
Claim 1.—A flue sheet having a flue opening and an annular groove surrounding the same, and a flue having a back-turned lip engaging



said groove, said flue being expanded, the material lying between the inner wall of the groove and the outer wall of the flue being tilted in an outward direction because of said expansion. Three claims.

1,167,361. WATERTUBE STEAM BOILER. WALTER A. MOFFAT, OF ERIE, PA., ASSIGNOR OF ONE-HALF TO ERIE CITY IRON WORKS, OF ERIE, PA., A CORPORATION OF PENNSYLVANIA.

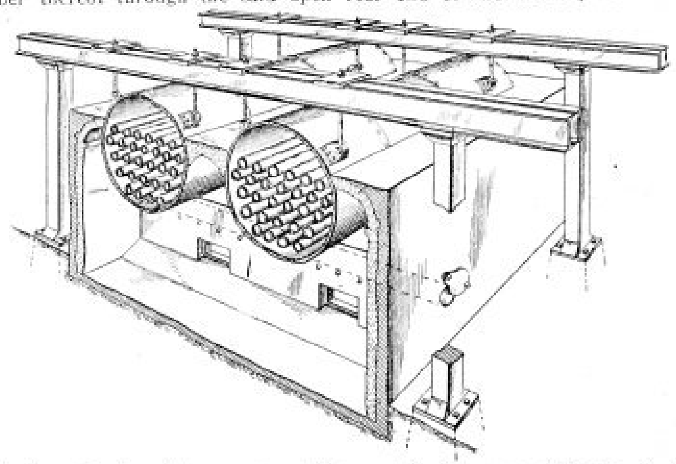
Claim 1.—The combination of a box-like boiler setting, a firebox at the front thereof having a discharge thereinto, a fire wall at the rear of said firebox, a steam and water receiving drum at the rear end of



said setting, a drum below the upper edge of said fire wall, watertubes secured to said drum, said tubes being in communication with the steam and water receiving drum, a drum located above said firebox, watertubes secured therein, said tubes being in communication with the drum behind said fire wall, steam and water conveying tubes connecting said steam and water receiving drum, and the drum above said firebox, and a series of baffle plates adapted to cause the fire gas to flow along the exterior of said watertubes in a direction opposite to the flow of water in said tubes, and in the direction of the flow of steam in the steam conveying tubes. Three claims.

1,166,670. STEAM-BOILER FURNACE. WILLIAM A. GILCHRIST, OF MEMPHIS, TENN.

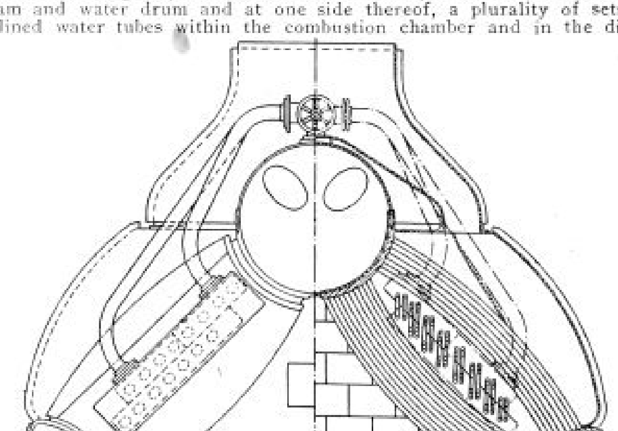
Claim.—A steam boiler for the use of sawdust and the like as fuel comprising, in combination, a firebox having a grate on which an ignited heap of the fuel is maintained and constituting a retort chamber, the rear end of the firebox being open for substantially its entire width and height, means for supplying air for combustion through the grate and fuel heap, a commodious combustion chamber located immediately in rear of the firebox and communicating directly with the chamber thereof through the said open rear end of the firebox, said com-



bustion chamber being constructed to retain the gases delivered to it from the chamber of the firebox within the zone of combustion until their combustion is substantially complete and the rear wall of the said combustion chamber being of refractory material and being located adjacent the firebox and having a surface which directly faces the chamber of the firebox through its said open rear end, whereby the combustion of the gases within the said combustion chamber, by direct reaction of heat upon the fuel heap and by radiation and reflection of heat from the said wall upon the head, facilitates the drying and destructive distillation of the fuel, and a heating flue leading out of the said combustion chamber.

1,167,841. STEAM GENERATOR. JAMES HERMANN ROSENTHAL, OF LONDON, AND EDWIN CHARLES CARNT, OF EAST COWES, ISLE OF WIGHT, ENGLAND, ASSIGNORS TO BABCOCK & WILCOX, LIMITED, OF LONDON, ENGLAND, AND J. SAMUEL WHITE & COMPANY, LIMITED, OF EAST COWES, ISLE OF WIGHT, ENGLAND.

Claim 1.—A steam generator, comprising a combustion chamber, an offtake for the gases, a steam and water drum, a mud drum below the steam and water drum and at one side thereof, a plurality of sets of inclined water tubes within the combustion chamber and in the direct



path of the gases to the offtake flue and connecting the steam and water drum to the mud drum, headers at one end of the generator, U-shaped superheater tubes connected to said headers, both legs of said tubes extending in a longitudinal direction between the sets of water tubes and at approximately right angles to the water tubes, the arrangement being such that the gases in passing from the combustion chamber to the offtake flue will pass transversely over one set of water tubes, the superheater tubes, and then the second set of water tubes without changing the general course of the gases. Six claims.

1,167,766. SOOT CLEANER FOR BOILERS. FREDERICK W. LINAKER, OF DUBOIS, PA., ASSIGNOR TO THE VULCAN SOOT CLEANER COMPANY, OF PITTSBURG, PA., OF DUBOIS, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—A soot cleaner for watertube boilers, including end castings and a connecting cylinder, a hollow piston and distributing pipe carried thereby reciprocable in said cylinder and castings, an operating rod extending into said piston and distributing pipe, fluid-operated means for moving the piston and distributing pipe in either direction, and indicating means for determining when the distributing pipe is within the connecting cylinder and castings. Twenty-five claims.

THE BOILER MAKER

OCTOBER, 1916

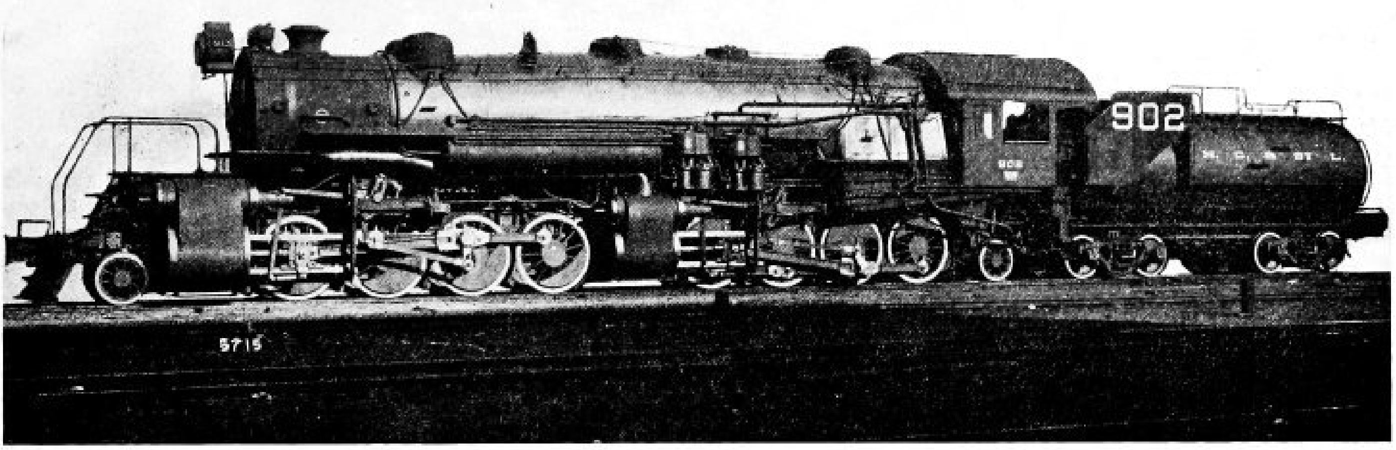


Fig. 1.—Locomotive with 16 Driving Wheels, Built by the Baldwin Locomotive Works for the Nashville, Chattanooga & St. Louis Railway

New Locomotives With Unusual Features

Limit of Growth Dependent on Boiler—Increased Size and Use of Superheated Steam Noteworthy

A remarkable locomotive with sixteen driving wheels in use on the Nashville, Chattanooga & St. Louis Railway is shown in Fig. 1.

The boiler is of the conical type with a diameter of 88 inches, the thickness of sheets being ⅞ inch, 15/16 inch and 1 inch, and the working pressure 210 pounds. The fuel used is soft coal and the firebox has a length of 126 inches, a width of 97¾ inches, and a depth at the front of 83 inches. The thickness of the firebox sheets is ⅜ inch and ½ inch.

The water space in front is 5 inches, and on the sides and back the same, while the tubes have a diameter of 5½ inches and 2¼ inches. There are 253 tubes, each having a length of 24 feet. The heating surface of the firebox is 228 square feet, and of the combustion chamber 116 square feet. The heating surface of the tubes measures 5,044 square feet, the total being 5,433 square feet, while the superheating surface is 1,262 square feet. The grate area is 85.5 square feet.

The weight of the engine on driving wheels is 430,300 pounds, that of total engine being 469,400 pounds, while the total weight of the engine and tender together is about 635,000 pounds. The tender has a tank capacity of 8,500 gallons and a fuel capacity of 14 tons. This locomotive is used exclusively for freight.

On the next page Fig. 2 shows a new superheated locomotive built for Chicago, Burlington & Quincy Railroad Company, and the Fort Worth & Denver Railway at Philadelphia, Pa. The boiler is of the wagon top type, having a diameter of 78 inches, the thickness of sheets being ¾ inch and 13/16 inch, and the working pressure 180 pounds.

It is of interest to note that the fuel used is oil and the firebox has a length of 108⅛ inches and a width of 72¼ inches, the depth in front being 84⅜ inches, the depth (back) measuring 72⅝ inches, while the thickness of sheets, sides, back and crown is ⅜ inch.

The water space front measures 6 inches, and at the sides it is 6 inches to 4 inches, while at the back it is 4 inches. The tubes of steel have a diameter of 5½ inches and 2¼ inches, with a length of 21 feet. This engine is equipped with a Schmidt superheater having a superheating surface of 834 square feet. The heating surface of the firebox is 215 square feet and the tubes 3,488 square feet, the total being 3,703 square feet. The grate area is 54.2 square feet.

The weight on the driving wheels is 213,150 pounds, and that of the total engine and tender is 434,000 pounds. The tender has a tank capacity for water of 8,200 gallons of water and 3,050 gallons of oil.

In Fig. 3 is shown a remarkable steam locomotive built for the French government by the Baldwin Locomotive

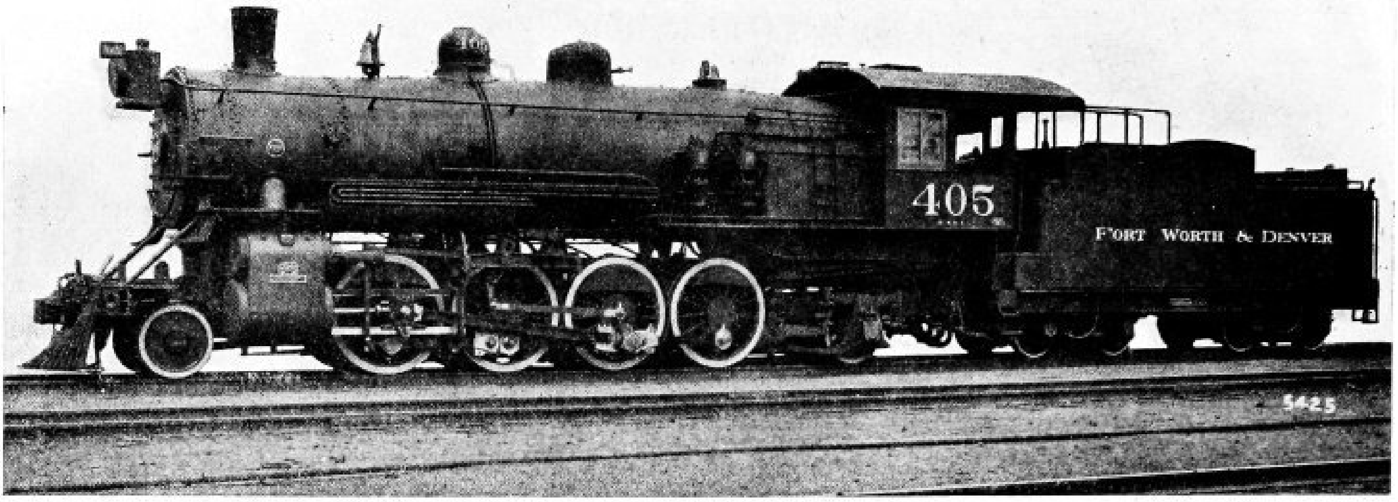


Fig. 2.—New Superheater Locomotive for the Fort Worth & Denver Railroad

Works, Philadelphia, Pa. It is a double-ended locomotive to be used exclusively for freight service on a narrow-gage road. The boiler is of the wagon-top type, coal fired. The fireboxes are two in number and made of copper. The tubes are of brass, and in all there are ninety-six tubes.

The small size and unusual construction of this locomotive distinguish it in a marked manner from the usual type of engine used for similar service in the United States.

Pulverized Coal Locomotives

Several road tests have recently been made by the Chicago & Northwestern Railroad with one of its standard high speed Atlantic type locomotives equipped for burning pulverized coal and with an engine of the same class hand-fired. The equipment installed on the pulverized coal locomotive was supplied by the Pulverized Fuel Company, New York. The pulverized coal is contained in an inclosed tank on the tender. Screw conveyors bring the fuel to the feeders, where it mingles with the air from a fan and is blown through outlets and flexible conduits to three burners on the locomotive. The comparative tests of the pulverized coal locomotive and the fiand-fired locomotive show that in the former there is an increase in evaporation of 13.1 percent and a decrease in the coal burned of 11.9 percent.

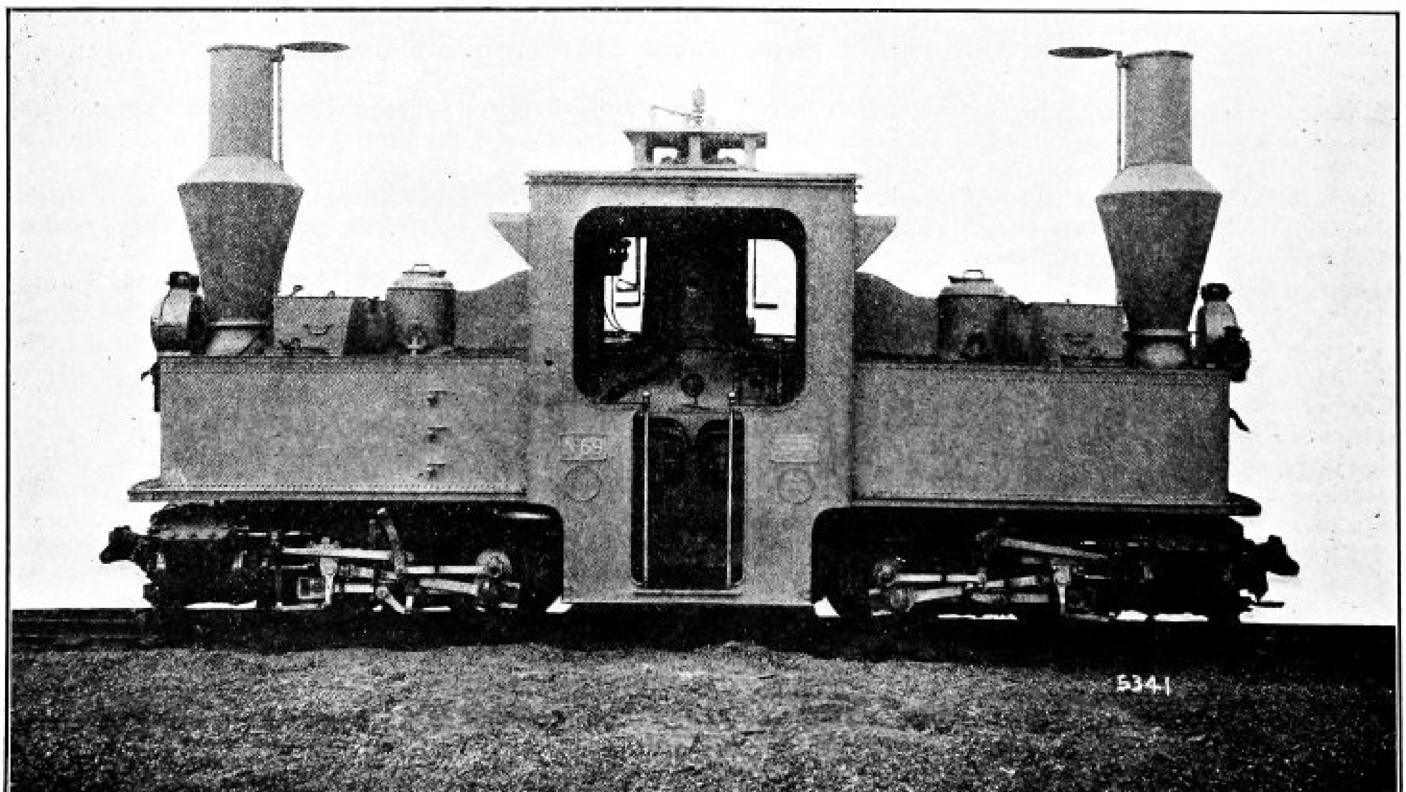


Fig. 3.—Double Firebox Locomotive Built by the Baldwin Locomotive Works, Philadelphia, Pa., for the French Government

Electric Motors, Belts and a Laying-Out Kink

Alternating Electric Motors and Good Belts Add to Shop Efficiency—Protection of Machinery Bearings from Shop Dust

BY JAMES FRANCIS

There can be no getting back of the statement that the very best drive possible for a metal-working machine is an independent electric motor, and the more directed connected the better. A motor coupled direct to the shaft or spindle of any machine is the ideal drive. There is nothing better known to-day. The motor connected by means of a single belt is the next best drive, and there are not two machines in the shop which should be driven by the same motor. An electric motor to each machine is the best possible and the most economical drive in the end, all things considered.

But the individual, direct-connected motor is not the "last word" by any means, for there is a good deal to be said regarding the selection, erection and care of shop motors. If you are setting up a new shop, then by all means put in alternating current (A C) motors. There is not as much trouble in keeping A C motors in condition and they do not burn out as readily as direct-current (D C) motors.

Change from Direct to Alternating Current

If you have an old shop you probably will already have one or more D C motors installed before you get next to the value of the A C motors. But, never mind, the next motor you put in arrange for alternating current and put in an A C motor. If you can arrange for both kinds of current from an outside source, then do so by all means, for they can make current cheaper than you can do it in the shop. But whether or not the electric company will sell you current cheaper than you can make it is a matter which you must determine from the local conditions around you.

If you can't get D C from the local company, then put in a little rotary transformer, if you *must* have direct current. Run the transformer by the alternating current, and there you are, fitted with both kinds of "juice."

Your shop probably will be in the transitory stage while you are getting in new A C motors and getting rid of the old D C ones as fast as possible, and you may find yourself with a countershaft driving two or three machines which have collected as the shop "grew up" and for which you do not feel able at once to purchase separate A C motors. You already have one D C motor belted to that counter, but the increasing work is too much for the motor when all the machines are to be operated at the same time, as is found necessary at more frequent intervals.

There is a very simple solution to the problem. Just rip out the countershaft and attach a separate A C motor to each machine and you will have it. But you may take out the shaft and put in two new motors, leaving the old D C motor still to run one of the machines. But perhaps the check book won't stand the purchase of two or three new motors at this time. It might stand for one motor, but you want to keep the old countershaft going until you can afford to purchase a motor to be direct connected with the machine which requires a special, reversible, variable-speed motor, and such motors come a bit high when purchased new, but they are worth waiting for and it is your problem to keep things going as best you can with but one new motor right away.

The motor already driving the countershaft is a D C affair and you don't want to purchase any more D C motors. But, never mind; procure a new A C motor and belt it direct to the countershaft, putting on a pulley which will permit the shaft to run at same speed whether driven by the A C or by the D C motor.

Having found and attached the proper sized pulleys, the two motors, A C and D C, may be run together when two or three of the machines are to be used at the same time, and only one motor may be used when only a single machine is needed. To start a combination of this kind, first cut in the D C motor and after the shaft and the connected A C motor are all up to speed, then throw in the starting switch of the A C motor, and the two motors will work together very nicely.

In a shop where a rig of this kind has been running for some time they use a rotary transformer and make their own D C juice and they keep the two motors each properly loaded by noting the pull of each belt. When the A C motor appears to be doing more than its share of the work, turn the lever on the switchboard which controls the voltage of the D C juice which they are making and increase or decrease its voltage until the D C motor belt shows same strain as that of the A C motor.

It would seem at first sight as though, once set, the rotary transformer should give current of the same voltage all the time. But, even if it does, the two motors may not always pull alike, owing to the variation in the voltage of the alternating current. As this current varies—which it does, but should not do—it will be necessary to adjust the D C voltage in order to make the two motors pull evenly together.

When the right time comes and the new reversible, variable-speed motor driven by alternating current is attached to the machine, then the counter will be abandoned and the old D C machine allowed to run one machine, the new A C motor will drive another machine, while the third machine will be taken care of by its own motor, as above described.

When the old D C motor wears out or becomes too small, it will be quietly replaced by a new A C motor, and then there will be only A C motors in the shop. The above shows that you need not hesitate in coupling a D C and an A C motor to the same shaft whenever it is necessary to do so. The "horse and the mule" will work together all right, as above described.

Care for the Belts—They Are Worth It

We are continually looking around the shop for some opportunity to add to the efficiency of a machine, to improve or cheapen a process, and in so looking about we frequently overlook the one thing which makes the shop profitable or a loser of money.

We overlook the belt, that dinky little contrivance which makes for the shop each and every dollar earned, and if we don't keep the belt in first-class condition we can expect nothing but losses from the shop. Just stop and think for a few minutes. The belts do all our work for us—every bit of it; therefore, isn't it up to us to keep them in the most profitable condition possible?

The teamster, who depends upon the work of his horses, takes great pains to keep them in the pink of condition. Nothing is too good for those horses. They are fed and cared for before he eats and cares for himself, and the work thus expended is a big profit-payer.

Then, why should we not take the best possible care of the shop belts? Nothing—absolutely nothing—can be done without them, and the more care and attention we give to the shop belts, the more profit will they earn for the shop and for us. Therefore, keep the belts clean, straight and well oiled. Never let them get crooked or full of short pieces which are out of line with the rest of the belt. Never let them run over the edge of a pulley. Never let it be necessary to nail up a "2 by twice" scantling in order to keep a belt from running off its pulley. And, furthermore, never let a machine get into a condition which requires twice the necessary power to drive it. An edge planer can easily get into a condition which will consume 14 horsepower where 7 horsepower should be ample. You are abusing the belts—the money-earners—while you are doing such things—or, rather, letting them "do" themselves—and you!

Remember that the good belt makes all the money for you, while the poor belt, the neglected belt and the overworked belt, is driving you surely toward discouragement and bankruptcy. And they will get you there unless you are willing to take right good care of the belts, first, last and all the time.

Laying-Out Kink

When it is desired to ascertain the length of a shell or ring, the boiler maker's "rule of thumb" is often brought into use, and to 3.1416 × the diameter is added three thicknesses of the stock to be rolled. This secures results

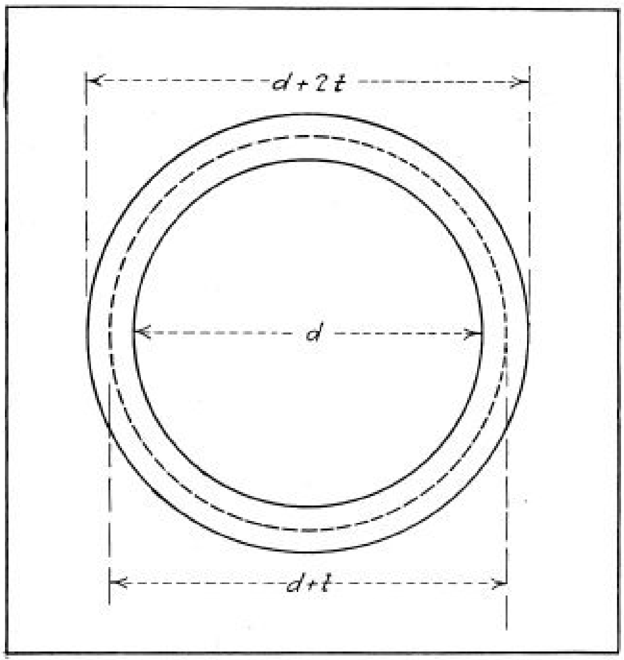


Fig. 1

fairly accurate, which will answer very well for boiler and for similar work, but the rule is not always accurate enough for the calculations of collars and internal hoops or rings.

Most workmen use the rule as above stated, without a thought of from whence it came. But the rule is but an approximation of "π" × diameter of neutral axis of the ring or hoop. The diameter along the neutral axis is $d + t$, in which d = diameter and t = thickness of metal; that is: one-half the thickness of the metal is added to each side of the circle, thus giving the diameter along that portion of the ring or hoop, which neither stretches nor is compressed—the real "neutral axis," as its name implies.

The workman was led to add three thicknesses of stock for the reason that it approximates very closely 3.1416 × t; that is, the fraction was thrown away and "three times thickness of stock" was retained as the addition for "take up" during the bending operation.

From the above may be formulated four general rules which are handy to remember. Referring to Fig. 1, the four rules are as follows:

To Find Circumference

Boiler maker's rule......... Circumference $= \pi d + 3t$
Draftsman's rule............ Circumference $= \pi (d + t)$
For outside diameter........ Circumference $= \pi (d + 2t)$
For inside diameter......... Circumference $= \pi d$

Steam Engines and Dust

I was recently in a large boiler shop where they were having engine trouble. The machinery was all driven by shaft and belt from a double steam engine which, with a couple of boilers, stood on the main floor of the shop without the least attempt to protect the engine by partitioning it off into a room of its own.

The boilers stood adjacent to the engine, and their dust and dirt were deposited upon the engine each time a fire was cleaned or ashes taken up. The shop dust and dirt also had free access to the engine, and the foreman told me that he was trying to babbitt the crosshead so as to make it run until new guides could be machined up and put in place. The foreman told me that crosshead guides and slides, eccentrics and straps and piston and valve rods wore out so quickly in the shop engine that one or the other of these parts was nearly always under construction in a near-by machine shop. And still this foreman made no move or request toward partitioning off the engine into a little room of its own where it would be free from dust.

Long lines of shafting and many countershafts were necessary to convey power to the widely scattered machines in this shop, some of the machines being more than 100 feet distant from one another. A millwright had a section of main shaft down for repairs and I noted that it was supported in hand-oiled, plain, flat boxes, each with a couple of old-time open oil holes which always stood invitingly ready to welcome alike oil and dust.

I was told that the shafting had always given a good deal of trouble in that boiler shop and that some of the bearings needed babbitting about all the time; that no sooner had the millwright fixed up one shaft than another needed going over and new soft metal linings poured. This shafting was quite high speed, which made the dust wear all the more prominent and made still more business for the millwright.

Self-Oilers Save Shafting

Seemingly it had never occurred to the foreman of this boiler shop that he could do much, with but little expense, to improve the condition of the shafting in his shop. There are several very good forms of self-oilers on the market, many of which could be attached to the shaft bearings by simply tapping with pipe thread the holes in the caps and screwing in the oilers. The lubricant in the form of candles is placed inside the lubricators and all the oiler has to do is to watch the candles and add another one when the one in the lubricator has shortened enough to leave room in the case for a second candle.

There are other forms of self-oilers which do not need even the tapping of a pipe thread for their attachment. Simply drive the oiler into the existing oil hole, which may be reamed or drilled out to fit one of the several standard sizes of self-oilers. These devices protect the shafting and the journal bearings absolutely against shop dust. No matter how much may be flying through the air, it cannot get into a bearing to amount to anything as long as there is no open oil hole. Dust does little harm to a shaft by getting in at the ends of the bearing. There may be a little wear at that point, but it seldom extends inward more than a quarter of an inch. Usually the coating of grease which has issued from the bearing forms a very effective dust trap, and no dirt can get past the ring of grease into the bearing.

Even the plain grease cup has done good service in more than one boiler shop, but it is necessary to give the cap of each cup a partial turn in order to force lubricant into the journal. I like grease cups on machines. In fact, I specify them on all machines which I design, but I do not care particularly for grease cups on shaft bearings. All such bearings should be self-oiling, either chain or ring oiling, and with the oil openings properly protected there will never be any trouble from dust or dirt in the bearings. A well-designed ring or chain oil bearing needs attention only once in a month or three months, and then usually only the replenishing of the oil supply in the reservoir. Aside from that the bearing is entirely self-oiling, as is claimed.

From the above will be seen the importance of isolating the steam engine from the body of the boiler shop and the importance of using good bearings and a good system of lubrication. There is another lesson to be learned in the shaft-bound, belt-tied, engine-driven boiler shop, and that lesson is: the economy of electric power transmission and the value of independent motor drives for each and every machine. In more than one instance it has been found that the cost of electric driving of machines was actually less than the maintenance of the shafting and loss of power therein, the belting repairs and renewals, to say nothing of the cost of fuel!

Layout of Tapered Cylinder

BY PHIL. NESSER

When laying out tapered cylinders we meet with problems in which the radii are too long to be reached with the longest trammels; besides, we could not even project the full cone and stay within the bounds of the shop yard for some problems.

To lay out a tapered cylinder within the reach of trammels it is a common practice to draw the side view, as Fig. 1, of the finished cylinder, in which 1-2 is the dimension representing the small diameter, and 3-4 the large diameter. The distance between these lines represents the length of the cylinder, whether measured on the vertical or slant lines, as line *A* must also be known before making the figure, this rule to be applied only to a right cone; that is, when the slant is equal and central to both sides.

Draw all lines full size to neutral dimensions; that is, draw the full thickness of the metal, and take the center of this for the line on which we project on each side the slanting sides till they intersect each other and also the center line at the point *O* in Fig. 1. This gives the full cone, as it would be if carried out to a point. From this we take away the small cone and leave the frustum, or tapered cylinder, when making the pattern. Your material must needs be large enough to cover the outlines without this small cone, plus laps and flanges, and the pattern for such a sheet is similar to the sketch in Fig. 2.

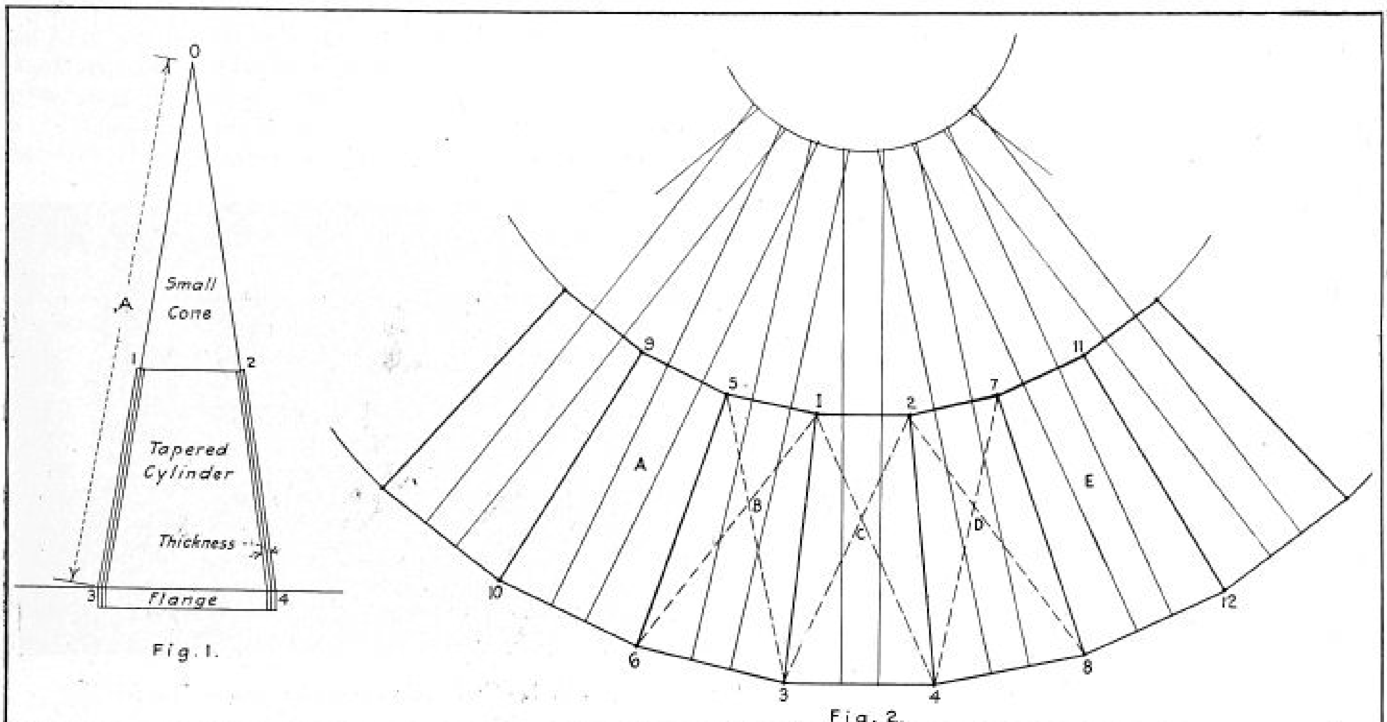


Fig. 1.

Fig. 2.

Pattern for Tapered Cylinder

Now, if, after drawing up Fig. 1, we found our tools not long enough to reach point *O*, we would have to work out the pattern some different way, and to this end the writer wishes to give this simple rule. Now, suppose we use our imagination a bit, for a layerout must have good imaginative power, which is the most essential thing. He must be able to see the finished article before he starts to make his pattern.

Now, let us suppose Fig. 2 was a plan of a round-house; then 1-2-3-4, in Fig. 2, would be pillars which bound one stall, or engine track, and to bound the next stall each way could be done without having a trammel long enough to reach the center of the turntable, because the diagonal distance from 1 to 4, Fig. 2, is equal to 1-6 and 3-4 is equal to 3-6; so also 2-3 is equal to 2-8 and 3-4 is equal to 4-8, and with the same reasoning we could go to the small side and locate the pillars 5 and 7, and could go on around locating all the pillars in the round-house without even knowing how far away the center of the turntable would be.

Now, if you imagine your side view of a tapered cylinder is a stall of a round-house and the corners 1-2-3-4 the same as in Fig. 1 or Fig. 2 are the pillars bounding this engine stall, see how simply you could use the round-house to lay out a tapered cylinder, and the round-house foreman would not even know you used it, because you used it only with imagination.

Having located the points 6-3-4 and 8, Fig. 2, we can take a stick and bend it so to trace a line through these points; so also we could trace a line through points 5-1-2 and 7, Fig. 2, and upon these curved lines, by keeping the line 5-6 for one end line, we could measure off on each side the length required to make each respective circumference, and draw the other end line through the points thus found. Of course, laps must be allowed, etc.

The measurements must all be taken on neutral lines, as shown in Fig. 1; that is, through the center of the material when drawing up your side view, and if either end is to be flanged, dimensions must be taken only up to these flanges and flange allowed on afterward the same as a lap. If the cylinder is to have a butt joint it should be sheared on the end lines, as stated above. If lap joint, always draw shear lines parallel to the rivet line, and not into the center, as this makes the lap a wedge.

There are so many little things which could be mentioned either of which would be enough to spoil a job, that the layerout must always be going back over his work and checking it up. While confidence is a very good thing, it is the worst thing in some cases. Confidence is greatly increased by knowing simple methods to do work. The most simple methods to understand are always the most sure to be right; but be sure you understand, then go ahead.

We have noticed a number of articles by other writers on this subject, which some call the "camber" line and "versed sine," etc., and we think this rule the simplest of any. It is wrong to use the circumference length at the top and bottom, as some of the previous articles have stated. If we take the circumference lengths in one trial and the diameters in another we will find a great difference in the radius for many problems, so it must be wrong. Of course, we do not want to discourage anyone, but if their rules are wrong, and we can see it, there can be no harm in mentioning these things.

Imagine a full cone laid down on the floor and rolled once over until its cover came off, and you can easily see that the peak, or point *O*, would remain in one place on the floor, while a point on the rim would at all times be at a distance away from it equal in length to the slant height of the cone when drawn up in side view, and not as when drawn up in circumference lengths.

We hope all will be helped by this article and welcome any information along these lines from other readers.

Novel Locomotive Tender Coal Sprinkler

Fig. 1 shows a unique coal sprinkler for locomotive tenders, developed at Williamson, W. Va. The sprinkler uses cold water instead of boiling water from the engine, as is usual, thus eliminating all danger to the fireman. The construction is marked by great simplicity, as well as strength. The cold water sprinkler may be used for all general purposes about an engine, such as washing of cabs, running boards, and sprinkling down coal, and the air from this sprinkler can be used for blowing sparks and cinders out of the cab.

The sprinkler uses air in the place of steam, and cold water instead of hot water. Under the present system of sprinkling, a number of employees are severely and dangerously burned and scalded each year by the hose either bursting or blowing off, caused by the great pressure on hose. While the present sprinkler uses boiler pressure steam and hot water, this cold-water sprinkler for locomotive tenders uses air and can be worked with 30 pounds air pressure, as well as 70, and the life of a hose is greatly increased, as hot water, with the great boiler pressure, destroys rubber.

It is claimed that under the system with the steam and hot-water sprinkler it is practically impossible for an employee with safety to himself to keep the tank cistern pockets clean around tank valves, as he is likely to get his hands or face scalded, and it is a violation of the Federal law to have coal around the tank valves. With this cold-water sprinkler any employee can wash the accumulated coal from around the tank valve without running any chance of being injured. The hose of the cold-water sprinkler is located on top of the tender, while the old one is located between the tender and the engine, and for the fireman to secure a safe place in which to work it is necessary to hang the hot and steam water hose on the side of the engine. The hose is similar in size to the hand-hold which is used in getting aboard the engine, and employees are sometimes injured in falling by taking hold of the steam and hot water hose instead of the hand-hold.

It is maintained that the cold-water sprinkler for loco-

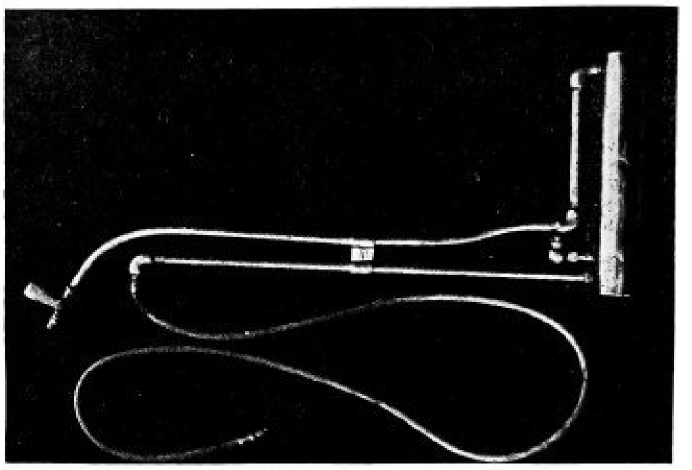


Fig. 1.—Coal Sprinkler for Locomotive Tender

motive tenders will eliminate this danger, as the hose is placed on top of the tender, and it has an advantage over the old system that the reservoir is always full and it is only necessary to start it by opening a half-inch cut-out cock. The cold-water sprinkler furnishes a great advantage over the old system in that when the injectors fail to work and it is necessary to kill the engine on account of low water in the boiler and none in the tank, which sometimes happens, all that is necessary to be done is to open the firebox door, open the half-inch cut-out cock and drown out the fire.

It is held that the cold-water sprinkler for locomotive tenders is a saving in the matter of hose, pipe and pipe fitting and globe valves, and it can be placed on any engine by using a 6 or 10-inch pipe inside of the present tank, and by so doing it will not be necessary to cut a hole in the tank to get the reservoir in.

Boiler Inspection Law at Erie, Pa.—An ordinance was recently passed by the city of Erie, Pa., making it compulsory that boilers hereafter used in the city shall conform to the rules of the American Society of Mechanical Engineers, such rules being known as the Boiler Code. Boilers on road vehicles and those in private residences for not more than two families are exempt, as are boilers under federal jurisdiction. The inspector is authorized to examine each boiler at least once a year unless it is inspected by a casualty company. The hydrostatic test calls for a pressure of 50 percent greater than the working pressure. At least two methods of feeding boilers are required. For each boiler annually inspected by the city inspector $5 shall be paid to the city treasurer, while a fee of $1 is required for each boiler inspected by a casualty company.

Machine for Grinding Boiler-Rings

In order to fully understand the construction of this machine, which has been designed for the purpose of grinding boiler-rings and similar work, it will be necessary for us to take up each section of it individually. The facts to be given, taken in connection with Fig. 1, which is a plan view of the entire machine, will give the reader a comprehensive idea of it.

The Table

Fig. 2 shows a side view of the table with its base and drive. The table *A* swings on the pivot *B* and has on its underside a finished circular surface at *C*, from which it is driven by the friction wheel *D*. A T-slot should be made around the underside of the table so that the reversing dogs, which regulate the length of the stroke, can be placed in any position desired. More will be said of these dogs later. The table should be designed light in section so as not to require a large amount of power for propulsion. It should have slots and holes in abundance so that different sizes and classes of work may be clamped down without difficulty. The adjusting screws *I* are intended to raise and lower the table so as to regulate the friction between the table and the driving wheel *D*.

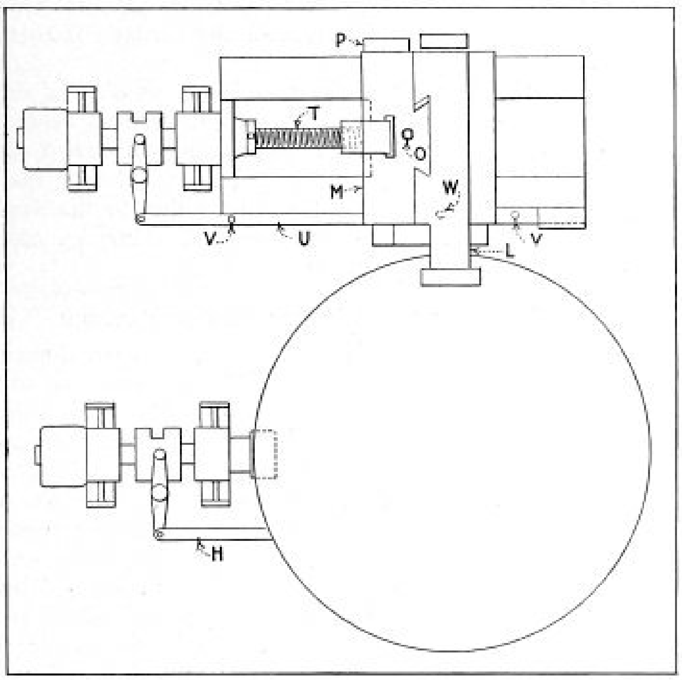


Fig. 1.—Plan View

The table driving pulleys *F* are loose on the shaft *D* and run in opposite directions; their hubs are machined to form tooth clutches. The clutch *G* is keyed on the shaft and is thrown to the right, left or neutral position as the operator desires. When the machine is in operation the clutch arm *H* (Fig. 1), which reaches under the table, is struck by a dog at the end of the table stroke and thrown to the opposite pulley. The movement of the table is reversed in this manner.

The friction wheel *D* should be faced with leather or some other fibrous material so as to minimize slippage.

The spindle and its bearing are shown in Figs. 1 and 3. The bearing *L* is designed to slide up and down as desired on upright *M* by means of raising screw *O*. This feature, of course, is to take care of the different heights of work. The spindle is driven by belt from the overhead countershaft and the idler pulley *P*, which is on a slide, takes up whatver slack is created by raising the spindle. The spindle bearing *L* has sufficient overhang to make up the difference between the larger and smaller rings, and the upright *M* is slid back and forth to meet the size of the work by means of cross feed screw *Q*.

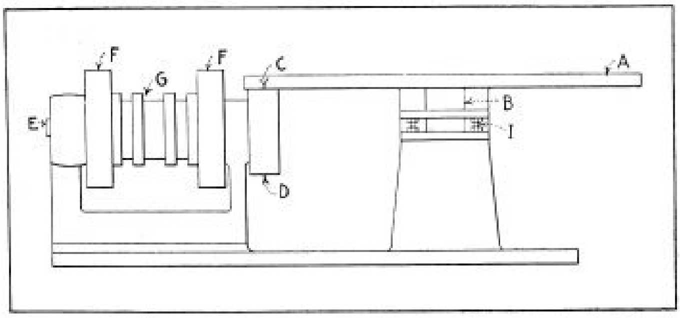


Fig. 2.—Side View

Carriage and Bed

Now that we have explained the construction and operation for grinding the circular work we will next take up the provisions for grinding straight surfaces. The carriage *R*, Fig. 3, is designed to slide on ways on bed *S* and is fed back and forth by means of feed screw *T* (Fig. 1). This feed screw has on one end reversing pulleys which are exactly the same as described for reversing the motion of the circular table. The arm *U* (Fig. 1) has at each end a projection *V*, which can be clamped any distance apart. A projection *W* on the carriage strikes dog *V* at either end of the stroke and reverses the screw.

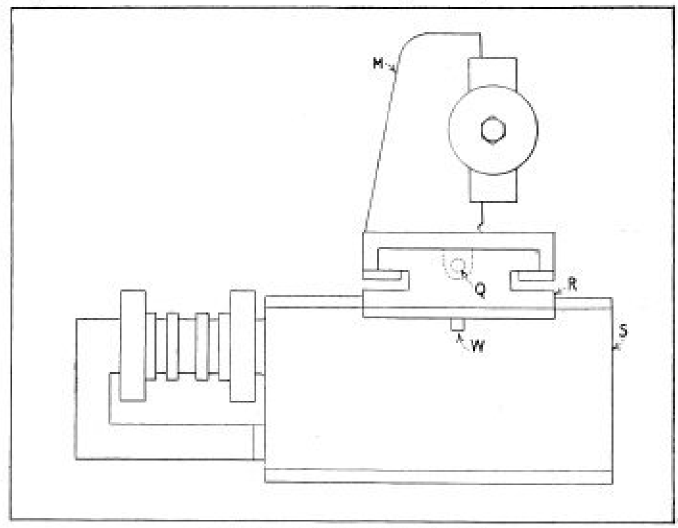


Fig. 3.—Carriage and Bed

Needless to say, the castings must be designed heavy and strong so as to insure against vibration. The bearing surfaces should be sufficiently large so as to stand plenty of wear, and the belts must be large enough to transmit the necessary power.

The foregoing is intended to give the reader a brief outline of the chief features of the machine. Any questions as to mechanical construction will be answered with pleasure by the writer.

T. R. Jones.

Boiler Inspectors' Meeting in New York City.—The American Institute of Steam Boiler Inspectors of New York City held a regular meeting on Friday evening, September 29, at the Engineering Societies Building, 29 West 39th street, New York City. The principal address of the evening was delivered by Mr. Franklin Van Winkle, associate editor of *Power*. Mr. Van Winkle is a mechanical engineer of long standing in New York City and has designed and supervised the construction of many steam plants in factories in all parts of the country. The subject of his lecture was "Steam Boilers and Such Matters as are Directly Connected with Them."

Patterns for a Pipe to Describe a Helical Curve About a Cylinder

The Elbow Problem in a New Light—How to Find the Amount of Twist in Elbow Sections Forming Helical Pipe

BY GEORGE A. JONES

A pipe is required to wind around a cylinder and, for for each one-half revolution of the pipe around the cylinder it has a rise equal to *R-S* of the elevation. It will be readily seen that patterns for such a piece of work will not be the same as ordinary elbow work. Each side or half of the pattern will be moved or set around, or, in other words, the developing lines for the pattern will not be on the same lines, but will be moved to one side in order to get the required twist.

Each miter in itself is the same as would be required for an ordinary elbow of the same curve, and the wind is obtained by theoretically turning one end of each piece of pipe axially upon the other end, thereby throwing the throats of the two miters out of line. With this much known the problem will not be so difficult, but will only require the finding of how much the throat of one side will be set above or below the throat of the other side.

In the case of a helix the amount of twist in the pattern will increase as the pitch or rise of the spiral increases. There are different ways this twist can be obtained, but one of the simplest and most accurate is that of developing a correct elevation of the helical curve, which is shown in the plan and elevation.

Obtaining the Helical Curve

First draw the circle *A-B-C*, or one-half of the cylinder. Around this lay out the winding pipe as though it were lying in a horizontal plane. In drawing these sections, it must be drawn so that the centerline of one section (not the miter line) will fall upon the centerline of the cylinder as shown at *B-F-E* in the plan. The reason for having this section here is because all sections will be alike and have the same length, and this arrangement shows how it can best be obtained.

On the centerline of the winding pipe, *H-F-O*, lay out 16 equal spaces and through every other space draw lines from the center *D* to the outside of the pipe as shown, and numbered 1-2-3-4-5-6-7-8. These lines are miter lines for the different sections. As the pipe is assumed to be 30 inches outside diameter of the small ring and 30 inches inside diameter of the large ring, made of ¼-inch material, the horizontal lines, *B* and *E*, should be 15 inches each side of the horizontal centerline *F* of the winding pipe.

Now line it up in the regular way for elbow work, as each section of the winding pipe has the same length and makes an equal portion of the revolution, as 4 to 5 in the plan. Each section must also rise an equal amount, so draw the vertical *R-S* in the elevation equal in length to one-half the height of the helical pipe, and space this distance into eight equal spaces, or a space in height for each section in the revolution in the plan, and numbered from 0 to 8, the same as the centerline is in the plan. From these vertical spaces draw horizontal lines across the elevation as shown. From similar numbered lines in the plan run vertical lines upward, and where these lines meet locate the points 0′ to 8′ as shown. Through these points draw straight lines as shown, and this irregular line represents the centerline or axis of each section of the helical pipe in one-half of its revolution around the cylinder. The line 4′-5′ in the elevation is the true length and proper inclination for each section of pipe.

Locating the Throats in the Elevation

The lines *e*-5, *f*-4, *g*-3., etc., drawn through the intersections or meeting points 3-4-5, etc., of the plan and extended to center *D*, intersect the vertical axis of the large cylinder, not at one point as it seems to in the plan, but at different points as shown by the numbers in *R* to *S*. So by drawing vertical lines upwards from the throats of each section in the plan, as *g* in the plan to 3 in the elevation locating *g*′, this locates the throat for this section.

In like manner locate the remaining, as *a*′ to *e*′ on the left and *f*′ to *l*′ on the right of the vertical centerline. These dotted broken lines represent the throats of different sections when in position. Now parallel with the line 4′-5′ and through the point *e*′ run a line to the vertical centerline and do the same through *f*′. Now we can obtain the twist for the patterns.

Obtaining the Twist in the Pattern

In getting the twist another view has been drawn, as shown in Fig. 3, and it is exactly the same as similar numbers and letters in the elevation and could be drawn about the point or center *G* in the elevation. But owing to so many lines it may be confusing if drawn in the elevation. Now as the section shown, as *B-F-E* in the plan, is 30 inches outside diameter, made of ¼-inch material, the neutral diameter will be 29¾ inches for this section, so about the point *G* in Fig. 3 strike a circle 29¾ inches in diameter and extend the parallel lines *e*′ and *f*′ to the circle and measure the distance *x* to *x* on the circle. This distance is the required twist for this section and will be used on the pattern.

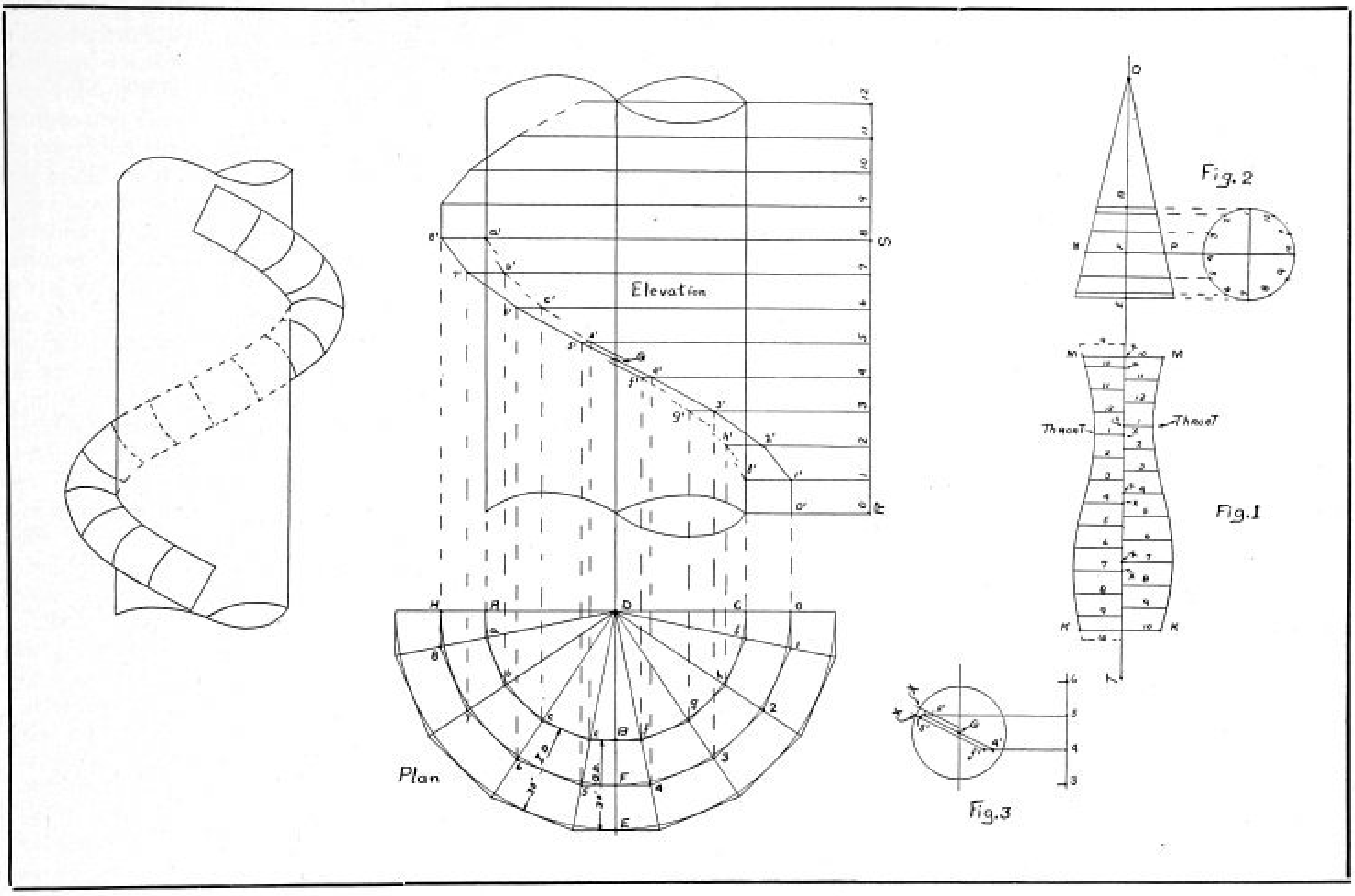
For the section of pipe in the plan 30 inches inside diameter or 30¼ inches neutral diameter, another circle will be drawn about *G* in Fig. 3 30¼ inches in diameter and the distance *x* to *x* on this circle will be the required twist on the pattern for all sections 30 inches inside diameter.

Laying Out the True Lengths

Before proceeding with the pattern we will have to draw another view of a section of the helical pipe showing it in its true length. As shown in the plan, it is not the true length.

In Fig. 2 erect the vertical line *D-T*. Take the distance *D-F* of the plan and locate *D-F* in Fig. 2. At right angles to *D-F* draw *N-P*. Take the distance *G*-4′ in the elevation and locate *F-P* in Fig. 2. Do the same with *F-N*. Draw lines *D-P* and *D-N*, which are the new miter lines. Draw horizontal lines *B* and *E* 30 inches apart. Extend the line *N-P* to the left and draw the profile.

Lay out 16 equal spaces in this profile and start at the throat and number them from 1 to 12. Run the horizontal lines over from these points to the miter lines in the layout and we are ready to lay out the pattern.



Layout of Sections of Pipe Forming Helical Curve Around Cylinder

Laying Out the Pattern

Any place below Fig. 2 on the line *D-T* erect the line *M-M* at right angles to *D-T*. Below *M-M* on the line *D-T* erect line *K-K* and make the distance between *K* and *M* equal to the circumference of the pipe shown in the plan 30 inches outside diameter. On the line *D-T* lay off between *M* and *K* 12 equal spaces and draw the lines to the right and perpendicular to *D-T*.

As the elbow will be lapped on the side or on point 10, as shown in the profile which will be the bottom when this section is in position, mark the line *M-M* as 10 and the third space 1, or the throat as shown. Then number them to 10 again on these lines just drawn. Drop points down from similar numbered points in Fig. 2 and trace the curve through them as shown in the pattern.

To lay out the left side of the pattern take the distance *x* to *x* as measured on the circle 29¾ inches in diameter in Fig. 3, and lay this distance on the line *D-T* in the pattern from point 1, the throat on the right, and locate point *x* on line 1, which is the throat for the left. Also lay this distance down from lines 4 and 7 and 10, as shown, locating the back and sides of the elbow between points *x* and *x*. For the left side lay out three spaces in each of the four quarters and numbered the same as those lines on the right. Draw the perpendiculars on the left and drop lines from similar numbered points in Fig. 2. Trace a curve through these points and this finishes the pattern for the 30-inch outside diameter section. Eight of these are required.

As eight are required of the 30-inch inside diameter, another pattern would be laid out, and in order not to have all laps on the same side, the pattern would be made opposite hand to Fig. 1. Thus the throat, or point 1, would be dropped down to where the back is, and the back would be raised to where point 1 is, and the developing lines on the left of the pattern, as shown, would be in the same order as in Fig. 1. The twist for this pattern would be measured on a circle in Fig. 3 30¼ inches in diameter.

In Fig. 2 the portion on the circle 1 to 7 is the top of the pipe. Also in Fig. 1 if the lines on the right of the pattern were below those of the left it would throw the helix in the opposite direction to the way it is shown in the elevation.

Fig. 1 is the pattern after it is punched and would be turned over before rolling.

Increasing Use of Pipe and Tubes for Various Purposes

When the name "pipe" is mentioned the average person thinks of the ordinary steam or water pipe in general use, but what is not so generally known is the fact that the uses of pipe are numbered by hundreds and even thousands. Among such uses may be mentioned:

Agricultural implements, automobiles, bedstead and hospital furniture, architectural iron work, grill work, etc., building columns, refrigerating machinery, dry kiln apparatus, elevator cars, fence posts, ornamental fences, flag poles, gymnasium apparatus, wheelbarrows, work benches, ornamental gates, elevator grain spouts, invalid chairs, irrigation systems, safety ladders, loom cylinders, warship masts, lighting and high tension poles, playground apparatus, electric wiring conduits, railway signal apparatus, speaking tubes, lunch counter stools, sprinkler systems, signal towers, etc.

No attempt has been made in the above to give a complete list, but mention is made of a number of uses not commonly associated in the public mind with pipe.

Coincident with the extended use of tubular products has been not only greatly increased tonnage, but also a change in material. Fifty years ago practically all of the screw joint pipe was made from wrought iron, but the invention of the Bessemer and the open-hearth processes of making steel has caused a decided change in the material and recently a Special Statistical Bulletin (No. 3, 1916) was issued by the American Iron and Steel Institute, and we give below a table showing the production in gross tons of iron and steel skelp in the United States from 1905 to 1915, inclusive:

PRODUCTION OF IRON AND STEEL SKELP IN THE UNITED STATES FROM 1905-1915. GROSS TONS

Year	Iron	Steel	Total	Percent Iron	Percent Steel
1905......	452,797	938,198	1,435,995	31.5	68.5
1906......	391,517	1,137,068	1,528,585	25.7	74.3
1907......	444,536	1,358,091	1,802,627	24.6	75.4
1908......	297,049	853,534	1,150,583	25.8	74.2
1909......	370,151	1,663,230	2,033,381	18.2	81.8
1910......	350,578	1,477,616	1,828,194	19.2	80.8
1911......	322,397	1,658,276	1,980,673	16.3	83.7
1912......	327,012	2,119,804	2,446,816	13.3	86.7
1913......	312,746	2,189,218	2,501,964	12.5	87.5
1914......	264,340	1,718,091	1,982,431	13.3	86.7
1915......	262,198	2,037,266	2,299,464	11.4	88.6

From this table it will be noted that wrought iron has not only decreased from 452,797 in 1905 to 262,198 in 1915, but at the same time the percentage of total has decreased from 31.5 in 1905 to 11.4 in 1915, and the percentage of steel has correspondingly increased.

The history of the widely ramifying uses of pipe reads almost like a romance and inasmuch as the National Tube Company has recently announced plans for building a new plant at Gary, Ind., having a capacity of 500,000 tons per year, it would appear that the uses of pipe have by no means reached their limit.

A Practical Discussion of the Effects of Combustion Space Upon Boiler Efficiency

A perusal of boiler history brings out one fact that most practical engineers of to-day seem to have overlooked. This fact is: no radical change in combustion space design. The structural changes, both in material and in placing of parts, have been numerous; nearly every engineer feels himself delinquent until he has in some way changed the baffling, the method of bricking or the arrangement of the internal feed pipes. Undoubtedly these are often of much value and lead to desirable results; but, as stated before, there is a lack of radical changes; the kind of changes that always mark a period of advancement in engineering. And the problem is up to the practical engineer, the man who is in close touch with all the good and bad points of his own special boiler, and he who can make first-hand observations under practical, every day working conditions, as governed by the many and ever-changing circumstances that fall to the lot of the practical engineer. The chemists have solved the problem of combustion and to-day the theory and the requisites of perfect combustion are available to all who put themselves to the trouble of going to the nearest library. The problem of obtaining the necessary requirements for perfect combustion is beyond the scope of chemists; it is the problem that now faces the engineer.

Until of late years the term combustion space held very little significance to engineers, it was simply used to designate a specific section of the boiler, and even to-day there are many to whom it apparently has the same old meaning; a name that is used because every one calls "that space above the grates and surrounded by heating surface," combustion space. But some years ago, when the internal combustion engine began to encroach upon the boiler field, the boiler builders began to sit up and take notice. There was a serious proposition to compete with, and they immediately began to investigate wherein laid the seriousness. It was evidently in the new method of mechanical utilization of the energy developed by combustion. But in addition the internal combustion engine people were going into the process of combustion in great detail and were finding out astonishing facts regarding the combustion of gases and vapors, all more or less similar to the same gases that had to be burned in boilers. So at once the term combustion space began to assume its rightful position in boiler society and was given the recognition long deserved but long neglected. Be this as it may, it is still spasmodic and to-day you can pick up many boiler catalogues, and while you will see references to grate surface, heating surface, baffling, structural integrity, etc., there is no mention of volume of combustion space. This is a fact and in the words of a poet, ignorance is bliss, but it is h—— on coal consumption.

Some few engineers of the day have taken up the matter of combustion space and their work has not only been of great value, but it has fully paid them for their trouble and time and it is to be regretted that they have not had further opportunities to go on with their work.

The boiler of to-day must be considered as consisting of two fundamental parts: (a) a heat generator; (b) a heat absorber. The first must, for the purposes of analysis, be divided into two parts: (a) a fuel gasifier; (b) a gas burner. So we can consider three operations: (1) gasification of the fuel; (2) burning of the gases; (3) absorption of the heat liberated. Conceding that these three operations are essential to a boiler, it stands to reason that as the efficiency of each operation varies, so will the boiler efficiency vary, as the latter is the product of the former. The operations named above are carried out respectively: (1) on the grate; (2) in the combustion space; (3) by the heating surface. Experiments have demonstrated conclusively that the efficiency of all boilers varies with the rate of combustion, falling off at maximum rates. Furthermore, that this decrease in overall efficiency is due to loss in furnace efficiency, a straight line law being applicable to heat absorption. Hence the logical conclusion is that there is something wrong with the heat generating ability of the boiler; and as the average boiler of to-day receives the greater amount of its heat by convection, and with the same boiler grate conditions being similar, it is quite apparent that the fault can be traced to the combustion space conditions. A brief consideration of conditions will lead to the same conclusion.

The combustion of coal in a furnace is a chemical process in which oxygen reacts with the carbon and the various combinations of carbon and hydrogen. Consider the grate covered with a layer of fuel; heating takes place and the volatile of the fuel begins to distill and rise into the combustion space. If the rate of heating is slow the total combustible matter driven off as volatile is small and gaseous in composition; if the rate of heating is rapid the amount of volatile is large and contains much tar vapor. The former burns rapidly, the latter burns slowly. In short, with any given grate surface, there can be generated varying amounts of volatile, this volatile varying in combustion and requiring more or less time to burn, as the case may be. Therefore it is quite safe to say that if the combustion space is of proper volume for the one case it is most certainly not correct for the other case. Or to put it generally, combustion space must be the result of something and not something that results. Combustion space must bear a definite relation to the rate of combustion, otherwise maximum efficiency cannot be attained.

TYPE.	G.S. Sq. Ft.	Combustion Space Ft.³	Combustion Space With Fire 1' Thick.	Ratio Column 2 and 3.	Ratio Column 2 and 4.	Rate of Combustion Lbs. Coal per Sq. Ft. G. S.	Seconds each Cubic Foot Stays in Combustion Space.
Normand (a)..	58.6	136	78	2.34	1.33	40	.077
Locomotive (a)	30	160	130	5.34	4.33	60	.17
Heine (a).....	35	250	215	7.14	6.14	25	.58
B & W (b)....	87.4	318	230.6	3.64	2.64	42	.15
B & W (b)....	87.4	318	230.6	3.64	2.64	13	.49

(a) Bureau of Mines Bulletin No. 23.
(b) Writer's Notes.

A consideration of the above shows that there is a wide variation in the ratio of combustion space to grate surface; also that the time allowed for the combustion of the volatile in the combustion space is small. Any chemical action that takes place in this time must be in the nature of an explosion. It will also be noticed that as the thickness of the fire bed increases, the combustion space decreases; likewise the period allowed for combustion, so that at high rates of combustion, great volumes of black smoke may not always be caused by improper firing, but caused by something beyond the fireman's control.

To consider a special case, take the B. & W. boiler, listed in the table above. The table shows that at the maximum rate of combustion, the time allowed for combustion of the volatile in the combustion space is about .2 of a second, increasing to .5 of a second at ordinary rates. Furthermore, as the rate of combustion increases the volume of combustion space decreases, due to the thickness of the fire bed, a necessary evil. In this case, a bed one foot thick reduces the original combustion space by eighty-seven cubic feet or 27 percent. And with the increasing amount of volatile, such volatile being of the kind that burns slowly, not a decrease of combustion space is desired, but most positively an increase.

What the proper volume of combustion space for given conditions of fuel consumption is can only be determined for each type of boiler by experiment. For boilers that steam year in and year out at a fixed capacity, the solution of this problem will be of the greatest benefit; for other boilers, namely, those that steam at various capacities, an investigation will, in all probability, be of benefit, for it is firmly believed, in view of the above facts, that in the average boiler of to-day the combustion space is too small.

In case that anyone desires to figure out the above data for his own boilers, the following procedure was carried out as regards the B. & W. boiler:

A sectional view blue print was used. The combustion space was divided into triangles, taking care to use right triangles when possible, as the area of these triangles can be obtained with length of base and altitude known —area being equal to one-half the base times the altitude. In the other triangles the following rule was used for obtaining the area: from half the sum of the three sides subtract each side severally; multiply together the half sum and the three remainders, and extract the square root of the product. Having obtained the sectional area, by adding the areas of the triangles, multiply by the width of the furnace and the result is the cubical space. To obtain column four, subtract as many cubic feet as there are square feet of grate surface. Column seven can be obtained from data on hand.

To obtain column eight, proceed as follows: Each pound of fuel will generate about twenty pounds of gases and water vapor. The temperature of these gases can be assumed to be about twenty-five hundred degrees Fahrenheit; so we get the following: Pounds of coal per square foot of grate surface multiplied by twenty, divided by thirty-six hundred, equals pounds of gases liberated per second. This under standard conditions. To reduce to conditions of the furnace temperature: Pounds of gases liberated per second multiplied by twenty-nine hundred and sixty multiplied by twelve and thirty-eight hundredths divided by four hundred and sixty equals cubic feet of gas liberated per second in the combustion space. Now divide column four by this last and the result will be the answer in seconds. D.

The Electric Arc Welder—Its Advantages and Disadvantages in Flue Welding

BY C. RICHARDSON

Doing firebox repairs with the electric arc welder has been of marked benefit to the railroad shop man during recent years; there has, however, been a great deal of misleading information given out from time to time on flue welding. The different makers of the welding machines are no doubt largely responsible for this, as the elimination of leaky flues on the road appeals strongly to all railroad men; holding the flues rigidly to back flue sheet temporarily stops the roundhouse foreman's old-time troubles and annoyances of having to continually work over flues whenever the engine is subject to the usual care to eliminate abuses on the ashpit or on the road.

Eliminating all flexibility at flues and back flue sheet brings about in many instances other boiler troubles that are much more serious than those that were helped. After a short time in service, in some cases only a few months, cracked bridges start to show. The arc welder can be used for making temporary repairs to these broken bridges; they will not hold for any length of time, however, and before long the cracked bridge condition gets so bad that the sheet must be cut out and renewed after less than a year's service has been obtained in some instances. In some cases the safe ends start to develop longitudinal cracks; also, as a result of welding them to the sheet, cracks appear, first very small, later develop and extend forward past the water side of flue sheet. These flues with cracked safe ends must be taken out and renewed, as there is no way of making effectual repairs.

Various methods of setting the flues have been experimented with to eliminate these failures. Flues were set with copper ferrules and without them, some were applied without beads, so that the least possible amount of added thickness would be given to sheet when the flue was welded. None of these arrangements seemed to be of any material assistance in eliminating the bridge cracks. One idea was suggested that at first appeared to be reasonable. Scale accumulation between the flues and next to back flue sheet on water side was blamed. It was claimed that the addition of this foreign matter to thickness of material at this point interfered with the water properly cooling the sheet. A careful investigation disclosed the fact that this scale accumulation was evidenced on boilers of exactly same design that had not had welded flues and no resultant cracked bridges.

The writer does not desire to belittle in any manner the great economical advantages of doing firebox repairs other than flue welding with the arc welder. Fireboxes of wide-box design that reriveted side sheet seams could not be made to hold in have been given part side sheet applications with arc welded seams with no bother at all being experienced with leaks. The life of fireboxes on these engines has been lengthened at least 50 to 65 percent as result. Heretofore when side sheets cracked badly along fire line these boxes had to be renewed.

The arc welding method has been found to be much more effectual than riveting or using patch bolts and more economical in all ways; many fireboxes have been brought back to life with the arc welder that would have been cut out and renewed. A new era nearly equaling the advent of high speed steel was presented when the present shop man was given the electric arc welder for his firebox repairs.

It would be gratifying to have the experiences of some of your qualified correspondents on this vital subject. As is usual with all improvements in mechanical details, there is much to be learned that does not appear at first sight, and doubtless an exchange of experiences and opinions would add to our stock of knowledge on a subject that is of great and growing importance to railroad men.

John Solves Some Sectors and Segments

Among Other Things John Finds Out How "Pi" is Made and How to Inscribe a Circle in a Triangle

BY JAMES F. HOBART

"Say, Mr. Hobart, do you remember that 'decagon' business we talked about in the August Boiler Maker?"

"Sure, I remember that very well. What about it? Anything amiss?"

"Not a thing that I know of. But the Professor happened along lately and I showed him what you said about his 'extreme and mean ratio' and also your method of laying out a polygon with any number of sides."

"And what did he say about it?"

"Oh! he nodded his head a couple of times and said: 'That is correct,' and then added, 'An enormous superfluity of words are required to express geometrical matters in ordinary language.' And, say, aren't those words corkers for fair?' And then I showed him the method you gave for laying out a polygon with any number of sides, and the Professor said 'That method is capable of being somewhat condensed.' Then he made a sketch like Fig. 1 and explained that to draw a figure with any number of sides, say seven, draw the diameter *A B*, and divide it into as many parts (equal) as the figure is to have sides, as shown at 1, 2, 3, 4, etc. Then, with *A B* as a radius, draw arcs intersecting at *C*. From *C* draw a line through 2, cutting the circumference of the circle at *D* and *A D*, will be the length of one side of the seven-sided figure or polygon. Set the dividers to the distance *A D*, step around the circumference, and the other five points of the figure will be found."

John Gets a Chance to Put One Over on the Professor

"That's a good stunt, John. It is almost exactly like the method shown in the August Boiler Maker, except the finding of point *C*, which is more simple, as shown herewith by Fig. 1. You may score one for the Professor, who has actually simplified a geometrical problem, something as seldom seen as a real joke in London *Punch*.

"And, John, just to get back at the Professor again, you might tell him that if he will draw lines through alternate points (4 and 6) on diameter *A B*, that these lines will cut the circumference of the circle at *E* and *F* so that it is not actually necessary to space that half of the circumference. And, John, you can also tell him that if he draws lines through the other marks on *A B*, the odd ones, 1, 3 and 5, he will locate the exact centers of the first three sides of the 'septagon,' or seven-sided figure. And this shows that if we draw lines through all the points in diameter *A B* it will give the angular points in the circumference for a figure or polygon with fourteen sides."

"I'll do that, sure! The Professor is a mighty good fellow, but I just do like to put one over on him every time I can get a chance! But, Mr. Hobart, there's another thing which is troubling me. One job which is going through the shop uses a lot of pieces of plate like those shown by Figs. 2 and 3. One is shaped like a piece of pie, the other like the crust of the pie squared off straight. The boss wants me to measure up a lot of these plates and mark each one with its area in square inches, and, believe me, that looks like some job."

Sectors and Segments

"Oh, John, John! I'm afraid you are scared at nothing again. That work is easy if you will only put your head and a little horse sense to it. That 'piece of pie' of yours, as shown by Fig. 2, is known as a sector. The other shape, shown by Fig. 3, is a segment and is formed by cutting the triangle off of the sector. I presume that these two pieces of plate are of the same radius. Seemingly the segment is the same as the portion of the sector below the dotted line. Now, John, it is not hard to calculate the area of these plates. You are perfectly able to do the work if you will only speed up that think-tank of yours. Take Fig. 2, the sector. It is nothing more or less, is it, than a triangle with one circular and two straight sides? Then, how do you find the area of a triangle?"

"Why, multiply the base by one-half the height, of course. But will that work with the round-bottomed triangle, Fig. 2?"

"To be sure it will work, John. There's a rule for finding the area of a circle which should prove to you that the triangle rule will work. How do you find the area of a circle?"

"Why, square the diameter and multiply the result by .7854, to be sure."

"Yes, John, that's one way—the usual one—but there is another rule which you should remember. It does not call for 3.1416 or .7854, and is well fitted for use with sector calculations and for circles when you know their circumference and diameter. You can't call that rule to mind? Why, it's easy to remember and I am surprised that you haven't got in your mental tool-box.

The Simplest Rule of All

"Well, John, here's the rule. 'To find the area of a circle, multiply its circumference by one-half its radius.' Now isn't that a very simple rule to use and to remember?"

"Oh, thunder, yes! I remember that rule now, but I never used it because we seldom have the circumference of a circle given to work from when the area is required."

"That's so, John, and that is probably why you forgot the rule. When a man neglects anything, either mental

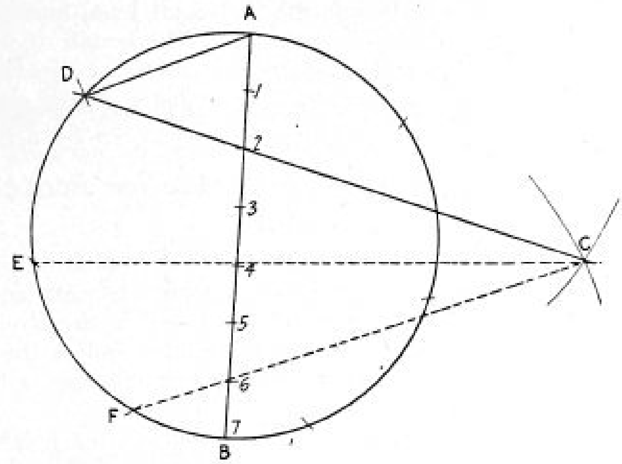


Fig. 1—Dividing Circumference of Circle

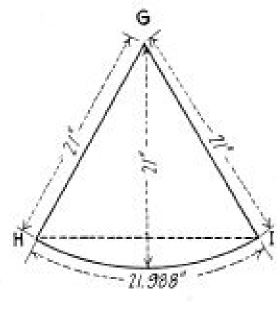


Fig. 2.—A Sector

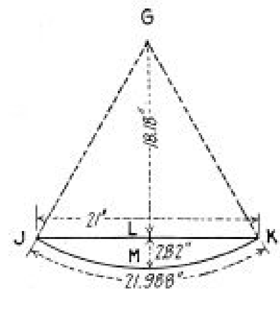


Fig. 3.—A Segment

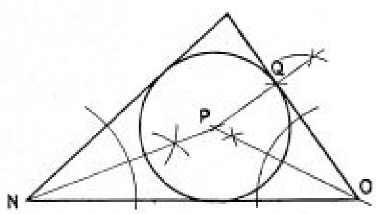


Fig. 4.—Inscribing A Circle in A Triangle

or physical, he is apt to lose the use of that thing altogether."

"But how can we use the rule with this problem? Fig. 2 isn't a circle!"

"But it's a part of one all right, and if you multiply its length of arc, which I see to be 21.988 inches, by 10.5, which is one-half the radius, the area of plate *G H I*, Fig. 2, will be found to be 230.874 square inches."

"But tell me, Mr. Hobart, how we can use a curved surface in that way. I don't understand how it can be used in a circle, to be multiplied by one-half the radius?"

"John, how much does the plate curve between points *H* and *I*?"

"Why, I suppose it curves the width of the segment shown by Fig. 3, which is 2.82 inches."

"Then, John, if we take a shorter length of the circumference, it will not curve as much, will it?"

"No, certainly not."

Straightening Out the Curve

"Then, if we take a very short length, it will not curve enough so that its curvature can be measured, will it? Say we took a length of .001 inch and multiplied it by 10.5, and then multiplied that quantity by the number of thousandths of an inch between *H* and *I*? Then wouldn't we have the area of the sector pretty accurately?"

"Y-y-e-e-s-s, I suppose we would. There wouldn't be any curvature to such short bits of circumference and a picture of the circumference straightened out would show a great number of pointed triangles attached thereto. Yes, that method must give the area of circle or sector correctly, for the sector is just a piece of the circumference, cut along radii to the center of the circle."

"That's right, John. Your head has something in it, after all, besides ivory or sap! Now then, we have found the area of the sector, Fig. 2, why, isn't it very easy and proper to find the area of the triangle above the dotted line *H I*, and deduct the area of that triangle from the whole area named above, the remainder to be the area of the segment, Fig. 3?"

"Suppose that is proper and 'oll korrect,' as the man wrote who invented 'O. K.' But it looks a bit queer to me to multiply the length of a straight line by some number to find the area of a triangle when we have just been treating in the same manner the length of a curved line in the same figure. Hanged if it don't seem kind of curious!"

"That's what it does, John, but the work will be correct when done in that manner."

What π Means

"Say, several years ago, didn't you tell how they worked out the ratio of circumference to the diameter of a circle? Seems as if you did, but I can't quite remember how it was done. Can't you tell me briefly how it is done?"

"John, I don't quite remember, myself, just the method I described for you, but here's a very brief description of one way which will give you an idea of how π (pi) is worked out. In a hexagon, a six-sided figure, of course you are aware that each side is one-half the maximum diameter of the circle in which the polygon is built?"

"Sure, I know that."

"Well, then, if we measure around the faces of the several sides, we find the circumference of the figure is exactly six times the radius or three times the diameter of the circumscribed circle?"

"Yes, that fact shows itself plainly, but the distance around the polygon is less than the distance around the circle?"

"Yes, and here is where we must make corrections by taking shorter sides and by doubling the number of sides in the polygon we have, taking the diameter as 1, made the circumference considerably larger. This doubling of sides is continued, halving each, for several times until the circumference (the radius being 1) becomes 6.28316941, and this number, being divided by 2, gives the familiar 3.14159.

"Perhaps, John, you or some of the boys may be interested in noting the manner in which the subdivision of a side is carried out in order to obtain a side so very short that its curvature can be neglected. The following table gives the several results, eight sets of subdivision calculations being usually deemed sufficient:

DETERMINATION OF 3.14159

No. of Sides	Length of Side	Length of Perimeter
6	0.5	6.
12	0.51763809	6.21165708
24	0.26105238	6.26522722
48	0.13080626	6.27870041
96	**0.06533817**	**6.28206396**
192	0.03272348	0.28290510
384	0.01636228	6.28311544
768	0.00818121	6.28316941

And as 6.28316941 ÷ 2 = 3.14159 we are justified in accepting as pi the figures 3.1416 as the ratio between the circumference and the diameter of a unity circle. It should be noted that there is very little difference in the lengths of perimeters for polygons with 348 and with 768 sides, therefore it is evident that the latter figures have got pretty close to the limit—to the actual circumference of the circle instead of around a set of flat faces or steps. It is also evident that carrying the computations farther would not bring the value of pi much more correct, for the reason that the little variation between the two last results obtained lies only in the fifth place of decimals. If we carried the calculations any farther the results would be of no value, for, except in astronomical calculations, we don't often need to work beyond four decimal places. Carrying the pi-finding process any farther would be like putting a Greene Economizer to a 10-horsepower boiler, the saving of fuel possible (so small is the whole amount consumed under so small a boiler) would not begin to pay the interest on the cost of the economizer. Therefore, it does not pay to do it, either with the little boiler or with pi."

"Say, Mr. Hobart, I'm mighty glad to get that explanation of how 'pi' is made, and it is going right into my note book. I don't suppose we will use it in the shop very often, but somehow it helps a fellow with lots of other things to know where the things come from which he does use in the shop and there is hardly anything, not even a hammer, more often used in the shop or in the planning room than good old 'pi.' But there is one more little thing I wish you would show me to-day, and that is how to lay out, without any cut or try business, the largest circle which can be inscribed in any old triangular piece of plate which a fellow may get hold of. There are times when a simple and quick rule for doing this stunt would be mighty handy."

"That's an easy one, John. Just sketch out any triangle —Fig. 4 will do—then bisect two of the angles, say those at *N* and *O*. The intersection of the bisecting lines at *P* will be the center of the largest circle which can be drawn inside the triangle."

"Then all you have to do is to set one leg of the compasses at *P* and draw a circle which will touch the three sides of the triangle."

"Yes, that is the requirement, but to set the compasses right the first time trying, just erect a perpendicular on one of the sides which will pass through point *P*. Such a perpendicular is shown by *P Q*. Set the compasses to this distance and if the work has been accurately done, the resulting circle will touch, or be tangent to, each and all sides of the triangle?"

"Say, Mr. Hobart, I wonder if geometry wouldn't have helped even the old negro who used to saw wood for a living up in Massachusetts, away back in 1876? The old darkie used to say: 'Dar's tricks in ebery trade but mine, but, by golly, dat's no trick in my trade, for *de stick must come off!*' I wonder if he had had geometry to have helped him if the stick wouldn't have come off a bit easier or quicker? Seems to me it would, the way geometry helps out in the boiler shop!"

Electric Welding Exhibition.—A feature exhibit of the New York Electrical Exposition, held in the Grand Central Palace, New York city, October 11 to 21, is the electric welding of iron and steel. The exhibit has been arranged by the Arc Welding Machine Company of New York city, and all grades of welding are being done in iron and steel, including structural pieces, plates and castings. Two arcs are kept in operation equipped with automatic control which prevents the metal from burning because of drawing too long an arc. The length of the arc is automatically controlled, so that even a comparatively unskilled worker cannot draw it beyond the point set.

Construction of Furnace for Scotch Boiler

The furnace of a Scotch boiler is composed of two or more corrugated furnaces, combustion chamber and return tubes. The furnaces are connected at the front end of the boiler to the flanges of the head and at the back to the flue sheet of the combustion chamber by a flange on the end of the furnace.

In building the furnace of a Scotch marine boiler, the several furnaces, bottom section of front end and combustion chambers are assembled on the floor, bolted together, holes reamed and riveted up and calked, girder bars, angle stiffeners, etc., applied to the combustion chamber. When complete the whole is moved into the shell front end, bolted up, riveted and calked. Staybolts are now installed into the back head through the back of the combustion chamber, also through the wrapper sheet and sides of combustion chamber. All through stays are now put in, also stay tubes and plain tubes.

If the boiler is one of the double-ended kind, then all furnaces, combustion chambers and one or more sections of front head are fitted together, riveted up and calked, the girder bars and staybolts applied to the combustion chambers and the whole moved into the shell ends of furnaces, inserted in the flanges of the other head, riveted up and calked. You are now ready for the through rods or braces, tube stays and plain tubes.

To Remove a Defective Furnace

We will suppose that the middle furnace of a three-furnace, single end Scotch marine boiler must be renewed. If, when designed, allowance was made for the removal of the furnace, there will be plain sailing, *but* (and there is where the rub comes) if the corrugations of the furnace are of larger diameter than that of the flange of the front head, and no special provision made for such repairs, there is no alternative but to cut the bottom section of the front end away from its connections and remove it and the furnace at the same time, leaving the other furnaces blocked up.

Where corrugated furnaces are made with a view to future repairs, the outside diameter of the corrugations and the flange at the back connection are at least ½ inch less than the diameter of the furnace at the front end. In removing a furnace of this kind, cut the rivets out of both back and front flanges (first having blocked up the furnace so that it will not drop down). Heat the flange of the front end just enough to cause it to expand just a little. Now with a screw jack or hydraulic jack (in the combustion chamber) up against the flange of furnace apply a little pressure and the furnace will move forward and out of the flange of the front end and the furnace is loose and can now easily be removed.

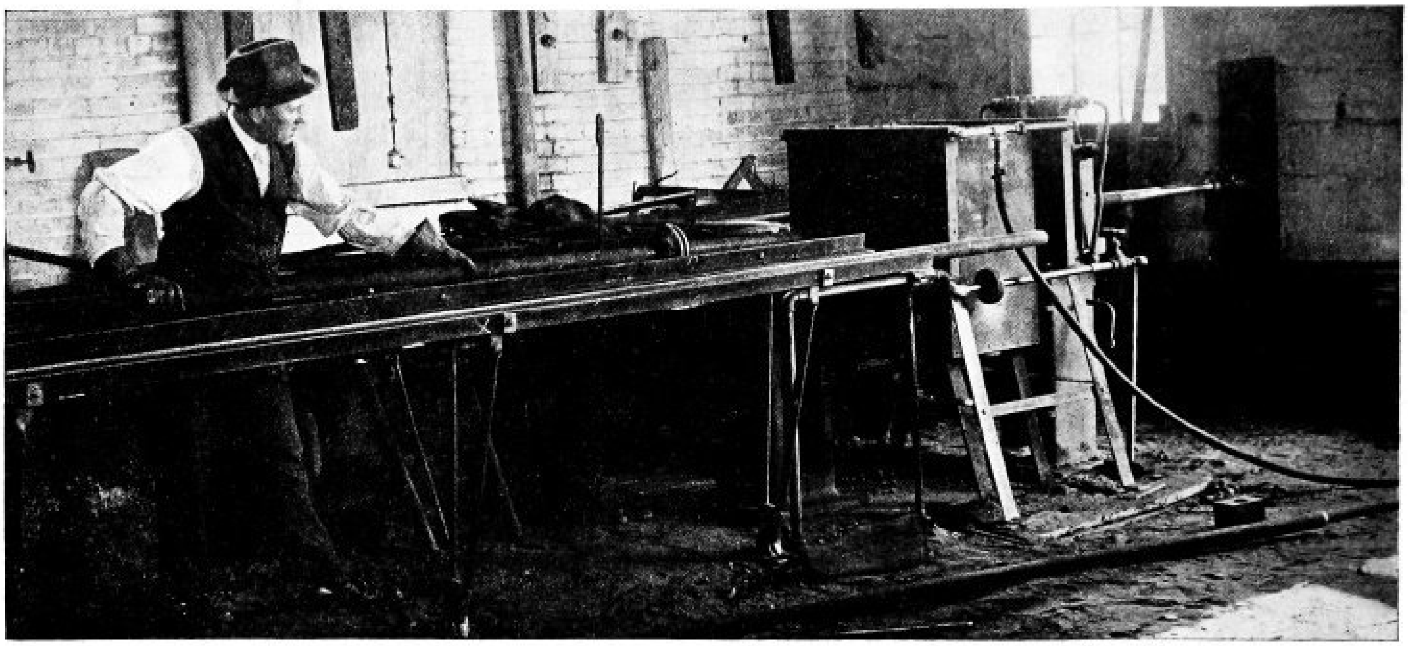
Much valuable time and labor is spent in making repairs on boilers that have been designed without any thought of future repairs, just because some engineer or draftsman wants to put in one of his pet ideas. I am of the opinion that all boilers, when designed, should have all parts so arranged that any one part becoming defective could be removed and replaced by a new one without having to cut away half the boiler to do so.

Pittsburg, Pa. Flex Ible.

Flue Reclaiming Attachments for Welding Long Ends on Flues

Unique flue reclaiming attachments for welding long ends on flues, as utilized in connection with the pneumatic flue welder and flue furnace, have been developed at Port Huron, Mich. This is a plan for welding long ends on boiler tubes, pipes or rods and for welding splits or flaws in pipes or tubes. It is pointed out that the operation is made possible by using the pneumatic flue welder placed behind the furnace, with the end of a long mandrel central between the dies of the hammer and in line with the center of the furnace. A waterback is placed between the furnace and the flue welder, in which cold water is circulated to keep the welder cool. Through the waterback is a cored hole, also in line with the center of the furnace and the dies in the welder. Through this the flue passes. throwing this table back into position allows the hot flue to roll over, and this straightens it. The flue is then allowed to cool on the table until it will support its overhanging weight. By this process there is no limit to the length of end that can be welded, this depending entirely on the length of the mandrel behind the flue welder. The flues shown in the illustration welded together are 12 feet and 14 feet long, respectively.

Attention is called to the fact that old flues with defective welds are constantly causing locomotive failures and in shop repairs large numbers of flues break at the welds while being rattled. After going to the expense of putting in a new flue-welding plant or remodeling an old one, and taking care to get good welds, there is nothing more annoying than to find a number of old welds on a flue leaking. This makes the flue useless unless it is long enough to cut for a shorter boiler.



Pneumatic Flue Welder and Furnace for Welding Long Ends on Flues

A similar water screen is used in front of the furnace to protect the operator. This cored hole is oblong or of such a shape that the operator can view the flue while being heated.

It is stated that the flues to be welded are prepared in the ordinary way, namely, scarfed and one piece expanded. The shorter piece is then pushed through the furnace onto the mandrel, and the other piece inserted into or over the lap and the part to be welded pushed to the center of the furnace. Then a clamp is placed on the tube at a certain marked distance back of a forked operating lever. This distance is the same as the distance between the center of furnace and center of welder, and should be about 18 inches. Then when the tube is at the proper heat for welding it is pushed forward into the flue welder and the clamp on the tube engages the forked connection and opens the operating valve, which automatically operates the flue welder at the same time that the weld is under the dies. By this operation the flue is welded in a very few seconds after it leaves the fire, which everyone having experience in welding thin flues knows is a very valuable consideration, for it practically guarantees, if properly heated, the weld will be perfect.

It is stated that after the flue is welded the clamp is thrown off and the flue pulled out on the tilting table, which has been pulled over under the flue. The act of

It is maintained that old, defective welds will always cause trouble to the railroads unless they are all cut off and one long end welded on. This latter plan is made possible by the Draper improved flue reclaiming attachments, by which pieces of flues of any length can be successfully welded together. There are three distinct uses for the device. First, all old welds can be cut off and one long end welded on; second, long ends can be welded on short flues for longer boilers; third, discarded flues can be picked from the scrap and welded to any desired length.

It is stated that when this latter plan is adopted the flues should be first rattled and all old welds and bad ends cut off. Then those that do not show more than the set limit of depreciation from the original weight can be reclaimed and welded to the proper length. This depreciation may be 10 percent, 15 percent or 20 percent, as may be set by each railroad to suit its own working conditions.

It has been found that many of the iron flues that have been in constant use for twenty years show very little depreciation in weight. Among some of the largest railroads the practice is to allow only three or four welds. All old welds are then cut off and the flues used for shorter boilers. But where 2¼-inch and 2½-inch flues are used in the larger locomotives, which require long tubes, this means the discarding of many tubes or making more welds, as there are no shorter boilers taking these sizes of flues.

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NOTICE TO ADVERTISERS
Changes to be made in copy, or in orders for advertisements, must be in our hands not later that the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

Favorable reports of the adoption of the A. S. M. E. boiler code continue to be issued periodically by the American Uniform Boiler Law Society. The latest is to the effect that the legislature of Louisiana has passed a bill authorizing the governor to appoint a commission of five, all of whom are experts, to examine the A. S. M. E. code and report to the assembly in 1918 as to its adoption as a law of the state. This committee is appointed with the understanding that its findings will be transmitted to the general assembly by the governor with his recommendations. Prof. E. W. Kerr, of the Louisiana State University, has had charge of this matter, and to him is due the credit for this favorable action. It is confidently believed that the committee will report to the governor that Louisiana should adopt the code and thereby protect as far as possible the lives of their citizens from the possibility of death by boiler explosions.

Another favorable report comes from the purchasing department of the Panama Canal. Major Earl A. Brown, of the Engineering Corps of the United States Navy, recently sent out specifications covering a boiler required in the Canal Zone, stating that the boiler is to be constructed in accordance with the rules for the construction and installation of steam boilers issued by the American Society of Mechanical Engineers, although alternate bids will also be considered on other classes of boilers. This partial recognition of the code by the government is held by the Uniform Boiler Law Society as a most gratifying result, indicating the reliance which is placed in the code by army engineers.

At the very successful convention which was held by the Ohio boiler inspectors at Columbus, Ohio, in September, the keynote in all the addresses delivered was for uniformity in boiler construction and inspection and the necessity for a uniform standard code was strongly urged. The meeting was largely attended, as reported in our last issue, and the results, it is believed, will lead to a more earnest consideration of the adoption of a uniform boiler code throughout the country.

In both New York and Michigan strenuous efforts are being made to secure definite action in the adoption of a boiler code, and from present indications the Uniform Boiler Law Society is confident that favorable progress will be made in these States in the near future.

In no part of the United States should this campaign be allowed to languish. The work should be vigorously pushed and every bit of favorable action that can be secured will bring the ultimate goal for which the members of the Uniform Boiler Law Society are striving so much nearer of accomplishment.

"It is needless to say that an executive to be successful must have the respect of his assistants. He need not be 'popular.' It is perhaps better that he should not be too much of a 'hail fellow well met.' There is is a reason for the army rule that officers should not drink with 'non-coms' and that 'non-coms' shall not drink with privates, and human nature is the same in business as elsewhere. A reputation for fair dealing, a willingness to listen to the whole story in case of a grievance, and an absence of anything savoring of 'side' counts for much more in the administration of a corporation than any amount of cheap popularity."—Dwight T. Farnham in *The Engineering Magazine.*

The above is doubtless true from an administrative point of view, but who of us regrets having worked for the boss who willingly shared our difficulties and successes in the give and take of everyday work? Personally we prefer a leader rather than a driver. Both respect and popularity are likely to be gained by a true leader; respect for his ability and the judicial exercise of his authority and popularity for his willingness to help and guide.

The next logical step in "Safety First" work, according to a pamphlet on "Health Conservation at Steel Mills," recently issued by the Bureau of Mines, Department of the Interior, is its extension to include "Health First." The first movement is now so well organized and its operation so systematized that its extension to cover health as well as accidents should involve little extra expense or labor. The prevention of disease and sickness is surely of equal if not of greater importance to all concerned than the prevention of accidents.

Engineering Specialties for Boiler Making

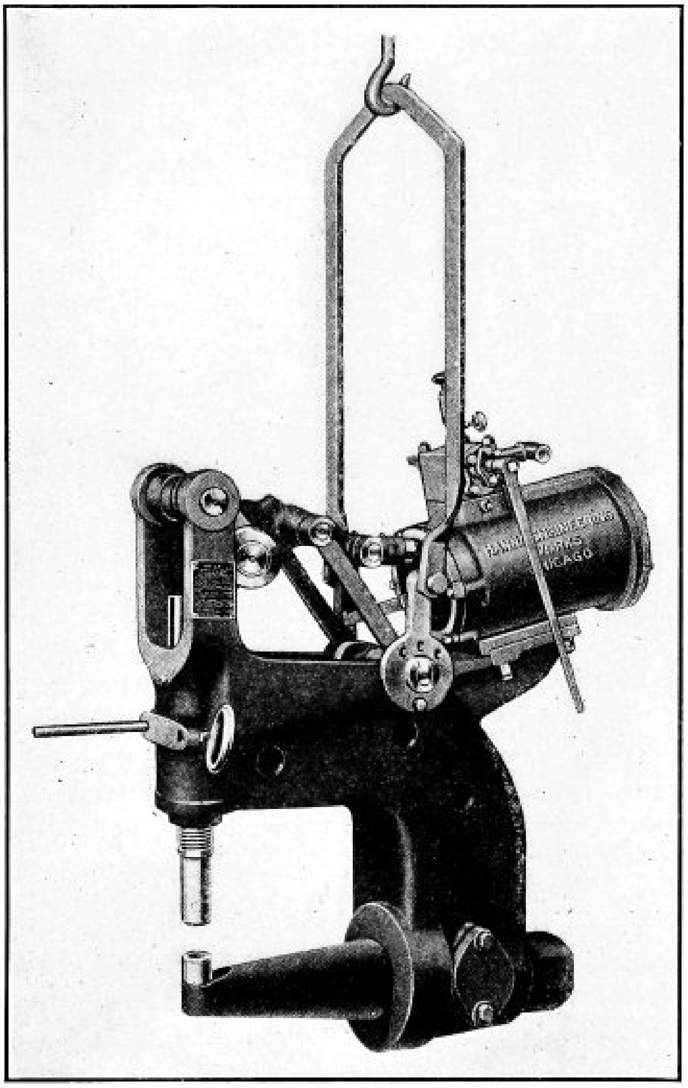
New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Special Hanna Riveting Machine

A specially designed riveting machine for operating in sections where space is limited has been placed on the market by the Hanna Engineering Works, 2059 Elston avenue, Chicago, Ill.

The removable alloy steel stake is a feature and may be shaped to any form best suited to the work on which it is to be used. It is particularly adapted to automobile and similar riveted work of close dimensions.

The toggles, levers and guide links are combined to give the large opening of the toggle joint movement with a gradual increase in the amount of pressure applied until the desired amount is secured. This is followed by a simple lever movement through a considerable space under approximately the maximum pressure of the machine.



Hanna Yoke Riveter

As was the case with earlier machines, the toggle action takes place in the period when the piston is making the first half of its travel, the die traveling through a large portion of its stroke at the same time. During the time required for the remainder of the piston travel the die completes its stroke, it being emphasized that the amount of piston travel is enough to eliminate any uncertainty regarding the pressure applied to the rivet.

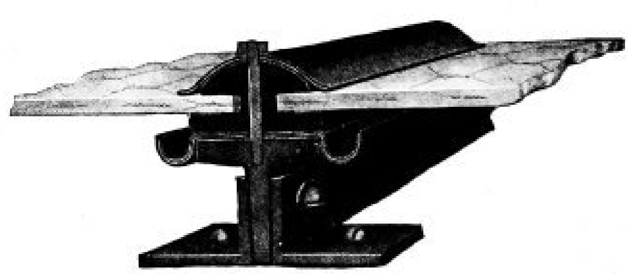
The change in the action of the mechanism from that of a toggle to that of a lever is accomplished automatically without a critical point. The relatively large space through which the rated maximum pressure is exerted, it is claimed, does away with the necessity for adjustment, after the machine has been set for a certain length of rivet and thickness of plate, to take care of ordinary variations in the length of the rivet, the size of the hole or the thickness of the plates. As a predetermined pressure is applied to the rivet at each blow, it is unnecessary to strike a rivet more than once. The slow movement of the die while the lever action is taking place is relied upon to give the metal in the rivet time to flow and fill the hole, as well as providing an opportunity for the rivet to set prior to the releasing of the pressure on the return stroke of the die.

Steel castings are used for the frame, main lever guide links, toggles, plunger and piston rod head and cast iron for the main frame bushing and parts of the cylinder. The lower toggle and the die holder and screw, dies and piston rod are made of high carbon steel.

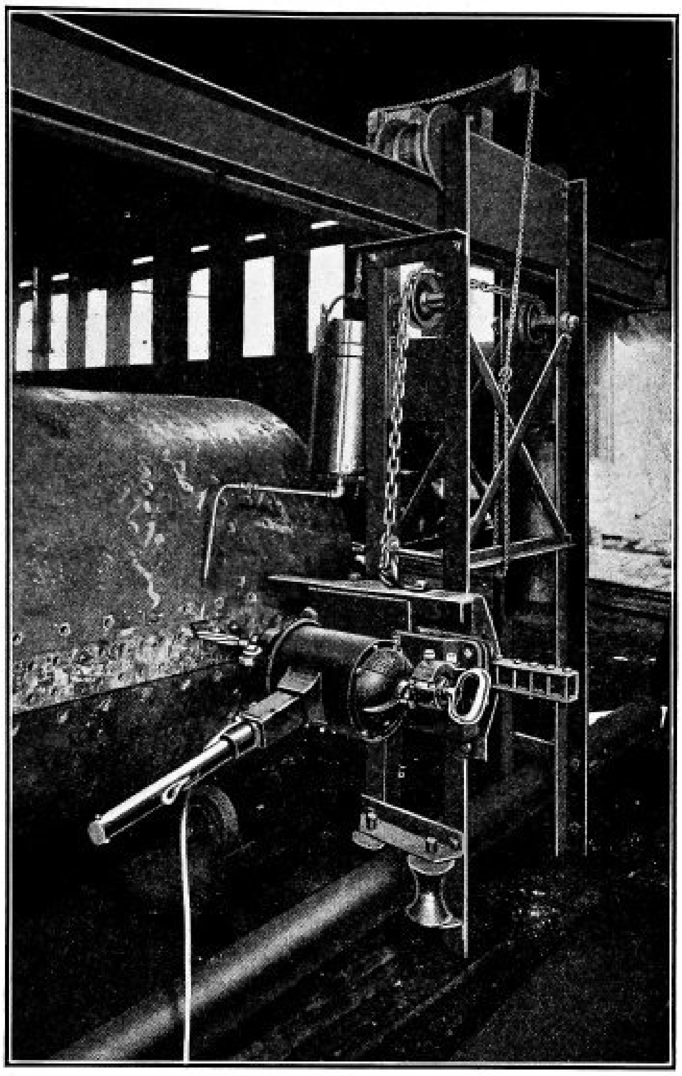
New Type of Skylight Construction

A form of skylight bar construction known as the Waugh glazing construction, employing asbestos-protected metal and a condensation gutter, the latter entirely separate from the steel skylight beam, has been developed by the Asbestos Protected Metal Company, Pittsburg, Pa. It is designed to secure freedom from corrosion and from glass breakage due to deflection of the bar.

The skylight beam used is a plain standard section, being a "T" in the case shown. This bar is covered and hermetically sealed by a special coating. As a preliminary the steel is freed from grease, moisture, oxides and other surface impurities, after which the steel is heated uniformly and immersed in a bath of an asphalt compound. As an additional protection a covering of asbestos felt is pressed into the asphalt while it is soft and hot, and this in turn is protected by a coating of special fume and moisture-proof hardening material, the nature of which depends upon the particular service to be rendered. This coating, it is pointed out, is both heat and fire resisting, protects the steel from stray electric currents and galvanic action. To collect and dispose of the condensation that sometimes has to be taken care of with a single sheet of glass special gutters are fitted snugly



Waugh Glazing Construction



Device for Reaming Holes in Boiler Shells

over the top of the bars. These gutters are also made of asbestos-protected metal.

The glass itself rests directly upon a cushion of asphaltic compound. The outside edge of the glass plates and the joints between them are covered and bridged with a half oval section of asphaltic compound.

Device for Reaming Holes in Boiler Shells

Reaming holes in boiler shells with the ordinary air or electric drill is a very tiresome operation; it is also very hard to hold the reamer squarely against the shell. When the men doing the work get tired they generally let the drill drop down, making the holes oblong.

Mr. E. A. Anderson, superintendent of the boiler department of Kroeschell Bros., of Chicago, has designed a simple frame for holding air or electric drills rigidly in the proper position for reaming, and is using a No. 4 Duntley electric drill which has proven to be the best tool for the purpose. Most of the reaming is from 11/16 to 15/16 inch diameter and about 1½ inches thickness. This device is described in *Ideal Power* as follows:

As may be seen from the photograph, the frame holding the motor can be adjusted to different angles and can also be moved up and down, a counterweight balancing the weight of the motor. It is made high enough to take in shells from 30 inches to 90 inches in diameter and long enough to take in a seam 10 feet long without moving the shell.

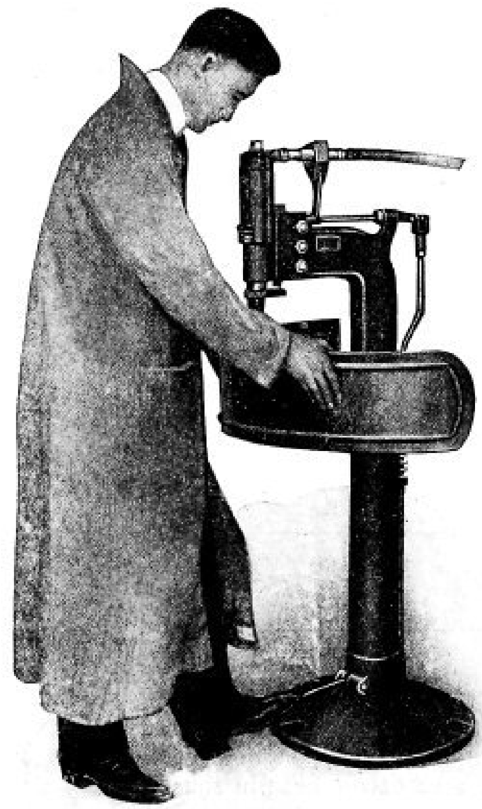
It is also provided with a tank for holding soapwater and a pan below for catching same so it can be used over again.

The frame is made rigid enough so it can be used as a drill-press. A screw-feed is then put on instead of the lever feed that is used when reaming. It can be put up between two posts almost anywhere in a shop, and if necessary can be moved with very little trouble.

Boyer Pedestal Riveter

The Boyer pedestal riveter, manufactured by the Chicago Pneumatic Tool Company, 1010 Fisher Building, Chicago, Ill., is designed for riveting small, light parts that can best be handled in a stationary machine, and is constructed so that the machine can be operated by a foot lever, leaving the operator's hands free to handle the work.

The yoke consists of a crucible steel frame mounted in the end of a pipe column, all of which is supported on a cast iron base and held together with a ¾-inch bolt. The base is provided with anchor bolt holes to permit its being securely fastened to the floor. The standard yoke has a gap of 8 inches and a reach of 11 inches. At a slight additional cost yokes may be furnished of any desired dimensions to accommodate larger work.



Boyer Pedestal Riveter

Where it is desirable to handle more than one size rivet a special dolly may be supplied that will accommodate four different size rivets. This dolly is made to permit of its being used in very close corners, and it can be replaced at very reasonable cost when worn out.

The riveter head is a standard Boyer riveter 1 1/16 x 3, 1 1/16 x 4 or 1 1/16 x 5, and is held in a clamp, which permits of its being adjusted to take care of the wear on the dies or the variation in length of rivets.

The net weight of this machine when equipped with 1 1/16 x 3 riveter is approximately 173 pounds.

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.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Bursting Pressure of Yarrow Drums

Q.—Recently there have been many ruptures of *longitudinal seams, double-riveted lap joint* of the lower water jacket of a Yarrow boiler. I would like to know how to calculate the bursting pressure on this seam. The drums are D-shaped. There seems to be additional stresses caused by the flatness of the tube plate, setting up a reaction on the joint. I have witnessed *hydrostatic* tests and have noticed deformation in contour of wrapper near the lap as shown by the dotted line on the enclosed sketch, Fig. 2, running from ½ inch at joint to nothing along 10-inch circumference of wrapper. H. R. G.

A.—The pressure within a cylinder acts in the directions shown in the sketch of a cylindrical shell, Fig. 1. The forces due to the steam pressure acting in the direction of the arrows *A* tend to pull the plate apart in a transverse direction. The resistance to this force is equal to the plate thickness times the neutral circumference of the plate times the tensile strength of plate. The force is equal to the area of the head in square inches times the working pressure in pounds per square inch.

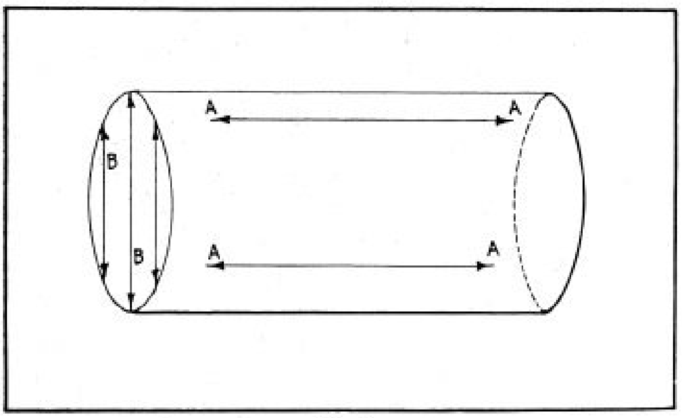


Fig. 1

The pressure acting in the direction of the arrows *B* tends to rupture the plate in a longitudinal plane. The resistance offered to this force is equal to the length of the shell times two, times the plate thickness, times the tenacity of the plate.

The same conditions in the action of the forces due to pressure are met with in the Yarrow drum. From the shape of the Yarrow drum in question the semi-cylindrical part *a* cannot change its original form without a distortion of the tube plate *b*. Owing to the rigidity of the tube plate and being stayed by the flues, a great resistance is offered by it to the pressure. When the riveted joint is strong enough there is only one other part it seems is liable to become distorted, that is, the plate *c* between the riveted joint and the tubes. It may be possible that the transverse force is sufficient to bend this part of the plate downwards, thereby distorting the drum in the manner shown in the correspondent's sketch. If the conditions are such as indicated in the sketch, Fig. 2, it shows either faulty design or construction. The force tending to burst the longitudinal seams is equal to the inside diameter of the drum multiplied by the length multiplied by the pressure.

The bursting pressure per square inch within a cylinder without riveted joints may be found according to the following formula:

$$P = \frac{T\,t\,2}{D}$$

P = bursting pressure in pounds per square inch,
T = tensile strength of plate in pounds per square inch,
t = thickness of plate in inches,
D = diameter of cylinder or drum in inches.

Consider a drum 24 inches in diameter, plate thickness equal to 9-16 inch, tensile strength of plate equals 55,000 pounds. Then, according to the formula, and substituting values, we have:

$$\frac{55{,}000 \times \frac{9}{16} \times 2}{24} = 2578 \text{ pounds,}$$

magnitude of the force required to rupture a seamless drum 24 inches in diameter.

If the drum is constructed with a double riveted lap joint having an efficiency of 74 percent, the allowable bursting pressure would equal $2578 \times .74 = 1917.6$ pounds per square inch.

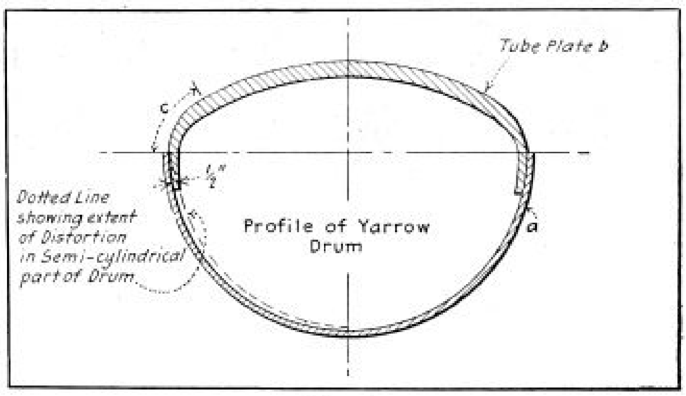


Fig. 2

The safe working pressure should be much less than the calculated bursting pressure. The ratio between the bursting pressure and the safe working pressure is the factor of safety. Some authorities use 4, 5 and 6 as factors of safety, others use a factor found according to certain allowances for the condition of the plate and other material, the design, and workmanship in constructing the boiler.

In this case consider a factor of safety of 6, then the safe allowable pressure on the drum equals $1917.6 \div 6 = 319.6$ pounds per square inch.

Allowance for Rolling Thick Plates

Q.—In making plate allowances in the stretchouts for shells rolled to either outside or inside diameter, how is the required amount calculated? W. E. R.

A.—During the operation of rolling a thick plate the outside diameter of the sheet stretches and the inside gathers, but at the center of the plate thickness, or its neutral layer, it neither gathers nor stretches. The outside stretches or gains in length, while the inside becomes shorter. The difference between these lengths is called "takeup." If no consideration is given to the gain or loss in rolling, the cylinder will be smaller or larger, depending upon the diameter the stretchout is calculated from. Layerouts use either of the following three methods, either of which gives about the same result, although the first method described is considered the accurate one.

First Method.—Multiply the neutral diameter of the shell by the constant 3.1416. Using an example to illustrate this case and the following ones, consider a section of a tubular boiler 60 degrees inside diameter and made of ½-inch plate. Find the correct length of the stretchout. The neutral diameter of the cylinder equals 60 + ½ =60½ inches; 60½ × 3.1416 = 190.067 inches, correct length of plate needed, exclusive of lap.

Second Method.—This method involves a calculation based upon the outside diameter of the shell, in which case apply the following rule:

Rule.—Multiply the outside diameter by 3.1416 and from the product subtract three times the plate thickness to take care of the gain in the length of the plate.

Outside diameter equals 61 inches; 61 × 3.1416 — 3 × ½ = 191.638—1.5 = 190.138 inches, the length of plate required, exclusive of the lap if lap joints are used.

Third Method.—According to this method, we consider the inside diameter of the shell, which is 60 inches, and apply this rule:

Rule.—Multiply the inside diameter by 3.1416, and to the result add three times the plate thickness for the loss in the plate length.

Then, 60 × 3.1416 + 3 × ½ = 188.496 + 1.5 = 189.996 inches, stretchout of plate needed, not including the lap for lap joints.

Comparing the three results we find that there is not a great difference between the methods, as will be seen from the following:

The difference between the first and second methods equals 190.138 — 190.067 = .071 inch.

Difference between second and third methods equals 190.138—189.996 = .172 inch.

Copper Ferrules

Q.—What is the object of putting copper ferrules in the back flue sheet? Why don't they put them in the front flue sheet too? O. J.

A.—To insure a tight connection between the flues and tube sheet at the firebox end copper ferrules are usually employed. Copper, owing to its greater expansion than steel or iron when heated, tends to keep the tubes from leaking between the joints. Copper being a very soft metal, is easily worked into the small crevices in the tube plate. Ferrules are generally put in the firebox end, although many locomotives have them in the smokebox end. The tube ends at the smokebox end are not as liable to leak as at the firebox end, as the heat at this point is usually uniform, and as a result there is practically no contraction between the tubes and plate when in operation. On the other end the heat is intense, and, owing to the frequent intervals of firing, allowing an inrush of cold air through the fire door, the expansion and contraction is considerable. Owing to the rigidity of tube sheet it does not expand or contract as quickly as the tubes, hence the difficulty in keeping a uniform relationship between the tubes and plate is by the use of the copper ferrules.

Boiler Tubes

Q.—I have some Franklin watertube boilers, equipped with iron tubes. The water used is bad, having some salt and possibly some oil in it. The boilers are fired with oil and are working about 20 percent overload. The tubes burst quite frequently, and occasionally do damage. All tubes burst against the grain. What I wish to know is:

1. Would steel tubes stand the strain better?
2. What thickness should the tubes be, if steel?
3. What thickness should the tubes be, if iron?
4. Would the trouble be eliminated if good water were used?

Subscriber.

A.—The conditions under which you are operating your boilers are bad. The oil in the feed water will adhere to the boiler plate and tubes, and may cause overheating, thus affecting and lowering the strength of the metal. The boilers should not be worked at a greater pressure than that for which they were designed. The overheating of the tubes and overloading of the boiler account for the bursting of the tubes.

Steel and iron are being used successfully in boiler tubes. Steel is found to meet the requirements by some manufacturers and operators, while iron is preferred by other people. There is such a great difference in the opinion of experts on this subject, and as each material has its supporters, we cannot very well offer a definite decision as to which metal to use for all cases. This is a matter open for discussion by our readers, and no doubt they have some valuable information upon it, so let us hear from them on the matter.

In the operation of steam boilers, the feed water should be good, free from oil and corroding elements. Where the boilers are overworked or loaded to secure a greater quantity of steam, the tubes should be cleaned more frequently than under ordinary conditions, because more water is being generated into steam, and therefore a greater quantity of sediment and scale will gather. If this matter is not removed it affects the good steaming qualities of the boiler, and eventually the parts so affected will overheat and cause trouble.

Tube manufacturers make the tubes of different diameters to standard dimensions. They are of such thickness for all diameters that they will withstand the pressures met with in practice.

Collapsed Flues

Q.—I would like to know of methods of repairing collapsed flues of internally fired boilers and what percentage of the original strength is recovered by the restoration of the plate? Japan.

A.—There are various repairs to shells of boilers and the repairs to be followed out vary, owing to the different structural features and defects in the shells. Therefore, we cannot cover all cases at this time.

In restoring collapsed furnace crowns or flues, first find out whether the plate is burnt, cracked or affected by corrosion, and determine the plate thickness if it is wasted away. When the plate is in poor condition remove the damaged part and fit a good patch over the opening. Make the rivet seams as strong as the weakest riveted joint in the boiler. If the plate is bulged and the plate is in good condition, restore its shape by first heating it and then hammer it back with round-faced sledge hammers. Usually it is difficult to do this without distorting the metal. When the bulge in the furnace or flue is large it is advisable to use a hydraulic jack to bring the plate into place. In using a jack, the plate is first heated, which may be quickly done by a portable furnace to the desired temperature. The strength of the furnace or flue is practically restored if the metal is in good condition and the work is carried out in a proper manner. If more definite information is given us in regard to the nature of the repairs we shall be pleased to render other assistance.

Information Wanted Regarding the Use of Gas in a Furnace

We have just received a letter from a boiler foreman stating that he is starting to use gas in their flue furnace, but is not getting the success that should be expected. He asks us to give space in the magazine with a view to getting ideas from some who have had successful experience with such apparatus, and also sketches of the furnaces used.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

How to Test Staybolts

If you have an engine to examine which is equipped with flexible staybolts, take your hammer, go into the firebox and tap the end of the flexible bolt with your hammer. Do this several times, then do the same to the solid staybolts, and you will notice the difference between the sound of the blows on the two bolts; one has a firm and solid sound, while the other has a hollow sound. Now, remember this, that a broken staybolt of the solid kind will give off the same sound as will the flexible staybolt, for the reason that the flexible staybolt is fastened in one sheet only and the cap end is free to move. Therefore, a solid bolt when broken is free to move on the outside sheet, and the sound made by striking the bolt with the hammer must be the same as that made by striking the flexible bolt.

It will be useless to try to determine by the hammer test if the flexible bolts are broken. This cannot be done unless there is a steam pressure of 40 or 50 pounds on the boiler, and then it is very doubtful and risky. To examine the flexible stays the caps must be removed and the bolt head struck with the hammer. Should the bolt be broken the head will fall out of the sleeve. R. B. H.

Testing a Boiler After Overhauling

We will take it for granted that the boiler is ready for the test, that all mud plugholes have been retapped and all we have to do is to make connections to the testing machine. Make this connection at any convenient point, having the testing gage connected to this pipe between the testing machine and the boiler.

Now all things being ready, turn on the steam from the shop boiler, allowing the pressure to rise in the testing boiler until it is equal to that of the shop boiler, which will usually be about 100 pounds. Then take up all leaks. When this is done, blow out the cylinders by opening the throttle and exhaust all steam from the boiler (having first closed the connection from shop boiler) and as quickly as possible turn on the water through the test injector.

When boiler is quite full, close the valve on the top of the dome, that has been opened to give vent, and turn on the pressure with the injector to the desired amount, which should be 25 pounds in excess of working pressure unless it is the time for the annual test, then the amount which is required by law should be applied.

Take up all leaks while the water pressure is on and calk dry all over the boiler. Should it be near the time for the annual test or examination, it will be necessary to remove the dome cap and all obstructions out of the dome to allow the inspector to go inside the boiler and examine all braces and connections, which should be done with the greatest of care.

The object of using a steam test first is to warm up the old material and give it more life and elasticity, and practically eliminating the possibility of fracturing the boiler. Perhaps some of your readers may better understand the reason for this if they have noticed ball players just before a game, how they knock the ball out and throw it to each other; in other words, they are warming up for the test.

In all cases where the writer has been entrusted with the testing of boilers, this has always been his practice, unless it was on an outside repair job on a locomotive boiler. In that case the boiler was filled with water and fired up with wood to the working pressure, and should any leaks develop it was an easy matter to dump the wood ashes and enter the firebox.

The writer's reason for using the steam pressure test first is this: Many years ago, while then an inspector on a trunk line, the roundhouse foreman insisted upon testing an engine with cold water and the force pump. The writer protested and the roundhouse foreman said that he would take the risk and assume all responsibility. The writer told him to go ahead, which he did, with the result that before the pressure had reached the 100-pound mark there was a loud report, and upon examination it was found that the dome had burst on both sides and along the barrel some 8 inches or more. It was in the winter time and the water was intensely cold, yet this man, lacking in experience of this kind, would have his own way, thinking he could save a little time by doing so. The experience was enough for the writer, and nothing could induce him to assume the responsibility of such a test.

Pittsburg, Pa. FLEX IBLE.

How are the Holes in Flue Sheets Prepared for the Reception of Flues to be Expanded?

Assuming that the flue sheet to be cut is ready to be punched, it is taken to the punching press and ¾-inch holes punched in, when it is removed to the drill press, where it is drilled to the required size. If it is a front flue sheet for a locomotive boiler for an installation of 2-inch flues, the holes are cut or drilled 2 1/64 inch. If the sheet is a firebox flue sheet for flues of the same size and to be installed straight and to have copper ferrules 1/16 inch by ⅝ inch by 2⅛ inch outside diameter, then the holes must be cut 2⅛ inch. In all cases where copper ferrules are used, the holes should be cut to accommodate the copper.

Cutters and drills of various kinds and shapes are used. For quick and fairly clean work a drill with three lips will be found to give good satisfaction. All drills and cutters should have a teat for holding the center while the holes are being cut.

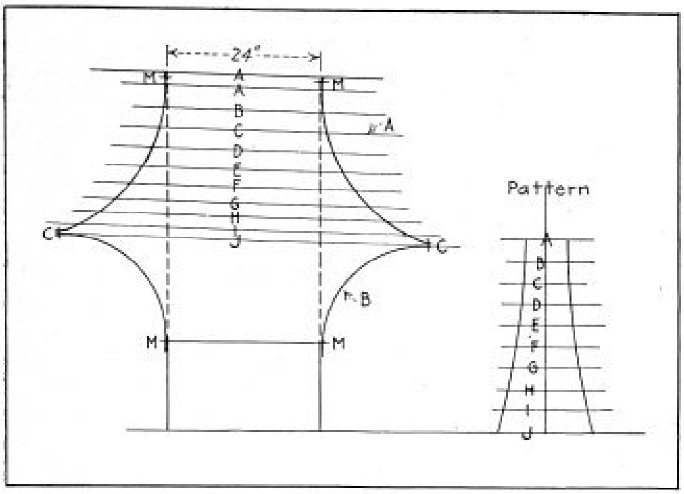
Great care must be taken in grinding drills and cutters for this work, for it is an easy matter to grind a drill a trifle large, so that when ferrules or flues are tried the fit is found to be a bad one. In all well-regulated shops there are standard gages for all sizes of flues, and when a flue sheet is to be cut the driller is furnished with the proper gage. For all boilers where flues are to be installed without copper ferrules, holes cut 1/64 inch larger than the flue to be used will be found all that is required.

In drilling copper flue sheets care must be taken not to force the drill, for it is an easy matter to tear the copper and make a very bad hole. For this purpose a cutter is much better than a drill.

Pittsburg, Pa. FLEX IBLE.

Layout of Ornamental Top for Stack

In order to develop the plates for the ornamental top for a stack, as shown in the drawing, we must first lay out a full-sized plan. The ornamental top will consist of two sections, *A* and *B*, riveted together at *C*. Section *A* will



Pattern for Stack Top

be made in 12 pieces, although any number may be used. Section *B* will be the same as section *A*.

After we have laid out our plan we will commence by measuring the distances *A, B, C, D, E, F, G, I, J*. Then find the circumference of each end and divide this by the number of pieces.

Take the dividers and space off the distances from *M* to *C* in the drawing, as shown in the patern from *A* to *J*.

Paterson, N. J. JOHN ZINGA.

What are the Causes of Cracked Tube Plates?

The most common causes of cracked tube plates are due to the following conditions: defective material, improper construction, accumulation of mud and scale and, most common of all, the expansion and contraction of sheet, due to improper combustion and temperature in the firebox. Care should be taken that the tube sheets are made to specifications from firebox steel.

Cracks due to improper construction are caused by expanding or rolling the tubes beyond their actual strength, as this has a tendency to weaken the bridges between the tubes, and also by having the tube holes too close to the flange. Mud scale cracks are due to the accumulation of mud between the the tubes and around the staybolts, or any projection on which mud can stick. Mud or scale prevents the water from making a direct contact with the sheets. This can be eliminated by proper cleaning and washing out of the boiler.

Cracks due to improper combustion are caused by having a bad fire in a firebox, causing a sudden change in temperature, which in turn causes the sheet to expand and contract very rapidly.

Cracked sheets are repaired by cutting out the cracked parts and puting on a patch. A much better and cheaper way of doing this, however, is by welding. For welding cracks between the bridges the electric welder is more satisfactory, as it keeps the heat in a limited space, although acetylene gas is successfully used for welding patches and cracks, depending on the condition of the work to be done.

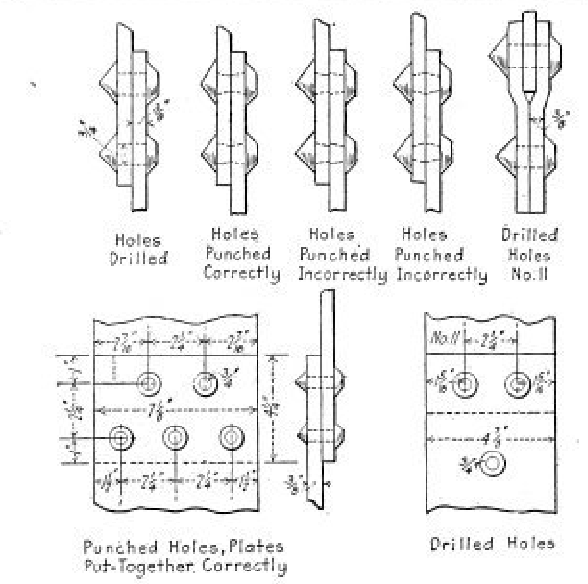
Chicago, Ill. J. CURTIS.

Punching Versus Drilling

Seeing the above subject up for discussion, I will submit a cut showing the results of a test made by me quite recently, which I think may interest our readers.

You hear a good deal nowadays about the terrible machine, the punch. Some elaborate quite extensively on the drift pin—follow it up and listen on the ground, locate the noise—and ninety-nine times out of one hundred the learned gentleman never spent two hours in a boiler shop in his life. Probably some of our readers noticed an article signed "Dean," with a cut of butt strap joints, which are ridiculous as well as impossible, and yet they tell us that they are used very extensively in this country and Europe. The man in the shop to-day is looking for something better than this from his learned brother.

We are told that the better class of boiler makers drill all their holes. They do, but you can find the innocent-looking waste-bag laying on part of a side seam, especially when the inspector is in the shop. This is to cover up some bad holes, and this condition sometimes exists in the better class shops with drilled holes. Inspectors demand that drilled joints must be taken apart to remove the burrs. This is good practice and has only one fault, and it is a bad one. The joints cannot be put back where they were previous to their being taken apart, even with straight pins. A good, sharp punch and a well-set die with enough clearance is not such a hideous tool as they would make you believe. I have seen side sheets and shell plates punched small and drilled to size. I have seen



Sample	Actual Strength	Sample	Shearing Strength per Sq. In.	Sample	Actual Strength	Sample	Shearing Strength per Sq. In.
1	87,650	Drilled Holes	39,750	3	97,770	Punched Holes	44,340
2	100,110	Punched Holes	45,400	5	82,140	Drilled Holes	37,200
Sample	Actual Strength	Sample	Shearing Strength per Sq. In.	Sample	Actual Strength per Sq. In.	Sample	Shearing Strength per Sq. In.
6	89,380	Drilled Holes	40,350	8	91,870	Drilled Holes	41,500
7	98,680	Punched Holes	44,650	10	97,770	Punched Holes	44,340
Sample	Actual Strength		Shearing Strength per Sq. In.	Sample	Tensile Strength		Tensile Strength per Sq. In.
11	87,650	Drilled Holes	39,700	13	68,890	Drilled Holes	56,560
12	68,890	Drilled Holes	56,560				

Rivets Driven with Air Hammer. Burden best Iron Rivets used.

Samples No's. 1-2-3-5-6-7-8-10-11. Rivets Sheared.
Samples No's. { 4 Pl. tore through Rivet Hole Stress per Sq. In. 44800; 9 " " " " " " " 45650; 12 " " " " " " " 56560 }

Results of Tests on Drilled and Punched Plates them drilled all the way, and I have seen them punched full size, and with service conditions on a par there may have been some slight gain with the drilled job, but if there was, someone swiped it, for we never could find it.

We know that drilling does not change the properties of the material and we know that we can't say this about punching. We also know that soft, ductile metal is injured less than metal of harder properties. Rolling done carelessly will kink the holes on a straight seam when punched to full size, or injured while being knocked down to the roll.

I witnessed a test on a cold-drawn strip taken from a finished shell some time ago; the material was cold drawn from 5/16-inch firebox steel to .105. The tensile strength was greater after it had been drawn with four operations. You will all agree that this is severe abuse, yet the material had not been injured to any extent. In presenting the record of his test it is understood that I am for, and not against, drilling. There is one drawback to a test of this kind; the metal between the rivet holes in a riveted joint cannot stretch as a proper test piece does in the testing machine, and consequently it shows a greater tensile strength than a test piece from the same plate. Some tests on single or double riveted joints with small pitches show an excess of strength from this cause amounting to 10 percent or more. The excess appears to be uncertain and irregular, so that if any allowance is made for it, it should be left to a skilled engineer after a careful study of all the tests that have been made. The tensile strength shown by the test pieces in the testing machine should be taken in preference to the joint test, especially when the pitch is large.

Failure of steel is rather peculiar at times. I have seen flange steel fail with the last heat, yet there was a reason for it. I remember the case of a throat sheet which was finished and was found next morning with a thousand fractures. In looking into the case I found that when the flange turner finished the sheet it was quitting time and he stood the sheet on edge with dogs. We all know that in most well-regulated shops it is the business of the helpers to wet down the floor around the flange fire. Accidently the helper threw a bucket of water, which struck the hot throat sheet, which caused the fractures and ruined the sheet.

I noticed that "Flexible" quoted "Samuel Nicholls," who witnessed some very elaborate tests along the lines of punched versus drilled holes, and in looking over the test he stated that, taking all the plates that gave way through the hole, we find that the drilled plates give an average ultimate tensile strength of 41.075 tons per square inch, and the punched plates of 41.24 tons per square inch, from which it may be fairly assumed that riveted joints in steel plates with punched holes are quite as strong as the plates with the drilled holes.

And in conclusion I may say that my test shows that the punched-hole sample tested out the best, yet that we can have a scamp drilled job just as well as a scamp punched job is a well-known fact with average boiler makers, and the fact remains that there are tricks in all trades, and the boiler maker puts it over the boss and the inspector once in a while just the same, regardless of drilling or punching. Boiler making at the present time is down to a science, and it is up to the men higher up to educate the shop man so that we may obtain the desired results.

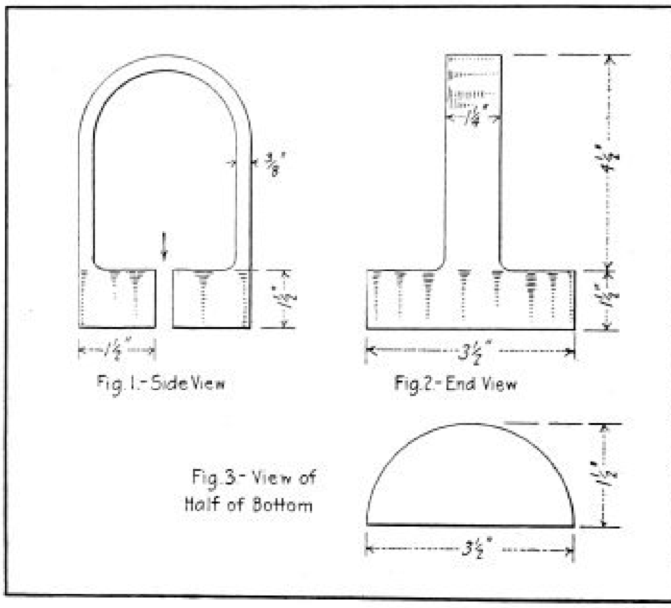
Milwaukee, Wis. N. Roberts.

Work laid out by an apprentice should be carefully checked by an instructor, and any errors pointed out and corrected.

How to Locate and Remove a Leaky Tube in a Watertube Boiler

The Cahall watertube boiler is one of the most difficult boilers in which to change tubes. It is not so difficult to locate the leaky flue, perhaps, as many boilers, for as a rule they do not give much trouble until they get thin where the flame strikes them; then they burst.

To locate the defective flue the boiler should be filled with water, and by crawling back over the brick wall you can stand up and examine the flues by walking around the furnace. If the flue is burst it will generally be found in the front groups. Now remove the water, open the top and bottom manholes and impress well upon your mind which group and which flue in the group is to be removed. Next go to the top drum and locate the proper group and flue. If you have a chalk line with you, tie a nut or any small weight and drop it through the key flue, which is the center flue in each group. Your assistant in the bottom drum will know by this means where to start cutting.



Spring Tool for Lifting Out Tubes

If your memory is not good, another way to locate the flue is as follows: First of all get the location of the manhole in the top drum and count from the defective flue around to the manhole; then go to the top drum and count from the manhole back until you are at the required flue. Now proceed as before.

Having located the flue or flues to be removed, the assistant in the bottom drum splits and opens the bottom of the key flue. When this is done take a screw jack and bring it up against the end of the split and opened flue. It is best to put a small piece of wood between the jack and flue so that it will not slip. Having made it fast, the man in the top drum cuts off the bead and removes the copper ferrule that is always around the key flue.

Having got the copper ferrule out of the way you are now ready to lift the flue, which is done in the following manner: Get a spring tool (like the spring swadge usually found around a steam hammer) about 3½ inches over all, or large enough to go inside of the flue; now drive a chisel or a wedge in the middle of the tool, and spread it until it grips the sides of the flue so that it will not slip when the weight of the flue is on it. Through the handholes in the top of the drum and directly over the key flue drop a chain or stout rope. Fasten on to the loop of the tool already in the flue, and hoist it out. Now you are ready for the next flue.

Cut loose the bottom end the same as for the key flue; put your jack in position, split and close the top just enough to allow it to pass freely through its own hole. Now carefully lower on the jack until the end of flue clears the top flue sheet, and carefully transfer to the key flue hole; screw up on the jack until the flue is through the sheet enough to allow the spring tool being inserted, and hoist away. Every flue in the group can be removed in this way and new ones installed by just reversing the order of things, but putting the first new flue in the place of the last flue removed and rolling the top end of flue first.

Great care must be exercised in changing flues in this kind of boiler, not only in the handling of the flues, but the tools also, and the man in the top drum should always be selected for his coolness and good judgment, and should never be allowed to enter the drum without a piece of canvas or stout bagging to spread out over the openings of the other flues, and all tools should be kept in a small box and not allowed to lie on the flue sheet, for by some mischance a tool may drop through the flue onto the head of the man below and put him out of business.

Here is a job where there should be no hurry, for men working in the cramped position which they are compelled to assume in both drums cannot hurry, but will get out of it just as soon as their jobs are done.

The reason why the writer mentions the screw jack for holding the bottom end of the flue is because a light jack can nearly always be found around works where boilers of this type are used. If a jack cannot be procured, then make one like those used to buck up with on the bottom of large oil tanks. If you are called upon to change numbers of flues and must carry a kit of tools, get a jack made of wood the same as the wheelwright uses, just large enough to pass through the manhole.

If any braces in the bottom drum have been removed in the operation of changing flues, care must be taken in replacing them and making everything secure. The sketch (Figs. 1, 2 and 3) will explain the kind of tool used in the top end of flue for lifting it out of the boiler. The tool can be made any size to suit the user's fancy. The sizes given are to convey some idea of the size wanted for a 4-inch flue. The arrow points to the place to drive the wedge.

The Key Flue and Its Purpose

The key flue is the center flue of each group of flues. This flue is set with a thick copper ferrule, and when setting this flue it must be lowered on the jack into the bottom drum to allow the copper ferrule being rolled when it is jacked up into its place and rolled.

Its purpose is the same as that of the big hole usually made in the front end of a locomotive boiler, and it *must be removed every time* a flue in that group has to be changed, for it would be impossible to take a flue out of its own hole. On top of the drum and directly over the key flue of each group is located the handhole, through which the flues are taken out and replaced.

The writer knows of a case of boiler makers going to repair a boiler of this kind and, not knowing anything about the key flue, cutting fresh holes in the top of steam drum every time they were called upon to change a defective flue.

Pittsburg, Pa. Flex Ible.

Boiler Makers Demand Increased Wages

The demands of the boiler makers, coppersmiths, blacksmiths and metal workers employed by the Missouri, Kansas & Texas Railroad, of Texas, for an increase of five cents per hour in wages and the substitution of an eight-hour day for the present nine-hour day has been rejected by that road.

The boiler makers and machinists employed by the St. Louis & San Francisco Railroad on its lines in Texas are seeking to have a new contract entered into by which they shall receive an increase of five percent in their wages and an eight-hour day, instead of the nine-hour day under which they are now working. In the pending negotiations the boiler makers are represented by A. E. Bingham, of Springfield, Mo.; the machinists by J. J. Dowling, also of Springfield, and the railroad by G. H. Schleyer, of Fort Worth, receiver.

Free Instruction for Boiler Makers

The 1916-17 term of the Murray Hill Evening Trade School, 232 East Thirty-eighth street, New York City, commenced September 25. It is announced that classes for engineers, firemen, boiler makers and boiler inspectors will be organized. These classes were poorly attended last term, and it was believed would be discontinued. In response to numerous requests, however, the Board of Education has decided to continue them if the attendance warrants.

The course for boiler makers, under the direction of Mr. James H. Sheridan, consists of laying out, mechanical drawing, estimating and boiler inspection, and is free to all employed at the above-named trades. Special attention will be given backward students and individual instruction when necessary. It is an opportunity of which those residing in New York and vicinity should avail themselves.

PERSONAL

John A. Clas, formerly with the Shevlin Manufacturing Company, Saratoga Springs, N. Y., has accepted the position of assistant foreman in the Delaware & Hudson shops at Colonie, N. Y.

F. A. Scott, formerly superintendent of the Ames Iron Works, Oswego, N. Y., has resigned his position to become general superintendent of the Hammond Iron Works, Warren, Pa.

At the last meeting of the board of directors of the Lima Locomotive Corporation, Mr. W. E. Woodard was elected vice-president in charge of engineering and design, with offices at Lima, Ohio.

Mr. Woodard was born in Utica, N. Y., in 1874, where he attended the public schools. He was graduated from Cornell University with a degree of mechanical engineer in 1896, after which he was engaged in laboratory and road testings with the Baldwin Locomotive Works. In 1897 he entered the shop and drawing office of the Dickson Locomotive Works as elevation man. In 1900 he went with the Schenectady Locomotive Works, which afterwards became the American Locomotive Company, in whose employ he has been up to the present time. As assistant chief engineer he had supervision over the general drawing office of the American Locomotive Company at Schenectady, N. Y.

Mr. Woodard's work gave him exceptional opportunity to make an extensive study of the development and the needs of the modern American locomotive. That he made good use of his opportunities is demonstrated by the number of patents granted him. Mr. Woodard's patents all cover car and locomotive devices that are in common use to-day on heavy modern equipment.

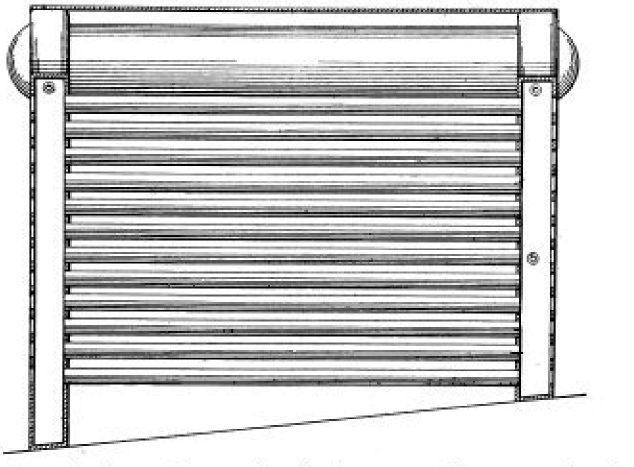
Slected Boiler Patents

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

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

1,166,619. BOILER. EDWARD C. MEIER, OF PHOENIXVILLE, PA.

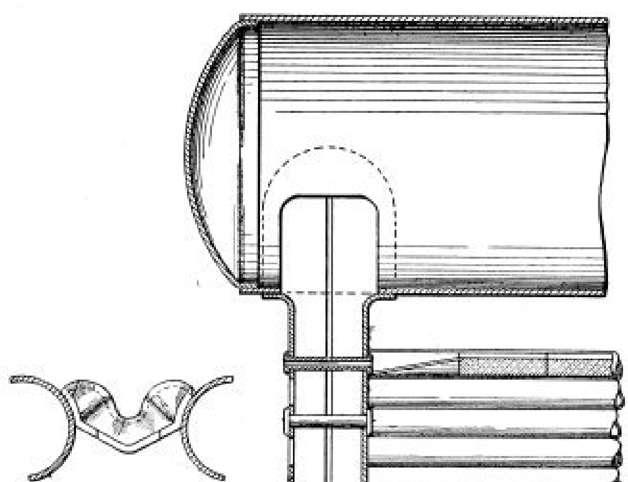
Claim 1.—A boiler, comprising boxes spaced apart, tubes connecting the boxes, water legs at the ends of the boxes, said water legs extending below the boxes and supporting the latter at an elevation, brackets



secured to the legs and supporting the boxes, couplings connecting the legs and the boxes, and water tubes connecting the legs and forming a vertical series of tubes operating as a wall support, substantially as described. Two claims.

1,167,510. FURNACE TILE. EDWARD C. MEIER, OF PHOENIXVILLE, PA.

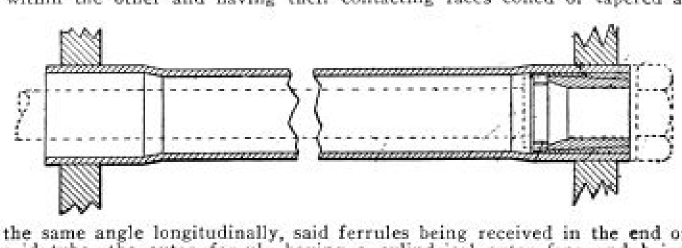
Claim 1.—A tile, comprising a steam guide adapted to be located at the end of a series of baffling tile and having a groove in its upper



face forming a steam passage widest at its inlet end and diminishing in width to its outlet end. Two claims.

1,181,856. MEANS FOR SECURING BOILER TUBES. ROBERT B. DOWNER, OF MANOR PARK, ENGLAND.

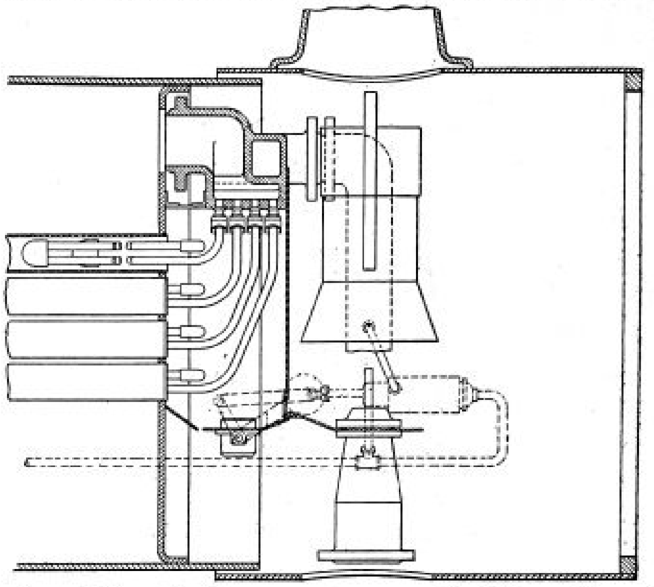
Claim.—In combination, a boiler tube plate, means for securing the end of a boiler tube in said plate consisting of two ferrules nested one within the other and having their contacting faces coned or tapered at



the same angle longitudinally, said ferrules being received in the end of said tube, the outer ferrule having a cylindrical outer face and being fixed and of a radially expansible construction and the inner ferrule being of an unyielding construction so that by adjustably moving the inner ferrule longitudinally in an appropriate direction relatively to the outer ferrule, the latter has its outer face extended to a larger diameter still of cylindrical form, and means for so adjustably moving the inner ferrule.

1,167,508. DAMPER FOR LOCOMOTIVE SUPERHEATERS. NEAL TRIMBLE McKEE, OF YONKERS, N. Y., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

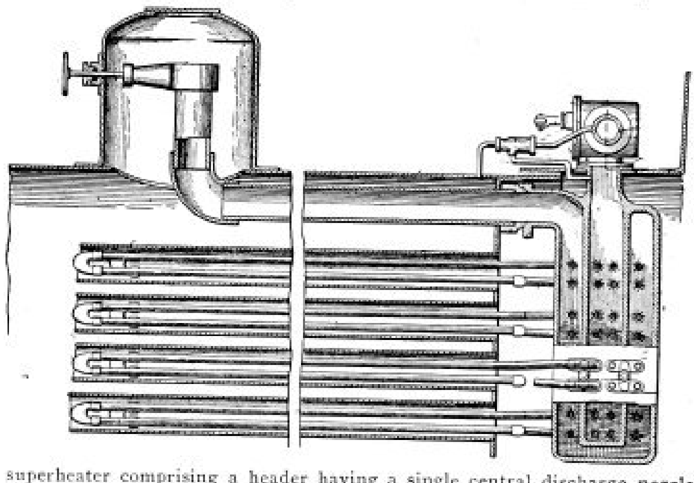
Claim 1.—In a locomotive provided with a blower and a superheater, the combination with the superheater tubes, of baffle means including a damper in the path of the furnace gases, steam actuated means oper-



atively attached to the damper, a steam connection between the main steam pipe and the steam actuated means tending to open the damper and a steam connection between the blower and the steam actuated means tending to close the damper. Six claims.

1,181,392. LOCOMOTIVE WITH SUPERHEATER. JULIUS KINDERVATER, OF RICHMOND, VA., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

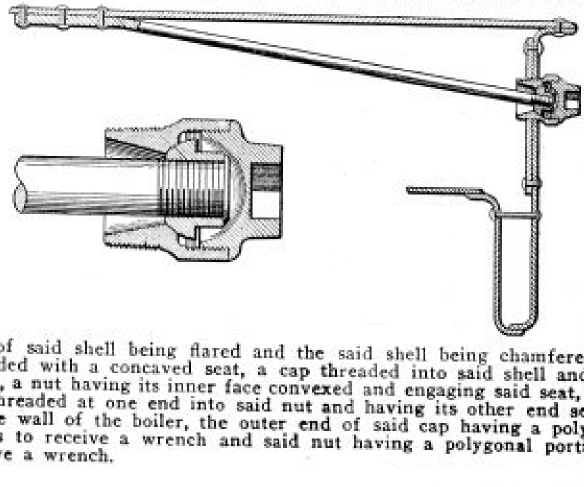
Claim 1.—The combination with a locomotive boiler having the usual smoke-box and stack, of a superheater mounted in said smoke-box, said



superheater comprising a header having a single central discharge nozzle projecting up through the top of the boiler shell at a point behind the smokestack, and a throttle valve casing detachably mounted on such projecting nozzle wholly outside of said smoke-box. Nine claims.

1,183,701. BOILER-BRACE COUPLING. SYLVESTER ULYSSES WALCK, OF LANSFORD, PA.

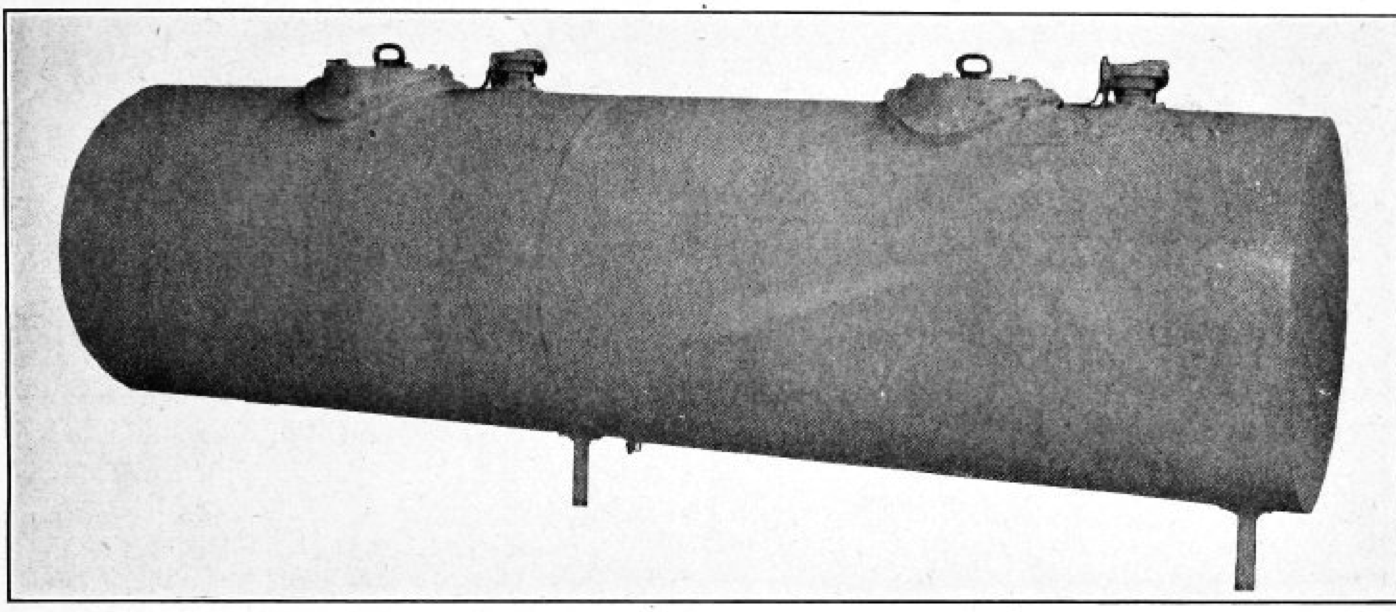
Claim.—A boiler head coupling comprising in combination with a boiler having a threaded aperture in a wall thereof, a shell circumferentially threaded and engaging said aperture, the opening in the inner



end of said shell being flared and the said shell being chamfered and provided with a concaved seat, a cap threaded into said shell and concaved, a nut having its inner face convexed and engaging said seat, and a bar threaded at one end into said nut and having its other end secured to the wall of the boiler, the outer end of said cap having a polygonal recess to receive a wrench and said nut having a polygonal portion to receive a wrench.

THE BOILER MAKER

NOVEMBER, 1916



Two-Compartment Wagon Tank of ¼-Inch Material

Welded Joints in Tank Construction

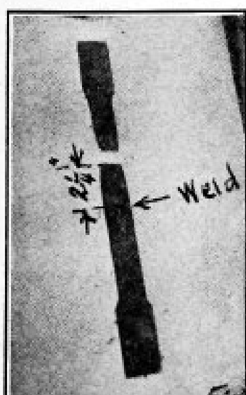
Results of Comparative Tests to Determine Relative Strength of Welded and Riveted Joints—Electric Arc versus Oxy-Acetylene Welds

BY WILLIAM EICHHOFF, M. E.

Autogenous welding by means of the electric arc or oxy-acetylene flame is accomplished by fusing the surfaces to be welded by means of the high temperature generated in the arc or flame with or without the addition of filling material also melted.

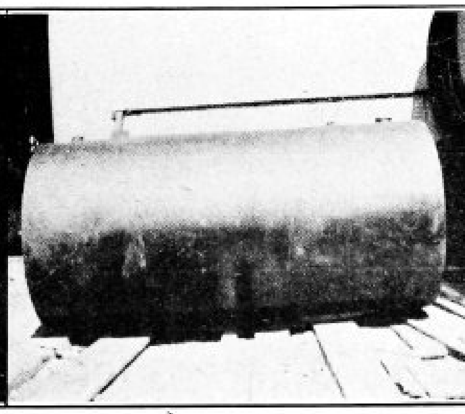
In short, the process is practically one of casting. This should always be borne in mind when applying this process of uniting two pieces of metal together. Always remembering that the autogenous welding process in its present stage is a casting together of metals, the experienced welder can intelligently judge for himself where this process can be applied safely and advantageously.

In welding cast iron or cast steel we use as filling material either cast iron or steel, respectively. We can expect in the weld a material similar to the one contained in the parts to be welded together. In a well-executed gray iron weld the weld is stronger than the original material, but when we weld rolled steel, iron or copper together we

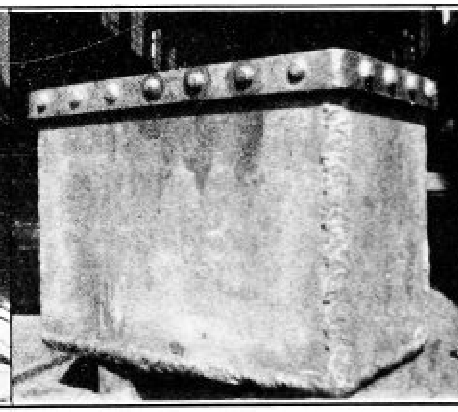


Test Piece No. 4, Table 2, After Break

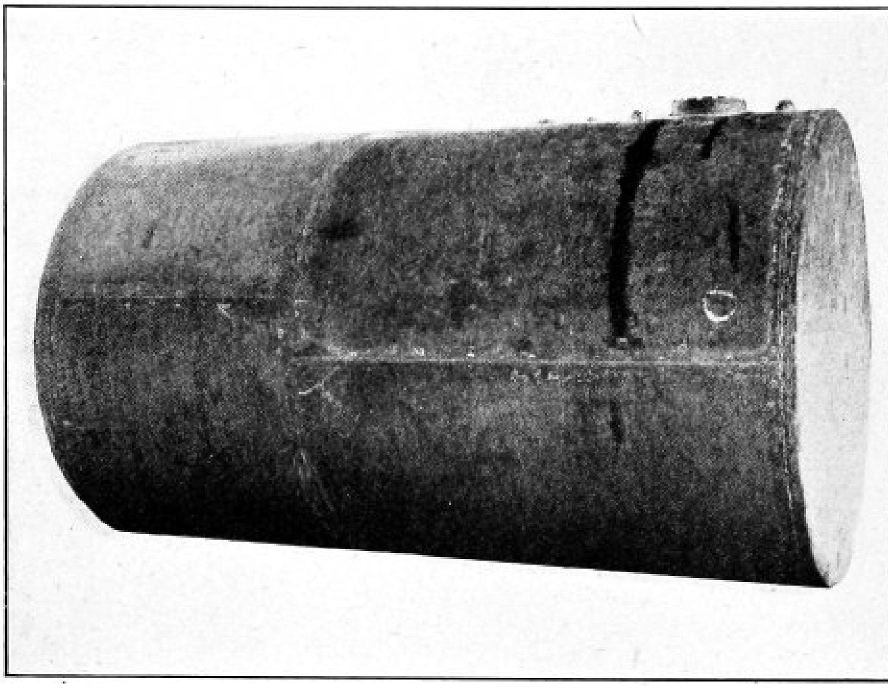
14 In. by 48 In. Pressure Tanks Tested to 300 Pounds Pressure



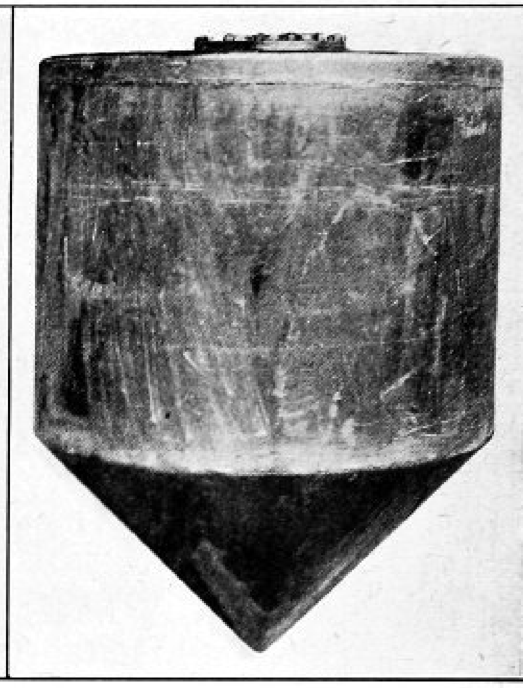
54-Inch by 136-Inch Tank. Shell, ¼ Inch; Heads, 5/16 Inch



Galvanizing Tanks, 5 Feet by 4 Feet by 3 Feet, of Material 1 Inch Thick. Flange Steel Welded at Corners. Has been in Use 9 Months



96-Inch by 16-Foot Welded Tank; Shell, 1/4 Inch; Heads, 5/16 Inch. All Seams Butt Welded



54-Inch by 60-Inch Cone Bottom Tank of 1/4-Inch Material. Seams All Butt Welded

obtain a material very much different from that contained in the original stock. In the case of steel, the material in the weld is similar to cast steel, and in case of copper it resembles cast copper. Even in the best welds, without the existence of any oxides, there is a material difference. The same holds true with all other rolled or forged metals which are welded together. This fact should always be borne in mind when an important welding job has to be performed.

At the present time we have no method of autogenous welding where the welded portion can be made of the same quality and characteristics as the material to be joined together, as far as it concerns rolled steel, wrought iron, copper, and so forth.

An ideal weld should show perfect union of the pieces of metal, and not only this, but the material in and around the weld should be in the same condition physically and chemically as contained in the original stock. In short, at the present time this is not possible. We can, however, improve such a weld and give it more densification and

TABLE 1.—TEST OF WELDED JOINTS.

TEST PIECES WERE TAKEN FROM SAME PLATE CORRESPONDING TO RESPECTIVE THICKNESS. PLATE USED WAS "TANK STEEL," USED IN THE MANUFACTURE OF GASOLINE AND OIL TANKS. OBJECT OF TEST WAS TO DETERMINE THE EFFICIENCY OF WELDED JOINTS COMPARED WITH SOLID PLATE. ALSO TO COMPARE WITH THAT OF RIVETED JOINTS USED ON SUCH TANKS.

No. of Test Piece	Original Size		Area of Test Piece	Condition of Test Piece	Tensile Strength		Elongation	Efficiency of Welded Joint
	Thickness	Width			In Lbs., Actual	In Lbs. Per Sq. In.		
1........	.245	1.5	.3675	Solid	21,220	57,740	22	..
2........	.259	1.489	.3856	Welded and Peaned	18,960	49,695	6.5	86
3........	.25	1.5	.375	Welded	18,130	48,345	4	83½
4........	.356	1.5	.534	Solid	33,200	62,170	24	..
5........	.356	1.503	.534	Welded	27,060	50,766	5½	81½
6........	.165	1.503	.248	Solid	12,700	51,210	28	..
7........	.17	1.504	.265	Welded	11,690	44,115	3	86

Tests were made on Riehle Testing Machine.

TABLE 2.—TEST OF WELDED JOINTS.

TESTS WERE MADE TO DETERMINE EFFICIENCY OF JOINTS FOR WORK SUBJECTED TO PRESSURE UNDER NORMAL TEMPERATURE, ALSO THE SKILL OF WELDERS IF FITTED FOR THE WORK IN QUESTION. IN CALCULATING THE STRENGTH FOR THIS WORK THE EFFICIENCY WAS ASSUMED AT 70%. WELDED PIECES WERE TAKEN FROM SAME PLATE AS SOLID PIECES CORRESPONDING TO RESPECTIVE THICKNESS. TESTS WERE MADE ON RIEHLE TESTING MACHINE.

No.	Material	Condition	Original Size		Area	Tensile Strength		Elongation	Efficiency %	Remarks
			Width	Thickness		In Lbs. Actual	In Lbs. Per Sq. In.			
1	Flange steel.......	Solid	1.496"	.373	.557	33,840	60,575	24%	..	
2	Flange steel.......	Welded	1.498"	.373	.558	30,020	53,620	2%	89	
3	Tank steel........	Solid	1.495"	.247	.37	21,040	56,865	16%	..	
4	Tank steel........	Welded	1.502"	.245	.368	18,340	49,820	22%	88	Broke in the solid.
5	Tank steel........	Solid	1.497"	.191	.286	18,540	64,825	22%	..	
6	Tank steel........	Welded	1.497"	.194	.29	15,690	54,100	9%	83½	
7	Tank steel........	Welded	1.505"	.195	.293	14,560	49,690	5%	76½	
8	Black soft steel....	Solid	1.497"	.142	.2125	12,380	58,255	20%	..	
9	Black soft steel....	Welded	1.504"	.147	....	....	....	...	..	Burned.
10	Black soft steel....	Welded	1.5"	.145	.217	12,340	56,865	17%	97½	
11	Black soft steel....	Welded	1.502"	.147	.22	10,520	47,820	5%	82	

TABLE 3

TEST OF WELDED AND RIVETED JOINTS													
No. of Coupon	Condition of Coupon	Original Size		Area	Elastic Limit		Tensile Strength		Elongation	Efficiency	Sketch of Joint	Sketch of Break or Line Showing Location of Break	Remarks
		Width	Thickness		In.Lb. Actual	In.Lb. per Sq. In.	In.Lb. Actual	In.Lb. per Sq. In.					
1-E	Plain Weld	1.495"	0.275"	0.4111"	20,000	48,650	26,590	64,695	9%			½"	Broke ½" from Weld
2-E	Welded & Annealed	1.495"	0.287"	0.429"	21,000	48,995	27,510	64,125	17%			3"	Broke 3" from Weld
3-E	Welded Annealed Hammered	1.498"	0.281"	0.42"			19,180	45,655					Burned Broke in Weld
4-A	Plain Weld	1.496"	0.279"	0.417	22,000	52,755	26,700	64,030	10%	95%			Broke in Weld
5-A	Welded Annealled Hammered	1.497"	0.271"	0.405	18,700	46,170	26,850	66,295	15%			1"	Broke 1" from Weld
6-A	Double Lap Weld	1.495"	0.282"	0.421	18,700	42,040	21,760	51,685	6%	76½%			Broke in Weld
7-E	Double Lap Weld	1.492"	0.272"	0.406"	20,000	49.260	27,680	68,175	13%			1"	Broke 1" from Weld
8-A	Riveted ½" Rivet	1.494"	0.275"	0.41"	19,500	47,465	27,670	67,490	14%			1¼"	Broke 1¼" from Weld
9	Riveted ½" Rivet	1.491"	0.272"	0.405"			11,100	27,405		40½%	2"		Rivet Sheared
10	Riveted ½" Rivet	1.496"	0 288"	0.43"			11,100	26,000		38½%	2"		Rivet Sheared
11	Riveted ½" Riveted	1.487"	0 267"	0.397"			11,120	28,010		41½%	2"		Rivet Sheared
12	Riveted ½" Rivet	1.489"	0 270"	0.402"	13,000	32,340	16,520	41,095	12%	61%	2"		Broke in Plate
13	Riveted ⅝" Rivet	1.497"	0 281"	0 42"	11,000	26,190	13,640	32,476	12%	48%	2"		Broke in Plate
14	Riveted ⅝" Rivet	1.485"	0 270"	0 4"	12,800	32,000	17,230	43,075	11%	64%	2"		Rivet Sheared
15	Solid	1.496"	0.272"	0.407"	21,000	51,595	27,410	67,345	18%			4"	

NOTE: *Electric Arc Welded* / *Oxy-acetylene Welded* — *All Coupons were taken from the same Plate*

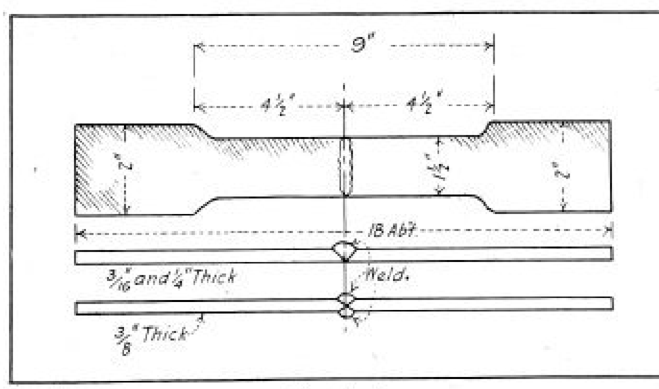
strength. This is accomplished by hammering the weld in the plastic state with a peening hammer. Never treat a seam with a heavy hammer at a lower heat than in the red-hot state, as this may cause fractures and spoil a weld. Re-heating and annealing the welded piece also improves the quality and increases the ductility.

In the construction of pressure tanks, vessels subjected to exacting conditions, such as boilers or air receivers, one should give the subject very careful consideration before applying the autogenous welding process. With such work, only the most skillful and conscientious welders should be entrusted. The United States marine law allows repairs to be made on boilers with this welding process under certain conditions. It requires that the person who intends to do such welding work on boilers should submit test coupons for inspection. However, this method is questionable, as the coupons might show a very good weld and the repair job might be an inferior one at that.

Manufacturers of welding outfits claim that a welded joint can be made as strong, and even stronger, than the best riveted joint. This might be true to a certain extent, but it should not be forgotten that the ductility of the material in welding joints is very much impaired by the process. In boiler work this is a serious point, considering the severe treatment under which boilers are operated.

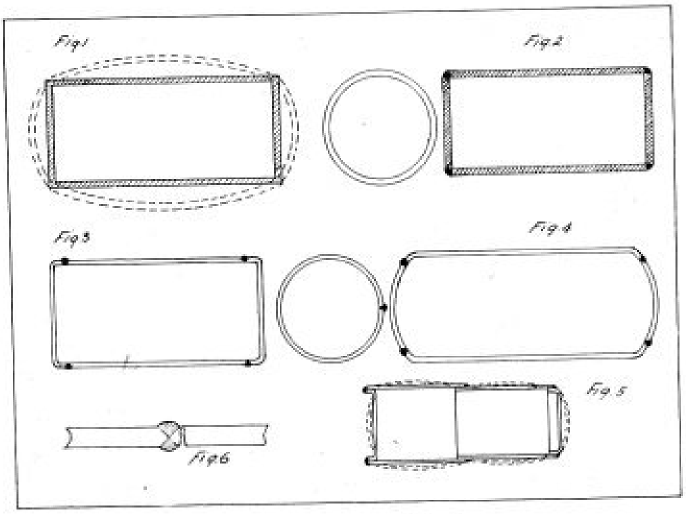
To compare welded with riveted joints such as are used in the construction of storage tanks the writer has had tests made. These tests were performed by a testing laboratory not interested in any way with the concern manufacturing the tanks. The object of the tests was to determine the strength of different joints, as stated before, but also to determine the efficiency of the welders. The testing machine was a Riehle. The results of the tests are given in Tables 1, 2 and 3.

The test pieces in Tables 1 and 2 were welded by the oxy-acetylene process. It should be mentioned that the steel used was tank steel with one exception, namely No.

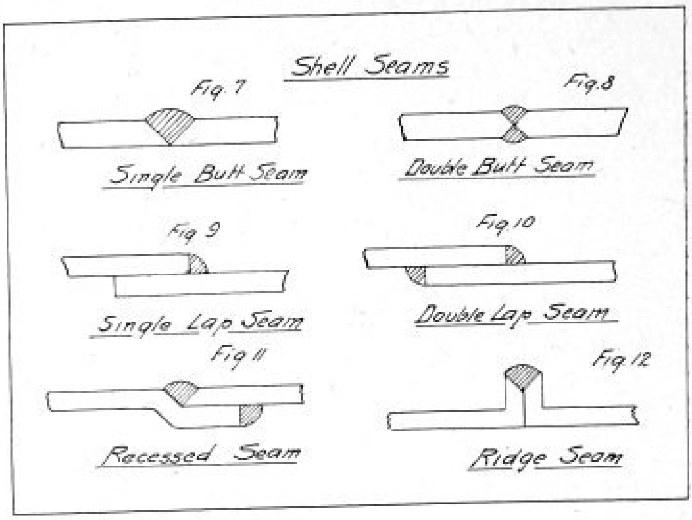


Sketch A

1, Table 2, which was flange-steel of 60,575 pounds per square inch tensile strength. Pieces were taken out of the same plate of the same thickness. The ductility is very much impaired, which, of course, was to be expected, but there is quite a difference in the quality of material in the



Location of Joints in Tanks



Methods of Welding Shell Seams

same plate, which is also natural with tank steel. From Tables 1 and 2 we see that in regard to tensile strength the welded joints compared very favorably with single and double riveted lap joints, such as are used on all kinds of storage tanks. In fact, the efficiencies are as high as those of butt strapped, double and treble riveted joints.

The test coupons were made in the usual shape as recommended by the manufacturers' standard specifications, as shown in Fig. A.

With the exception of two all welded pieces in Tables 1 and 2 broke directly in the weld; one, No. 3, Table 2, broke in the solid, 2¾ inches above the weld, and another coupon, No. 2, Table 2, broke above the weld where same joins the straight plate, as shown in Fig. 6. This joint was welded from both sides with a double "V" groove. The cause of breakage close to the weld might be caused by the original material having been changed physically or chemically close to the weld, but it is remarkable that in No. 4, Table 2, the break happened 2¼ inches away from same. Table 3 will show other results obtained in that line.

Table 3 contains the results of tests made with coupons taken from the same plate, which was what is called in the trade "tank steel." The object of the tests was to determine in the first place the comparative value of electric arc welding with oxy-acetylene welding, also to compare welded joints with riveted joints. A single rivet only was used in the joints, as single riveting is mostly used in the construction of storage tanks. The pitches used in this connection vary so much that a good sample is hard to produce, but the plate stock in our sample comes close enough to the net material in a riveted joint so as to form an opinion in regard to the strength.

The welded pieces were all made with a double "V" groove, and stress was laid to reinforce the weld. The object of reinforcing same was to see if a weld could be produced that was stronger than the original material as far as tensile strength is concerned.

Results of Tests

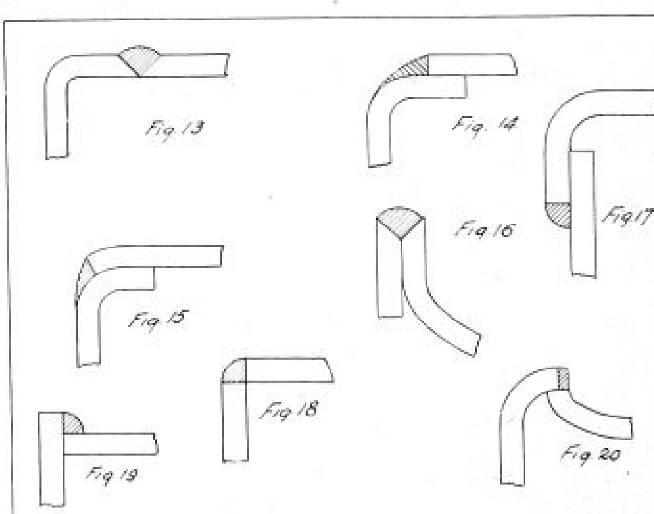
From the sketches in the table it can be seen that some of the pieces did not break in the weld; in fact, on one the break is 3 inches away from the same. Breaking of the solid piece near the weld might be caused by the effect of the flame or arc changing the character of the material close to the weld, but even should this be the case, welding is preferable to riveting for certain work, as the chances are that such material changes also take place around the rivet holes during and after the process of punching and riveting.

From these tests we also see that annealing the pieces improves the ductility of the material, but that it is questionable if annealing and hammering in a red-hot state has any improving influence on a weld. Hammering with a puddling hammer should be done during the process of welding.

There seems to be no remarkable difference in the strength of arc-welded and oxy-acetylene welded seams, if properly executed.

As to the decrease in ductility, it has to be considered that in boiler specifications the material has to show certain characteristics before the different boiler inspection laws permit the use of plate for construction. At higher temperature, mild steel changes its structure from the original coarse grain in the cold state into a finer grained material.

The welding process is in its infancy, and one should be very careful in its application to work subject to extreme conditions, such as boilers. On the other hand, we have to consider that the best efficiencies with quadruple riveted joints do not exceed 95 percent. These high efficiencies can only be obtained by the most careful calculation and the best workmanship, under the assumption that the material in question is of a specified high standard. Riveting of important vessels such as boilers and high pressure vessels has for many years been subjected to the most minute study and tests. This enabled the engineer to form for himself a fair opinion of the quality of such joints. The experienced person, therefore, can judge to a certain degree the qualities of a riveted joint without actual tests.



Methods of Welding Head Seams

So far we have no means to either predetermine a welded joint or to determine the efficiency of welded joints, unless we test same to destruction. Such tests, of course, will render the fabricated article worthless. It is therefore advisable to subject welded tanks to a higher test pressure than riveted ones, also to select a higher factor of safety.

Welding may safely be performed on tank work not subjected to great mechanical strain, but where exacting conditions exist welds should be accepted with great caution. The quality of a weld remains a somewhat unknown quantity until we have found some means to determine its value.

It is a well-known fact that all vessels subjected to an internal pressure have the tendency to assume the shape of a sphere. This is best illustrated by Fig. 1. Here we have a cylindrical body. Let us assume this vessel is made in one continuous piece, if such construction would be possible. The cut serves to illustrate the point in question. When we apply an internal pressure this body will assume a shape resembling the one shown by the dotted lines. The pressure tends to increase the diameter towards the center of the cylindrical side, also to press the flat ends outward.

A similar condition exists in rectangular tanks when internal pressure is applied. It would not be advisable to weld such tanks at the corners, as shown in Fig. 2, the vessel is subjected to varying pressures. A sort of hinging motion would take place at the corners during the time of no pressure to the maximum pressure, and vice versa. What effect such repeated motion would have on the corners can easily be seen. A weld is liable to be more or less brittle. The outside of the corner is in compression and inside in tension. The corner is liable to crack as a result of this varied strain; besides, if we place the weld at these corners it would be on the weakest point. The proper method to weld such tanks is shown in Fig. 3. In welding joints there should always be sought a tendency to convert a bending strain into a pulling or compressing strain. Another method to avoid such bending strain in welding such cylindrical tanks is shown in Fig. 4.

Let us again look at the tank, Fig. 5, which is made of lap joints, welded on one side only. The dotted lines show the effects of inside pressure on the tank and the joints. It is easily seen that this condition is not a desirable one, as the laps and weld are subjected to bending stresses. Such construction is objectionable on pressure work or work which has to stand severe treatment.

The different seams used at present in the construction of vessels are shown in the following sketches. The weld should always be a reinforced one; i. e., built up.

SHELL SEAMS

Fig. 7 shows a *single butt seam*. This seam is a very good one to use. It is mostly in direct tension or compression, depending on whether the pressure is applied outside or inside of a vessel. This fact is best demonstrated by studying Fig. 3. Compared with other seams it is more expensive to make, but is a strong seam and is to be recommended in longitudinal seams of cylindrical tanks, and if made by an expert welder can also be used in welding girth seams. If the weld is brittle in the girth seam it is apt to crack, especially on tanks of large diameter and weight when handled roughly in transportation and erection.

Fig. 8 shows the *double butt seam*. This seam is stronger than the former one and should always be used on heavy plates. For the same thickness of material it is somewhat cheaper than the former, as a saving of material is realized, especially when two torches are applied in welding. If not properly welded it is subject to the same troubles mentioned in connection with Fig. 7.

Fig. 9 shows a *straight lap seam, single welded*. This should not be used on pressure work, for reasons explained in connection with Fig. 5. Besides, it is more liable to crack when handled roughly. Also the effects of unequal expansion and contraction, caused by the welding process, give rise to trouble. In circumferential work the courses should be snugly fitted, well bolted together at short intervals and properly tack welded before the welding proper is commenced.

When lap joints have to be applied on important work they should be *double welded*, as shown in Fig. 10. A better lap seam is the *recessed lap seam* or *joggle joint*, Fig. 11, but if not welded on both sides as shown in the sketch it has some of the disadvantages of a single welded lap joint in regard to stresses caused by pressure. This joggle lap seam is to be well recommended for large storage tanks, which are subject to rough treatment in transportation and erection, as the joggle joint stiffens the tank considerably and provides an even surface on the outside.

Fig. 12 shows the *ridge seam*. It is the cheapest seam to make, as a considerable saving on material, also considerable speed in welding, can be realized. Exposed to a tensile stress, it is a very poor joint, as in straight work the load is an eccentric one.

HEAD SEAMS

For ends and bottoms of rectangular tanks and heads on cylindrical vessels a number of different constructions are in vogue. The best constructions, providing a good weld is performed, are shown in Figs. 13 and 3. This method is also shown on the photographs of the cone-bottom tank and large storage tank. It is the *butt seam*.

Another weld for heads is shown in Fig. 14. It is called *inside bridge seam*, as the flanged portion of the head is inside. This construction is made stronger by bending over the edge of the shell, as shown in Fig. 15. In tank construction this seam is very much used, often with the construction shown in Fig. 16, which is called *ridge seam*. The latter is not so expensive to make as either one described before. Fig. 17 shows the *outside bridge seam*, where the flange of the head is outside of the shell.

Fig. 18 shows the *square corner seam* and Fig. 19 the *plain corner butt seam* much used on work not subject to mechanical strains. Two other good constructions are shown in Figs. 20 and 4.

In the construction of tanks and vessels it is of paramount importance to have:

A skillful, conscientious welder.

First-class equipment.

The best material available. And to use—

The very best of judgment in regard to the weld and joints. The welding process is in an embryonic state, but is slowly and surely paving its path to replace, in the future, all riveting.

PERSONAL

Sherman Vaughn has purchased the interest of Mr. Gus. James in the Bailey & James Boiler & Machinery Company, Joplin, Mo., and is now the sole owner of this company.

W. Cook, foreman boiler maker, National Transcontinental, at Transcona, Man., has been appointed foreman boiler maker of the Grand Trunk Pacific at Edmonton, Alta. His place on the National Transcontinental has been taken by R. Summerville.

William Cooper Cuntz, managing director of the Goldschmit Company, New York, died recently at Auburndale, Mass., aged forty-five. Mr. Cuntz was formerly connected with the Pennsylvania Steel Company, of Stockton, Pa., and became connected with the Goldschmidt Thermit Company in 1910.

Fuel Economy and Locomotive Boiler Design*

Losses of Heat Due to Boiler—Furnace Inefficiency and Methods Proposed for Increasing Economy by Improved Design

BY J. T. ANTHONY†

The importance of the subject of fuel economy is fully realized by all mechanical and operating officials. The many angles from which it can be approached and the numerous points that bear directly on it are more or less familiar to all of you.

Beginning with the specifications covering the purchase of the coal at the mines we might enumerate: Inspection and loading at the mines, storage, weathering, handling at coal tipples, loading on tenders, firing instructions, water-level and cut-off, lubrication, drafting and front-end arrangements, steam leaks, boiler washing, engine dispatching, train loading and terminal and other delays. Other factors which tend to increase the total fuel wasted might be mentioned, and the sum of these would certainly amount to an appreciable percentage of the total coal purchased by the railroads.

It is doubtful, however, if the losses enumerated above will exceed the losses directly chargeable to the boiler, despite all efforts to increase the boiler economy and efficiency by the addition of such devices as the arch, superheater, feed-water heater, etc. To illustrate the losses that take place in the average locomotive boiler we will take a typical boiler, such as is used on a medium size Pacific or Mikado engine. The boiler had a grate area of 54 square feet, 210 square feet of firebox heating surface, 4,100 square feet of firetube and superheater surfae (the tubes being 21 feet long and 2¼ inches in diameter), air opening through ash pan 20 percent of grate area, and air opening through grates 28 percent.

Fig. 1 shows average heat losses as the rate of combustion increases from 30 to 180 pounds per square foot of grate per hour. As might be expected, the results in individual tests varied widely; but the curve as drawn will approximate average results.

The most striking losses are those due to sparks and cinders, which exceed 20 percent at the maximum rate; carbon monoxide and incomplete combustion, which exceed 13 percent; and heat in dry front end gases, which in some cases reaches 16 percent. In addition, there are comparatively small losses due to combustible in ash, radiation and unaccounted for, and heat losses in evaporating moisture in air and burning hydrogen in coal.

As shown by the line "*B*," the over-all boiler efficiency drops from 80 percent at low rates of combustion down to 43 percent at the highest rate. In other words, when burning 30 pounds of coal per square foot of grate per hour 80 percent of the heat contained in the coal fired is put into the steam; while at the maximum rate only 43 percent of the heat contained in the coal is transferred to the steam.

It is to be noted that the losses due to sparks and cinders and incomplete combustion increase rapidly as the rate of combustion increases; while the losses due to combustible in ash, radiation and unaccounted for also increase. Under the same conditions, the losses due to burning hydrogen and evaporating moisture in the air remain almost constant, as does the loss due to heat in front end gases.

The sparks and cinders loss is due in part to the nature of the coal; but largely to the high draft necessary at high rates of combustion and to the absence of efficient baffling and mixing devices and sufficient combustion chamber space.

The losses due to carbon monoxide and incomplete combustion are due to the lack of sufficient oxygen at the high rates of combustion, and to lack of efficient mixing devices and combustion chamber space.

* Paper read before New England Railroad Club, Boston, Mass., October 10.

† Assistant to President, American Arch Company, New York.

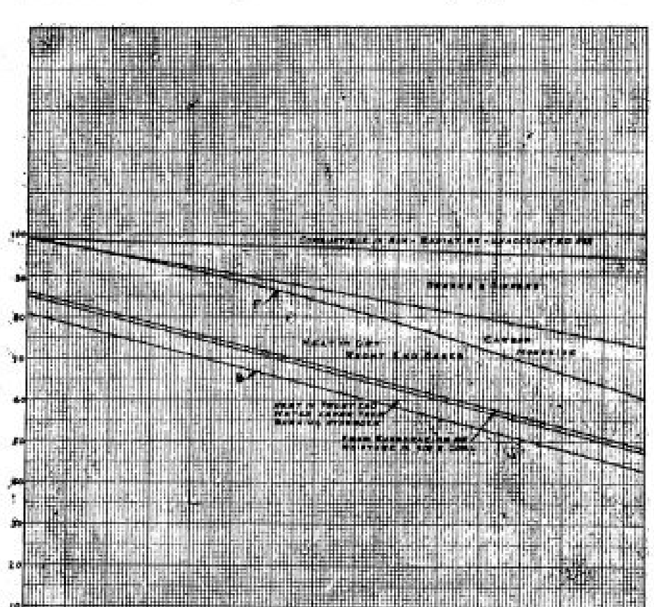


Fig. 1

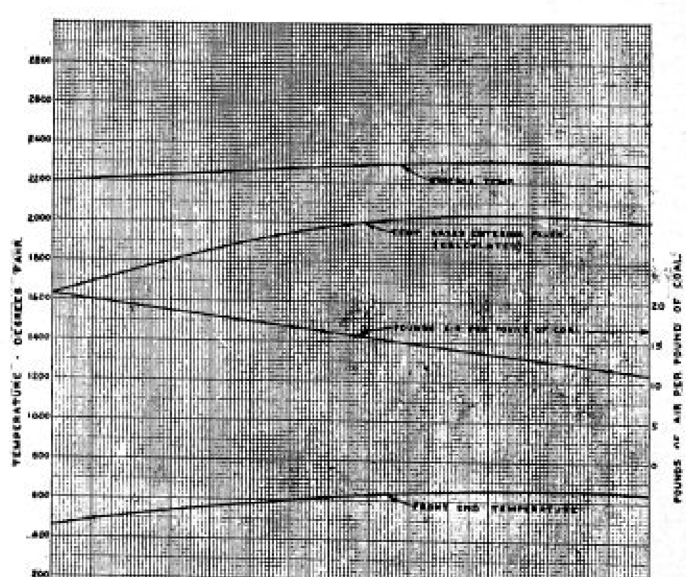


Fig. 2

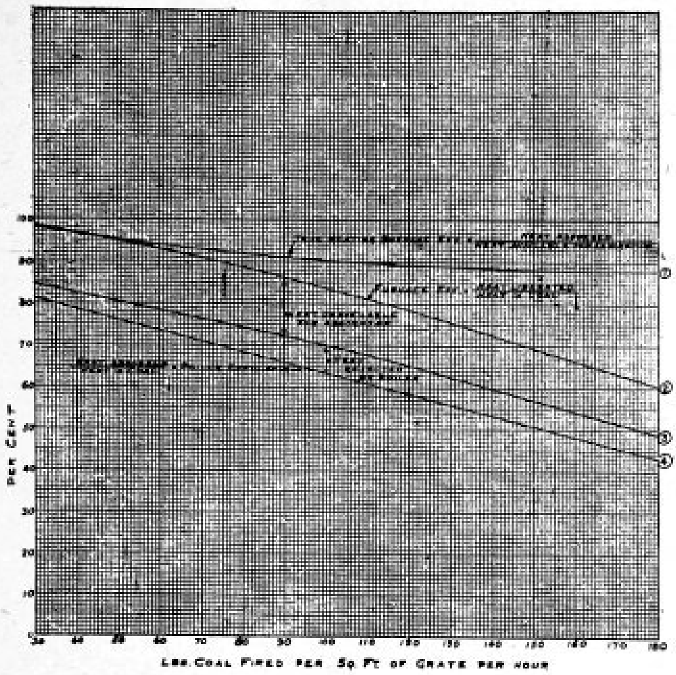


Fig. 3

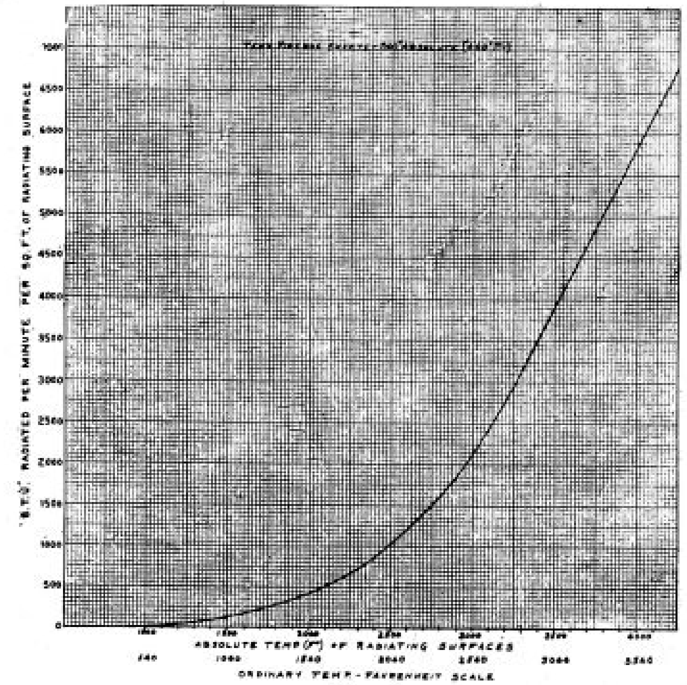


Fig. 4

The loss from combustible in ash is due partly to the nature of the coal, but largely to the design of the grate and method of firing.

Radiation loss for a well-lagged boiler is comparatively small, though difficult to determine with any degree of accuracy.

The unaccounted-for loss is due principally to the escape of unburned hydrocarbon gases, which are not detected by the ordinary front end gas analysis.

The heat in dry front end gases is controlled by the temperature of the gases escaping at the front end and the amount of air used per pound of coal burned.

These two factors also control the loss due to evaporating the moisture in the air, and heat loss due to the hydrogen, of course, depends upon the amount of hydrogen contained in the coal and the temperature of the escaping gases.

Fig. 2 shows the temperature of the front end gases, temperature of firebox and pounds of air supplied per pound of coal, at the different rates of combustion.

It is a difficult matter to get a regular curve showing the air supplied, on account of the wide variation in results given by the different gas analyses. This trouble is due not to any difficulty in making the gas analysis, but to the great difficulty of getting a fairly uniform sample of gas for analysis.

All of the heat losses shown in Fig. 1 are chargeable to the boiler. Some of them are directly chargeable to the furnace (or firebox), while others are chargeable to the heating surfaces. If we ignore the radiation losses from the barrel of the boiler and assume that all the losses under this head are chargeable to the furnace, the sum of these losses—together with those due to sparks and cinders and incomplete combustion—will be the measure of the furnace efficiency.

This is shown in Fig. 3 by curve No. 2, where the furnace efficiency is equal to the heat liberated divided by the heat in the coal. As shown, the heat loss due directly to the furnace varies from 2 percent to 40 percent of the entire heat in the coal; in other words, this much of the heat contained in the coal is not liberated in the firebox and is not made available for absorption by the heating surfaces.

Curve 4 shows the over-all boiler efficiency, which is measured by the ratio of heat absorbed to heat in the coal. The space between curves 2 and 4 represents heat liberated in the furnace but not absorbed by the heating surfaces. This amounts to from 18 to 20 percent of the heat contained in the coal; and of this large amount a relatively small proportion is available for absorption by the heating surfaces.

It is evident that the temperature of the gases flowing through the flues cannot possibly be reduced below the temperature of the water or steam in the boiler. With a boiler pressure of 200 pounds, the steam temperature is 388 degrees; and all the heat required to raise the products of combustion up to this temperature is unavailable for absorption by the heating surfaces and cannot be charged against them. As explained above, the amount of this unavailable heat depends principally upon the temperature of the front end gases and the air supply per pound of coal. On the chart it is represented by the space between curves 2 and 3.

The space between curves 3 and 4 represents the heat contained in dry front end gases that is available for absorption, but is not absorbed, and this heat can, of course, be directly charged against the boiler heating surfaces.

Curve 3, then, shows the amount of heat available for absorption, and curve 4 shows the amount absorbed, and the ratio of heat absorbed to heat available becomes the measure of the heating surface efficiency. In other words, the percentages expressed by curve 4, divided by the percentages of curve 3, will give a figure which is a true indication of the heating surface efficiency.

This heating surface efficiency is shown by curve 1, which, it will be noted, ranges from about 98 percent to 88 percent at the highest rates, there being very little drop in the heating surface efficiency after the rate of combustion gets up to about 100 pounds of coal per square foot of grate.

We stated that curve 2 shows the true furnace efficiency in that it represents the ratio of the heat liberated to the heat in the coal. Some authorities charge against the furnace all of the unavailable heat contained in the products of combustion, maintaining that it is the true function of the furnace to make all of the heat contained in the coal available for absorption by the boiler heating surfaces.

In this case, curve 3 would become the furnace efficiency line. This seems hardly fair, as a large part of the heat contained in the gases (even with the theoretical minimum air supply) is unavailable for absorption and should not be charged against the furnace. Disregarding these technicalities, curve 1 will represent the efficiency of the heating surfaces; curve 2 will represent the efficiency of the firebox (or furnace), and curve 4 will represent the over-all efficiency of the boiler.

Having located and grouped the heat losses, thereby determining the efficiency of the heating surfaces and the furnace, the next problem is to determine the best method of reducing or eliminating these losses and increasing the efficiencies.

As indicated in Fig. 3, the losses directly chargeable to the furnace are far greater than those chargeable to the heating surfaces, and the firebox therefore seems to offer the largest field for future improvement.

The loss due to sparks and cinders is due principally to the high draft necessary at the high rates of combustion. By reducing the rate of combustion we can in a measure reduce this loss. Boiler capacity, however, is of prime importance, and we cannot afford to reduce this capacity by reducing the amount of coal fired.

It becomes necessary, then, to reduce the rate of combustion by increasing the grate area. This will enable us to carry a light fire, get a more uniform supply of air through the fuel bed, reduce the lifting action of the draft upon the fine particles of coal, and, if accompanied by increase in firebox volume or combustion space and efficient baffling devices, will result in a material reduction in loss due to sparks and cinders, as well as those due to incomplete combustion and escape of carbon monoxide and unburned hydrocarbon gases.

In order to burn coal completely it is necessary to supply a sufficient amount of oxygen, to mix the oxygen with the combustibles of the coal and give them time to burn. Complete combustion cannot be obtained unless these requirements are met.

The effect of grate area upon evaporation is perhaps not well understood. Firebox heating surfaces take up practically all of their heat by radiation; that is, heat travels from the luminous fuel bed, flames and brick-work by "rays" or "waves" to the firebox heating surfaces. The amount of heat so received depends primarily upon the temperature of the radiating bodies and upon the area or extent of these radiating bodies, and not upon the extent of the firebox heating surfaces.

The amount of radiant heat transferred is influenced to a small extent by the temperature of the firebox heating surfaces, but the effect of a slight increase in temperature here is insignificant as compared with an increase in temperature of the radiating surfaces—such as the fuel bed or the flames.

When working at ordinary capacity, with clean sheets, it is possible that the temperature of the fire side of the firebox sheets is about 440 degrees. With this temperature of the firebox sheets the amount of heat radiated by each square foot of radiating surface is shown by the curve in Fig. 4.

It will be noted that a slight increase in temperature of the radiating surfaces gives a marked increase in the amount of heat radiated, and therefore in the amount of water evaporated. Increasing the firebox temperature from 2,040 degrees to 2,540 degrees doubles the amount of heat radiated from each square foot of radiating surface and practically doubles the evaporation from the firebox heating surfaces.

This shows the vital importance of high temperatures, both in fuel bed and flames, and is suggestive of the ill effects that result from bank firing, or the placing of a lot of green coal in the firebox at one time. In order to get the maximum evaporation it is necessary that the fuel bed be kept at a white-hot temperature all over. The bank of green coal reduces the effective heating surface, reduces the temperature of the firebox and reduces the evaporation.

Accurate data on the question of firebox evaporation is difficult to get, as no conclusive tests have ever been made. Using the available data as a basis, however, we have plotted curves in Fig. 5 showing the possible firebox evaporation and tube evaporation. The top curve shows the actual equivalent evaporation from the boiler at the varying rates of combustion. The firebox evaporation was calculated and the tube evaporation is, of course, the difference between the firebox and the total.

The firebox evaporation was calculated by using the firebox temperatures shown in Fig. 2 and adding the heat radiated by the flames to that radiated from the fuel bed, assuming in all cases that the temperatures of the flames and of the fuel bed were the same and that the average temperature was that shown by the curve, Fig. 2.

The coal used in this particular test contained about 35 percent volatile with a heat value of 14,500 British thermal units per pound. With a coal of this volatile content the firebox will be completely filled with flame at moderate or high rates of combustion. If the firebox is completely filled with flame the effective flame-radiating surfaces will be equal to the exposed firebox heating surfaces.

The firebox in question had a heating surface of 210 square feet. Assuming that the fuel bed covered the side sheets to a depth of 1 foot, we would have 180 square feet exposed to the action of the flame, and if the firebox is completely filled with flame we could safely assume that we would have 180 square feet of effective flame-radiating surface.

At low rates of combustion, the amount of volatile combustible driven off would not be sufficient to completely fill the firebox with flame, and it is probable that at very low rates (around 30 or 40 pounds per square foot of grate) the firebox would be only about half filled with flame.

We worked on this assumption in making the calculations, with results shown by the curves in Fig. 5. As indicated by the curves, the firebox evaporated nearly one-half of the total at low rates and about one-third at the highest rate. The maximum calculated evaporation from the firebox was 21,000 pounds per hour, or an equivalent evaporation of practically 100 pounds of water per square foot of heating surface.

To secure such evaporation it would be necessary to have a temperature drop of 140 degrees between the fire side and the water side of the sheets, assuming that we use sheets 3/8 inch thick, free from scale, which would give a fire side temperature of 528 degrees, and which is probably well within safe working limits.

Under the same conditions the maximum evaporation from the tube heating surfaces (including superheater) would be 10 pounds per square foot per hour, or the firebox would be evaporating ten times as much as the tubes per square foot of surface.

An equivalent evaporation of 100 pounds of water per square foot of firebox heating surface per hour seems abnormally high; but there is no logical reason why such an evaporation should not be obtained. It is merely a question of getting enough radiating surface at a sufficiently high temperature.

Increasing the grate area increases the area of the fuel bed radiating surfaces, and increasing the firebox volume or combustion chamber space increases the flame-radiating surfaces. Increasing the grate area also means low rates of combustion, more uniform air supply, lighter fire, reduction in losses due to unburned fuel, an increase in the percentage of heat liberated and an increase in firebox efficiency, both as a furnace or heat liberator, and as a heat absorber.

It is possible that the value of combustion chamber space is not fully realized, for the large number of engines now being built with abnormally long boilers and flues offers opportunities for combustion chamber installations of which advantage is not being taken.

Bituminous coal is not a homogeneous substance. It burns partly as a solid and partly as a gas. The solid part burns on the grate in the form of fixed carbon, while the volatile burns in the combustion chamber space as a gas.

The coal used in the test under consideration contained 58 percent fixed carbon and 26 percent volatile combustible. Therefore, one pound of the coal contained .58 pound of carbon, which, burned on the grate, liberated 8,500 British

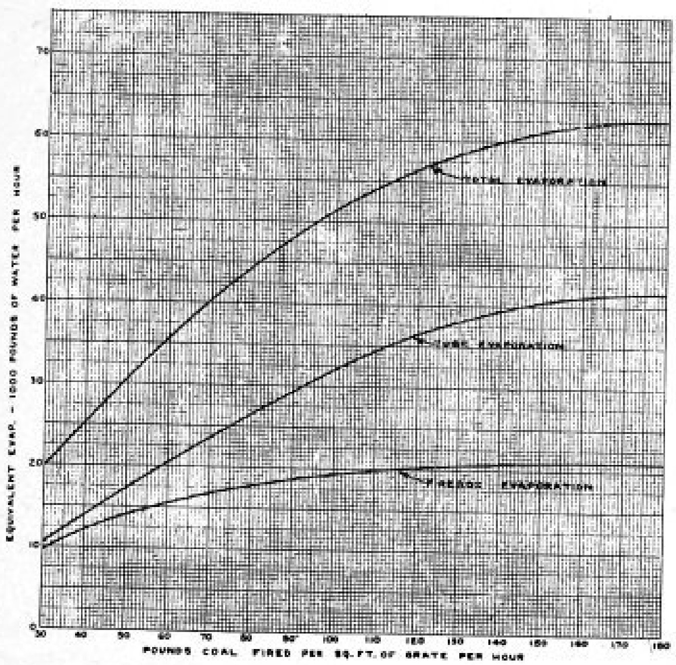


Fig. 5

thermal units, and .26 pound volatile combustible, which, burned in the combustion chamber space, liberates 6,000 British thermal units.

Thus we see that more than 40 percent of the heat is liberated by burning gas in the combustion chamber space, considering that all the fixed carbon burns on the grate. In actual practice, however, the fixed carbon is not completely burned on the grate.

The oxygen, on coming in contact with the hot coal near the grates, combines with the carbon to form carbon dioxide, and this carbon dioxide, passing up through the hot fuel bed, takes up more carbon and is partly reduced to carbon monoxide. After leaving the fuel bed this carbon monoxide is burned in the combustion chamber space and again forms carbon dioxide, provided, of course, that sufficient oxygen is present and proper mixing is accomplished. The amount of carbon monoxide formed in the fuel bed depends upon the temperature of the fuel bed and its thickness.

Gas samples taken just above the fuel bed in stationary furnaces indicate that a large percentage of the fixed carbon is incompletely burned to carbon monoxide in the fuel bed. While there are no data available as to the exact percentage of carbon monoxide formed in the fuel bed of a locomotive, considering the temperatures and thickness of the fire generally carried, it is not unreasonable to suppose that the fuel bed acts principally as a gas producer and that at least four-fifths of the carbon is incompletely burned on the grate. The combustion of the carbon monoxide so formed is completed above the grate, in the combustion chamber space.

If this condition does exist, every pound of coal burned liberates 3,750 British thermal units in the fuel bed and 10,750 British thermal units in the combustion chamber space above the fuel bed. In other words, 26 percent of the combustible is completely burned on the grate, and 74 percent is burned above the grate. While these figures may not be strictly accurate, they serve to show the importance of ample combustion chamber space and of the presence of free oxygen or air above the fuel bed.

The table below shows the approximate composition, weight and volume of the gases arising from the fuel bed under the conditions mentioned above, and of the gases in the front end when the combustion is complete, the figures being based on the burning of one pound of the coal with 16.2 pounds of air (as shown in curve in Fig. 2), at a rate of combustion of 100 pounds of coal per square foot of grate. Under these conditions, in actual practice, combustion would not be perfect, and the front end gases would show some CO and a smaller CO_2 content.

TABLE SHOWING COMPOSITION, WEIGHT AND VOLUME OF GASES ARISING FROM THE FUEL BED AND IN FRONT END AFTER COMBUSTION IS COMPLETED; WHEN 1 POUND OF COAL, CONTAINING 58 PERCENT FIXED CARBON AND 26 PERCENT VOLATILE COMBUSTIBLE, IS BURNED WITH 16.2 POUNDS OF AIR

GASES	ARISING FROM FUEL BED (T = 2,300°)			IN FRONT END (T = 615°)		
Name and Symbol	Wt., Lbs.	Vol., Cu. Ft.	Vol., Per-cent	Wt., Lbs.	Vol., Cu. Ft.	Vol., Per-cent
Carbon monoxide, CO...	1.08	78	6.57	....	....	....
Hydrocarbons,* C_2H_6....	.26	17	1.43	....	....	....
Carbon dioxide, CO_2....	.43	20	1.68	2.89	51.5	11.17
Sulphur dioxide, SO_2....	.03	1	.08	.03	0.4	.09
Oxygen, O_2	2.75	174	14.65	1.16	28.4	6.16
Nitrogen, N_2..........	12.39	890	74.92	12.39	356.0	77.22
Water vapor, H_2O......	.07	8	.67	.54	24.7	5.33
Totals	17.01	1,188	100.00	17.01	461.0	99.97

* Ethane (C_2H_6) assumed to represent the average composition of the hydrocarbon gases.

With a firebox temperature of 2,300 degrees every pound of coal burned produces 1,188 cubic feet of gas. Of this large amount, 78 cubic feet is carbon monoxide, which is combustible; and 17 cubic feet is a rich hydrocarbon gas, the average composition of which we have taken as ethane (C_2H_6). Mixed with these combustible gases are 20 cubic feet of carbon dioxide, 174 cubic feet of free oxygen and 890 cubic feet of inert nitrogen, together with traces of sulphur dioxide and water vapor; or, we have 95 cubic feet of combustible gases mixed with 174 cubic feet of free oxygen and more than 900 cubic feet of inert gases.

To put it another way: For every molecule of combustible gas there are present less than two molecules of oxygen, which are mixed with ten molecules of inert gases. These inert gases interfere with the meeting of the combustible gases with the oxygen and tend to retard combustion.

The light, combustible gases are not difficult to burn if supplied and intimately mixed with the necessary amount of oxygen and given time to burn; but, as the figures indicate, the relatively small amount of oxygen present is mixed with such a large amount of inert gas that the probability of the combustible gas coming in contact with the oxygen within the very limited time available is greatly reduced.

The heavy hydrocarbons are driven off in a semi-fluid or pasty condition, sometimes in the form of small globules of tar, which are very difficult to burn, and which for the most part escape unburned. The heat loss due to this source can be reduced only by the use of efficient mixing devices and the provision of long combustion chambers and ample air supply above the fuel bed.

We spoke of the time required for combustion of the volatile hydrocarbons. As shown by the table, under the conditions given, every pound of coal produced 1,188 cubic feet of gas at a firebox temperature of 2,300 degrees. When burning coal at the rate of 100 pounds per square foot of grate per hour there is produced 1,780 cubic feet of gas per second. The volume of the firebox in question is 250 cubic feet; so this firebox must discharge and be refilled with gas more than seven times per second, or, the time available for the combustion of each particle of gas is less than one-seventh of a second. As the rate of com-

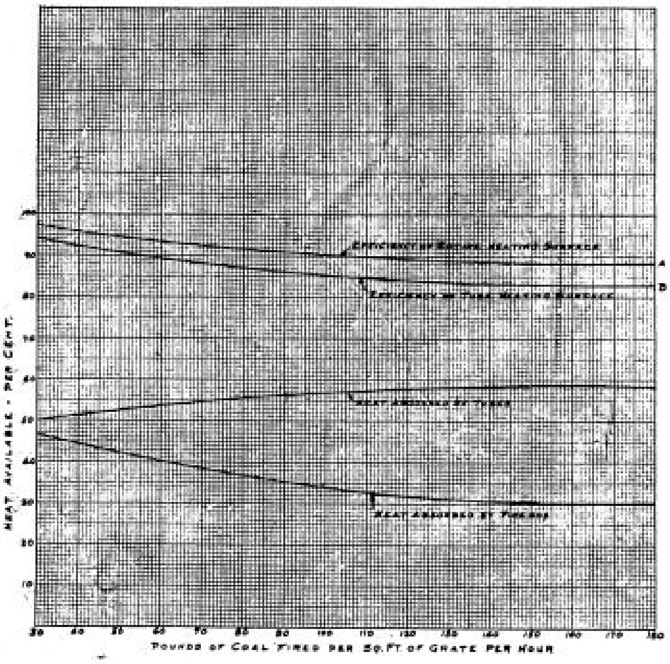


Fig. 6

bustion decreases, this time increases, and as the rate of combustion increases, this time available decreases.

It is very apparent, however, that by increasing the firebox volume and the combustion chamber space we increase the time available for the combustion of the volatile matter. We see, therefore, that combustion chamber space is valuable both as a means of increasing the efficiency of combustion and also as a means of increasing the radiating surfaces and firebox evaporation, and as we increase either of these we increase the over-all efficiency of the boiler.

The curves in chart, Fig. 6, show the amount of heat absorbed by the firebox and tube surfaces, and the efficiency of the entire heating surfaces as compared with the tube heating surfaces. It will be noted that at low rates of combustion the tubes absorb from 90 to 94 percent of the heat available, while at high rates they absorb about 83 percent of the heat available. In other words, as we increase the amount of heat to be absorbed by the tubes we decrease their efficiency. It will be noted that the efficiency line of tube heating surfaces almost parallels that showing the heat absorbed by the firebox. As the percentage of total heat absorbed by the firebox decreases, the percentage of heat to be absorbed by the tubes increases and the tube efficiency decreases.

It will appear from this that if, under any given set of conditions, we can increase the firebox evaporation, the efficiency of the tubes and the over-all efficiency of the boiler will be increased. The firebox heating surfaces have an efficiency of, we might say, 100 percent; that is, these surfaces will absorb practically all of the heat that is available, and by "available heat" in this case we mean the radiant heat. The firebox heating surfaces absorb but very little heat by convection from the hot gases, and the heat contained in the hot gases cannot be considered as available for the firebox heating surfaces. By increasing the amount of heat given off by radiation we decrease the amount of work to be done by the tubes.

Flues take up heat by convection; that is, by actual contact of the hot gases against the flue heating surfaces. The amount of heat so received depends upon the temperature, density and velocity of the gases passing through. As we increase the rate of combustion we increase the weight and volume of the gases, and therefore the velocity. At the same time there is an increase in the temperature and a decrease in the density.

In order to get heat out of the gases into the flue heating surfaces it is necessary to bring the small particles of gas into actual contact with the heating surfaces. To do this successfully it is necessary to break up the gas into small streams by the use of small flues. As the gases pass through the flues the molecules are vibrating rapidly in all directions and are striking against the heating surfaces, giving up their heat. The amount of heat given off will depend not only upon the temperature of the particles of gas, but also upon the number of blows they strike against the heating surfaces. This depends partly on the density, which controls the number of molecules in a given volume of gas, but largely on the diameter of the tube.

A decrease in the diameter of the tube decreases the average distance of each particle of gas from the heating surfaces. Each particle will therefore have a smaller distance to travel in order to strike the heating surfaces, and in passing through a flue of given length it will come in contact with the surfaces oftener and will give up more heat, resulting in a lower front end temperature and higher boiler efficiency.

The efficiency of a tube increases as the diameter decreases and as the length increases, though tests seem to indicate that tube lengths in excess of 100 or 110 times the internal diameter are not productive of high capacity or efficiency. In other words, the tube heating surface gained by increasing the length above 110 times the internal diameter is of little benefit in reducing front end temperatures and in increasing the boiler capacity. It would seem, then, that any improvement in the efficiency of tube heating surfaces must be brought about by decreasing the diameter of the tubes or by decreasing the amount of work to be done by the tubes.

As was indicated by Fig. 6, increasing the percentage of heat absorbed by the firebox reduces the percentage of heat to be absorbed by the flues and increases the flue efficiency. This increase in firebox heat absorption can be obtained by increasing the grate area, combustion chamber space, and, necessarily, the firebox heating surfaces.

The use of larger fireboxes and longer combustion chambers would enable us to reduce the present excessive length of flues, and possibly to increase their efficiency by a reduction in the diameter. The preesnt troubles on account of tubes plugging and filling up are not due to the size of the tubes used, but are due entirely to the incomplete burning of the fuel in the firebox.

If the present furnace conditions can be remedied to the extent that approximately perfect combustion can be obtained there is no logical reason why a tube smaller in diameter and shorter in length cannot be used effectively, but such tubes can be used only in conjunction with a fire-

(*Continued on page 342*)

Layout of 90-Degree Transition Piece

Three Methods of Laying Out Ninety-Degree Transition Piece or Reduced Connection—Simplicity and Accuracy of Methods

BY R. J. HETTENBAUGH

This layout was brought to me by one of the local tinsmiths who couldn't lay it out. I straightened him out in a very short time by showing him three methods of laying out this pattern, one of which is shown in Plate I. This is one of the simplest methods of laying out this pattern, but is not the most accurate.

Lay out the plan and side elevation in accordance with the plate. Space off the base circle equally, 30 points being used in this drawing. With point *X* as a center, scribe a half circle representing the half plan of top. Space this off equally in the same number of points used in the base circle. Connect these points with broken and full lines as shown. As it is necessary to draw only a half pattern of this object, both sides of the center line are used to show the lines more distinctly.

The side elevation will be spaced off in like manner. From points *Y* and *Z* scribe half circles representing the half plan of top and base. Space these off in the same number of points as was used in the plan and project at right angles to the object. Connect these points with broken and full lines. These lines are of no material value, but they are used as guides in finding correct points later.

The construction triangles in Figs. 1, 2, 3 and 4 must now be formed. Draw a horizontal and perpendicular line at right angles, as in Fig. 1. On these lines the construction triangles are formed. With a pair of dividers take the distance between points *X* and 16 on center line of plan view, and place this on horizontal line of Fig. 1. This is the base line of the first construction triangle. From point *C* in side elevation get the distance between point *C* and 1 and put this on perpendicular line of Fig. 1. This is the height of the first triangle. Draw a line diagonally across the two points. This line is the hypotenuse or true length of line 1-16. This can be proved by setting dividers on line 1-16 and if they check the work is correct. It might be said that if the lines can be gotten in this manner, why all the red tape; but lines 1-16 and 30-15 are the only two lines in the side elevation that can be checked in this manner. All other triangles are found in like manner, taking the base from the plan and the height from the side elevation.

The next step will be to piece the triangles together to form the half pattern. Take the true length of line 16-1 in Fig. 1 and place it at any convenient point on the sheet, and with point 16 as a center scribe an arc equal to one of the spaces in the base circle as 22 to 23. Next take the length of line 1-17, in Fig. 2, and with point 1 as a center scribe an arc to cross the one just taken from point 16. The point of intersection will form point 17. With point 17 as a center and the length of line 17-2, in Fig. 1, scribe an arc and with point 1 as a center scribe an arc

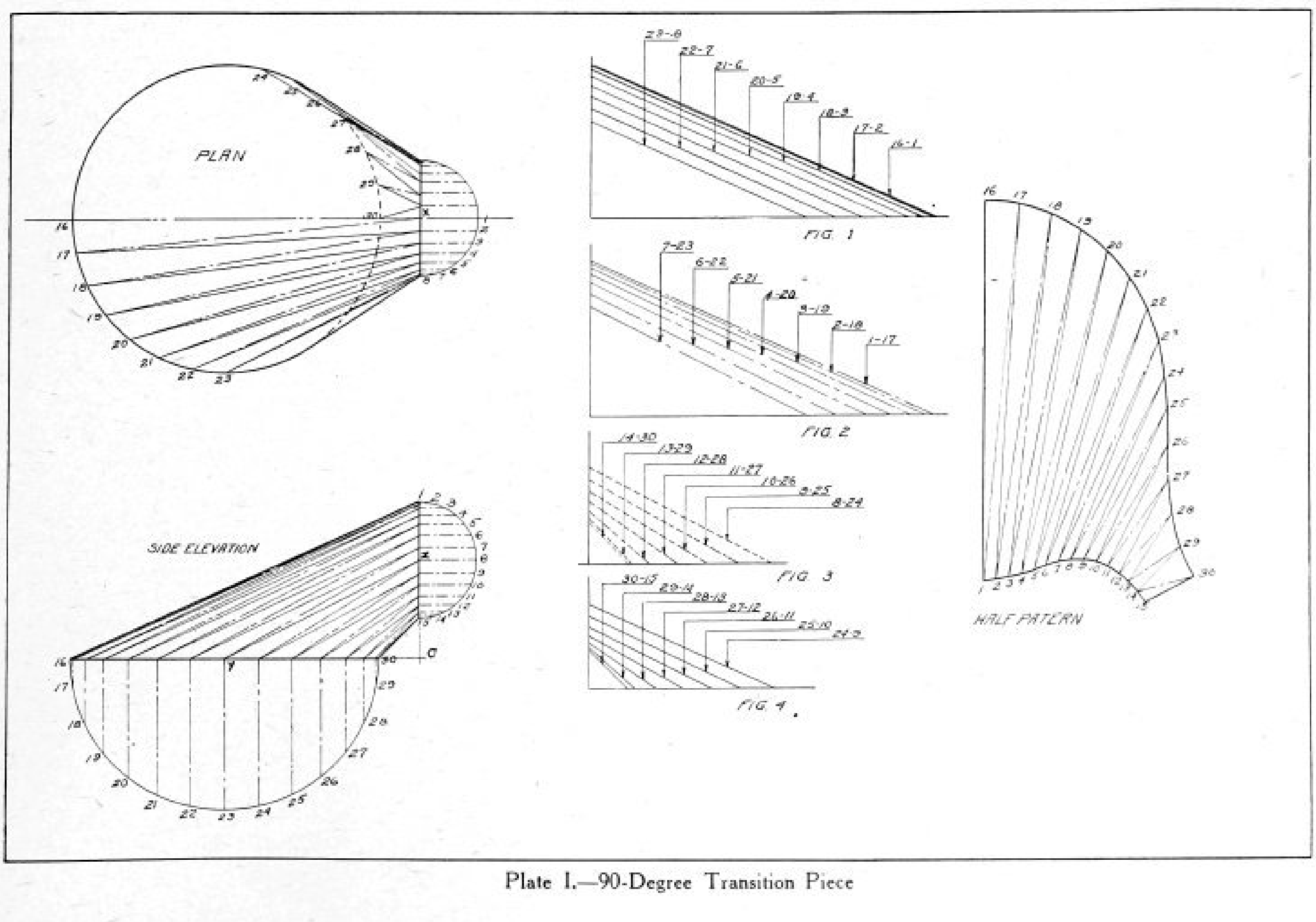


Plate I.—90-Degree Transition Piece

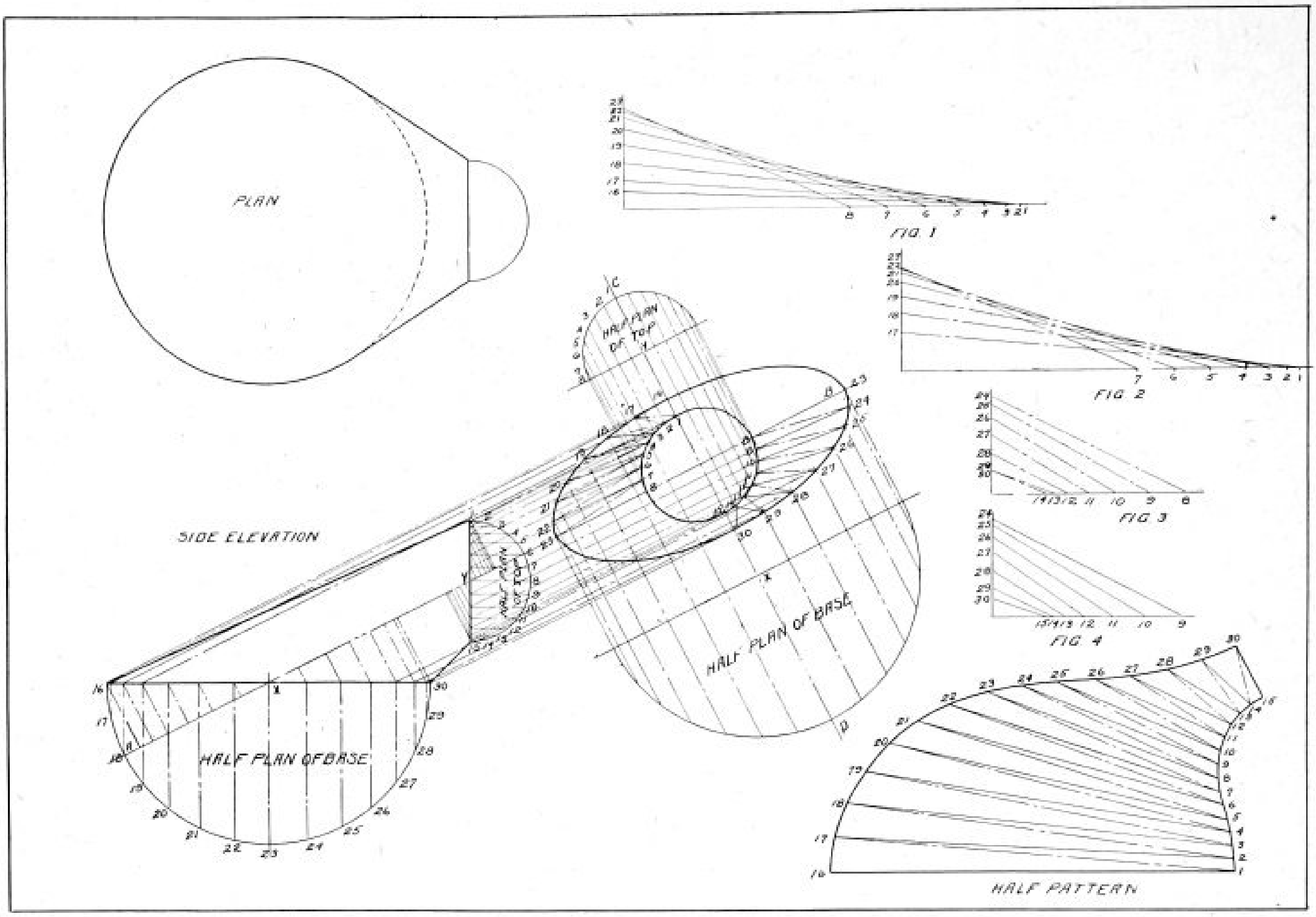


Plate II.—Layout of 90-Degree Reduced Connection

equal to one of the spaces in the small circle to cross the one just taken from point 17. This will form point 2. Continue in this manner until half pattern is complete.

Fold the half pattern on line 1-16 and cut out double, making the full pattern.

Layout of 90-Degree Reduced Connection

It may look like a lot of work to lay out the pattern in Plate II, but it is very little more work than taking the triangles from the plan and side elevation, and it gives better results. It is also an excellent lesson in projection for beginners who wish to broaden their knowledge as much as possible.

To develop this pattern, first draw side elevation and through points 23 and 8 strike the center line *A-B*, projecting it far enough to allow for the end view. From points *X* and *Y* scribe large and small circles representing half plans of the base and top. Space these off equally in the same number of points and project them at right angles to the object, and from the object project them at right angles to the center line *A-B*.

Next strike the center line *C-D* at right angles to center line *A-B*, and on this line scribe half circles the same as in the side elevation. Space these off equally in the same number of points as was used in the side elevation. Project these points both from the large and small circles to end view parallel to the center line *C-D*. Next project points from the side elevation to the end view, so that they cross the lines just taken from circles on line *C-D*. The points of intersection form the end view, but care must be taken that the numbers correspond. That is, lines taken from points 1, 2, 3, 4, etc., in small circle on line *C-D* must cross the ones taken from same points in side elevation.

Connect these points of intersection with broken and full lines, as 16-1, 1-17, 17-2, etc. These lines should be on the same side of center line *C-D*, but as it is necessary to form a half pattern only the bottom half is shown on the other side to make it plainer.

The construction triangles shown in Figs. 1, 2, 3 and 4 must now be formed. First lay out the horizontal and perpendicular lines at right angles, as in Fig. 1. Take the distance between points 1 and 16 in the end view with a pair of dividers and place it on the perpendicular line of Fig. 1. Next take the distance between points 1 and 16 on the center line of side elevation and place this on the horizontal line of Fig. 1. Scribe a line diagonally connecting these points. This line is the hypotenuse or true length of line 1-16. The true lengths of all other lines must be found in like manner.

After the true lengths of all the lines are found they must be pieced together to form the half pattern.

Take the true length of line 16-1, in Fig. 1, and place it at any convenient place on the sheet, and with point 16 as a center scribe an arc equal to one of the spaces in half plan of base, and with point 1 as a center scribe an arc to cross the one just taken equal to the length of line 1-17 in Fig. 2. The point of intersection will form point 17. With point 17 as a center scribe an arc equal to the line 17-2 in Fig. 1, and with point 1 as a center scribe an arc to cross the one just taken from point 17 equal to one of the spaces in half plan of top. This point of intersection will form point 2.

Continue in like manner until the half pattern is completed.

Fold the pattern on line 1-16 and cut out double; this will make the full pattern.

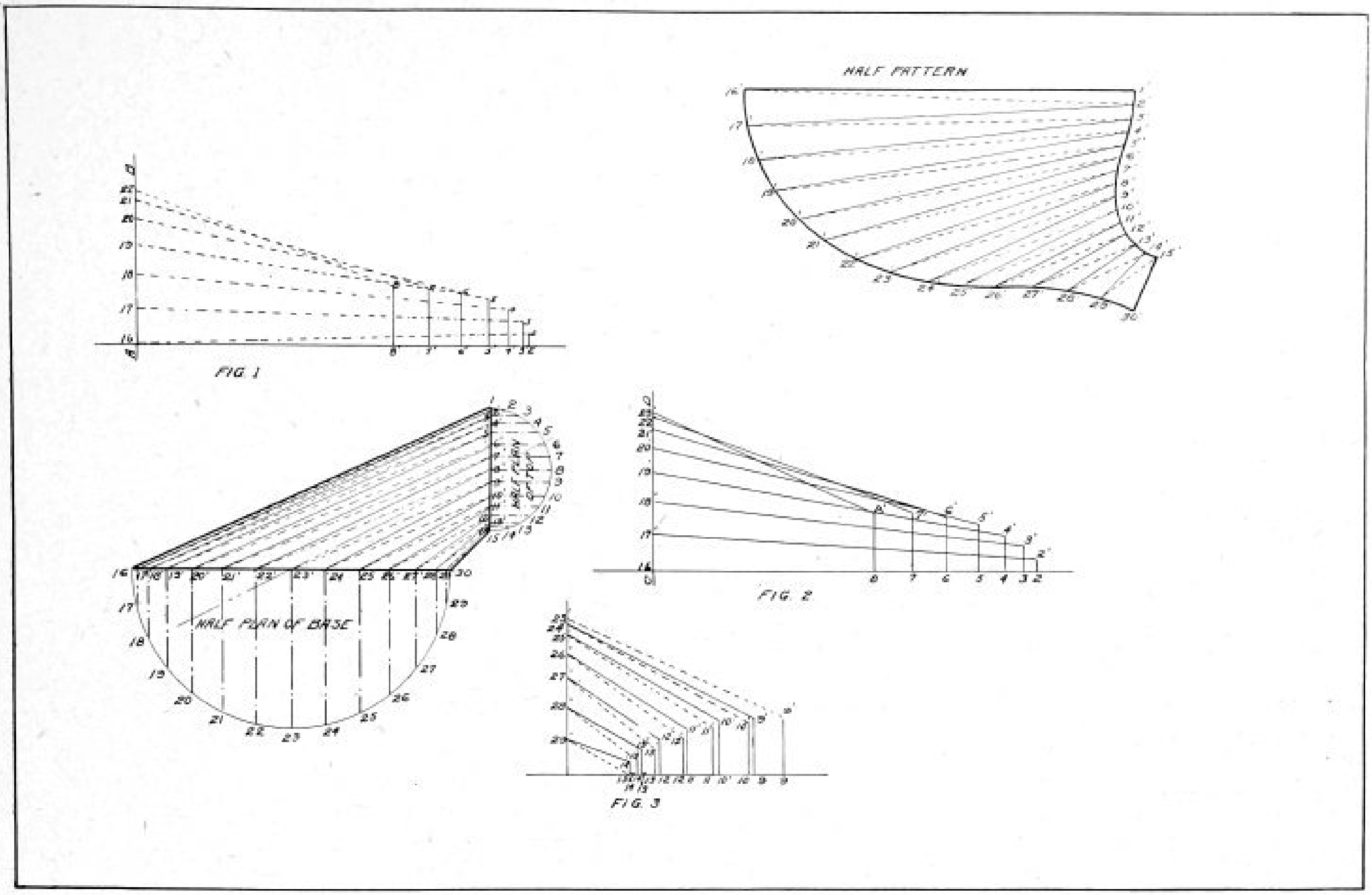


Plate III.—Layout of 90-Degree Reduced Connection

THIRD METHOD (PLATE III)

This is the shortest method of laying out this pattern and it is a very simple one, as only one view of the object is necessary.

Draw the side elevation and from points *A* and *B* scribe the circles representing the half plan of top and base. Space these off equally into the same number of points, 15 being used in this drawing. Project these points at right angles to the object, as shown, and connect those in the top with those in the base with dotted and full lines as 1-16, 16-2, 2-17, 17-3, etc.

The next step will be to find the true length of all the lines just mentioned. The line 1-16 will be taken directly from the side elevation, as it is shown here in its true length. The line 15-30 is also shown in its true length, but the true lengths of all other lines must be found.

First scribe the horizontal line in Fig. 1, and from this line erect the perpendicular line *A-B* at right angles.

Take the length of line 16′-2′ from the side elevation and place it on the horizontal line of Fig. 1, and from point 2′ erect the perpendicular line at right angles, and with point 2′ as a center scribe an arc equal to the distance between points 2-2′ in the half plan of the top. Connect these two points 16′ and 2′ with a dotted line and this will be the true length of line 16′-2′.

With point 16′ as a center, in Fig. 2, scribe an arc on the perpendicular line *C-D* equal to the distance between points 17′-17′ in the half plan of base. Next take the length of line 2′-17′ from the side elevation and place it on the horizontal line in Fig. 2, and from point 2 erect a perpendicular line at right angles. With point 2 as a center scribe an arc on this line equal to the distance between points 2-2′ in half plan of top.

Now take the length of line 17-3 from the side elevation and place it on the horizontal line in Fig. 1, and from point 3 erect the perpendicular line 3-3′, connect points 17′ and 3′ with a dotted line, this being the true length of line 17′-3′.

All other lines are found in the same manner as shown in Figs. 1, 2 and 3, so I will not show each one in detail.

After the true lengths of all the lines are found, the half pattern must be pieced togethed. First take the true length of line 1-16 from the side elevation and scribe it at any convenient place on the sheet, and with point 1 as a center scribe an arc equal to one of the spaces in the small circle or half plan of top, and with point 17 as a center scribe an arc equal to the true length of line 16-2 in Fig. 1. The point of intersection will form point 2.

With point 2 as a center scribe an arc equal to the true length of line 2-18 in Fig. 2, and with point 16 as a center scribe an arc to cross the one just taken equal to one of the spaces in the large circle or half plan of the base. The point of intersection will form point 17.

Continue in this manner until half pattern is complete. Fold the pattern on line 1-16 and cut out double, and this will give you a full pattern.

According to the record of boiler explosions in the United States compiled by *Power* and published in their issue of November 7, 347 boiler explosions occurred in the period from July 1, 1915, to July 31, 1916, resulting in the death of 158 persons. The number injured by the explosions totaled 400.

The Industrial Safety Congress of New York State will be held at the Hotel Onondaga, Syracuse, N. Y., on December 11, 12, 13 and 14. Addresses will be delivered at the morning and afternoon sessions of the Congress by experts on fire protection, factory sanitation, safeguarding of machinery and other factors entering into industrial safety, to be followed by open discussions on each topic.

Starting a New Shop of His Own

Superintendent of Long-Established Boiler Shop Takes Over the Business and Installs New Equipment

BY JAMES FRANCIS

"Well, Henry, seems to me that things have been happening over your way? Just what has been the change and how did it come about?"

"Why, Mr. Francis, our superintendent has started a new shop of his own and we are working for him now."

"What! All hands left the old shop? Everybody gone with the superintendent? Seems to me that is rather a strange state of things."

"No, Mr. Francis, it's all right. You see, it was this way: the owner of the old shop had another business to which he gave all his time, leaving the boiler department entirely to the superintendent, who did everything, getting orders, getting out the work and getting in the collections. The old shop was pretty old, too. It hadn't seen any new machines for twenty years except once, and that was when an oxy-acetylene outfit was placed in the shop and things finally came to the point where it was absolutely necessary to put a lot of the modern machinery onto the shop or else quit the business of making boilers, and that was just what the owner of the old shop did. He closed the shop, and our old superintendent took all the work and orders which the old shop had on hand the middle of last June."

"Well, I suppose your superintendent took over all the workmen and all the tools, didn't he?"

Old Tools Discarded

"That's just where you lose, Mr. Francis, for the "Old Man" didn't take any of the tools except the smith tools, anvil, tongs and the small stuff which goes with any smithy layout. And he didn't take all the men, either. There were a few who belonged to the old shop. Our superintendent has kept them because the owner of the shop "wished" the men on him, but when the new shop was set up, the former owner found places in his other business for these men, and they did not go with us."

"Well, Henry, what have you got for a shop now? What tools have you got and how are things arranged. How did you work things in setting up a new shop and taking over finished and new work?

"Well, say, the "Old Man" is a crackerjack at that kind of business. He went over to Chicago one day, and when he came home next day he was the owner of a whole outfit for a boiler shop. He bought an overhead crane, a bending press, flanging clamp, bending rolls, punch press, shear, emery grinder, an air compressor and two air "guns" and a couple of air drills and a whole raft of small stuff, plate tongs, screw presses, chain hoists and all the small tools needed in a boiler shop."

"Well, did he buy new or second-hand tools?"

"Well, now, Mr. Francis, that's a rather hard question, for a tool is 'second hand,' I take it, the minute it has been set up in a shop, isn't it?"

"Well, that's some question. I suppose if I buy a tool and put it in my shop it is a new tool and remains so for a long time, but just as soon as I sell or offer that tool for sale, it is 'second hand,' isn't it?"

"I don't like that name 'second hand,' Mr. Francis, not a little bit. I had rather say 'used or unused machines' than 'new' or 'second hand,' and, taking it that way, the 'Old Man' bought both kinds. He just made out his list, called on 'Uncle Joseph T. Ryerson and he picked out a pretty good overhead crane, the punch, the shear and some bending rolls, flanging clamps and the flanging forge. All the small tools he bought new; also the air compressor and a brand new 15-horsepower induction motor to run the compressor."

"Say, Henry, that reads mighty interesting; just go ahead and tell me how you built and set up the shop. That ought to make interesting reading, too."

Construction of the Shop

"Well, the shop is a balloon frame concern with a main building high enough for the crane, with a 'lean-to' on one side, in which were placed the air compressor, the emery grinder, flanging forge and tools. There is a place for another 'lean-to' on the other side of the shop, later, and the overhead crane track runs right out of doors through the end of the building, three vertically swinging doors being arranged over the crane track to permit passage of the traveler through the end of the building. The track out of doors is just set up on temporary posts so we can use it in the yard on large work. Later there will probably be a lot more shop built around the crane track. And then, that compressor. I want to tell you how they set that machine in place and got it working inside of ten hours!"

"Suppose they had the concrete foundation all ready for it before the compressor came off the cars, didn't they?"

"No! They just didn't. There isn't any concrete foundation for that compressor, and it is running right along as nice as you please. They had a little trouble the first day; broke off the air-delivery pipe, but that was repaired and the compressor has run steadily ever since."

"How did they set it up?"

"Why, they got two 8-inch by 8-inch timbers, yellow pine, and 30 feet long. A shallow trench was dug along the east side of the shop lean-to, and a couple of layers of condemned paving bricks were laid in the trench. The bricks were rammed into an inch or so of sand placed in the trench for a 'cushion,' and the timbers were laid right on top of the bricks."

"Say, Henry! Did you say 'condemned' paving bricks? What's the matter with them? Aren't they sound?"

Use Found for Condemned Paving Bricks

"Yes, Mr. Francis, these bricks are just as sound and as strong as those which are accepted and laid in the street. The only trouble is that a corner or an end has been chipped off. When more than a certain width of break is found on a paving brick it must be rejected. They use all they can of these culls for making pieces for filling the courses where they lie against the curbs, but sometimes, on a big paving job, there are a few thousand 'condemned' bricks, which will be sold cheaply to get rid of them, and anybody who needs bricks around a shop should snap up these culls, for they are mighty good for general use around a shop. In our little shop the flanging forges are built up with these condemned paving bricks. Once I lined the firebox of my kitchen range with these brick,

which, split carefully in half, lengthwise, proved just a fit in the range firebox and lasted two years with a night and day fire before a new lining was necesary."

"Well, Henry, that is a new one on me. I'll chalk that scheme down for future reference. How did they fasten the bricks under the air compressor; grout them with liquid cement?"

"No; they didn't do anything except throw on some sand and a bucket of water; then swept the sand and water in between the bricks with an old broom. The compressor was bolted to the timbers and the motor base, with its belt extension screw, was placed on the ends of the timbers, close in the corner of the lean-to. The compressor was placed 12 feet or so along the timbers from the motor, and both being fastened to the timbers, formed a fine arrangement to resist the strain of the belt. This motor and compressor will never get out of alinement, and it is a fine way for connecting the two machines. The motor belt was placed directly upon one of the compressor balance wheels, thus making a neat outfit, with no other pulleys necessary save the one on the motor shaft. The compressor was speeded about 265 revolutions per minute, and, being splash lubricated by oil in the crank case, gave no trouble save a little vibration which the second day caused the air delivery pipe to break off just above the compressor."

"Did the vibration of the compressor do that? Seems to me that the pipe should have absorbed all vibration that could exist there?"

Trouble with Air Compressor Remedied

"Well, the piping was not just right, I'll admit. The air receiver was placed on the same timbers which carried the compressor, and pretty close to the compressor, as the timbers were only 30 feet long and 12 feet space was occupied by the belt and about four more by the cylinder end of the compressor and the far portion of the motor. This took up 16 feet of the timbering. The receiver was made from a boiler shell 12 feet long and 30 inches in diameter. This took up 12 feet more of the timbers, making 28 feet occupied, consequently the receiver was placed only about 2 feet from the cylinder end of the compressor. The delivery pipe extended upward about 2 feet, then over to the receiver and downward.

"This connection proved too short. The bricks directly under the compressor settled a bit and some vibration set in. To make a complete cure, a hole about 2 feet long was dug under the compressor cylinder, some cement mortar was made up; then the hole was filled with condemned paving bricks, which were rubbed into the thin mortar. This was done Saturday afternoon, and by Monday morning the mass was solid, and has never yielded a bit thus far. The delivery pipe was removed, carried clear up to the roof of the lean-to, a distance of about 5 feet, and this length of vertical pipe, together with the reduced vibration, has proved all right, for there has been no more trouble with the air pipe or with vibration of the compressor."

"Henry, what kind of a system have they got for stopping and starting the compressor? Suppose it keeps the receiver charged up to 90 pounds pressure all the time?"

"Yes, it does that. There is a pop safety valve on the receiver, but it has never blown off yet. It is like this, you see, the compressor runs all the time; they have an 'unloader' connected into the air supply pipe, which takes air from above the lean-to roof and——"

"An 'unloader!' What kind of a thing might that be?"

"Why, it is a sort of reducing valve, only it don't reduce anything. Whenever the pressure in the compressor delivery pipe rises to 90 pounds a diaphragm in the unloader causes a little valve to operate and shuts off the air supply to the compressor. Then the next stroke of the compressor is made without much air, and, as there is nothing to be compressed in the cylinder, very little power is consumed or wasted in an overcharge of the receiver. As soon as the pressure in the air pipe falls below 90 pounds the 'unloader' opens the air pipe again and the compressor resumes work at the old stand."

"Well, Henry, that's sure some scheme. Works all right, too, you say? Now tell me how the flange forge was arranged? Do they have hoods to carry away the smoke and gases, and how were the flange forges made up? Didn't you say something about their being made of condemned paving bricks?"

Arrangement of Flange Forges

"Yes, that's just what our flange forge fires are made up with. We have two; the smaller one is in use and the larger fire has been built and is all ready for use save the putting up of the stack and hood to take care of the smoke. Yes, sir! There are hoods and stacks to both flange fires, or will be, and there is also a small hood and stack for the forge fire when we dress tools. But this fire is not always used for forging tools. You see, we have a couple of rivet heating fires which are portable and can be placed just where they are needed. All that is necessary to run a fire in one of these little forges, either for rivet heating or for small forging and tool dressing, is to attach the compressor air hose to one of the little forges and go ahead with the heating.

"But those flanging fires! The smaller one is made in an old boiler iron ring about 4 feet in diameter and 18 inches high. It is flatted into an oval about 30 inches across the narrow way. An air pipe 2 inches in diameter is run through the steel shell about 3 inches above the ground, and two tees, 2 inches by 1 inch, are placed in the middle of the oval, about 12 inches apart. The branches in these tees, 1-inch nipples, projecting about an inch, are screwed into the branches of the tees, which look upward."

"Are there no tuyre irons, Henry, or any provision for cleaning out any dirt which may fall down into the air pipe?"

"There's no tuyre, Mr. Francis, but the pipe to which the tees are attached passes right through the steel casing of the forge and is closed by a cap, which can be removed by the fingers when it is necessary to clean out the air pipe. You see, there is no blower in this shop for the forge fires. We do it all with compressed air from the receiver, and anything which gets into the air pipe is pretty apt to come out by the time it gets 90 pounds of compressed air behind it. We can throttle down the air as we please and have just as gentle or as strong a blast as we please. We like the compressed air better than fan blast and it saves the trouble and expense of a separate motor, a blower and a lot of big fan piping. I tell you, Mr. Francis, compressed air is 'it' for forge fires, with coal or coke, for tool dressing or for heavy flanging and bending."

"How about the paving brick in the flanging fires? You haven't told me that yet."

"Oh, yes! Some bricks were placed on end and the steel shell lined with them and they were all set in cement mortar, too; made 1 : 2 of cement and sand. Then the shell was filled right up with the paving brick, set solid in mortar and finished with a paving layer in the form of a saucer, just level with the top of the air nipple, then sloping up all around, to the top of the outer steel casing. The oval saucer or bowl thus formed was about 10 inches

(*Continued on page* 343)

The Boiler Maker

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

A public hearing on the A. S. M. E. Boiler Code will be held on Friday afternoon, December 8, in the Engineering Societies Building, 29 West Thirty-ninth street, New York city. The hearing will be continued on the following day and into the next week if occasion requires. This hearing is in pursuance of the following recommendation of the Boiler Code Committee to the Council: Your committee recommends that you appoint a permanent committee to make such provisions as may be found desirable in these rules and to modify them as the state of the art advances, and that such committee should hold meetings at least once in two years at which all interested parties may be heard.

A conference committee to the Boiler Code Committee has been created which will consist of representatives of the states and municipalities that adopt the code. The Council of the mechanical engineers society has voted to invite each such State and municipality to appoint a representative to act on this committee. All discussion will be confined to the technical field of boiler construction and installation.

In the interest of promoting the general welfare of the boiler making industry, together with the general protection of life and property, the Industrial Commission of Ohio has called a meeting at the Willard Hotel, Washington, D. C., for the week beginning December 4 of representatives from all States and cities interested in the subject, to compare conditions and organize a permanent movement, to the end that all laws pertaining to boilers shall become more efficient and beneficial to all the commonwealths of this country. Although among the laws conserving human life and property that the State of Ohio has enacted are to be found comprehensive laws for the construction and care of steam boilers, nevertheless boiler manufacturers have found that they are embarrassed in following the provisions of these laws on account of the non-conformity of laws of adjacent States. For the efficient administration of State boiler laws a free interchangeability of boilers should be necessary, and manufacturers should not be handicapped by lack of uniformity in the laws. Undoubtedly this meeting will do much to clear up the situation regarding the promulgation of uniform boiler laws and all interests affected by such legislation should be fully represented at the meeting.

The California Boiler Rules, recently issued by the Industrial Accident Commission of California, will go into effect January 1, 1917. These rules are for the most part made up of the Boiler Code of the American Society of Mechanical Engineers. No new power boiler can be installed in the State of California after January 1 which was not stamped when built by the manufacturer with the American Society of Mechanical Engineers' boiler code stamp, except after a general inspection by the Industrial Accident Commission and another inspector holding a certificate of competency. The lowest factor of safety on boilers of this kind shall be 6, except that all new boilers carried in stock in the State on or before January 1, 1917, by dealers or private owners, may be installed after these orders take effect, using a factor of safety as stipulated for existing installations, provided that they shall be equipped with all the necessary appliances to comply with the new rules as laid down for new installations. Danger from lap seam construction is minimized by providing that where it is found impossible to definitely determine the age of a boiler of lap seam construction, the factor of safety should be not less than 5½. Furthermore, no pressure on a boiler of lap seam construction shall exceed 165 pounds per square inch.

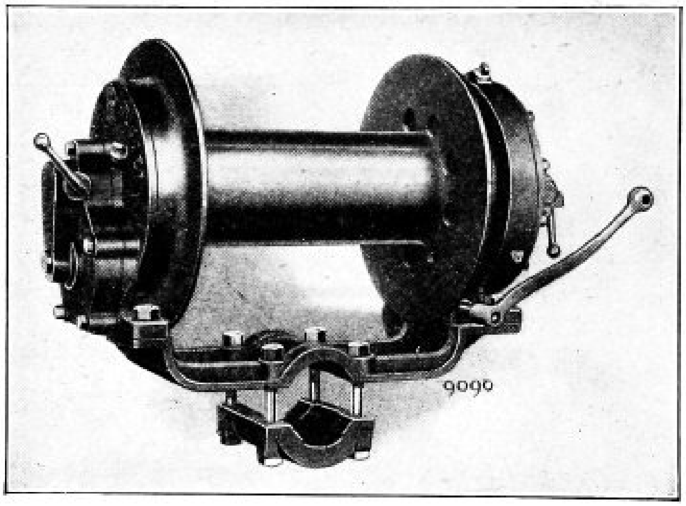
The article on "Welded Joints in Tank Construction," published elsewhere in this issue, emphasizes the uncertainty which exists in determining the strength of welded joints in boilers or tanks subject to internal pressure. It is conceded that at the present time we have no method of autogenous welding where the welded portion can be made of the same quality and characteristics as the material to be joined together. While welded joints of high efficiency can be constructed by conscientious and skillful workmen, it should not be forgotten that the ductility of the material in welded joints is very much impaired by the process. In the tests described in this article, it is shown that the tentile strength of welded joints compares very favorably with that of single and double riveted lap joints such as are commonly used on all kind of storage tanks. In fact, the efficiencies are as high as those of butt-strapped double and triple riveted joints.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

New Model Little Tugger Hoist

For the use of those who prefer manila rope to wire rope for light hoisting and hauling, the Ingersoll-Rand Company, New York, has brought out a new model "little tugger" hoist which is designated No. 11. The square piston, reversible driving engine, automatic lubrication, enclosed gearing, drum release clutch and worm-operated band brake, are essentially the same as in the No. 1 model



Little Tugger Hoist

manufactured by this company. The main differences are in the diameter and length of the drum, the width of the flanges, and, necessarily, the main frame and overall dimensions.

The new No. 11 "little tugger" has a hoisting drum 7 inches in diameter by 17 inches long with 5-inch flanges. This acommodates 300 feet of ⅝-inch manila rope. The maximum capacity of this hoist is conservatively rated at 600 pounds. The weight of the hoist itself is 358 pounds. It is 21½ inches long, 31¼ inches wide and 23 inches high.

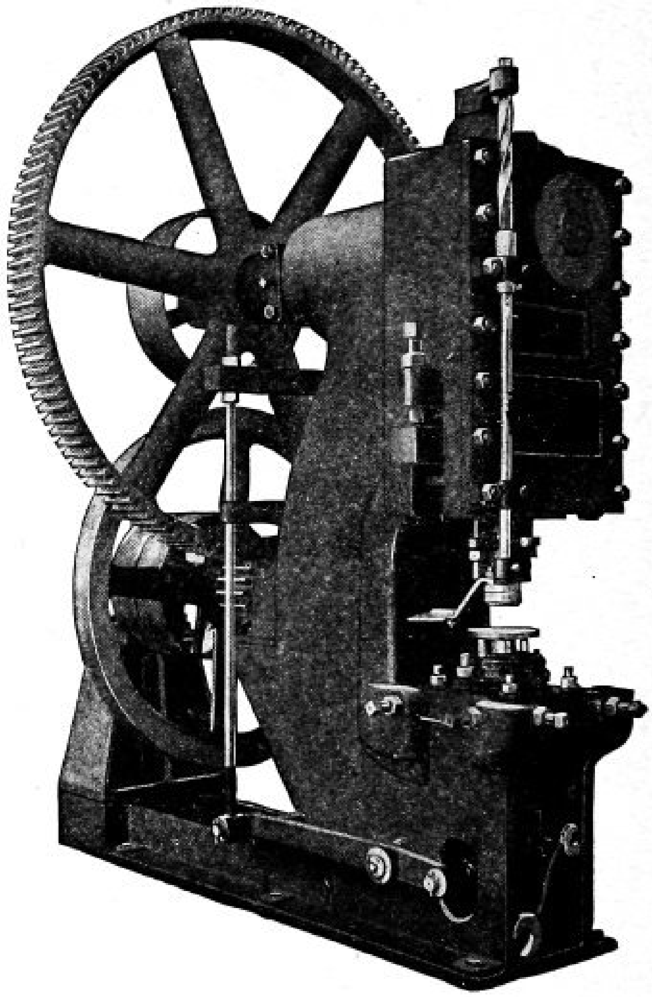
Like the No. 1, the No. 11 "little tugger" is built for operation both by compressed air and steam. The standard clamp fits a 4½-inch diameter column or pipe, but by removing the clamp the hoist can be readily bolted directly to any convenient support, timber, flooring, etc. The device is recommended by the manufacturers for all-around hoisting, hauling and handling in industrial plants.

Southwark-Mason Washer Press

The press illustrated, which is manufactured by the Southwark Foundry & Machine Company, Philadelphia, Pa., is adapted for making washers and other stamped specialties from either scrap sheets and plates or new material. Its most useful field is in the utilization of waste material by converting it into standard or special washers, large quantities of which are always used around railroad and industrial plants. In other words, it can be classed as a scrap reclaiming machine.

By a special die construction, the press makes a complete washer at each stroke of the ram, insuring the concentricity of hole with the outer circumference. The punched washer is thrown out automatically into a box or to a pile by a mechanical hand operated from the slide. The machine may be used for various forms of stamping, punching, shearing, etc.

The frames are one solid casting of the open gap type on which is mounted the gearing (a single reduction except in case of motor drive) plunger, cam shaft, dies, etc. The plunger is equipped with a bronze taper gib to take up any wear. Fastened at the bottom is the die and piercer,



No. 3 Press, Designed for Making Washers Up to 2-Inch Bolt Sizes

the former for cutting the outside of the washer and the latter for punching simultaneously the center hole. The punch is on the bottom and is held in a substantial punch holder block on the lower jaw of the frame.

Surrounding this punch is the stripper ring, which, through connecting rods and lever, is operated from a cam on the back of the main shaft. In an annular space between the piercer and die is a series of knockout pins for knocking down the washer which sticks in the upper part of the die mechanism and goes up with the upward stroke of the plunger.

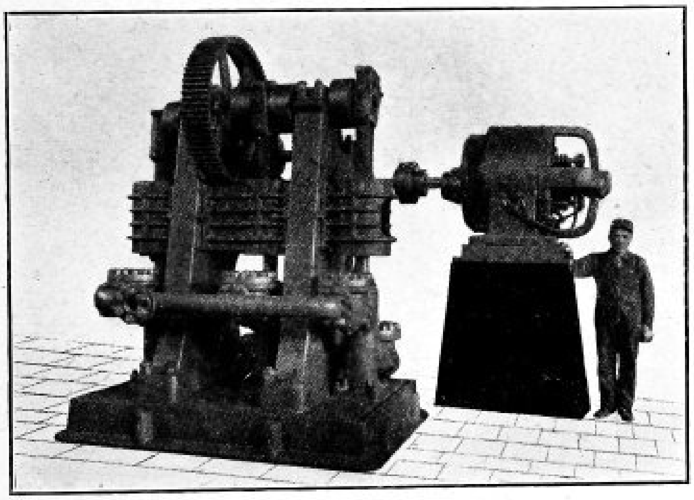
These pins are operated by a bar passing crosswise through the ram and, at the top of the stroke, stopping against a pair of set screws in lugs cast on the frame.

At the side of the machine is a vertical shaft, which is splined at the top with a steep pitch thread. This passes through a nut which is fast to the top of the plunger. The up-and-down stroke of the ram imparts a rotary motion to the shaft. On the bottom of the shaft is the hand or cup which receives the knocked-out washer and throws it into a pile or suitable receptacle.

The machine is equipped with a pulley for belt drive or, when specified, motor bracket and suitable gearing for electric motor drive and one set of punches and dies for any size within range of the capacity. The machine is made in five sizes, the capacities of which range from ½ inch to 3-inch bolt size.

New Pot Valve Type Motor-Driven Vertical Triplex Hydraulic Pump

A new vertical triplex hydraulic pump designed and built recently by the Hydraulic Press Manufacturing Company, Mount Gilead, Ohio, is of the pot valve type, capable of delivering a large volume of water against a high pressure. The volume of water and pressure depend upon the diameter of the plnngers with which the pump may be equipped. These may vary from 4 inches to 5¾ inches. With each plunger making 45 strokes per minute, the 4-inch plungers have a capacity of driving 88 gallons against a pressure of 1,700 pounds per square inch. In



Vertical, Triplex, Hydraulic Pump

the same length of time the 5¾-inch plungers will deliver 183 gallons against a pressure of 800 pounds per square inch. The capacity of the pump varies proportionately with the intervening sizes of plungers.

Each plunger of this pump has a stroke of 12 inches, with a normal speed of 45 strokes per minute. Thus the pump has a normal effective speed of delivering 135 feet of water per minute against high pressure. The volume of this water in gallons, of course, varies with the diametem of the pump plungers.

On account of the large volume of water which this pump is capable of handling in a given time, each pump plunger is equipped with pot valves for both the suction and delivery chambers. The total area of these valves is proportionately no greater than the single valve type of pump, yet they permit the use of lighter checks, which have greater freedom of movement than a large single check would have. The lift of the checks also is reduced, thereby cutting down the slippage which occurs in single suction and discharge valves when used on pumps of large water capacity.

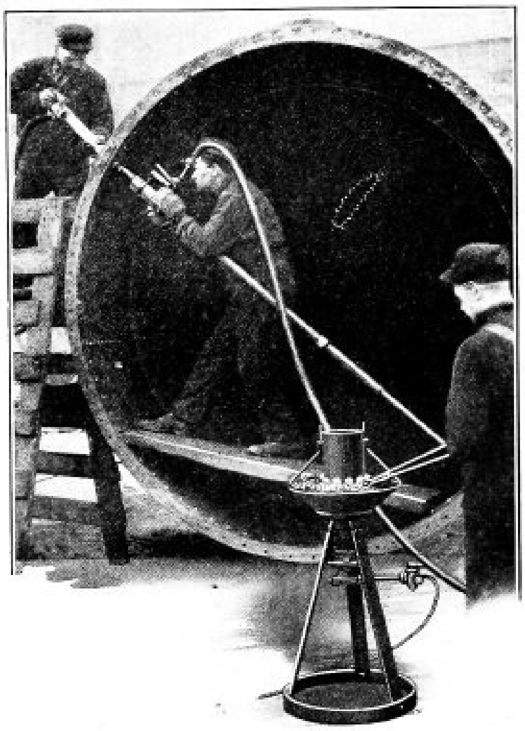
This pump is designed for direct connected motor drive only and requires a 100-horsepower motor for operating. It has a double reduction of gears, the first being 5 to 1 and the second 3 to 1. The height of the pump is 10 feet, while the floor space of the pump without the motor is 8 feet by 5 feet 9 inches.

Necessarily, this pump is sturdily built throughout to withstand the strain of delivering a large volume of water against the high pressures for which it is designed.

"Gunnell Holder-on"

The Manitowoc Engineering Works, Manitowoc, Wis., has placed on the market an improved type of holder-on in which a rider piston is mounted on the regular air piston. In the process of riveting with a pneumatic hammer this tool is used in the usual way, but for each blow struck by the pneumatic hammer there is a corresponding reaction by the rider piston.

It is claimed that this reactive blow lays up the head of the rivet and produces a much tighter rivet than the old style single piston holder-on. In all kinds of structural steel work in which holes are reamed out or pinned



Holder-On That Calks the Rivet Head

they often are not perpendicular to the surface of the metal. The rivet thus inserted diagonally bears only on one edge of the head, and the action of the old holder-on simply holds the rivet in its position while it is being driven. The Gunnell holder-on with its reaction piston lays down the head of the rivet on the other side of the work just as the pneumatic hammer does the point. In boiler work the holder-on practically calks the head of each rivet.

Thomas E. Durban, Erie City Iron Works, Erie, Pa., chairman of the Administrative Council of the American Uniform Boiler Law Society, organized to bring about the legal adoption of the boiler code of the American Society of Mechanical Engineers, has been asked to serve in an advisory capacity with the Industrial Board of New York State to draw up a boiler code.

Questions and Answers for Boiler Makers

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

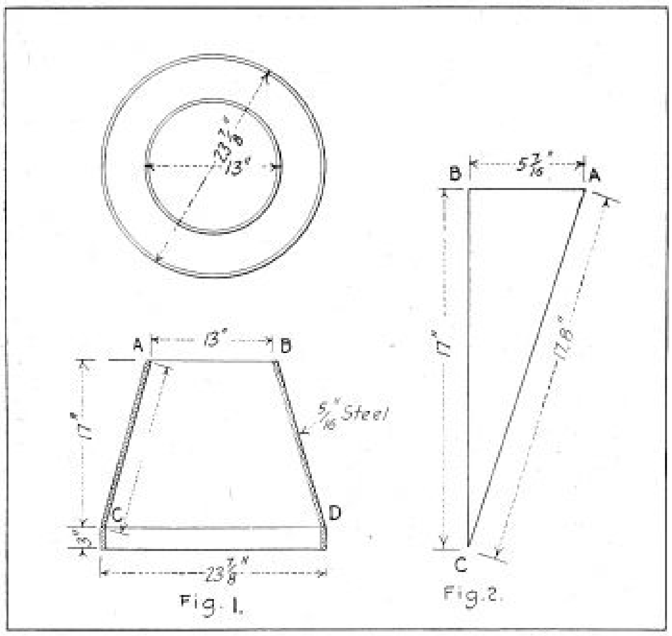
This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Disk Calculation

Q.—Will you kindly inform us how to lay out, and how large a disk and how large a hole in the center of the disk would be required to make a cone of 5/16-inch steel as per sketch? To form this piece we will use the steam hammer with a top and bottom die. This piece is to be made in one piece from a flat disk. The sketch referred to is shown in Fig. 1. N. S. L. Z.

A.—From the given dimensions in Fig. 1 first find the area of the convex surface of the frustum of the cone *ABCD* along the neutral layer of the plate. The neutral diameter at the small end of the object equals 13 5/16 inches; at the large end 24 3/16 inches. The slant height, being not



Layout of Disk to Form Cone

indicated in the drawing, determines its length either by constructing a section of the elevation to scale or by calculation, which may readily be done as follows: The difference between the diameter of the ends of the object equals 24 3/16 — 13 5/16 = 10⅞ inches. 10.875 ÷ 2 = 5 7/16 inches, equals the horizontal distance between points *A* and *C* or *B* and *A*, as shown in Fig. 2. This figure indicates a triangle having the dimensions of the base and altitude given. The hypothenuse *A'C'* or slant height corresponds with the slope length *AC* of the object, Fig. 1, and its length may be found according to the rule expressed in the formula,

$$AC = \sqrt{AB^2 + BC^2}$$

Substituting values given for the letters in the formula, we have,

$$AC = \sqrt{17^2 + 5\,7/16^2} = 17.8 \text{ inches.}$$

The area of the convex surface of the frustum *ABCD*, Fig. 1, may be determined by the rule expressed in the following formula:

$$\text{convex area} = 3.14 \times \frac{x + y}{2} \times z,$$

in which x = neutral diameter of small base in inches,
y = neutral diameter of large base in inches,
z = slope of conical object.

Using the values given and substituting them in the formula, we have,

$$\text{convex area} = 3.1416 \times \frac{24\,3/16 + 13\,5/16}{2} \times 17.8 = 1048\tfrac{1}{2}$$

square inches.

To the convex area of the frustum add the area of the small base in square inches and the area of the 3-inch cylindrical section in square inches.

Area of small base equals $13\,5/16^2 \times .7854 = 139.19$ square inches.

Area of 3-inch section equals $3.1416 \times 24\,3/16 \times 3 = 227.96$ square inches.

Total area equals $1{,}048\tfrac{1}{2} + 139.19 + 227.96 = 1{,}415.65$ square inches.

To find the diameter of a disk having the above area employ the following rule:

Divide the area of the disk by .7854 and extract the square root of the quotient. Expressing the rule in the form of a formula, we have

$$\text{diameter} = \sqrt{\frac{\text{area of disk}}{.7854}}$$

Substituting the value 1,415.65 square inches to find the diameter, we find that the

$$\text{diameter} = \sqrt{\frac{1415.65}{.7854}} = 41\tfrac{1}{2} \text{ inches nearly.}$$

The object is open at both ends, so it is necessary to remove sufficient material from the center of the disk for the opening at the small end. By describing a circle a trifle smaller in diameter than 13 5/16 inches will give the outline of the section to be removed. In working the plate it will stretch on the outside and gather on the inside, so it may be found necessary to reduce the diameter of the disk. This matter, however, must be found out by trial or experiment, as no fast rule can be given for work of this character, because, in working plate material by the *raising* or *hammer* process, no two workmen will handle the forming alike.

Stress in Rectangular Tank

Q.—Kindly let me know how to find the maximum pressure in a rectangular tank for holding water. Assume a tank *A*-feet long, *B*-feet wide and *C*-feet deep, made of ¼-inch steel plate, with braces across and lengthwise of the top to keep the upper edges straight. The construction is shown in the sketch, Fig. 1. My idea is that the pressure will increase as the length increases up to a certain place, it being understood that the pressure increases as the height increases. C. M.

A.—Your question is an interesting one; not only from a mathematical viewpoint, but also because of your idea relating to the stresses due to the length of the tank.

In the first place this fundamental fact should be observed: The pressure on the ends is the same, no matter if the tank be 1 inch long or 1,000 feet long; the pressure against the sides will be the same for a tank 1 inch wide as for one as wide as the Atlantic ocean. On the other hand, the effect of the pressure—that is, the strain produced by it—varies with the width and the length of the tank. By its effect the plates tend to curve outward and assume cylindrical form, as shown by the dotted lines *A* in Fig. 2. The bulging is prevented to a certain extent by the stiffness of the corners. The bending tendency increases with the length of the plates between the corners. Vertical stiffening angle irons will prevent this bulging.

Assume that the cross ties on the top hold the edges straight and as securely as the lower edge is held by the

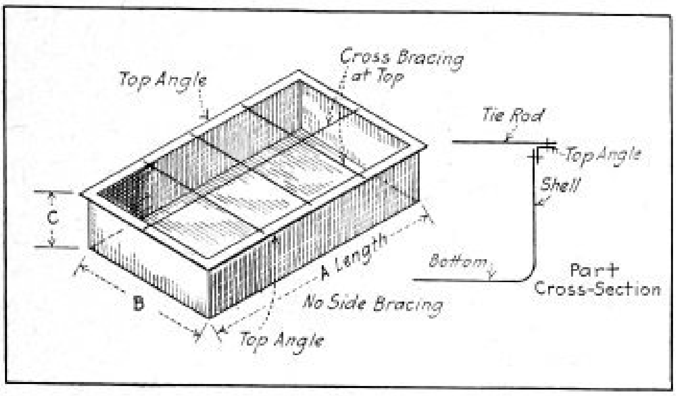
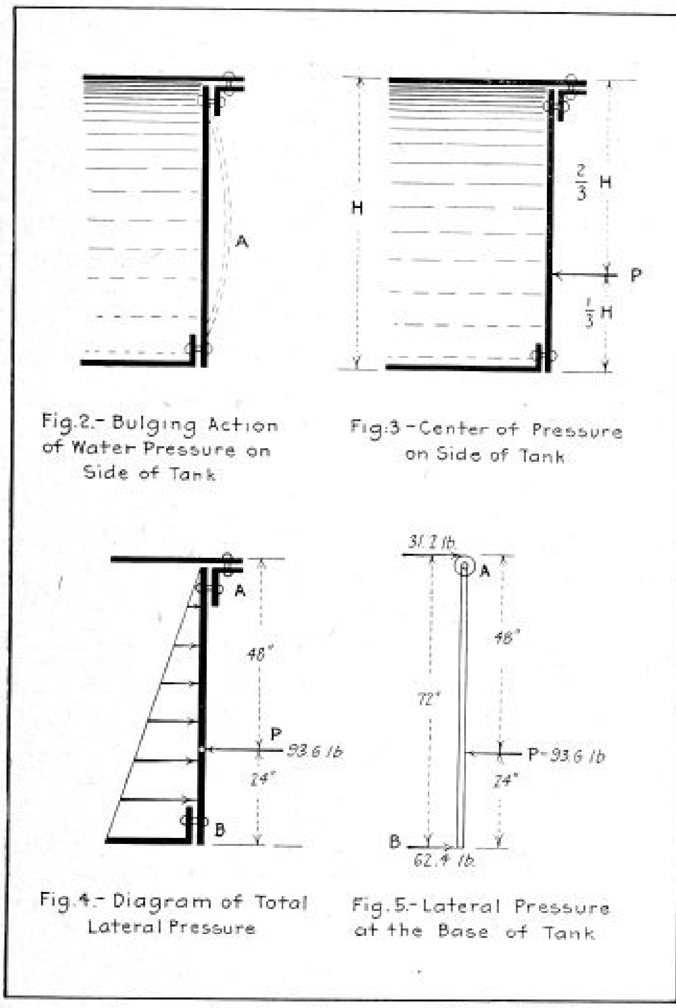


Fig. 1



Diagrams Showing Pressure on Sides of Tanks

bottom plate. The maximum stress is along the joint around the bottom. There is a static pressure against this joint equal to the weight of the water, and there is an outward pressure depending on the area of the plate. The calculations are made as follows: The pressure at the bottom of a column of water is equal to the weight of the water. The weight of water is 62½ pounds per cubic foot, or .0362 pounds per cubic inch. Taking the tank dimensions in inches, the weight W in pounds per inch in length of the tank tending to force the bottom joint of the tank is $C \times .0362$. Thus, suppose the height is 6 feet, or 72 inches, then $W = 72 \times .0362 = 2.6$ pounds.

The center of pressure on the side plates is along a line 2/3 the depth, measured from the top. In this case it would be located down $72 \times 2/3 = 48$ inches, or 24 inches above the bottom. By the center of pressure is meant the point or line about which the pressure above just balances that below it. This is shown in Fig. 3, where the pressure P is applied so as to hold the side of the tank in place against the water free from all support by the joints at the top and bottom. The amount of P is equal to the total water pressure against the plate, and this equals, per unit of length, half the depth times the weight of water unit times the area of the pressed surface. A diagram of this is shown in Fig. 4.

At A, or the top edge of the plate, the pressure is zero, while at B, the bottom edge, it is a maximum, or $72 \times .0362 = 2.6$ pounds. The average unit pressure of all these pressures from zero to 2.6 pounds from A to B is $72 \times .0362 \div 2 = 1.3$ pounds. Then the total lateral pressure P equals the average unit pressure multiplied by the depth AB, or 72 inches, 1.3×93.6 pounds on each strip 1 inch wide extending from the top to the bottom of the tank.

Having the total outward pressure against each 1-inch strip, or for the whole side if desired, the bursting pressure at B may be found by the principle of moments; that is, each force multiplied by its lever arm about a pivot will form moments that are equal to each other when just in balance. Thus, suppose the side plate to be pivoted at the top edge, as at A in Fig. 5, and a force P be applied to hold the side against B at the bottom. Then the force at B will be

$$\frac{93.6 \times 48}{72} = 62.4 \text{ pounds,}$$

and the joint should be designed to stand this maximum pressure with a large factor of safety, say 10 or 20. The pull at A in pounds per inch length of tank at the top on the tie rods is found by taking the pivot at B, or

$$A = \frac{93.6 \times 24}{72} = 31.2 \text{ pounds.}$$

The strains can be modified by the application of braces, and the like, but the pressure from the water is always the same.

Hendricks' Commercial Register

The twenty-fifth annual edition of Hendricks' Commercial Register of the United States for Buyers and Sellers, which has just been issued, rounds out a quarter of a century of usefulness by this standard publication. The work is especially devoted to the interests of the architectural, contracting, electrical, engineering, hardware, iron, mechanical, mill, mining, quarrying, railroad, steel and kindred industries, containing about 350,000 names and addresses, with upward of 45,000 business classifications. Full lists are included of producers, manufacturers, dealers and consumers, listing all products, from the new material to the finished article, together with the concerns handling these products, from the producer to the consumer.

There are 1,512 pages of text matter and the index of contents numbers 149 pages covering over 5,000 trade references. The list of trade names, brands, titles of identification, etc., is published for the first time, and numbers 202 pages. This list furnishes ready reference for purchasing agents and prospective buyers to distinctive products manufactured by firms listed in the work.

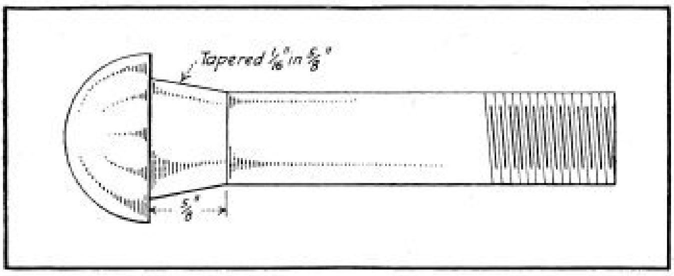
Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Setting of Crown Bar Bolts

In the September issue of the BOILER MAKER, H. E. S. asks for information on the setting of crown bar bolts. The information given was fundamentally correct, but there's trouble ahead for H. E. S. if he applies his bolts in the manner shown.

In the first place let me ask H. E. S. to get away from that idea of a copper gasket. "Iron to Iron" is the slogan these days, and if he will apply the crown bolts with a slight taper under the head, as shown in sketch, he will



Crown Bolt with Taper Under Head

have a tight job. Bolts should be tapered so that they will fit snug in the hole when 1/16 of an inch from the head; then a few blows with the hammer will set them up good and tight to the crown sheet.

If H. E. S. has given us the proper sketch of his crown sheet and wrapper sheet, let me ask him to get busy and change his sling stays before a Federal inspector comes along and gives him a lesson on the proper distribution and alinement of sling stays.

Sling stays must be applied in as near a vertical position as it is possible to get them, and not fastened with a key bolt, but with a threaded bolt and nut cotter pin applied when bolt is tight. JOSEPH SMITH,

Boiler Foreman, Baltimore & Ohio R. R.

Lorain, Ohio.

Allowable Pressure on Drum with Lap Seam Construction

I beg to call your attention to an error on page 312 of the October issue regarding perssure attainable on 24-inch drum of a Yarrow boiler, wherein it is presumed 319.6 pounds would be allowed on a lap seam design.

The A. S. M. E. Code, paragraph 188, for a shell or drum 36 inches diameter or less, having lap riveted longitudinal seam have a limiting pressure allowance of but 100 pounds. The code is in force in Wisconsin, California, Pennsylvania and Massachusetts, and Ohio has exactly the same ruling, while in Indiana the boiler laws will now admit lap seam boilers under 36 inches diameter.

Since the great boiler shops approve the code and as it is generally accepted even where laws are not in force, it follows the error should be corrected, as I presume your valued paper supports the code, per editorial on page 309.

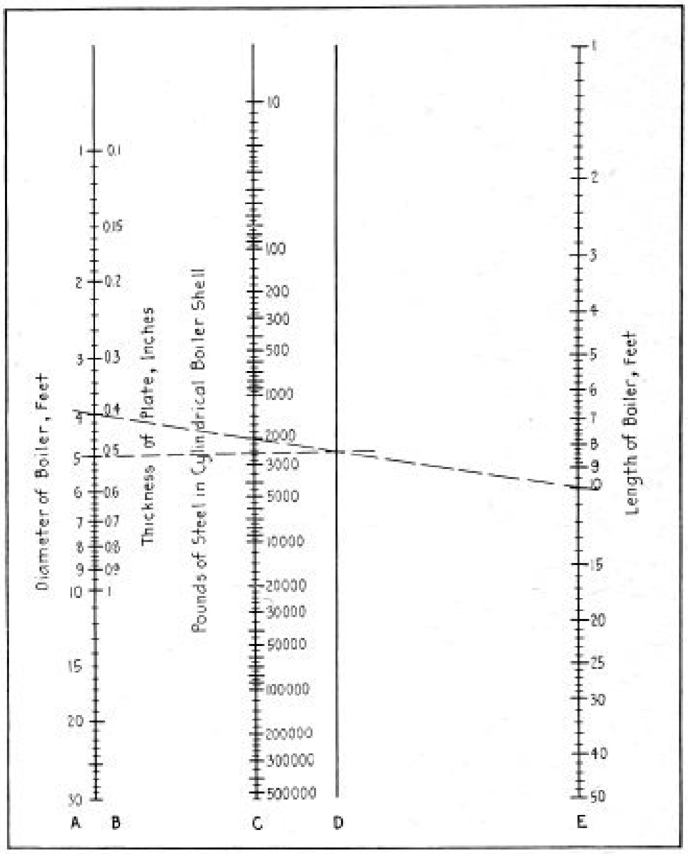
New York. T. T. PARKER.

C. W. Gallup has succeeded Mr. Crowfoot as purchasing agent of the D. M. Dillon Steam Boiler Works, of Fitchburg, Mass.

A Handy Chart for Determining the Weight of Boiler Shells

Lay a straight edge across this chart twice and it will immediately give the weight of any ordinary cylindrical shell such as used in boiler making.

For example, how much steel would be used in a boiler



Weight of Boiler Shell Found by Chart

shell 4 feet in diameter by 10 feet long, metal being 0.5 inch thick?

Connect the 4 (column A) with the 10 (column E) and locate the intersection with column D. From that point of intersection run over to the 0.5 (column B), and the intersection with column C shows the weight to be very close to 2,550 pounds.

By following this self-same method any problem may be solved where length does not exceed 50 feet, diameter 30 feet and thickness 1 inch.

N. G. NEAR.

A Burned Crown Sheet

If there is mud on the crown sheet the crown bolts will gradually begin to leak, and as the mud or heavy scale becomes thicker they will leak more, and finally the sheet will begin to show sagging or bulges between the bolts. The leaking bolt can usually be stopped (for a short time) by lightly hammering the head of the bolt.

This kind of burn is not very serious, but very annoying, and may in a short time give rise to more serious consequences. A note of all leaking crown bolts and sagging crown sheets should be kept, and the sheet watched closely for cracks which will start from the crown bolt holes when mud is present on the crown sheet. In making out a report, the fact should be mentioned so that the master mechanic who gets the report can tell the condition of each boiler.

The difference between a mud burnt crown sheet and one burned for the absence of water is very noticeable, if you can get a look at the sheet directly after the burning. The sheet burnt from the lack of water will look like a sheet of new 1/16 inch iron with the nice blue color all over it, if seen directly the burning takes place and before the boiler is fired up. If the burn is only slight the crown bolts will leak only a little, and can easily be calked. The sheet will also appear to be sagged between the bolts and when struck a sharp blow with the hammer will give off a clear sound, showing that there is no mud present. It is also possible to hear the scale falling back on the sheet.

If the sheet is badly burned the bolts may become loose or possibly the heads pulled off and sheet bagged down like the one mentioned.

In calking crown bolts great pains should be taken to find out what kind of a bolt it is—the radial bolts, the ones that screw into the sheet with a big head like bolt in Fig. 1,

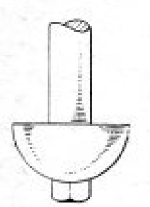


Fig. 1

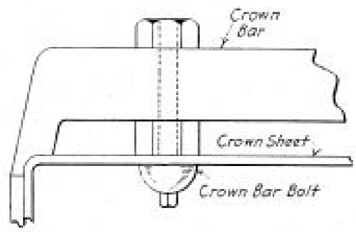


Fig. 2

and the old time ones riveted at both ends. The radial bolts may be stripped and quite loose in the sheet, and in that case it would be quite impossible to make them tight. The crown bar bolt shown in Fig. 2 will be quite as difficult to calk tight after it has once been burned, for there is no thread on this kind of bolt and all that holds it in position is the nut on top of the bar.

When these bolts are first put in they are driven up with a heavy hammer. A bolt 1 inch under the head is driven into a 15/16 inch hole. It is driven in like a drift pin, and the nut screwed down tight on the bar so that the crown bar, crown sheet, and the thimble that comes between the bar and the sheet are drawn close together and usually makes a splendid job. But once the sheet is burned the bolt becomes loose in the hole, and, like a drift pin, wants to fall out.

This is really a dangerous thing to monkey with when there is steam on the boiler. Always find out how the crown bolts are fastened. If they go through the wagon top and are riveted, there is very little danger of them falling out unless they are broken. In that case the steam generally blows them out.

In all report forms there are questions asked—the condition of flues, arch, firebox, crown bolts, grates, etc.—to which you must make the proper report. In the case of the engine with the loose crown bolts, the answer should be, crown bolts in bad condition and loose in the sheet (state how many), crown sheet badly sagged or corrugated between the bolts. This should draw the attention of the master mechanic to the engine, and he should have her shopped.

If your engines are all second hand the chances are that none of them has flexible bolts in, so you cannot compare the sounds with a solid bolt, but the way you say is correct. Now suppose you know that you have a solid bolt, the sound is that of striking something solid and well supported, then strike the sheet around the bolt, and the sound will be solid and that of something weak and well supported. Also the feel of the hammer is quite different, and, in fact, it is a question which (sound or feel) conveys the fact to your mind that the bolt is broken. They are both reliable and will in a short time become quite familiar to you, so that you will be able to tell a broken bolt at the first touch of the hammer.

Another thing to remember, when inspecting, is that you are there for the protection of the company, and they expect you to do your duty. This can be done only by keeping a record of all boilers examined—the size, the location of all patches, the condition of all flues, particularly the bead, if any are plugged or ferruled, and the number of them. Make this note for your own guidance, and upon the first examination carefully go over the firebox, look for cracks, patches or cracks that have been plugged. State which sheet, between what row of staybolts from bottom, top, back or front end, as the case may be. Give the date of the first examination, and on making subsequent reports you can refer to your book and at the same time know if the condition of the firebox is worse than on previous examinations. Don't forget to examine the four corners of the mudring and the bottom of the flue and door sheets; also the outside of the firebox or any part of the boiler you can get at. The object of this is that should anything happen to cause an accident you will be able to give full information as to the condition of things when you first took hold. If the engine is shopped for repairs make a note of such repairs in the page set apart for that engine in your book. See that all staybolts are drilled with the telltale holes. If not, report the fact on your first report on that engine.

All the above may appear a lot of details to look after, but remember that these particulars are for the benefit of the master mechanic who does not go into the firebox like Mr. ——— does, and when the master mechanic sees a report giving all the defects that you may find, he is liable to sit up and make inquiries about the man making such reports, and this may lead to something better later on.

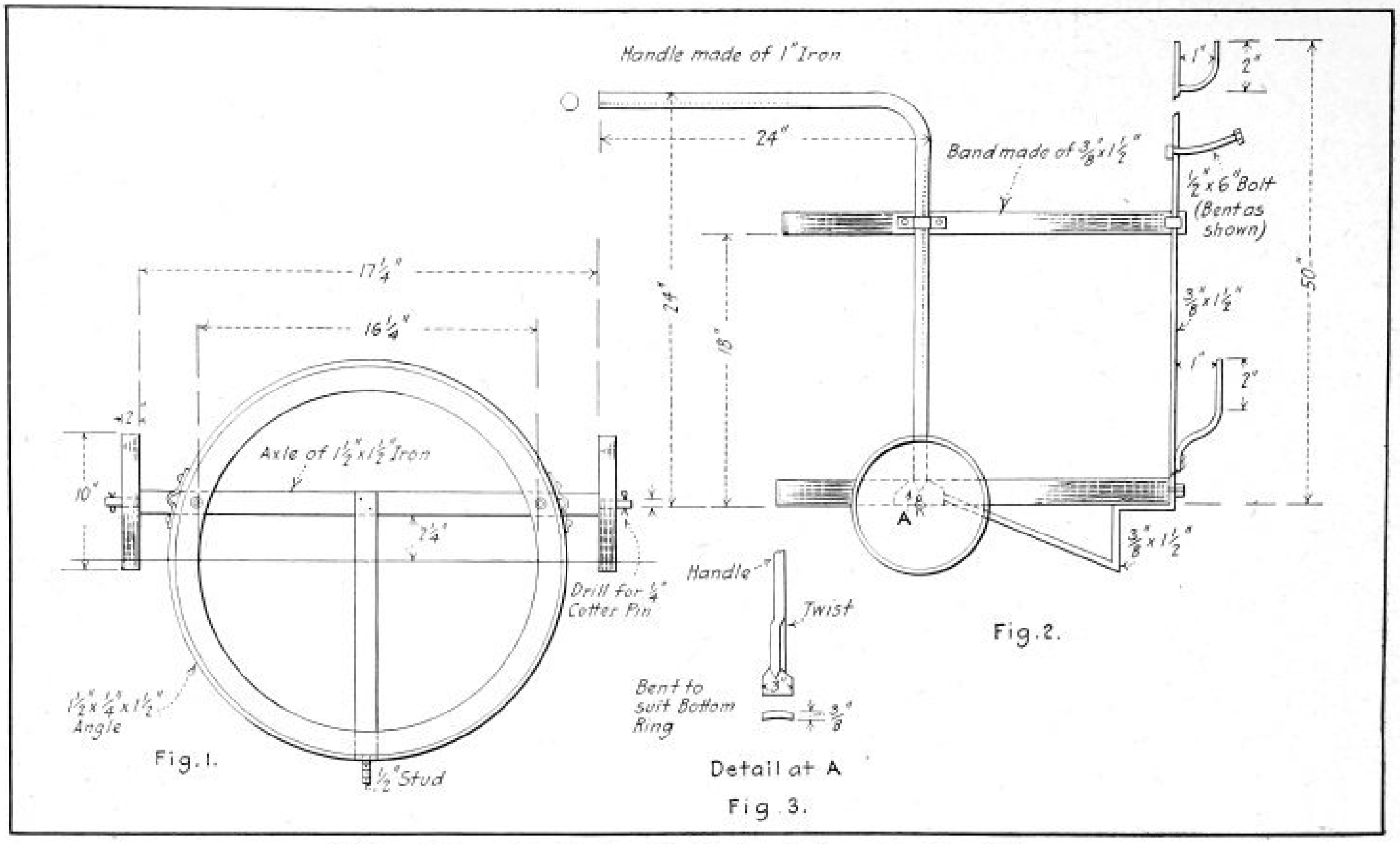
I do not anticipate any trouble in your case if you follow out what I have told you, for with telltale holes the bolt when broken will make itself known, and all bolts showing the least sign of leak should be stopped.

Youngstown, Ohio. R. B. H.

Wagon for Hauling Tank, Burner and Hose of Fire Starting Equipment at Union R. R. Round House, Hall, Pa.

Fig. 1 shows a plan view of a wagon used for hauling the tank, burner and hose of a fire starting equipment at the Union Railroad round-house at Hall, Pa. The wagon is made as follows:

The bottom ring is of 1½-inch by ¼-inch by 1½-inch angle iron, 16¼ inches inside diameter (in which the tank rests), and is secured to the axle by two ½-inch rivets driven into countersunk holes. The axle is set 2¾ inches from the center of the ring, which provides for the weight of the apparatus when at rest and prevents its overbalance. The ends of the axle are turned down to 1 3/16 inches to fit the bore of the wheel. The wheels are solid cast iron, 10 inches diameter, 2 inches wide (tread). The handle fastens on to the base ring directly over the center of the



Details of Wagon for Hauling Fire Starting Equipment in Round House

axle by two 3/8-inch rivets, driven into countersunk holes so that they will not interfere with the bottom of the tank.

It will be noticed by referring to Fig. 3 that the bottom of handle is forged to suit the bottom of the base ring, and has a slight twist or turn about 8 inches up the bar. This twist brings the handle back square with the base line. Eighteen inches up the handles are 7/16-inch holes, to which are bolted the band which encircles the top of the tank. This band is made of 3/8-inch by 1 1/2-inch flat iron, and is in two sections. When the tank is placed in the base ring this band (or gland) is put around it, bolts passed through the ends of the band, and holes in the handle, and driven together, the front section of this band having a 1/2-inch stud, as shown at the front of the base ring. This provides a fastening for the front brace, made of 3/8-inch by 1 1/2-inch iron, with a top extension provided with brackets at top and bottom on which to hang the burner. At any convenient distance from the top piece is a 1/2-inch by 6-inch bolt, with a nut on both sides of brace. This hook will hold the coil of hose.

This apparatus was originally intended to be carried by two men, and when loaded with 20 gallons of oil the whole was quite a load. With this truck one man does the work easily.

Pittsburg, Pa. G. H. Harrison.

Is the Tidy Man Best?

It is hard to tell a man just how he should go about a repair job, especially if the job is different from others he has tackled. I have seen mechanics who plunge right into the job head foremost, almost, following a method that is not actually the quickest, and finish it in a jiffy as though there were nothing to it. Others begin it immediately and after a while find that they are on the wrong track and so begin all over again. The third type thinks it over carefully first, goes at it in an orderly manner, and may beat the first type in point of time and may not. The first type may hit the correct method right away. The fourth and last type thinks and thinks and putters. He works in an orderly manner, but never seems to get anywhere. He is more theory than practice, and can be compared with the Arkansas inhabitant who didn't need a roof when weather was fine, and who couldn't fix the leaky roof when it rained. It is possible to do too much thinking.

I doubt if this phenomenon is real thinking. It is "dread" of the actual work more than anything else, in my opinion. He "wishes" he could find an "easy way out of it."

Which type of man is best, though? That's the question, and I can't answer it. Write the types on four pieces of paper, shuffle them in a hat and select any one, and you are bound to pick the type that can handle "a certain job" correctly. Perhaps I shouldn't be so hard on the other three types, but I can't help it.

Personally, I prefer the tidy man—the man who does things in an orderly way, who has a place for everything, and who seems to have even his mind indexed. I believe in systematic and not haphazard performance, and it has been my experience that the tidy man "averages" better than the disorderly man, yet the latter often beats the former on certain jobs. You know that yourself, but have you ever thought of it before?

New York. N. G. Near.

Fuel Economy and Locomotive Boiler Design

(*Concluded from page* 328.)

box containing large grates, efficient baffling and gas mixing devices, large volume and long flame-way or combustion chamber space.

A comparatively small percentage of the engines in service to-day are equipped with combustion chambers, although this deficiency has been partly overcome on more than 30,000 locomotives by the installation of the brick arch. What has been said about the value of radiating surfaces, high firebox temperatures, complete mixing and baffling of the gases and combustion chamber space is sufficient to explain the benefits derived from the arch, and to account for its almost universal use.

In an ordinary firebox without an arch, cold air through holes in the fire rushes directly into the bottom flues, chilling them and causing them to contract and leak; the hydrocarbon gases, being driven off from the bank of green coal under the fire door, are passing out for the most part unburned. There is a notable absence of any mixing of the gases, and the combustible hydrocarbons are escaping unburned from one portion of the fuel bed, while from another portion a large supply of excess oxygen is passing out.

On the other hand, an arch not only mixes the gases, but protects the flues from any cold air coming through holes in the fire or through the open fire door from entering directly into the flues.

It is almost impossible to burn all the hydrocarbon gases, even with an arch, when carrying a heavy bank of green coal under the fire door. In addition to the loss due to these unburned hydrocarbons the bank of green coal reduces the radiating surface of the fuel bed, lowers the firebox temperature at that point and reduces firebox evaporation.

The effect of uneven firing is to cause an amount of volatile hydrocarbons being distilled off from the green coal and escaping partly unburned, but an ideal light, level fire gives a uniform air supply through the fuel bed, more uniform mixing of the gases and a uniformly high firebox temperature. This is productive of the highest firebox evaporation and over-all boiler efficiency. In this connection the arch, by causing all the flames to pass around and over it, completely fills the firebox with the burning gases or flames and thereby increases the radiating surfaces, as well as the temperature, in the combustion chamber formed above the arch.

The value of this device is thoroughly recognized. While it has done much to reduce fuel losses and increase locomotive efficiency, it cannot overcome all of the deficiencies of firebox or boiler design. It will increase the efficiency of a firebox limited in grate area or volume, but the maximum firebox efficiency cannot be obtained by the use of the arch alone. Large grates, with medium rates of combustion and long combustion chambers, are necessary, and, when used in conjunction with the arch, will add materially to both the capacity and efficiency of the locomotive boiler.

To summarize briefly:

The capacity and efficiency of the locomotive boiler seem to be limited by the inability of the firebox to properly burn the coal and liberate the heat contained.

The larger part of the heat losses (particularly at high rates of combustion) are due directly to the inefficiency of the furnace.

The second largest heat loss is that due to the heat escaping in the front end gases, which is unavailable for absorption by the boiler.

The amount of heat rejected by the heating surfaces is comparatively small, and the heating surface efficiencies are high as compared with the furnace efficiency.

The efficiency of the furnace can be increased by increasing the grate area and reducing the rate of combustion by providing effective baffles and gas mixers, and by increasing the firebox volume by making the fireboxes as deep as possible and equipping them with long combustion chambers.

The front end heat loss will be reduced as the efficiency of the furnace is increased, but there will always remain a large portion of unavailable heat, which can only be utilized by means of some auxiliary apparatus—preferably a device for pre-heating the air used in the furnace.

The efficiency of the heating surfaces can be increased by increasing the radiating surfaces. This will result in a higher firebox evaporation and reduction in the amount of heat to be absorbed by the flues, which in turn would mean higher flue efficiency.

Increasing the size of firebox and length of combustion chamber necessarily means shortening the flue. If the flues are reduced in length to less than 110 times the diameter, the decrease in efficiency will be largely offset by the increase in heat absorption by the larger firebox, and can be more than offset by decreasing the diameter of the flue to correspond with the decrease in length.

The vital part of the boiler is the firebox. It liberates and makes available the heat energy stored in the coal. A considerable portion of this energy is now being wasted through the inability of the firebox to properly burn the coal. The highest degree of fuel economy cannot be obtained while this condition exists. The success of future efforts to reduce the coal bill will depend largely upon the effectual elimination of firebox defects, which we have attempted to point out in this paper.

Starting a New Boiler Shop of His Own

(Concluded from page 334.)

deep at the two air pipes and was given a plaster coat of cement mortar ½ inch thick. Then the air was connected to one end of the pipe, the other end was capped, and a fire was built after the mortar had been in place two days. The other flanging fire was round, about 5 feet in diameter, the steel shell 20 inches high. A 2-inch air pipe was run through the bottom of the shell and a single tee with a 1½-inch branch and nipple was placed in the center of the shell, which was lined with paving brick and then built to a saucer shape as described. There is a single 1½-inch air pipe in this fire, against two 1-inch air pipes in the other fire."

"Henry, where did they locate the shafting, the punch, shear and bending rolls in your little shop so as to be handy and at the same time out of the way of the overhead traveler?"

"Why, the shafting was placed just underneath the traveler on the side next to the lean-to and bolted to the timbers—built up of 2-inch plank—which carried the traveler. The punch and the shear were placed between these posts, partly in the main building, from which side the machines were operated, and partly in the lean-to. The bending rolls were placed at the far end of the shop, in the main building, the driving belt running across the main shop close to the far end wall and below the traveler. This left the greatest possible amount of floor space available for floor work and at the same time permitted the traveler to serve all three of the machines mentioned without one being in the way of the other."

"Do you like the new shop as well as you did the old one, Henry?"

"Oh, yes, Mr. Francis. It's far more comfortable than the old shop. Why, here you can see what you are doing, but in the old shop you had to turn on a couple of electric lamps to see if it was daytime or night."

The largest steam boilers ever installed in the United States are the six-drum, single-ended boilers, each having 25,000 square feet of heating surface and covering a floor space of 384 square feet, designed and built by the Badenhausen Company for the new Highland Park plant of the Ford Motor Company.

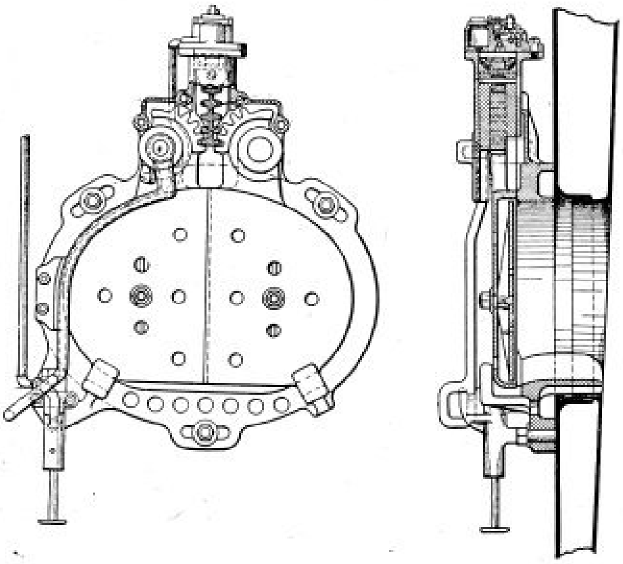
Selected Boiler Patents

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

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

1,186,977. FIRE-DOOR APPARATUS. ALBERT G. ELVIN, OF SOMERVILLE, N. J.

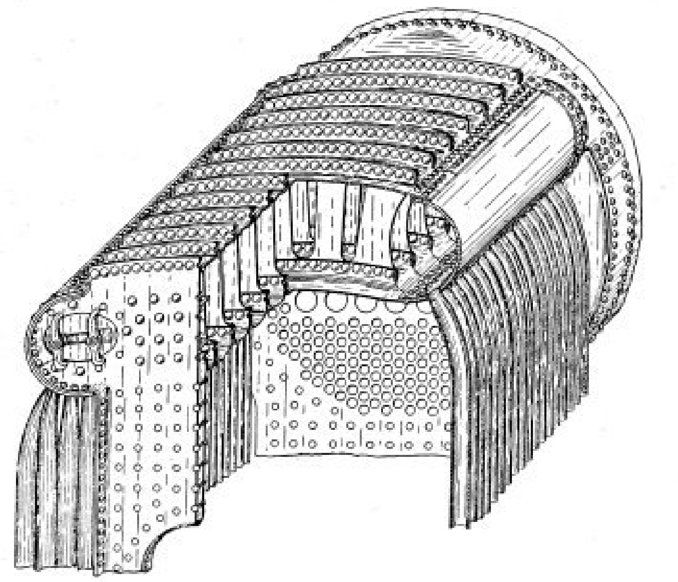
Claim 1.—In a fire-door apparatus, the combination of a pair of doors, each pivoted to swing laterally and vertically, a vertical cylinder located



above said doors, a piston in said cylinder for operating said doors, and a floating stop carried by the piston for arresting the doors at the full open position. Seven claims.

1,181,650. FIRE-BOX. CHARLES DUCAS, OF NEW YORK, N. Y., ASSIGNOR TO JACOBS-SHUPERT UNITED STATES FIRE-BOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF PENNSYLVANIA.

Claim 1.—A fire-box comprising a door sheet, a flue sheet, a water chamber comprising a crown sheet, a roof sheet and lateral semi-cylin-



drical connecting sheets, the water chamber being connected to the tops of the door sheet and flue sheet, and watertubes connected to the water chamber and located at the sides of the fire-box. Thirty claims.

1,177,515. DRAFT DEVICE AND FLUE-CLEANER. LOUIS H. HATFIELD, OF NEWARK, OHIO.

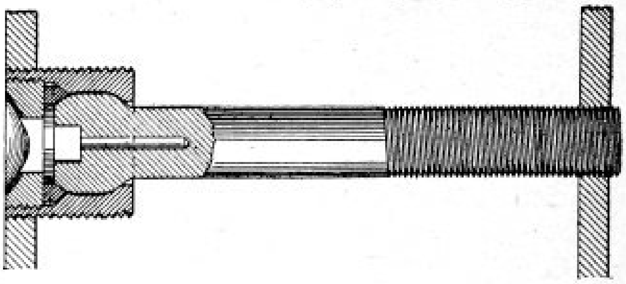
Claim 1.—In combination with a steam boiler having a smoke box, a nozzle disposed in the smoke box, and an exhaust steam pipe connected with said nozzle, of an inverted funnel surrounding said nozzle within the smoke box and having its bottom peripheral edge curved concentrically with the curvature of the peripheral wall of the smoke box adjacent said nozzle, and supporting legs carried by said funnel and contacting with the bottom peripheral wall of the smoke chamber adjacent said nozzle whereby, the bottom peripheral edge of the funnel is held in space relation with the bottom of the smoke box and the neck of the funnel in spaced relation with the mouth of the nozzle.

1,180,369. AIR DEFLECTOR FOR FIREBOX DOORS. RICHARD DUBOIS BALDWIN, OF CHICAGO, ILL.

Claim 1.—A deflector adapted for attachment to the door of a firebox back of the damper opening, comprising a shell formed to provide a throat having a horizontally presented inlet opening or mouth in line with said damper opening and a downwardly presented discharge opening near the bottom of said door, said throat having a wall adapted to deflect the body of air entering through the inlet opening or mouth, downwardly through the discharge opening, said shell having a plurality of upright spaced webs in the discharge opening of said throat for splitting up the body of air passing through the discharge opening into a plurality of smaller bodies. Two claims.

1,182,690. STAYBOLT. HARRY A. LACERDA, OF SCHENECTADY, N. Y.

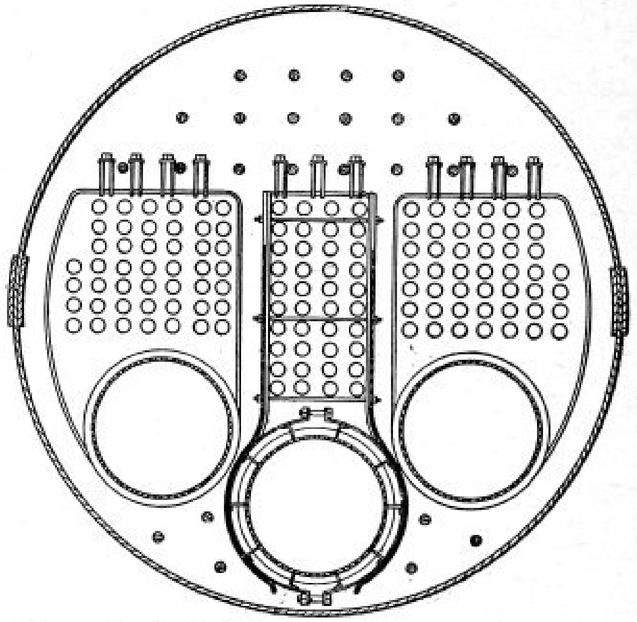
Claim.—A staybolt, comprising a bolt, a plug having a ball and socket joint connection with the said bolt, a packing ring fitting into the outer



face of the said ball and socket joint connection, the said ring projecting outward beyond the face of the bolt, and a cap screwing on the plug against the said ring, the said cap having a central opening for gaining access to the bolt.

1,183,988. CIRCULATOR. EDWARD T. KLIPPERT, OF DETROIT, MICH.

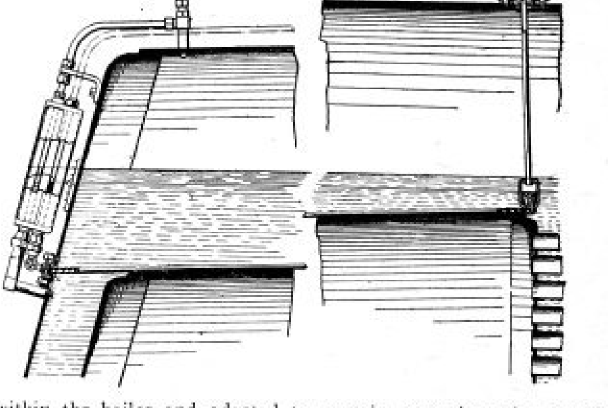
Claim 1.—The combination with a boiler provided with a heating chamber, of a horizontally flexible and removable curtain suspended in spaced relation on each side of said chamber, the two curtains made up



ing at the top through which the heated water is discharged and an opening at the bottom through which the colder water is drawn. Nine claims.

1,183,439. AUTOMATIC LOW-WATER-LEVEL MARKER. WILLIAM DALTON, OF SCHENECTADY, N. Y.

Claim 1.—The combination, with a steam boiler of a type which is subject to rolling or pitching motion in service, of a water level marker comprising an indicator outside the boiler, a reservoir located at a critical



point within the boiler and adapted to contain a portion of a leveling liquid, said reservoir being so proportioned relatively to said indicator and so disposed as to establish a relatively large leveling liquid surface at a level corresponding with that of the critical point, said indicator being adapted to contain another portion of such liquid, a liquid communication conduit connecting the lower portions of said indicator and reservoir, and means whereby equal pressure may be maintained on the surfaces of the liquid in the reservoir and in the indicator. Four claims

THE BOILER MAKER

DECEMBER, 1916

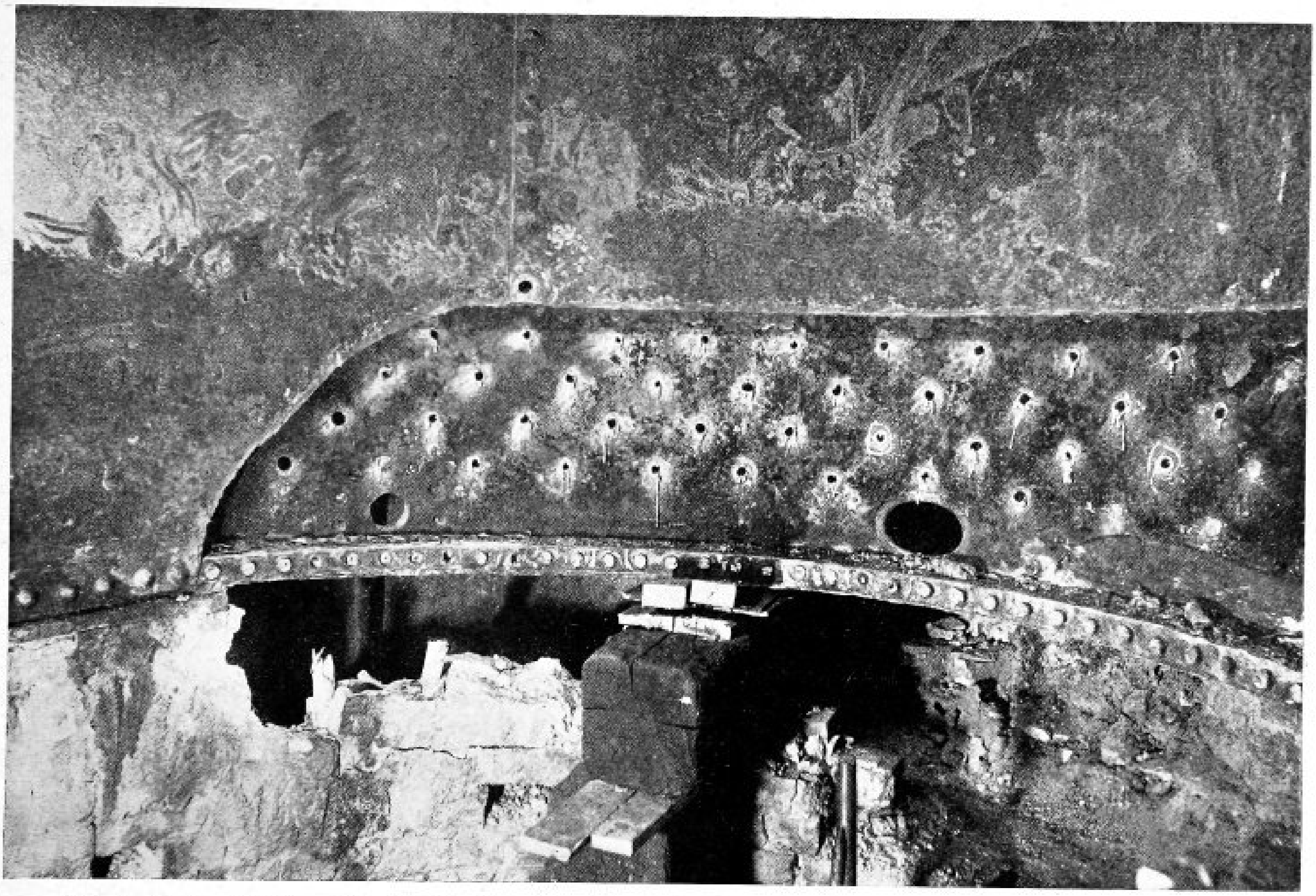


Fig. 1.—Interior of Firebox After Staybolts Have Been Burned Out and Sheet Cut Away with Oxy-Acetylene Torch for Patch

Cutting Out Staybolts and Welding in Firebox with Oxy-Acetylene Torch

An excellent example of the immense value and usefulness to an up-to-date boiler maker of a compressed gas welding and cutting equipment is shown by the illustrations on this and the following page. The most common type of these machines is the oxy-acetylene equipment, and such equipment has repeatedly proved its value for all classes of cutting and welding of metals. Its use for manufacturing and repairing boilers, tanks, etc., has rapidly extended until now it has become one of the most important tools in a modern boiler shop.

The photographs reproduced herewith show a repair job on a vertical boiler in a manufacturing building on West Broadway, New York City. The boiler is of the Manning type, in the firebox of which a cast iron ring was fitted to hold up the grate bars. As the boiler was located in the cellar of the building, it was frequently subjected to drafts of cold air and the cast iron ring in turn was, therefore, subject to sudden expansion and contraction. This, in turn, caused leakage, thereby corroding and eating away the firebox plate until it became a source of danger.

Fig. 1 shows the interior of the firebox, where the plate and staybolts had been cut away preparatory to fitting in the new plate or patch and welding it in. Fig. 2 shows the operator in the act of burning out the old staybolt heads preparatory to putting in new ones.

This boiler is one of a pair standing side by side. Its mate had been repaired in a similar manner a year previous and the engineer in charge of the plant stated that since the repairs were made he has had a pressure of 180 pounds per square inch in the boiler without a sign of a leak or undue stress.

In conclusion, it may be stated that this is only a sample of one of the many accomplishments that may be at-

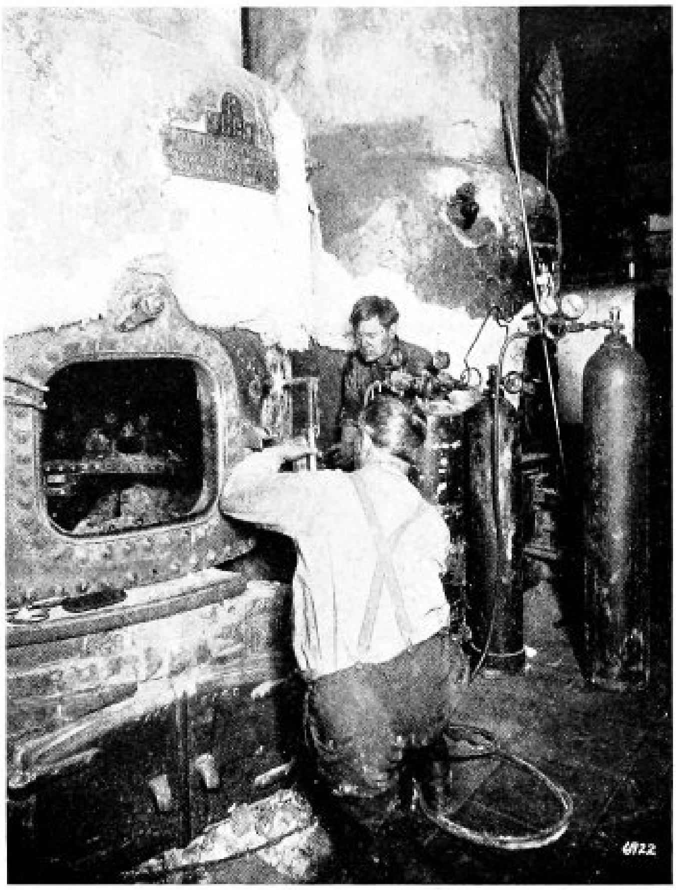


Fig. 2.—Burning Out Staybolts with Oxy-Acetylene Torch

tained by the use of the oxy-acetylene equipment. The particular job illustrated was done by the Michael Fogarty Boiler Works of West Thirty-third street, New York. The apparatus used was supplied by the K-G Welding and Cutting Company, 556 West Thirty-fourth street, New York.

Patching Concrete Floors

One of the principal objections often raised against the use of concrete finished floors is the difficulty and cost of successfully repairing places that become worn or damaged. For best results it is usually considered necessary to cut down the worn place at least one and a half inches into the unbroken concrete, under-cut the edges, clean out the dust and loose particles thoroughly, wash with a thin cement grout, fill in with a paste grout, and finally float to a level surface a mortar of cement and crushed stone or gravel. The patch must then be kept moist for at least a week or ten days, keeping all traffic off in the meantime.

Mr. W. P. Anderson, president of the Ferro Concrete Construction Company, states that his company often uses a method of patching concrete floors which is much cheaper and requires far less time than the method commonly used. Mr. Anderson's method requires the use of a mastic material made from a mixture of asbestos fiber and rubber gum. This mixture is applied with a trowel after thoroughly cleaning the damaged surface. Very little cutting of the old concrete is necessary, other than to break off loose particles. The gum can be worked to a feather edge so that it will readily join with the undamaged concrete surface and eliminate the under-cutting required with the old style patch.

A patch of this sort can be opened to foot traffic within a few hours and to heavy traffic within a day or so. It is thus possible to repair a much-used portion of a mill or factory floor almost over night. The cost varies with the size of the patch, but will amount to from 16 to 18 cents per square foot.

It should be noted that while the mastic mixture described above is especially applicable to thin patches and for locations where loads do not exceed one and a half tons, it is not suited for deep holes and large broken areas.

A "Thickness of Material" Chart

Ths chart will be found convenient for computing boiler plate thickness or tank thickness for any gage pressure between 10 and 1,000 pounds per square inch, and for any diameter of tank or boiler between 10 inches and 1,000 inches.

The idea of making this chart came from J. L. W.'s contribution to the April BOILER MAKER, page 100, where he uses the much used factor of safety "five," a joint

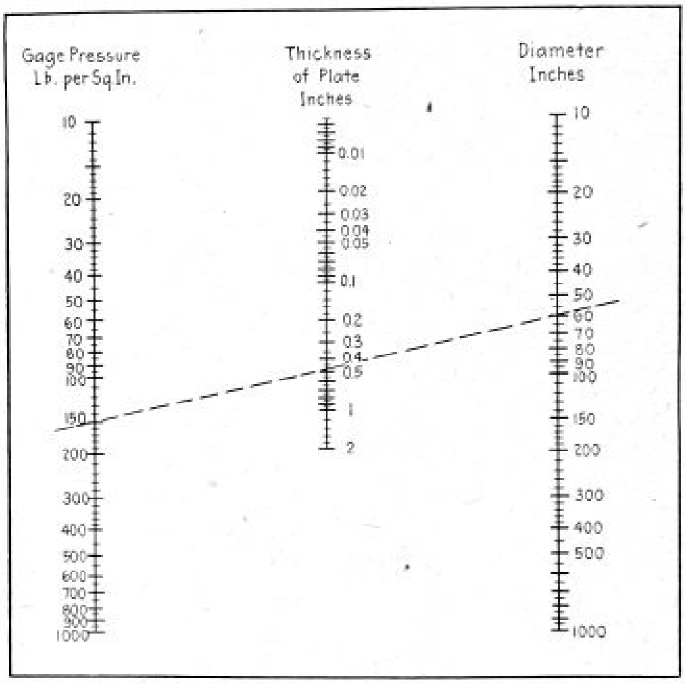


Chart for Finding Plate Thickness

efficiency of 85 percent, and a unit stress of 55,000 pounds per square inch. This chart is therefore based upon those figures and incorporates them in such a way that they are included in the result. All you have to do is to stretch a thread across the chart as indicated by the dotted line and the thickness is read off directly from the middle column.

Of course, if you are going to use a different unit stress, different factor of safety, or different joint efficiency, this chart will not solve the problem without further figuring, but since the figures recommended by J. L. W. are used so much I feel that the chart will prove itself useful to the designer or estimator.

The dotted line drawn across the chart solves the problem presented by J. L. W. without any ado. The answer is 0.48 inch thick. The dotted line shows the answer distinctly. Of course, a ½-inch plate would have to be used.

New York. N. G. NEAR.

JOHN MOHR & SONS, boiler makers, Chicago, recently suffered a loss estimated at $115,000 from fire which practically destroyed its shop on West Illinois Street.

THE HAMBURG BOILER WORKS, maker of pneumatic and storage tanks and air receivers, Hamburg, Pa., is extending its main shop 50 feet and will require a number of new boiler shop tools.

Locomotive Firebox Proportions*

Firebox Volume Measured by Ratio of Firebox Heating Surface to Grate Area—Objections to High Ratios

BY LAWFORD H. FRY

In discussing the report of the committee on fuel economy at the Master Mechanics' Association convention in 1915, the writer called attention to the necessity for sufficient firebox volume, and pointed out that the volume provided could be conveniently measured by the ratio of firebox heating surface to grate area. The present article is intended to discuss further the question of firebox volume and this proposed method of measuring it, and at the same time to deal with an objection which has been made.

Let us take first the question of firebox volume, and consider what happens during combustion, not so much the chemical, but the mechanical action taking place. Air and coal are brought together for combustion. The air, by reason of the draft created by the blast pipe, is sucked in through the grate openings and firedoor, and swept through the firebox into the tubes and out through the smokebox. The coal, on being thrown into the firebox, is rapidly split up by the heat into fixed carbon and volatile matter. The fixed carbon lies on the grate and burns there with part of the air entering through the grate, while the volatile matter, which carries a very considerable proportion of the heating value of soft coal, is swept through the firebox with the remainder of the air and the smaller particles of coal carried off the grate by the draft. The volatile matter and the small particles of coal will be burned if they have an opportunity of coming into contact with the oxygen of the air while at the high temperature of the firebox. When the gases enter the tubes the temperature falls too low for combustion to continue. Consequently the completeness with which soft coal is burned will largely depend on the time and opportunity afforded to the gases for mixing in the firebox. A brick arch will greatly assist the mixing of the gases at high temperature, but firebox volume is of high importance. In practically any locomotive boiler an increase in firebox volume would mean an increase in opportunity for more complete combustion and consequently an increase in efficiency.

Now, in a locomotive firebox of a given grate area, an increase in firebox heating surface means an increase in firebox volume, and we may therefore say with quite sufficient accuracy that an increase in the ratio of firebox heating surface to grate area means an increase in the ratio of firebox volume to grate area; or going back to the previous proposition, we can say that an increase in the ratio of firebox heating surface to grate area means an increase in the efficiency of combustion.

This is undoubtedly true, but the superintendent of motive power of a large Western road has pointed out to the writer that a high ratio of firebox heating surface to grate area does not necessarily indicate a desirable locomotive, and that it may, in fact, be accompanied by conditions which give undue difficulty in firebox maintenance. The point is illustrated by the four locomotives, the dimensions of which are given in Tables I and II. The locomotives of the three classes, *A*, *C* and *D*, with respectively 4.45, 3.40 and 3.39 square feet of firebox heating surface per square foot of grate area, are very satisfactory, while the class *B* locomotives, with 5.28 square feet of firebox surface per square foot of grate, give an undue amount of operating trouble from leaky staybolts.

An instructive lesson in locomotive proportions and in the use of ratios for comparing locomotives can be drawn from a consideration of this statement. In the first place we have our attention called to the fact that a single ratio is never sufficient for a criticism of a locomotive, the reason for this being that the value of the ratio may be increased by increasing one of the quantities compared or by reducing the other. For example, in a given design we can increase the figure for the firebox heating surface per square foot of grate area, either by increasing the firebox surface or by reducing the grate area. Therefore a high ratio may mean either ample firebox surface (which would give ample firebox volume), or it may mean a restricted grate area. Our conclusion that an increase in the ratio of firebox surface to grate area gives an increase in efficiency is based on a comparison in which the rate of combustion per square foot of grate area is the same. If the boiler with the larger volume ratio has to be forced to a higher rate of combustion per square foot of grate, all the efficiency gained by the greater volume may be lost, and further drawbacks may be introduced. As we shall see, this happens in the case of the class *B* locomotives. To study this side of the question we need some measure for the relation between the size of the grate and the service for which the locomotive is intended, and for this purpose the rated tractive effort per square foot of grate area is suggested. The values of this for the four locomotives

TABLE I—PROPORTION OF HEATING SURFACES AND GRATE AREA

1 Class	2 Firebox Heating Surface, sq. ft.	3 Total Heating Surface, sq. ft.	4 Grate Area, sq. ft.	5 Sq. ft. of Total Heating Surface per sq. ft. of Grate Area	6 Sq. ft. of Firebox Heating Surface per sq. ft. of Grate Area
A	140	1,498	31.5	47.6	4.45
B	162	2,814	30.8	91.4	5.28
C	167	2,844	49.0	58.0	3.40
D	187	3,839	55.1	69.6	3.39

TABLE II—TRACTIVE EFFORT FACTORS

1 Class	2 Cylinder Diam., in.	Cylinder Stroke, in.	4 Driving Wheel Diam., in.	5 Boiler Pressure, Lb. per sq. in.	6 Rated Tractive Effort, Lb.	7 Lb. Tractive Effort per sq. ft. Total Heating Surface	8 Lb. Tractive Effort per sq. ft. of Grate Area
A	20	24	50	150	25,400	17.0	808
B	20	28	62	205	31,400	11.2	1,005
C	22	28	56	205	42,000	14.8	860
D	24	28	62	205	45,300	11.8	825

referred to above are shown in Table II. The rated tractive effort is calculated by the usual formula from the cylinder and driving wheel dimensions, using 85 percent of the boiler pressure as mean effective, and the table shows in column 7 the rated tractive effort per square foot of total heating surface, and in column 8 the rated tractive effort per square foot of grate area. It will be seen that while classes *A*, *C* and *D* have from 808 to 860 pounds of tractive effort per square foot of grate, class *B* requires each square foot of grate to furnish no less than 1,005 pounds of tractive effort. This means that to develop the same proportion of total power the class *B* locomotive must have the combustion per square foot of grate forced from 20 to 25 percent harder than the other classes. Herein lies the cause of the firebox and staybolt trouble with this class. The forcing of the fire means an ex-

* From *Railway Mechanical Engineer.*

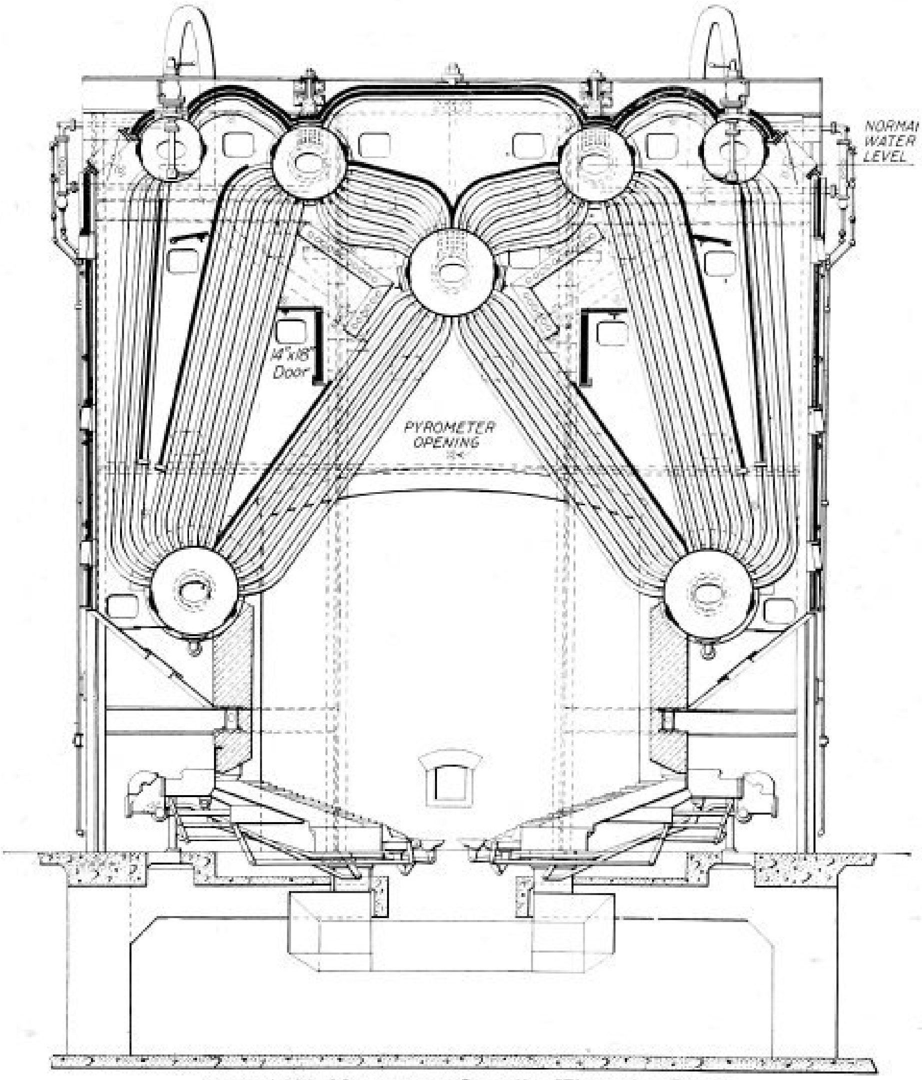
cessively high firebox temperature, which is detrimental to the life of the box, both by its direct action and by reason of the great drop in temperature produced when the engine is shut off.

It is interesting to compare also the figures for tractive effort per square foot of total heating surface. On this basis of comparison the class *B* engine makes the best showing, having only 11.2 pounds per square foot, while class *D* has 11.8, class *C* 14.8 and class *A* 17.0 pounds of tractive effort per square foot of grate. These figures show that if the four locomotives are loaded in proportion to the cylinder dimensions, class *B* will of all four engines make the greatest demand on the grate and the least on the evaporative power of the heating surface. And if the matter be put the other way about and the loads of the four engines be proportioned to the dimensions of the gates, class *B* will make a very favorable showing so far as efficiency of steam production is concerned, as both the large proportion of firebox surface per square foot of grate and the large proportion of total heating suface per square foot of grate make for boiler efficiency. As a whole, however, our conclusion will be that the class *B* engine could be improved by an increase in the area of the grate, the other dimensions remaining as they now are.

Returning now to general principles, we can say that a high ratio of firebox heating surface to grate area is desirable when it is obtained by giving ample firebox surface and undesirable when obtained by a restricted grate area. A usual figure in large modern locomotives is 3.5 square feet of firebox to each square foot of grate area. It would be better to have 4.0 square feet, and 4.5 square feet can be obtained in some cases, and should be aimed at where practical. It will usually be found impossible to do better than this if the grate area is full size. As a general indication of modern practice in the proportions of grate area to tractive effort the following figures are given:

Type of locomotive		Rated tractive effort in lb. per sq. ft. of grate area.
4-4-2	Saturated	500
	Superheated	600
4-6-2	Saturated	550
	Superheated	650
2-8-0	Saturated	825
	Superheated	925
2-8-2	Saturated	775
	Superheated	875

These figures are for soft coal burning locomotives, and the aim should be not to exceed them, or, in other words, to provide as much grate area as is practicable.



1,000-4,000 Horsepower Connelly Watertube Boiler

MANUFACTURE OF NATIONAL PIPE.—A series of three industrial motion picture films, illustrating the manufacture of National pipe from ore to finished product, was shown before the National Association of Stationary Engineers at Coplay, Pa., on Tuesday evening, December 12, at 8 o'clock. These pictures were taken under the direction of the National Tube Company, Pittsburgh, Pa., after eight months' work and at an expenditure of thousands of dollars. They are educational and intensely realistic, so that even a novice after seeing the pictures may feel that he has started at the Mesaba ore ranges in Minnesota and follow the ore step by step until it is finally shipped out as a finished product in the form of National pipe.

Connelly Watertube Boiler

Seven Drum Unit of from 1,000 to 4,000 Horsepower Built for 300 Pounds Pressure

Steam turbines have advanced so rapidly in capacity that to supply them with steam from the ordinary sizes of steam boilers would require an extremely large boiler room, as regards floor space. Furthermore, small units are not so efficient in operation as large ones and the tendency of present-day practice is toward large boilers for the modern high pressure power plant. Among others engaged in building large capacity boilers is the D. Connelly Boiler Company, Cleveland, Ohio. In some respects the Connelly watertube boiler has characteristics not unlike those of the Stirling. It can be built in units of from 100 to 1,500 horsepower in the four drum type, and from 1,000 to 4,000 horsepower in the seven drum design, and is built for a working pressure of 300 pounds. In the illustration is shown the 1,000-4,000-horsepower design. Remove the two top and one lower right-hand drums and their tube connections to the center drum and the design of the 100-1,500-horsepower boiler is shown. In the large unit three of the seven drums are filled with water, the other four being partly filled. The feed water is introduced into the two outside upper drums and flows through the rear bank of tubes into the bottom, or mud drums, where it mixes with the hot water coming down through the middle banks of tubes from the two top inner drums. The water passes from the two mud drums through the inner banks of tubes into the center drum, which is full of water, from which it goes to the two top inner drums, thus completing its cycle. Steam that has been made in the two inner banks of tubes is liberated into the upper inner drums and then passes through the steam drying tubes into the two outer drums, from which it is piped to the superheater.

In this boiler the top outer drums to which the steam nozzle outlets are attached are set higher than the inner drums, which gives a greater distance from the water line to the steam outlet nozzle and additional steam space. There is no connection below the water line between the two upper inner drums and the two upper outside drums, therefore there is no commotion of the water in these drums to interfere with the delivery of superheated steam to the generating units.

Owing to the large water capacity and unrestricted circulation, the boiler can be operated under varying loads and at heavy overload capacity, and the water level as indicated by the gage glass shows no variation when the boiler is operating under fluctuating conditions.

There are but four fixed points in the boiler, the upper drums. The boiler is suspended from a steel frame. All three inside drums are suspended from steel beams and are arranged as to flexibility so as to allow for the expansion of the two inner drums and the tubes. All watertubes are 3¼ inches diameter and are set with alternately wide and narrow spaces, so that any tube in the boiler can be removed without interfering with any other.

Bafflings are made of standard fire tile and no special shapes are required. In the smaller boiler units up to 1,500 horsepower, the baffling is such that four passes are made by the gases in going from the furnace to the uptake. In the larger sizes the gases make three passes for each half of the boiler. A baffle at the two outside banks of tubes directs the gases to the bottom ends so that they escape at the front of the two outside top drums instead of at the bottom of the last bank of tubes, as is the case with the smaller units.

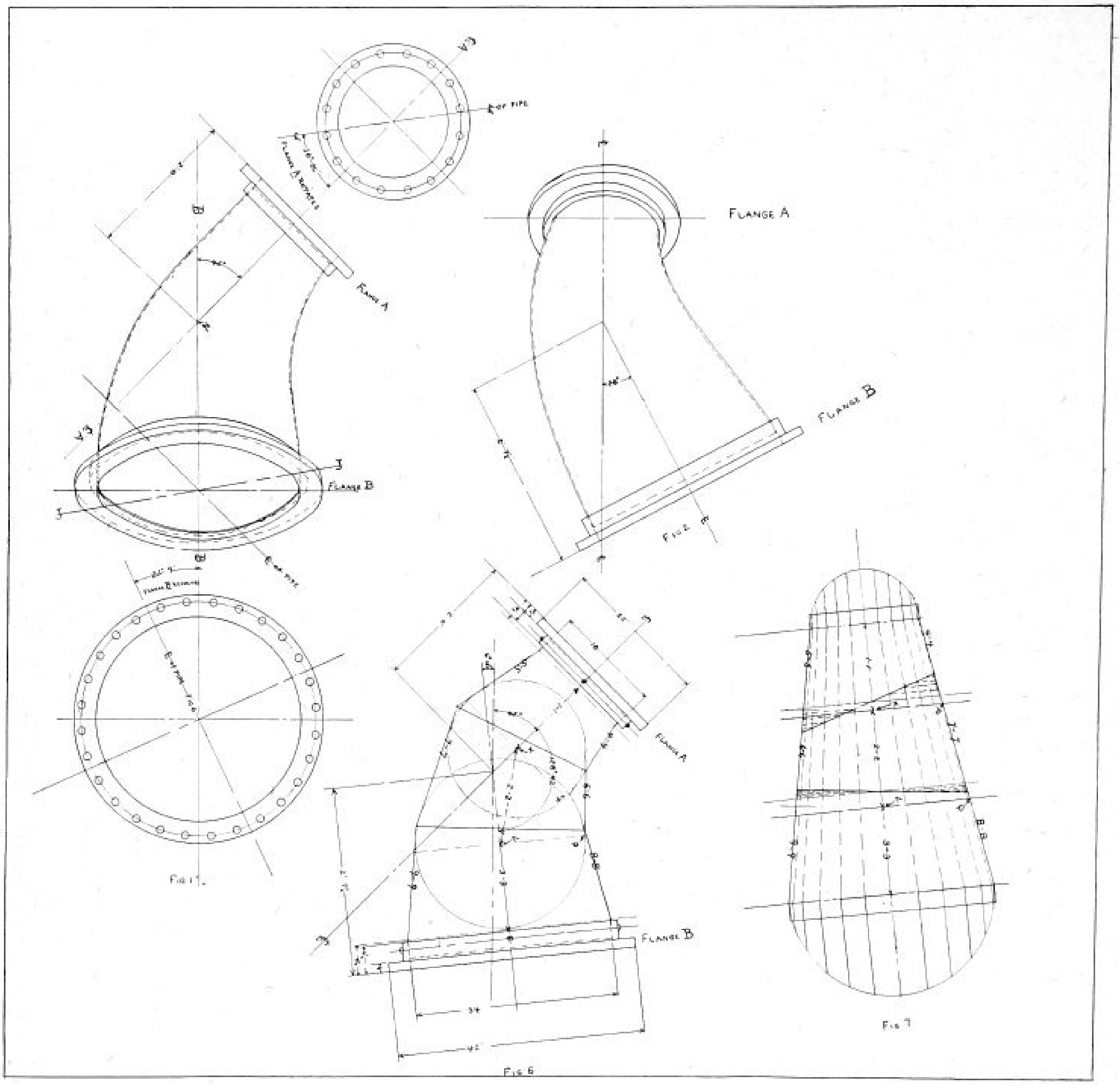
Some of the differences in points of construction between the small standard Connelly boiler and the Stirling are that the rear drum of the former is higher than the center and front drums and the tubes connecting the front and center drums are always filled with water, as is also the front drum, which in the illustration would be the center upper drum. The two highest upper drums of the smaller units are tied together by two sets of drying tubes instead of one as in the Stirling. At normal water level the front drum of the smaller unit is full of water, the center drum is one-half full and the upper rear drum about one-third full. The arrangement, together with that of the baffling, brings the upper portion of the two rear drums and their tie tubes in the path of the hot gases between the third and fourth pass. The result is that the steam in these drums and tubes is somewhat superheated.

The main superheaters of the large unit are placed between the first and second pass, as shown in the illustration. As the water column connection is to the front drum, which is always full of water, the level showing in the gage glass does not fluctuate so much as it would if connection was made to the two upper central drums as in the case of the larger units, where the drums are but partly filled with water, which is affected by the circulation from the center drum.

All forged steel manhole plates are hinged to the drumheads. The interior of the boiler setting is accessible through large doors in the front and doors in the side and rear walls, the frames of which are ground and fitted with asbestos gaskets to prevent air leakage.

Soot is blown from the top of the mud drum by providing a cleanout door in the side wall of the boiler setting, where a steam lance can be inserted and the soot blown across into a cast iron box in the opposite wall. The door of the cleanout box is opened by a lever extending through the rear wall. All pressure parts of the boiler are designed and built to conform with the boiler code of Ohio or that of the American Society of Mechanical Engineers.—*Power*.

Downflow Type of Boiler.—In a paper read before the annual meeting of the American Society of Mechanical Engineers Mr. John C. Parker describes the early experiments which demonstrated the possibility of circulating the water in boilers apparently contrary to the natural way; that is, downward rather than upward. From these experiments there was developed the downflow boiler which was designed by the author and has been built by him for a number of years. Chief among the advantages claimed for the downflow principle is that the course of the water and steam are opposite to those of the flame and hot gases; consequently the hottest particles of each are in communication with the hottest particles of the other and there is a minimum difference of temperature between the adjacent particles of the two. An interesting form of construction described in the paper is a double-ended design in which there are two furnaces back to back, the products of combustion from which unite and flow together through the same course as in a single-unit boiler.



Sketches of Elbow and Layout for Patterns

Layout of Compound or Double Angle Elbow

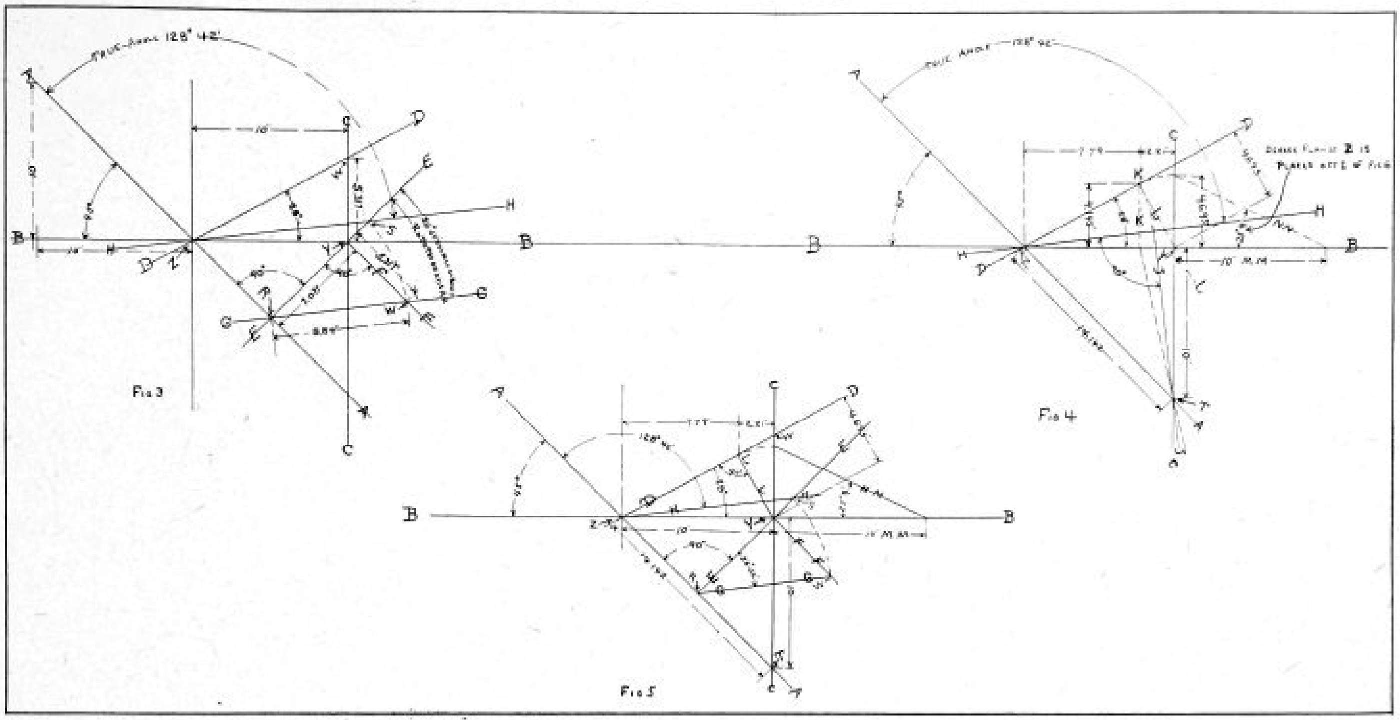
Method of Finding True Angles of Elbow—Detailed Explanation of Layout of Patterns

BY P. W. MC DONOUGH

In the language of the shop, the elbow shown in Fig. 1 is termed, generally speaking, a "compound elbow" or double-angle elbow. But, nevertheless, when properly developed it is but a single-angle elbow, and differs from an ordinary conical elbow in the respect that there are three elements which need be determined beyond those of the ordinary conical elbow.

Those three elements are, first, to determine the proper angle of elbow which, when rotated on the horizontal axis *AA*, a certain number of degrees results in the required combined angle; in this instance a horizontal angle of 45 degrees and a vertical angle of 28 degrees. The second is the number of degrees the elbow is rotated on the axis *AA*. The third is the number of degrees the large end of elbow is revolved by the rotation of the small end on axis *AA*.

In Fig. 1 is shown the horizontal angle of 45 degrees and a plan of the vertical angle of 28 degrees. In Fig. 2 is shown a projected view of Fig. 1, or, as the elbow would appear looking in from the back. It is desired in this problem to have the bolt holes straddle the horizontal and vertical center lines. The flanges are used for con-



Construction Lines to Determine True Angles of Elbow

venience. This problem may often occur when it is necessary to connect two pieces of pipe, one with a horizontal angle and the other of a vertical angle. In such a case the center lines of flanges would correspond to the center lines of the horizontal and vertical pipes.

In Fig. 3 is shown the method followed to obtain the first element (the true angle of elbow), and as well the second (the degrees of rotation of pipe on the horizontal axis *AA*). When the second element is obtained it is equivalent to the number of degrees flange *A* (Fig. 1) is placed off of the center lines of the true elbow shown in Fig. 6. In the development of the true angles any convenient length may be assumed as the basis for the angles. In this instance 10 inches, as it is the most convenient. The first line drawn is the horizontal line *BB*. Next draw line *AA* of an indefinite length, crossing line *BB*, Fig. 3, at an angle of 45 degrees. It will be noted that both of these lines correspond to lines *BB* and *AA*, Fig. 1.

Then 10 inches from the intersection of lines *AA* and *BB* (or from point *Z*), at right angles to *BB*, draw line *CC* from an indefinite length on both sides of *BB*. Then from point *Z*, at an angle of 28 degrees from line *BB*, draw line *DD* indefinitely through *CC*. This line in this instance will intersect line *CC* at a point 5.317 inches from the horizontal line *BB* or point W. This line *DD* will correspond to the vertical angle of 28 degrees shown in Fig. 2. Then at right angles to line *AA* draw line *EE*, intersecting line *BB* at point of contact of line *CC* with line *BB*, or point *Y*. Then at right angles to line *EE* draw line *FF* from point *Y*. On line *FF* locate point *W*, which in this instance is 5.317 inches from point *Y*. It is equivalent to point *W*, at the intersection of line *CC* and *DD*. Then connect point *W*, line *FF*, with point *R*, or at the intersection of line *EE* with line *AA* with line designated *GG*. It will be seen, if it were possible to place either of the two angles described by the lines *BB*, *CC* and *DD*, and *EE*, *FF* and *GG*, in an upright position, point *W* would correspond to a point 10 inches horizontally from point *Z*, Fig. 1, on the vertical angle of 28 degrees. This completes the necessary angles to obtain the first element, or true angle of elbow. One more operation being necessary with point *R* as the center of radius and point *W*, line *GG*, as the lengths, draw an arc intersecting line *EE* at the point *S*. The arc is shown dotted. Then draw line *HH* from point *S* to point *Z*. The angle described by the lines *HH* and *AA* is the true angle, the first element in this instance 128 degrees, 42 minutes.

The second element is as well obtained from Fig. 3. The angle described by line *EE*, *FF* and *GG* is the degree of rotation on the horizontal axis *AA*, or in this instance 36 degrees 56 minutes. The center lines of flange *A* will be placed 36 degrees 56 minutes off of center lines of true elbow shown in Fig. 6. The vertical center line of true elbow, Fig. 6, is shown in its proper position when rotated in end view of Fig. 1.

There are an indefinite number of ways to obtain the third element or the number of degrees the large end of elbow is revolved by the rotation of the small end on the horizontal axis *AA*, but, as the method to be explained in Fig. 4 seems to combine more readily with Fig. 3, it will be selected. In Fig. 4 the lines *AA*, *BB*, *CC*, *DD* and the true angular line *HH* are drawn in as in Fig. 3. It is proposed now to develop the horizontal center lines of true elbow, Fig. 6, when revolved in position as shown by line *JJ*, Fig. 1. At right angles to line *HH* draw line *JJ*, intersecting line *CC* at point of intersection of lines *CC* and *AA*, or point *T*. This line *SS*, Fig. 4, will correspond to the horizontal center line of true angle, Fig. 6, before revolving. Then with point *Z* as a center of radius and with trammel set at point where line *SS* intersects line *HH* draw an arc to line *DD*. The arc is shown dotted. Then from point of intersection of arc with line *DD* and at right angles to *BB* drop dotted line *KK* to line *BB*. The dotted line drawn from the point of intersection of lines *KK* and *BB* to point *T* corresponds to line *JJ*, Fig. 1, or the horizontal center line of Fig. 6, after being revolved into position. A line drawn at right angles to line *DD* from point of intersection of line *KK* with line *DD* or line *LL* will give horizontal declination of the vertical center line when in position. It will be observed that this line which is shown dotted intersects line *BB* at point *Y*.

This dotted line *LL* is to form the vertical side of the angle which flange *D* revolves, or otherwise the large end of elbow. For convenience the angle will be shown to the right of line *CC*. Using *Y* as a center of radius and the point where line *LL* intersects line *DD* as the length of radius, draw an arc intersecting line *CC* at a point 4.695 inches from line *BB*. This will form one side of the desired angle. For the base the distance from point *Y* to point *T*, or in this instance 10 inches will be used. Then the angle described by the lines *MM* = 10 inches, and that part of *CC* intersected by the arc, or 4.695 inches from *BB*, and dotted line *MM* will be the third element or the number of degrees the large end revolves, or in this instance 25 degrees 9 minutes.

Fig. 5 is included for the purpose of showing Fig. 3 and Fig. 4 combined, and it includes all the necessary lines for the development of the three elements.

The further development of this elbow shall be only outlined, as it is presumed, with the three unknown elements developed, the reader will be able to carry on to completion, without minor detail, by just a superficial explanation of drawings, Fig. 6 and Fig. 7.

In Fig. 6 draw in the center lines of indefinite lengths. These center lines will correspond to the true angle developed in Fig. 3. Then measure off from point of intersection of center lines 2 feet on one leg and on the other leg a distance of 2 feet 7½ inches. The measurement of 2 feet will correspond to the same measurement on line *AA*, Fig. 1. The measurement 2 feet 7½ inches is the same as shown on the angular line of 28 degrees, Fig. 2. The next object is to develop shape of elbow's sections, shown in Fig. 6.

First, the length of center lines of sections as shown by lines 1-1, 2-2, 3-3, Fig. 6, must be determined. The lengths of these lines are discretionary. It is good practice to make these center lines of such length so that when the job is completed it will appear somewhat symmetrical. With this aim in mind, measure off on center line from the point just located 2 feet from the center minus the distance which must be flared out to suit flange, or in this instance 4¼ inches, the line *A*, and locate point *X*. The same operation is to be done from the point 2 feet 7½ inches from intersections of angular lines, keeping in mind that the straight hub of flange must be taken care of, and locate point *Y*. Connect these two points with line 2-2, as shown in Fig. 6.

The next operation is to erect the cone as shown in Fig. 7. The combined lengths of line 1-1, 2-2 and 3-3, Fig. 6, will be the height of cone as shown in Fig. 7. The lengths of these lines are to be located as shown in Fig. 7. It shall be borne in mind that only the center lines of Fig. 6 with the points *x* and *v*, or the lines 1-1, 2-2 and 3-3 have so far been determined. The next operation is to develop the contour of the sections as shown in Fig. 6.

This is done by the further development of Fig. 7. The height of cone in Fig. 7 is equal to the combined lengths of lines 1-1, 2-2 and 3-3 of Fig. 6. The base is equal to the diameter of large flange minus the thickness of plate to be used. The smaller end of frustum will be equal to the diameter of smaller flange minus thickness of plate. These two diameters are to be connected by the lines which are soon to be subdivided again. With point *x-B*, Fig. 7, as a radius, draw a circle, using point *x* as a center of radius, as shown in Fig. 6. Using *N O*, Fig. 7, as a radius and point *Y*, Fig. 6, as a center of radius, draw circle as shown in Fig. 6. In Fig. 6, from the diameter of small end draw lines 4-4 and 5-5 tangent to the smaller circle, the center of radius of which is point *Y*. Then draw lines 6-6 and 7-7 tangent to both circles. Then lines 8-8 and 9-9 tangent to larger circle, intersecting the large diameter. Lines drawn through the points of intersections of these tangent lines 5-5, 7-7 and 9-9 and 4-4, 6-6, 8-8 will give the mitre lines or true shape of each section of elbow.

Fig. 6 is now completed. The next object is to transfer the lengths of lines 4-4, 5-5, 6-6, 7-7, 8-8, 9-9 of Fig. 6 to the side of frustum, Fig. 7.

The lengths of these lines are marked on any convenient strip and are alternately placed as shown in Fig. 7. The mitre lines are then drawn.

It will be seen that Fig. 7 consists of the three sections of Fig. 6 with the center section rotated at an angle of 180 degrees.

The next operation is to draw in the plans at each end of frustum. Divide plans into any convenient number of spaces and drop lines to end lines of frustum. Then radiate lines, those of the smaller end intersecting those of the larger at ends of frustums. At right angles to center line of cone, Fig. 7, and at all points where radial lines intersect mitre lines of the different sections draw lines to the angular side of cone. The true length of each line shown in the different sections can then be obtained by using the points just developed on side cone.

All the necessary drawings are made, and it remains now but to develop the different patterns for the sections using Fig. 7 exclusively. As the further development is just a matter of straightening out the sections shown in Fig. 7, it is presumed that the reader can do so. By placing the center lines of flanges the number of degrees determined by Figs. 3 and 4 off the center lines of elbow sections, Fig. 7, the problem is completed.

The lengths of different lines in Figs. 3, 4 and 5 are given as a further guidance in development of the three elements.

Square Root to the Aid of the Layerout

Some time ago, while in the employ of a concern engaged in contract work, I was surprised to learn how little was the intelligence of the foreman in charge. Various small jobs would be encountered wherein the foreman would feel as though an injustice were rendered him simply because the firm would accept such a job.

On one occasion in particular, I will state a case where we received one of these supposedly awful jobs. A customer came to the office and wanted a templet made, governing a 100-foot sweep, or a 50-foot radius. The templet to be serviceable and easily handled must not be over 60 inches long at the most, per his instructions.

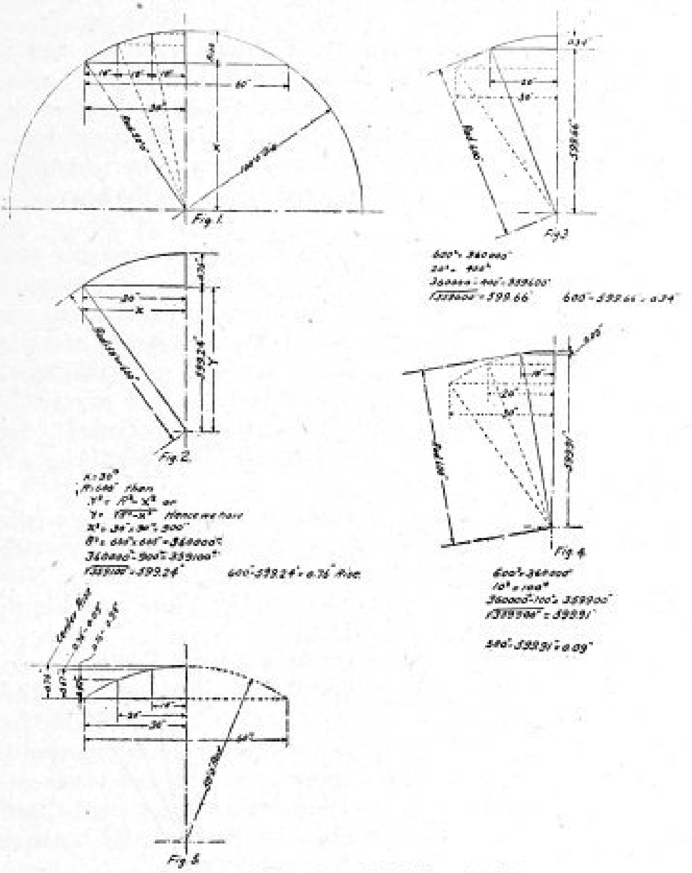
The company, as well as the shop, was small, and, as the office force did not possess a single mechanical engineer or draftsman, they were at a loss as to just how to go about this little, insignificant piece of work. There was, however, one man in the company who really could get about it some way, but unfortunately this man was out of town on a business venture. So the next best thing to do was to submit the proposition to the shop foreman.

I was surprised to note the look of disgust on the foreman's face when the proposition was handed to him; and then came that terrible oath, which never meant anything, but was a familiar pet of his. "I wouldn't mind anything reasonable," he said, "but this is entirely out of the question." Turning to me, he said: "How in the world do they expect us to strike a 50-foot radius? Why, the shop isn't that long!"

As he was of the infallible kind in all of his undertakings, I was at a loss to answer for a moment; but finally I answered, "Easy," for I had to do something to preserve my own dignity, owing to the lack of confidence in me on his part in the first place, and the small amount of credit I received from him in the second.

Of course, a lengthy argument ensued, in which I proved myself the victor, owing to his inability to cope with the trams, why, it would be useless to fool around whenever he saw me dig for my pencil and scratch pad. He began to argue again, saying, "If it couldn't be struck with the trams, why it would be useless to fool around with that pencil pushing."

At first I did intend to use my trigonometric functions, when the idea struck me that this would be all "Greek" to him, so I decided to use a method in square root, with which I was in the hope of convincing him. The fact



Layout of Templet of 50-Foot Radius

that he was ignorant of both ways made it harder for him to comprehend at any rate.

However, I proceeded as follows:

Of course, you will note that one-half of the templet is used as an illustration, both sides being alike.

In Fig. 1 the first performance is to find the versed sine or rise on the vertical center line of the templet, or, the cosine marked X, namely, the difference between the rise (versed sine) and the radius.

After obtaining this dimension, the distance 30 inches, or half the chord or (sine), may be divided into as many spaces as desired. In this case we will use three spaces equally spaced at 10 inches. It is always advantageous to arrange the spaces in equal inches or feet.

Now following Fig. 2, we will use the formula:

Let X equal 30 inches.

Let R equal 600 inches; then we have

Y squared equals R squared minus X squared, or $Y^2 = R^2 - X^2$, or Y equals the square root of R squared minus X squared, or $Y = \sqrt{R^2 - X^2}$.

600 squared equals 600 × 600, or 360,000.

30 squared equals 30 × 30, or 900.

360,000 minus 900 equals 359,100, and the square root of 359,100 equals 599.24 inches; hence we have 600 minus 599.24, or .76 inch.

Consequently the rise or versed sine at the vertical center of the templet is 0.76 inch.

Now we proceed precisely the same in Fig. 3 as in Fig. 2.

600 squared equals 360,000.

20 squared equals 400, and

360,000 minus 400 equals 359,600, and the square root of 359,600 is 599.66; hence we have 600 minus 599.66, or 0.34 inch.

This would be the rise on the vertical center line if the templet were to be but 20 inches long.

Now, in Fig. 4 we proceed in the same manner as follows:

600 squared equals 360,000, and

10 squared equals 100.

360,000 minus 100 equals 359,900, and the square root of 359,900 is 599.91; hence we have 600 minus 599.91, or 0.09 inch, the rise at the vertical center line if the templet were only 10 inches long.

Now, in constructing the templet, Fig. 5, the center ordinate will be 0.76 inch, the next one 10 inches from the center will be 0.76 inch minus 0.09 inch, or 0.67 inch; the next one 20 inches from the center will be 0.76 inch minus 0.34 inch, or 0.42 inch, and, of course the intersection of the sine and arc will be 0 inches.

Now, a line carefully drawn through these dimensions on the various ordinates will produce the desired sweep, and there we are.

This is but one of the many ways that this templet may be made, and only a small amount of intelligence concerning square root is necessary to develop it.

I might conclude that my noble foreman decided to learn a little "pencil pushing," as he put it; besides he discovered that two heads were better than one, and he also found it wise not to expect any more from those who came under his supervision than he was capable of doing himself. After this incident I always had someone confronting me with some sort of an example, but I told him to subscribe to THE BOILER MAKER, and he did. Now he learns something every month.

Albany, N. Y. JOS. F. HAVLAK.

What Type of Boiler is the Safest for Our Navy?

BY N. ROBERTS

Under the above caption I will endeavor to help our friend Grant—that the "auld Scot" may be all right—but the watertube boiler, be it Scotch, French, German or anything else, matters little with the marine world. Quick and efficient service is what is wanted to-day, and, like the Westerner with his gun, when he wants it he wants it bad. The following is said with all due respect to the Scot for the important part he played in the boiler game.

Now, while Watt could lay down a great many essentials of how a watertube boiler should be constructed, the fact remains that he never succeeded in building one that amounted to anything. The watertube for marine purposes is not new by any means. All watertube boilers on the market to-day have as a prototype some early form of experimental steam generators. The Goldsworthy-Gurney is the forerunner of types such as the Thornycroft, Normand, etc. The Perkins boiler was the forerunner of the Durr and Niclausse. The Babcock & Wilcox and D. Allest boilers have their prototypes in the Stevens boiler of 1805, which was built in our country and fitted in a Hudson River steamboat a century ago.

Various types of watertube boilers have been operated successfully—the Bellville, by the French; the Thornycroft, by the British; also the Babcock & Wilcox marine type. These boilers have been used both in merchant marine and in the various navies. The Niclausse was looked upon with much favor some years ago—still we have data that show that in various cases this watertube boiler proved a failure and was replaced by Scotch boilers. Of course, there is no progress without some failures, and this is when the weak points are noted and preparation made for a solid foundation, which ultimately establishes success.

The watertube boiler is a success and is here to stay; the question is, which type is best adapted for marine service in various waters under various conditions. A watertube boiler of a type that would prove durable and have the desired result in marine service and grow in favor as the result of its merit, so that it would displace our old Scotch firetube boiler, should possess the following features:

The steam drum should be placed at the front of the boiler, its centers square with the tubes; the water level should be at the center of the drum; no drum should be used smaller than 54 inches in diameter, of modern design and proper thickness—as per A. S. M. E. or Government rules. If back headers are fitted the steam discharge to the drum should be horizontal and connected to drums at the water level; all internal parts should be accessible. No part of the drum should be exposed to hot gases; all tubes should be straight and of uniform length. If possible they should be of the cold drawn seamless type and as near non-corrosive as possible. The ratio of length not to exceed 30 diameters and if placed on an angle they should not exceed 15 degrees from the horizontal. No tube should be less than 3¼ inches in diameter and be of the thickness required by the A. S. M. E. or Government rules.

If headers are used they should be of wrought steel—no cast metal should be used. Headers should be of sufficient area to insure good circulation, as the more rapid the circulation the greater the evaporation. All parts of the boiler should be accessible, particularly the interior and exterior of tubes.

Some provision should be made for a mud drum to receive by gravity any solid matter separated from the feed water and that the feed water so enters the boiler that separation will take place in the coolest part and away from the line of hot gases.

The boiler should easily be drained without any siphon—the path of gases leaving the furnace in the combustion chamber should be square with the tubes, so that all heat units may be abstracted from the gases before reaching the uptake.

Efficient baffling should be determined so that with reasonably good firing there should be no criticism owing to the pressure of high stack temperatures. A boiler for marine purposes should never have its steam drums placed fore and aft and tubes athwartships—this applies especially to ocean-going vessels and vessels navigating rough waters.

The boiler should be so constructed that it could be built or rebuilt in any well-equipped shop in any country and be temporarily repaired at sea with the engineering force aboard.

For naval service the boiler must stand forcing and severe abuse; the feed arrangement should be simple and feed be injected into the boiler at very high temperature. The use of induced draft permitting a low stack temperature making the installation independent of climatic conditions and causing a cool boiler room is very essential. Mechanical stokers may be used or oil burning be resorted to giving better combustion and uniform heat—constant steam pressure and eliminating loss from opening fire doors, which should be locked with latch from a safety point of view. The boiler should be so suspended to insure free expansion and should not be anchored at any point; the boiler should respond quickly to any sudden or unusual demand for steam and maintain a steady water level. The thermal efficiency of the boiler must be superior to any firetube boiler. All tubes should be so arranged that they can be renewed or plugged without disturbing other tubes or boiler parts. Sufficient water should be carried so that the boiler steaming under natural draft—a period of thirty minutes should elapse before water leaves the upper drum, burning fifteen pounds of coal to the square foot of grate surface.

The cubic feet of steam space should be about equivalent to the grate surface in square feet; ratio of heating surface to grate surface should be about 40 to 1—must be a rapid steam raiser, capable of being built in large units—should consist of cylindrical components, spherical heads, all parts to be self-sustaining; this would be the best boiler for our navy.

There are three distinct types of marine watertube boilers. First: Boiler with limited circulation; second, boilers with free circulation; third, boilers with accelerated circulation. In the former class we have the absence of water reservations, and the Belleville boiler belongs to this type.

The second group consists of boilers with practically horizontal tubes connecting to vertical reservoirs. The Niclausse Durr, B. & W. and Lagrafel D. Allest belong to this group.

The third group is composed of boilers having a distinguished characteristic, tubes running almost vertical connecting horizontal reservoirs. Mosher, Yarrow, Normand, Thornycroft, Blechynden, Reid, White and Ferguson boilers belong to this type.

Boilers with free circulation have been the only successful boiler in mercantile marine—yet this does not mean that I believe that the other classes of boilers are unsuitable for marine purposes. A boiler with accelerated circulation is very essential where speed, power, weight and space are large factors. They are very serviceable for high-speed, light war vessels, steam yachts, small river and coasting craft, but are a failure for deep-sea service.

Boilers with limited circulation, such as the Belleville, are not suitable for the merchant marine, yet this type of boiler has been used extensively throughout the world. The Lagrafel D. Allest has many good features, but was never looked on with much favor in this country. The Durr boiler has been very successful in Germany, although it lacks many of the most desirable features of the Niclausse boiler, which is looked on with much favor in this country, along with the B. & W. type.

High pressure produced from a little deck space, with as little weight as possible, is what we want to-day. The Scotch marine boiler is not adapted for this, as in a boiler of this type 16 feet in diameter, built for a pressure of 250 pounds working pressure, the shell would have to be about 1⅞ inches thick, with massive rivets, which only special machinery of massive type could drive. Massive rolls would also be needed to bend the plates. This shows that there is a limit to pressure in the Scotch type of boiler. As the cylindrical components to which the external pressure is exerted with large, flat surfaces to be braced, it will be easily seen with half an eye that this boiler is not suitable for high pressure.

With the watertube we have small cylindrical components with spherical ends and other parts being of such form as to require no staying and only subject to internal pressures, the result is a better and stronger boiler capable of withstanding great pressure and more abuse. With the installation of boilers of the watertube type we have less weight, which has a most pronounced effect upon the size and displacement of the vessel. More weight requires heavier hulls, which increases the wetted surface, displacement and resistance, which means a reduction of speed or heavier engines.

The weight of water in a Scotch marine boiler while in service is 33 percent of the total weight, while the weight in a watertube boiler is only 15 percent of the total weight. The Belleville boiler carries less weight of water in ratio to the total weight of the boiler, it only being 8.3 percent of the total weight.

Time occupied in safely raising steam from water at 70 degrees to blowing-off point in a Scotch marine boiler is from 6 to 8 hours, against 30 to 40 minutes with the watertube. If I recollect correctly, the United States Navy made a test on the B. & W. boilers on various naval vessels, the working pressure being 225 pounds. From the time fires were started until boiler blew off only 28 minutes was occupied.

Sudden change of temperature and active corrosion are the agents which materially affect boilers of the Scotch type, producing stress every time steam is raised. The watertube is not subject to distress from this cause, which materially prolongs its life. The large furnace in Scotch boilers is a serious drawback, with lost gases on top and cold air below; the service and abuse they have to stand is fearful. Regardless as to whether they are plain, Adamson ring or corrugated furnaces, a little oil on the inside or a peaked fire or the use of an underfeed stoker will bring them down. This is a repair that cannot be made successfully at sea. The large, flat-sided combustion chambers of Scotch marine boilers have a decidedly cooling effect upon the gases. The high velocity of these gases leaving the furnaces causes the products of combustion to be inefficiently distributed through the tubes, some parts of the heating surface being very inefficient and some parts of the combustion chamber being practically useless. The small furnaces in Scotch boilers not only bring the cooling medium very near the fires, but also afford no opportunity of getting the air over the fires, which seems necessary for complete combustion. These detrimental features are entirely eliminated in watertube boilers. There is also less danger of accident to boiler or injury to employees in case of explosion to either the boiler or steam lines, due to the fact that there is less water in a watertube boiler, whereas in the firetube boiler with a ruptured steam pipe the water at a high temperature would continue to deliver steam for a long period, making it impossible to enter the compartment to render aid to those who might unfortunately be caught, but not beyond help.

It is a well-known fact that the British Admiralty has adopted the use of watertube boilers owing to the fact that Scotch marine boilers would not stand up under forced draft.

Watertube boilers of good design can be forced to two or three times their natural draft without showing any signs of distress or affecting or endangering the boiler in any way. The small volume of water in the watertube boiler, which is of great benefit in many ways, also has its disadvantages. More care is required to maintain a true water level and steady head of steam in case of feed-pump trouble, thus causing injury to the boiler from overheating the parts, due to low water.

This condition is generally overcome with auxiliary means of feeding the boilers. It might interest our readers to know how long it might take to evaporate the water contained in various types of boilers to the danger line—this line to be suggested as an approximation for comparative purposes. This is based on the assumption that the boilers using natural draft will burn 15 pounds of coal per square foot of grate surface per hour or 10 pounds per square foot of grate surface and 1.5 pounds of coal per pound per hour. Time, Scotch marine, 28 minutes; B. & W., 16 minutes; Niclausse, 19 minutes; Bellville, 8 minutes—this with forced draft.

Long grates can be used with as great efficiency as short grates in watertube boilers, whereas in the Scotch boiler the maximum length of the grate is limited on account of the diameter of the furnace and draft from about 5 feet to 5 feet 6 inches, whereas in the watertube boilers the length of the grate is limited only by the length of the tubes.

I have seen grates 9 feet long under boilers with accelerated circulation with great success with a combustion rate of 100 pounds per square foot of grate.

The grate of the Niclausse, Belleville or B. & W. boiler is usually 6 feet 6 inches long, but at times shorter or longer grates are used in order that the boilers may fit into the available space more economically. In the Belleville boiler the tubes are a little over 4 17/32 inches outside diameter and the length is equal to 19 diameters, whereas in the Niclausse and B. & W. boilers the length of the tubes is 27 diameters, the Niclausse being 3¼ inches and the B. & W. 4 inches. The Belleville economizer tubes, which are 2¾ inches outside diameter, are 28 diameters long.

There is one advantage the firetube has over the watertube boiler for marine purposes; that is, a tube cannot be replaced or plugged without cutting out the boiler and sufficiently cooling so that it can be opened up for repair. The Scotch marine has another advantage over some types of watertube boilers, although the B. & W. has the same advantage, namely, that tubes and other repair parts can be purchased in almost any part of the world, while boilers requiring special tubes and attachments have to carry sufficient quantities to meet any kind of repair on long voyages.

Experience with Scotch and watertube boilers at sea undoubtedly indicates that the watertube boiler is not as economical in continuous steaming as the best type of Scotch boiler. High stack temperatures are very prevalent when watertube boilers are used. It is frequently asserted that better combustion can be obtained in boilers of the Scotch type, although this has not been proved. Actual test shows that the watertube is a more efficient and economical boiler than the firetube type, and it takes better skilled firemen to take care of the watertube boiler, being a higher type of boiler, and more brains required, and therefore does not appeal to the weak-brain, strong-back type of fireman now employed aboard ship, who are sometimes chosen for their ability to throw coal through a bottomless barrel hanging to a rope to represent a heavy sea. Short grates and narrow fires appeal to the average fireman in preference to the long grate, although thick and uneven fires kept by incompetent firemen are the cause of high stack temperatures and greatly responsible for the poor showing made at sea. With watertube boilers we all know that the Belleville boiler was christened "the fireman's Waterloo," but still gives a fairly good account of itself if given the proper care and attention and a good grade of clinkerless coal used.

The fact that the watertube boiler requires more skill and judgment to operate than the Scotch boiler should not condemn it, as the Scotch boiler is supposed to be perfect as far as mechanical design and engineering brains the world over can make it—"another feather in a Scotchman's bonnet." When the watertube boiler has passed through the experimental stage for marine purposes we will have watertube steam generators far superior to our Scotch boiler, the trouble of operating and stoking will have disappeared, for as the number of watertube installations increases, engineers and firemen will receive the experience which is necessary to overcome their prejudice against the watertube boiler. Most engineers have always risen to the occasion, and it is to be hoped that they will assist in the development of anything that is an advance step in engineering. Some transatlantic vessels have been very unfortunate in their experiences with the watertube boiler and welcomed back the firetube type; but this is no criterion, so we must put the good with the bad to arrive at a ratio to work from.

It is claimed by some engineers that the life of a boiler lies in the life of the tubes. This is not so, as any boiler can be retubed. There are just as many tubes in a Scotch boiler as there are in a B. & W. watertube boiler. The tubes in a watertube boiler are stronger, having a better ratio of length to diameter, and resist internal, instead of external, pressure. Care must be taken to install evaporators of ample size to distill the make-up feed water; sea water must not be allowed to enter the reserve feed tanks, as this will lead up to serious trouble with the boilers. A solution of slack lime put in the filtering box will greatly neutralize the effect of salt water, inasmuch as it converts the corrosive magnesium chloride into magnesia and chloride of calcium, neither of which is corrosive. Carbonic acid in the feed water has an injurious effect. This can be overcome by keeping the water in the boilers slightly alkaline. Air in the feed lime is another bad feature. This is caused from the pumps sucking from the hot well. Independent pumps and a good head of water on the suction valve of the pump will overcome this trouble. Sea water absorbs more air than fresh water. Galvanic action is one of the worst corroding evils. This generally starts between the sheet not freed from mill scale. Lap-welded tubes have been very unsatisfactory in this respect. The mill managements have been giving this great attention of late, and, with seamless tubes and the grade of steel we now get from the mill, this condition is gradually disappearing. The important thing is to keep the sea water out of the boilers.

A watertube boiler steaming with sea water in the feed would require more attention than a Scotch boiler, owing to the fact that it carries less water and would have to be brined or blown off more frequently. Scotch boilers cost less than watertube units, but the difference is only a matter of about 50 cents a square foot of heating surface.

Regardless of what any of us think, the watertube boiler is the boiler for all purposes—either on land or sea.

The Future of the Brick Arch

Anything that compels an increase in the amount of heat absorbed by the heating surfaces in the boiler is bound to improve the efficiency of operation of the locomotive. What the railroads need is more drawbar horsepower for each pound of coal burned on the grates. The development of the brick arch during the past ten years has made it a prominent factor in attaining the present locomotive power output. It has done this by producing more complete combustion and compelling the boiler to absorb a greater proportion of the heat units liberated in the firebox. But a good many railway men seem to think that in the present development of the arch it has practically reached its limitations as regards increasing locomotive capacity. It does not seem that there will be any such limitation. There have been many devices brought out in the past which seemed at one time or another to have reached the highest point of their development, but within a few years they have been subjected to changes and improvements which have resulted in still further increasing their efficiency. The brick arch is being given the constant attention of experts. It is being developed and improved whenever such improvements seem necessary or desirable and it is believed that the next few years will see still further increases in locomotive capacity and economy due to its use.—*Railway Mechanical Engineer.*

Boiler Explosions Here and Abroad

American engineers have been led to believe, and doubtless with valid reasons, that steam-boiler operation in England is carried on under a much more efficient system of inspection than is the general practice in this country.

In comparing the number of boiler explosions that occurred during the year 1915 in England and in the United States one should take into consideration the difference in area of the two countries and the number of boilers in operation. A notable fact in regard to boiler explosions in this country in recent years is that they are largely confined to sawmill and similar plants in which skilled engineers are not employed and in which explosions the larger number of persons are killed and injured.

Disastrous boiler explosions, such as those that occurred at St. Louis, Brockton and Chicago several years ago, have been conspicuous by their absence during the past few years, which would imply that the lessons presented as a result of these disasters have been heeded.

According to the annual report of the committee of management of the Manchester Steam Users' Association, there were noted throughout Great Britain during the year 1915 forty-eight boiler explosions, killing twenty-two persons and injuring fifty-four others. The association, which by the way has had but one fatality during its sixty-one years of operation, had under inspection over ten thousand boilers. In Massachusetts during the same year over twenty-six thousand boilers were inspected. By this it will be seen that the State of Massachusetts alone has about two and one-half times as many boilers under inspection as are inspected by the Steam Users' Association.

During the past twelve months there were in the United States, in so far as we were able to learn, two hundred and sixty-five boiler explosions or failures of all kinds, in which one hundred and thirteen persons lost their lives and three hundred and twelve others were injured. About one-fifth of these explosions were confined to low-pressure house-heating boilers; thirty-three were sawmill boilers, and these killed twenty-eight and injured fifty-five others.

The secretary of the Board of Trade, Manchester, reporting upon the working of the Boiler Explosions Act, shows that there were sixty-one explosions during the year ending June 30, 1915, resulting in the loss of twenty-two lives and injuries to fifty-five persons. It would appear from these figures, as well as from those of the Steam Users' Association, that there are as many boiler explosions in Great Britain as in the United States in proportion to the number of boilers in use. Deducting the number of house-heating boilers from the list of explosions for the year 1915 in this country, the total of high-pressure explosions is reduced to about two hundred and ten. This is about three and one-half times the number of explosions that occurred in Great Britain during the same period.

From the foregoing it would appear that as favorable a showing has been made in this country as has been made abroad. In fact, the figures credited to Great Britain seem to be excessive, and one is led to wonder if the war, which has doubtless called many engineers to the front, is not to some extent responsible in that less experienced men have been employed in their places.—*Power.*

Fig. 1.—Scene of Explosion of Three Boilers at Jackson, Tenn.

Boiler Explosion at Jackson, Tenn.

BY JAMES T. PHILLIPS

At the Harlan-Morris Heading Mill, Jackson, Tenn., a boiler explosion on August 21, instantly killed eight and injured about forty-five other persons. The property damage is indicated to some extent by the illustrations shown herewith.

The boiler plant consisted of two 66-inch by 14-foot boilers and one 72-inch by 16-foot boiler which had been in use for more than twenty years. The two smaller boilers gave way in the girth seams by shearing the rivets. The boiler heads were pulled slightly inward. All of the braces were intact, but some were badly bent. There was no split in the smaller shells or in the longitudinal seams, but in the larger boiler the rear sections of the shell split longitudinally as well as circumferentially.

Opinions differ as to the cause of the explosion. Most of the practical men, however, believe the cause was low water. A well-known engineer stated that he saw the tubes in the front end of the larger boiler on a Sunday morning a short time before the explosion occurred and that they were corroded and had wasted away about a sixteenth of an inch all the way around. Furthermore, they had never been turned over or beaded. A careful examination of the tubes bears out this statement.

The writer's investigation showed that the front head in the larger boiler was bulged out and the tubes had pulled through. This caused one of the boilers to explode, and, as they were all in a battery connected with the same steam line, the explosion of all three came practically together.

The night watchman told the writer that he left the boiler room about 6.30 o'clock; at that time the top gage was leaking water and the steam gage showed 110 pounds of steam. At 7 o'clock the plant was started and at 7.10 the explosion occurred.

Some mechanics have stated that the stave and heading mill did not pay enough to secure competent men to handle this plant. The writer has learned, however, from a reliable source that wages are about the same at the stave and heading mill as they are at other manufacturing plants in the same locality. It is wrong to try to lay the blame for boiler failures upon the engineers, except when it is known to be a case of negligence. There are many engineers and firemen running plants whose experience with different boilers has not been sufficiently varied and extended to enable them to detect the first slight indications of corrosion, cracks or slight deformations. A man might run a plant for several years without seeing evidence of corrosion, grooving or pitting. It requires experienced inspectors to detect such conditions.

Fig. 2.—One of the Smaller Boilers

Fig. 3.—Front Portion of Large Boiler

The Awakening of Jimmie and Bob

Two Apprentices with a Year's Experience Try Their Hand at Building a Boiler—Some Unforeseen Difficulties

BY W. D. FORBES

Jimmie and Bob sat with their feet up on the radiator of the room in their boarding place, smoking their pipes. They had both been a year at the boiler trade. Jimmie took his feet down and, knocking his pipe on the spittoon, said: "Let's build a boiler, Bob."

Bob looked at him and replied: "Oh, yes, let's build boilers. We are just fitted up for it in this room; we will advertise in THE BOILER MAKER, 'Eagle Boiler Works, Robert Taylor & James Mann, proprietors.' We are admirably fitted up to build boilers of any size. We have installed a first-class washstand, together with a pitcher and slop jar. Our large, double bed and sofa enable us to lay out anything that comes along. Our overhead lifting apparatus, by simply turning a small key, in connection with a lighted candle or lamp, can lift anything in the shop, including the building itself. Come one, come all and leave your boiler order.' Oh, yes, let us go into the boiler business."

"Stop your kiddin' and think, and if you can't think, look as if you could," answered Jimmie. "How do you suppose they start to build a boiler, anyway?"

"Can't say, I suppose they figure out what material is wanted so they can give a price," was Bob's answer.

"How can they do that unless they know what size boiler they are going to make? I heard a man say to the boss the other day, 'I want a 30-horsepower boiler; how much will it cost?' Now, how do they start to figure out the size?"

Bob thought awhile and said, "33,000 pounds lifted 1 foot high in a minute is a horsepower. I got that at the night school, but a boiler don't lift anything. Yes, we've got to have an engine for that."

"No," said Jimmie, "you could have a cylinder and a piston and run the steam into it and lift a weight without an engine."

"Well, it would be steam, all the same, that would do the pushing," mused Bob.

"That high brow draftsman we got is O. K., and don't you forget it," rejoined Jimmie. "I went over with him to-day to measure up that oil tank at Cary's. When we got there Cary took us over to the tank. It was almost buried in the ground; only about a foot of it stuck up so you could see it. It was lying flat and measured just 20 feet long. Old man Cary said he would send a man to dig out the dirt so we could get the diameter. Howland said he did not want any digging to be done, as he could calculate the diameter from what stuck out of the ground. Old man Cary wouldn't believe it, and he did not want to trust to fool figuring. Howland said, 'All right; I will figure it out and you can waste your money digging if you want to, but I bet you $10 you will find that I am right.' The old man took the bet.

"Howland took out a chalk line and, clearing away the ground a little, made me hold one end of the line close to the ground across the tank head, and he held the other, snapping a chalk line on the head. He took the middle of this chalk line and squared up another line to the top of the tank. Then he measured the length of the first chalk line and then the second. 'Now,' he said, 'that's all I want.' Next he got out a book and figured a bit and said: 'That tank is 6 feet 4 inches outside diameter.'

"Old man Cary just laughed and called to a man to bring a spade. After digging about an hour, Cary was able to get at the head of the tank, and, 'by gum,' it measured just 6 feet 4 inches to a dot. What do you know about that, Bob?"

"I know a lot about it, Jim, and that's what! I got it at the night school. I don't know how to figure it out, but I can do it on a drawing board. Here, I'll show you the trick. The highbrow teacher told us it was based on the axiom that any three points not in a straight line can be struck by a circle, and by but one."

Bob then proceeded on his drawing board to lay out a circle as shown in Fig. 1. He then drew the chord *A B*

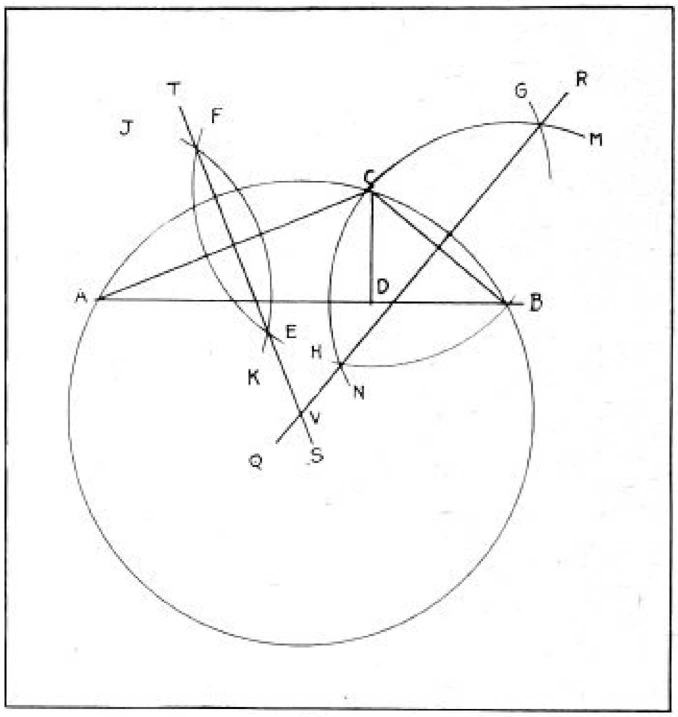


Fig. 1

and the perpendicular line *C D* and the two diagonal lines *A C* and *C B*. Next he struck the arc of circles *E F* and *G H*, with the leg of his compass at *C*. Placing this leg first at *A* and then at *B* with the same radius he struck the arcs of circles *J K* and *M N*. Placing his triangle on the intersection of these arcs as shown he drew the diagonal lines *Q R* and *S T*, which intersected or crossed each other at the point *V*. Placing one leg of his compass on this point he brought the point of the pencil to the point *C* and drew a complete circle, which of course struck the points *A B C*. "There!" he exclaimed, "that's how he did it."

Jim thought awhile and then admitted that he "guessed that was right. But," said he, "how are we going to start to figure out a boiler? Let's look at the hand book. Here's one. Horsepower of boilers. Now, we have it." Then reading a minute he looked up with a laugh and said, "This chap starts us in all bad. He says," reading from the book, "There is no such thing as the horsepower of a boiler; it is a misnomer." That's encouraging ,ain't it?"

Reading a little further, Jim said, "Here we have it.

It has been determined by experiments that an average consumption of fuel in a certain type of boiler on 1 square foot of grate will give a certain evaporation of water and steam so produced at a certain pressure will give a certain amount of horsepower when used in a well-developed engine."

"It seems to me," said Jimmie, "that, instead of being certain, it's about the most uncertainest thing I ever listened to."

The two boys were silent awhile, when Jimmie continued: "All the power has got to come out of the coal, so the more coal you burn, the more power you ought to get. Ain't that so?" Bob nodded. "Well, then, it seems to me the first thing we've got to find out is how much coal we want to burn on every foot of grate."

"But how are you going to burn any more than so much coal, anyway?"

"That's easy," replied Bob. "You've got to have a higher chimney. Then you will burn more coal."

"Why?" asked Jimmie.

"Because you get more draft, of course, and that means more air, and air makes coal burn. I heard some fellow say there was something in the coal; B. T. U.'s, I think he called them," continued Bob.

"Oh, go on!" said Jimmie, "they don't burn. It's the oxygen that burns, but I guess we had better start in and find out what these experiments this fellow talks about show. I never thought about it before, but I guess there is a lot to learn about boilers besides expanding flues and calking and riveting. I wish now that I had stayed at night school, but we can dig it out somehow, and it will be a mighty interesting thing to get at, and when we run ashore we'll ask that draftsman to give us a lift. He knows."

(To be continued.)

Better Cost Accounting Essential to Efficiency*

Among the essentials of efficiency in any business, correct and adequate knowledge of that business is the first. That is the foundation, and the corner-stone of a knowledge of business is the knowledge of costs. But the unfortunte fact is that a large proportion of the business men of the country do not know their costs accurately. Most of the big companies have good cost systems, but thousands of the smaller concerns have neither adequate nor accurate cost accounting.

Many concerns that report to the Federal Trade Commission manufacture four or five different articles. In these reports we ask them to give us the sales of each product separately, and nine times out of ten they cannot do more than give us the total for all their products together. If they do not departmentalize their sales accounts they certainly do not departmentalize their costs; hence they make prices on particular articles without knowing what those articles cost. Since they cannot tell where they are making money and where they are losing it, they cannot tell where to introduce economies.

Another still more serious feature of the situation is the fact that out of the 60,000 corporations that report an annual income of $5,000 or over, half do not charge off a single penny for depreciation. Obviously their cost systems are neither adequate nor reliable. They even go on paying taxes to the Government on inflated values and inflated earnings. But no business knows its true condition till it has made allowance for depreciation, and no cost of production is a true cost which does not include depreciation of plant and equipment.

It is not the inention of the Federal Trade Commission to assume the attitude of scolding business men. We understand how these conditions have come about. But do you not think it is time for someone to call the attention of the business community, and particularly the bankers, to the significance of these facts?

The Federal Trade Commission and Cost Accounting

The Federal Trade Commission is doing all it can to help in this matter. In the first place we have prepared two pamphlets giving plainly and briefly the fundamentals of cost accounting, one for manufacturers and one for merchants. Thousands of requests are coming in for these pamphlets. We are surprised at the earnest response.

In the second place, the Commission is coöperating with many trade associations which are endeavoring to get their members to adopt sound accounting systems. We send our experts to meet with them and discuss the features of cost accounting that are peculiar to the particular industry. We tell them to work out a system of cost keeping. When they bring it in the Commission will counsel with them and will approve it as a basic system for that industry. With this general standard officially approved, details to vary, of course, with the individual companies, the association has a strong argument to bring its members into line with sound accounting.

Such coöperation in order to put our industries in possession of the facts of cost is a vital function of the trade associations; for only when correct cost systems are essentially in use can industry intelligently attack the problem of improving scientifically its methods of production and distribution. This kind of coöperation counts most, and it can look the anti-trust laws squarely in the eye. Let me say right here that I do not believe in agreements to fix prices. I have no sympathy for associations or combinations that attempt it. In the first place, it is illegal, and in the second place, even if it were legal, it would still be a bad thing. It simply covers up inefficiencies instead of getting rid of them. It is not a remedy for the disease that ails business. It is merely an opiate.

The Banker and Cost Accounting

Bankers have an interest in every movement that makes for the welfare of American business and the general prosperity of the public, for that welfare and that prosperity constitute the security for your loans. But you also have a public responsibility, which I am sure you are proud to acknowledge, for the wise and healthful distribution of capital among the enterprises of the country. It is to your interest and is a part of your responsibility to do your share toward bringing about better knowledge of business costs and higher efficiency in business.

Suppose three manufacturers come to your bank for loans. Smith lays before you his cost sheets. They are detailed and clean-cut; he explains some recent economies they have taught him. He shows you his balance sheet. He has a carefully considered depreciation charge. He shows just what that business is worth, and you know he is right. Brown's cost sheets are very general. They don't give him a real analysis. He doesn't carry any depreciation charge; but guesses he ought to, and says that when a good business year comes along he will write off four or five thousand dollars. Then Jones comes in. He

(Continued on page 370.)

* Extract from address on "The Banker and Our Business Problems," by Edward N. Hurley, chairman of the Federal Trade Commission, before the annual meeting of the Ohio Bankers' Association, Columbus, Ohio, September 13.

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NOTICE TO ADVERTISERS

Changes to be made in copy, or in orders for advertisements, must be in our hands not later than the 25th of the month, to insure the carrying out of such instructions in the issue of the month following.

Too many boiler manufacturers practically overlook the necessity for an accurate determination of the cost of the work which they turn out from their shops. Inaccurate estimates of costs of manufacturing and selling lead to unfair competition and a regrettable tendency toward cutthroat prices, which eventually result in losses both to the unfair competitor and to the honest manufacturer. It is true that formerly the necessity for the determination of true manufacturing costs was not as imperative as it is to-day. Margins between cost and selling price in many branches of the trade were larger and costs could be ignored except in a general way, and a good return still be made on the money invested in the boiler shop. At the present time, however, margins and profit in the boiler making industry are very much narrower than formerly and the necessity for the most efficient management and closest analysis is felt as never before.

The Federal Commission has found an amazing number of manufacturers, particularly the smaller ones, have no adequate system for determining their costs and as a consequence fix their prices arbitrarily. With the object of aiding in the improvement of business generally, the Commission has published a pamphlet showing briefly the importance of accurate manufacturing costs and the fundamental principles underlying them. This pamphlet should be in the hands of every boiler manufacturer, and further than that, he should seek the aid which the Federal Trade Commission is competent and willing to give in the establishment of an adequate cost system in his plant.

In manufacturing, the cost consists of three elements, namely, material, labor and expense. It is not difficult to arrive at accurate figures covering cost of material and labor, but it is the matter of expense or overhead charges on which the boiler manufacturer is most likely to make serious errors. Overhead expense is the expense of every kind connected with the business, none of which can be directly located as belonging to a particular job. These expenses, while part of the cost of the job, are general, and so cannot reach the job direct, hence a method must be devised for them to reach the cost sheet in an indirect manner, the method at the same time being so plain that each job going through the shop will receive its fair proportion of the total burden, due to overhead charges.

In general, overhead charges may properly be divided into two classes—factory overhead, which consists of items directly belonging to factory operations, and general overhead, which is expense not directly connected with the factory. As soon as a job cost sheet has been charged with the three elements of cost, namely, material, labor and factory overhead expense, the total of these will constitute the factory cost. To this, however, must be added the general overhead covering shipping, selling and general expenses. When these items are included in their proper proportions a fair estimate of cost and price can be made for competitive purposes and for the general trade which will insure the manufacturer against unnecessary losses and give him an opportunity to secure adequate returns on his investment.

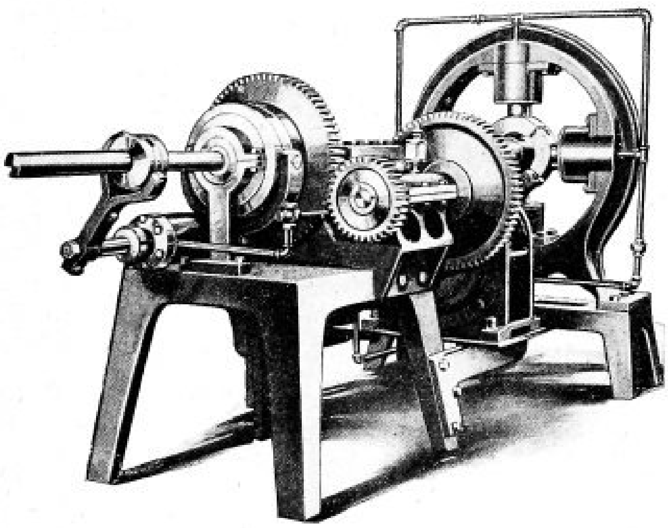
In selling boilers to Russia, American boiler manufacturers should become familiar with the rules and laws covering boiler installations in that country. The Russian laws require that the manufacturer forward to the purchaser a simple drawing of the boiler, showing the necessary dimensions for calculating the heating surface and the lowest water level. The drawing must be made to a scale of about one-twentieth actual size and must be signed by the applicant for permission to install it. The drawing must be accompanied by a description of the boiler, giving dimensions, quality of material, size of valves, area of heating surface, arrangement of feed, firebox construction, the working pressure and the purpose for which the boiler is to be used. Drawings are also required showing a plan and section of the boiler house with position of the boiler, flues and chimney. Boilers working at a pressure of more than 75 pounds per square inch are tested at twice the working pressure for a duration of five minutes and then kept at the working pressure until the inspection is completed. It is not necessary in Russia to submit detailed drawings and specifications of boilers to the Government Inspection Bureau for approval before offering the boilers for sale.

Engineering Specialties for Boiler Making

New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers

Universal Flue Welder

The new Southwark universal flue welder, illustrated, has been designed by the Southwark Foundry & Machine Company, Philadelphia, Pa., to meet conditions that have arisen since the general adoption of the locomotive superheater. It is built heavy enough to perform the welding of the large flues, and takes safe ends of unusually long lengths. The longer and heavier safe ends, which are applied to the superheater flues, make it necessary to support the end while it is being heated and avoid any unusual movement in the transition from the heating furnace to the welding operation. The furnace is located immediately in front of the welding mandrel, effecting considerable time and heat saving in transferring the flue to the welding machine.



Driving Mechanism at Back of Universal Flue Welder

A special device on the Universal flue welder allows the working of the weld on the inside instead of on the outside of the tube. Ordinary solid mandrels used in flue welding, of course, must be somewhat smaller than the inside diameter of the flue to allow free removal after welding. The hammering or rolling apparatus, used on the outside, works the metal down to the solid mandrel. This results in the internal diameter of the flue being smaller at the weld than at other points.

This reduction of area is disadvantageous from the point of view of free passage of gases on the superheater flues. A further disadvantage is the internal reduction of the diameter of the superheater flue that prevents the entering of the superheater elements.

All of these difficulties were weighed carefully before the completion of the design of the Southwark Universal Welder.

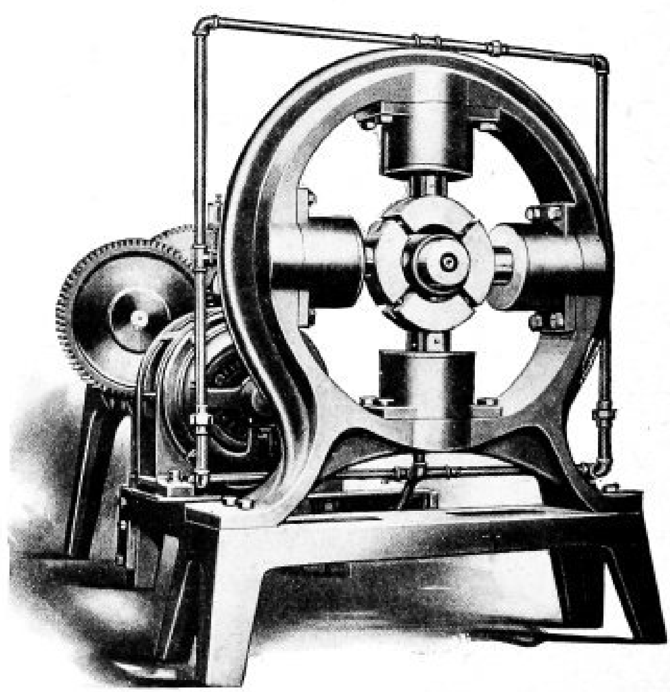
The clamping head at the front and the driving mechanism at the back are the two main parts of the machine. The clamping head is made from one circular shape casting, four air cylinders being mounted on the inside. The pistons are fitted with metal snap rings, instead of the ordinary cup leather type. The front end of the piston rods are equipped with sectional dies. These clamp the outside of the flue at the line of weld.

Piped up to a single air line, the cylinders operate simultaneously with the opening of the valve. Running through the center of this head longitudinally with the machine is the welding mandrel, which fits the inside of the flue.

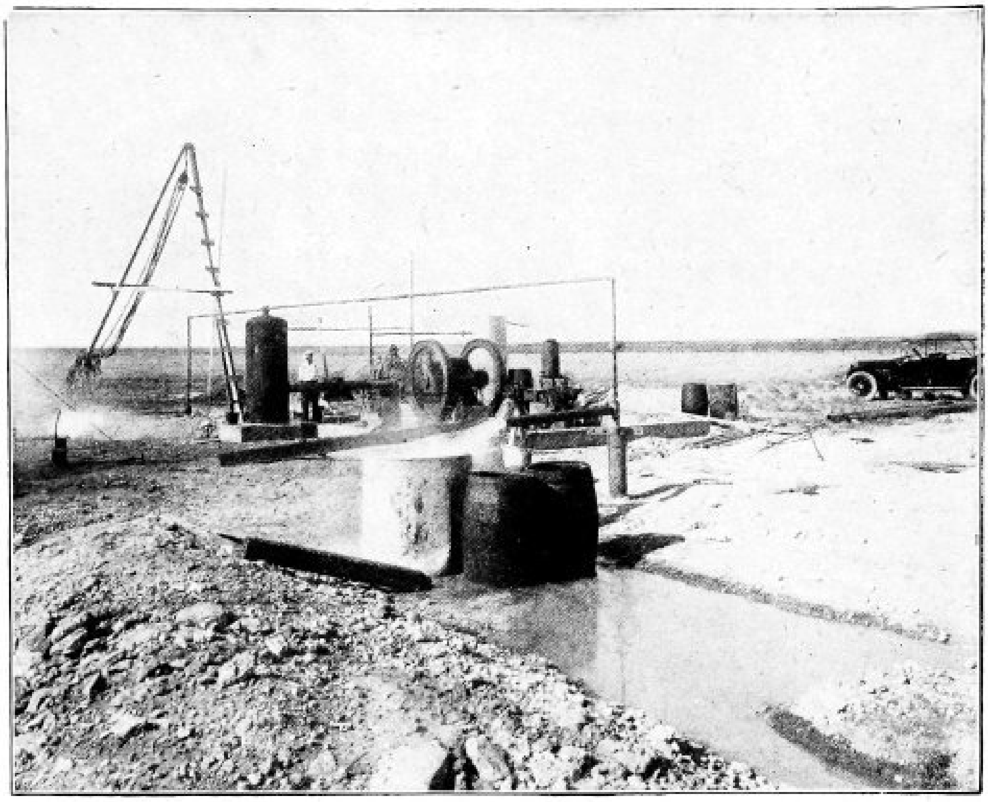
Four rollers are assembled in the body of this mandrel, which is hollow. Tapered and free in their bearings, they can be moved radially by inserting a taper mandrel that reaches through the middle of the spindle from the back of the machine. This mandrel is operated by an air cylinder also controlled by the main foot valve. The main mandrel is driven through two gear reductions to a 1½ horsepower motor.

A distinct feature claimed for the Southwark Universal flue welder is its economy of operation, a relatively small size of motor being required. An adjustable platform in front of the welder head, which supports the welding furnace, permits the proper location for different lengths of safe ends. A cast iron tank or water back protects the welding head from any excessive heat from the furnace. The size of the mandrel, back of the welding rollers, is made nearly the inside diameter of the flue. This supports the weight of the safe end, while being heated and moved to the welding position, which prevents any loss due to the dropping off of safe ends, as quite often occurs in the handling between the furnace and welding machine.

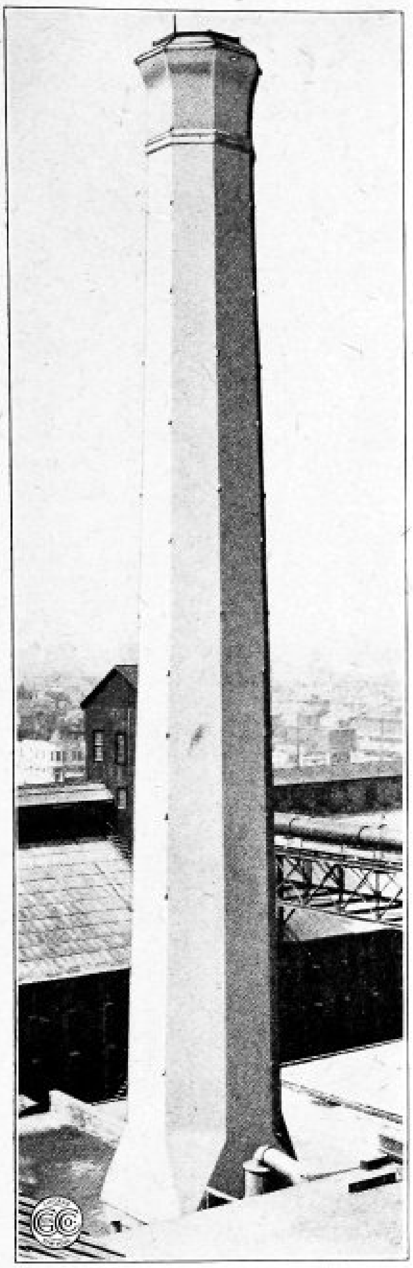
Standing away from the furnace, the operator uses a foot valve which controls the whole working of the welder. The piping is so arranged that the clamping heads close in on the outside diameter of the flue before the taper mandrel expands the rollers to make the weld. Driven directly from the motor, the mandrel is started by an air chuck operating automatically with the clamping of the flue. It is customary to rig up the front of the machine with some type of roller table to support the long flue. With this complete equipment it is claimed that one crew easily can weld in a day of ten hours, 120 superheater flues.



Clamping Head at Front of Flue Welder



Class N-SO "Chicago Pneumatic" Compressor Pumping Wells on Texas Ranch



Brick Stack Jacketed with Gun-Crete

Jacketing a Defective Brick Smoke Stack with Gun-Crete

The problem of saving a brick smoke stack, the outer surface of which had become seriously affected by alkali, was successfully solved by the use of the Cement-Gun process at the plant of the Solvay Process Company in Detroit, where an old brick stack 12 feet in diameter on the flat, octagonal in shape and extending 125 feet above the roof of one of their buildings, had become so seriously affected on the outside by the alkali in the air that the mortar in the joints had fallen out to a depth in some cases of several inches. The surface of the brick also, especially where the brick had not been very hard burned, had been so attacked that the brick to some considerable depth had entirely lost its strength.

The stack was rapidly reaching a dangerous point and something had to be done. To tear down the stack and rebuild it was not only a very expensive process, but interfered with the operation of the plant. The problem was solved by the Cement-Gun Construction Company, of Chicago, Ill., in the following manner:

The outside of the stack was first carefully scaled and cleaned by removing all the defective mortar and chipping off the defective brick work. A reinforcing fabric consisting of No. 28A American Steel & Wire Company's triangular mesh was then placed around the stack, securing the same by driving spikes into the mortar joints, to which spikes the wire mesh was then securely fastened. This wire mesh was so placed that it was approximately 1 inch outside of the original outline of the stack. Gun-crete was then shot through the wire mesh with Cement-Guns, making a jacket entirely surrounding the stack, having a thickness of 2 inches outside of the original outlines of the stack.

The entire work was done by contract at an agreed price, without in the slightest degree interfering with the operation of the stack.

The total cost of doing this work, not including the cost of scaffolding and of cleaning, was under $1,800, and the stack as it now stands, it is claimed, is stronger than it was originally and will stand indefinitely.

Pumping Water With Compressed Air

On the J. A. White ranch, three miles northwest of Fort Bliss, near El Paso, Texas, a Class N-SO "Chicago Pneumatic" compressor pumps two wells, each about 600 feet deep, the water standing about 250 feet from the surface. The compressor forces the air down into the wells, and although they are not yet entirely free from sand, the water is raised in sufficient volume to supply a town of 2,000 inhabitants.

Class N-SO compressors are made in four standard strokes, 8, 10, 12 and 14 inches, with capacities from 70 to 300 cubic feet. They may be supplied portable (on truck) or skid-mounted as well as stationary, and are manufactured by the Chicago Pneumatic Tool Company, Chicago, Ill.

MASTER BOILER MAKERS' CONVENTION.—The next annual convention of the Master Boiler Makers' Association will be opened on May 21, 1917, at the Jefferson Hotel, Richmond, Va.

PERSONAL.—Paul H. Coop has been appointed representative of the Eckliff Automatic Boiler Circulator Company, with offices in the Hobart building, San Francisco, Cal.

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.*

Address your communication to the Editor of the Question and Answer Department of THE BOILER MAKER, 461 *Eighth avenue, New York city.*

Determining the Capacity of a Locomotive Tank

Q.—Will you please explain how to find by calculation the number of gallons of water in a locomotive tank? L. T.

A.—In Fig. 1 the common shape of such a tank is given, together with its dimensions. It is first necessary to find the total area in square inches of the bottom of the tank; then multiply this area by the height, which gives its volume in cubic inches. Divide its cubical content by 231, the number of cubic inches in one U. S. gallon. Total

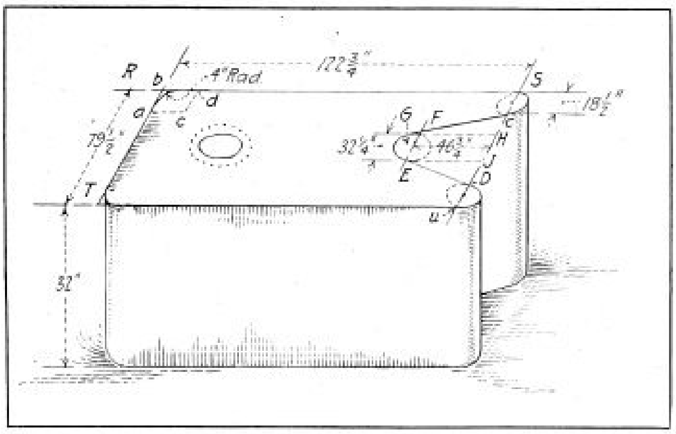


Fig. 1

area of rectangle *R. S. T. U.*, which also corresponds in size with the bottom dimensions, equals $122\frac{3}{4} \times 79\frac{1}{2} = 9{,}758\frac{5}{8}$ square inches. The area of the semi-circles at the coal bunker end equals $18.5^2 \times .7854 = 268.8$ square inches. $9{,}758.625 + 268.8 = 10{,}027.425$ square inches. From this area subtract the area of the coal space and the area *abd* at the back end sections, which is lost in rounding the corners with a 4-inch radius. Area of triangles *FHC* and *EDJ* may be found by this rule: "*Dividing the product of the two short sides by 2 equals the area of a right triangle.*" $HC = 5\frac{1}{8}$ inches; $HF = 46\frac{3}{4}$ inches.

$$\frac{46\frac{3}{4} \times 5\frac{1}{8}}{2} \times 2 = 239.6$$

square inches, area of the two triangles. Area of rectangle $HDEF = 32\frac{1}{4} \times 46\frac{3}{4} = 1{,}507.6875$ square inches. Area of semi-circle *G* equals

$$\frac{32\frac{1}{4}^2 \times .7854}{2} = 408.4 \text{ square inches.}$$

Area of rectangle *abcd* equals $4 \times 4 = 16$ square inches. Area of quarter circle *adc* equals

$$\frac{8^2 \times .7854}{4} = 12.567 \text{ square inches.}$$

$16 - 12.567 = 3.433$ square inches, area *abd*.

$3.433 \times 2 = 6.866$ square inches, area that is lost in rounding off the back corners.

$239.6 + 1{,}507.6875 + 408.4 + 6.866 = 2{,}162.554$ square inches.

$10{,}027.425 - 2{,}162.554 = 7{,}854.871$ square inches, area of bottom of tank.

$7{,}864.871 \times 32 = 251{,}675.872$ cubic inches, volume of the tank.

$251{,}675.872 \div 231 = 1{,}089.5$ gallons.

Plate Thickness for Dished Heads

Q.—Please publish in your next number of THE BOILER MAKER a formula for finding the thickness of dished heads for tanks. In this problem the radius of the dish must be greater than the diameter of the head, as shown in Fig. 2. M. W.

A.—The American Society of Mechanical Engineers gives the following rule for finding the thickness of plate for convex heads:

The thickness required in an unstayed dished head, with

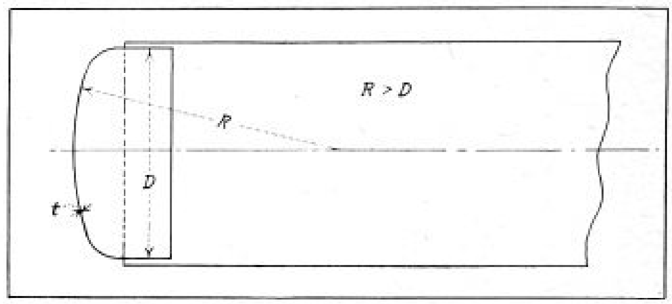


Fig. 2

the pressure on the concave side, when it is a segment of a sphere, shall be calculated by the following formula:

$$t = \frac{5.5 \times P \times L}{2 \times TS} + \frac{1}{8},$$

in which t = thickness of plate in inches,
P = maximum allowable pressure in pounds per square inch,
TS = tensile strength of plate in pounds per square inch,
L = radius to which the head is dished.

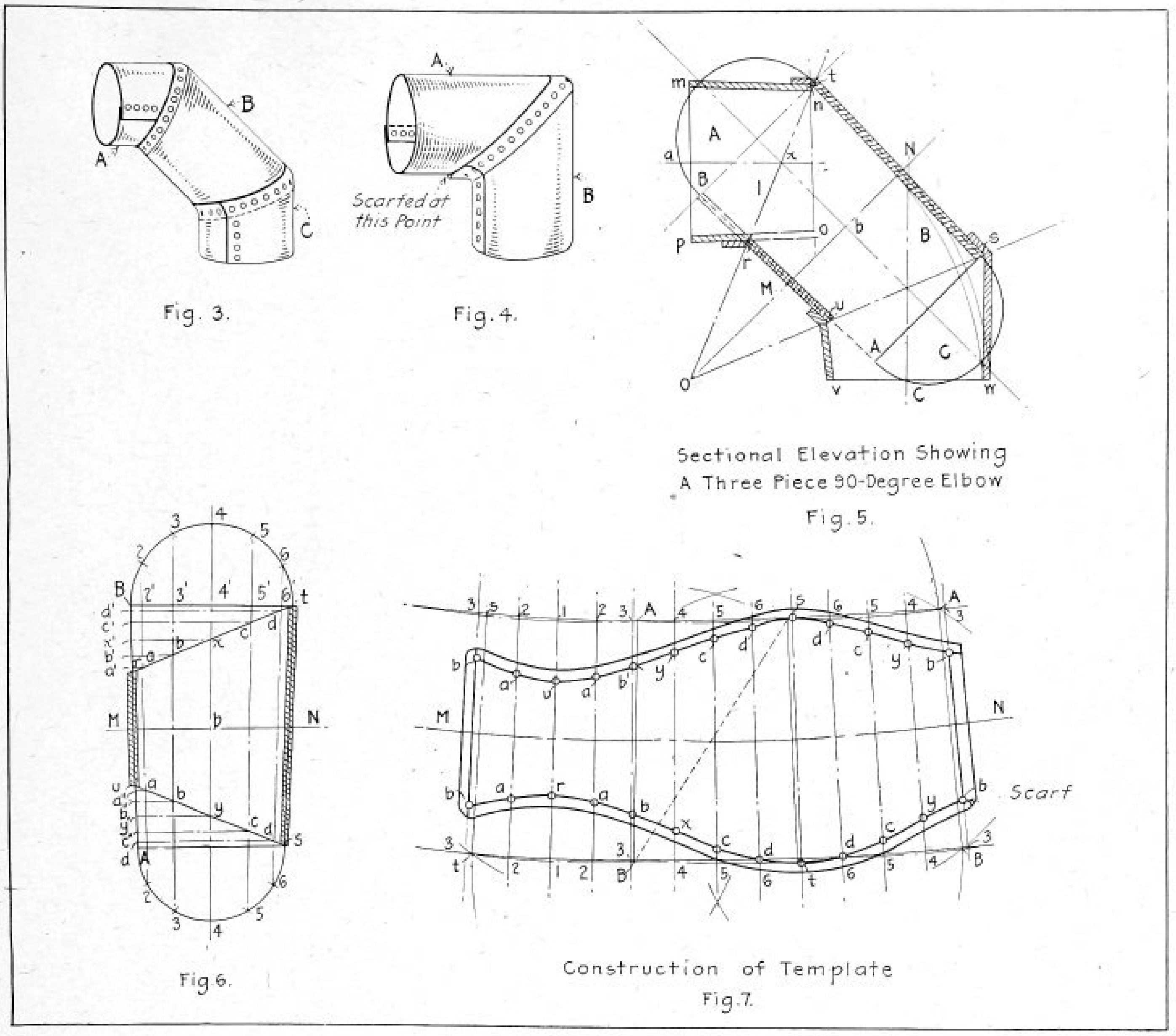
Heavy Elbow Layout

Q.—(1) Please show how to lay out elbows of round or oblong pipe of not less than ¾-inch steel with inside and outside laps at opposite ends of each section of the pipe. Also show how to get the end pieces of the pipe.

(2) Please show how to lay out 90-degree, two-piece elbow of 12-inch pipe (either round or oblong) of not less than ¾-inch steel so that the rivet holes in the miter will come fair. APPRENTICE.

A.—In all elbow developments requiring thick plate and having three or more sections which taper so as to secure in each section an outside joint at one end and an inside joint at the other, as shown for section *B*, Fig. 3, the plate thickness and taper must be taken into account. Fig. 4 illustrates a two piece elbow, and in this case a separate layout will be necessary for the sections *A* and *B*, as they are of different diameters. In the construction of the elbow, Fig. 3, one pattern will be sufficient, as will be understood from the explanation of Figs. 5, 6 and 7.

Construction of Fig. 5. This view shows a sectional elevation of the elbow, Fig. 3, and illustrates how the sections fit together at the joints. Each section is a frustum of a cone. Section *A* equals the section *MNus* of section



Layout of Patterns for Heavy Elbow

B, and section C, section $MNrt$. The difference in the diameters B-t and AS is equal to two times the plate thickness; hence it will be seen that the taper is very small. In developing the Fig. 5 draw first the arc a-b-c from point O as a center. This arc is considered to lie in the center of the elbow. To find the miter lines when no protractor is at hand divide the arc a-c into one less the number of divisions or sections required. In this case three sections are wanted; hence bisect the arc a-c into two equal parts at b. Draw the line O-N through b. Bisect a-b at x and b-c at y. Through x and y draw the radial lines O-x and O-y, upon which lie the miters r-t and u-s. Lay off at each end A and C the required diameters, showing the plate thickness. Construct frustums $mnop$, $BtsA$ and $vwus$, thus locating the position of the elbow sections from which the pattern may be secured, as explained for Figs. 6 and 7.

Pattern or Template Development. Transfer the section B to Fig. 6. Note that the layout is based upon the neutral plate dimensions and neutral diameters of the end of the frustum. The transfer of section B may be readily done with the use of dividers or trammels by first drawing the center line x-y, about which draw in the sides and ends of the frustum. Then locate the miters r-t and s-u. Draw semi-circles at both ends with the required radii taken to the neutral layer of the plate. Then locate the construction lines intersecting the miters at a, b, c, d, etc. The true lengths of the radial lines a-a, b-b, c-c, etc., must be found by drawing horizontal lines from these points parallel with the bases and to intersect the outside radial line AB at points a', a'', b' b'', c', c'', etc. The lines t-s and u-r are shown in their true length.

Before the pattern can be laid off some means must be adopted in developing the frustum of the cone $ABst$, Fig. 6, to secure the proper curvature in the pattern stretchout. This may be accomplished as in Fig. 7 by assembling three sections of $ABst$ so that their sides coincide as in the diagram. The use of the dividers or trammels is again needed for this operation. By noting the position of the arcs at the top and bottom and from where they were drawn no difficulty should be met with in assembling the sections. The neutral plate dimensions are used in laying this diagram off. Having assembled the sections, draw in the camber lines at the top and bottom of the pattern, and also the center line MN, so that they extend a short distance beyond the outer edges of the sections. With the traveling wheel measure off the stretchout length at the top and bottom of the template; then divide these lengths into the required number of divisions. Through these points draw in the lines 1-1, 2-2, 3-3, 4-4, etc. From line M-N, Fig. 7, locate the distances between the points m-a',

m-b, m-c, m-a'', m-b'', m-c'' of Fig. 6, as shown. The rivet centers lie on the points a, b, c, d, etc., and if a greater number are needed, bisect the arcs between the points into the desired number of parts. Allow for laps and scarf the end shown. The seam line is on line b-b, but this seam can be placed anywhere desired, so as to intersect with the seam of the adjoining sections.

Development of a Hood

Q.—I would like a layout for the patterns of a hood and the intersection shown between a cylinder and one section of the hood, as illustrated on the sketch, Fig. 8. L. B.

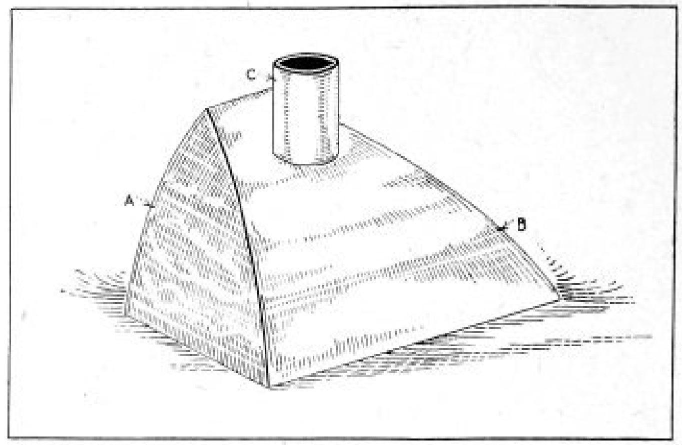


Fig. 8

A.—The perspective Fig. 8 gives a general idea or plan of the shape of this hood, and the intersection between the sides *A* and *B* and pipe *C*. The opposite side *A* is another section of the same shape as *A*. Lay off the center line m-n and construct the two views, plan and elevation, Fig. 9, to the given dimensions. Then draw the side view, indicating the position of the center line o-p, on which locate the position of the pipe. Divide the profile or circle into equal parts in the side view and project vertical lines from them to intersect the curve $a''b''$, as at 1', 2', 3', 4', 5', etc. The intersection between the cylinder and section *B* in the front view is an ellipse, as shown, and the development of the side view. The lengths between points $a''x''$, $x''y''$, $y''z''$, $z''b''$ are then stepped off equal to the corresponding lengths, side view. Perpendicular to line m-n draw the lines a-a, x-x, y-y, etc. Make the length of these lines equal to the corresponding lengths of the plan, and then draw in the outline of the pattern through the points a-x, y-z and b, etc. The pattern for *A* is laid out in a similar way, but the stretchout a-b equals the arc length $a'b'$ of the

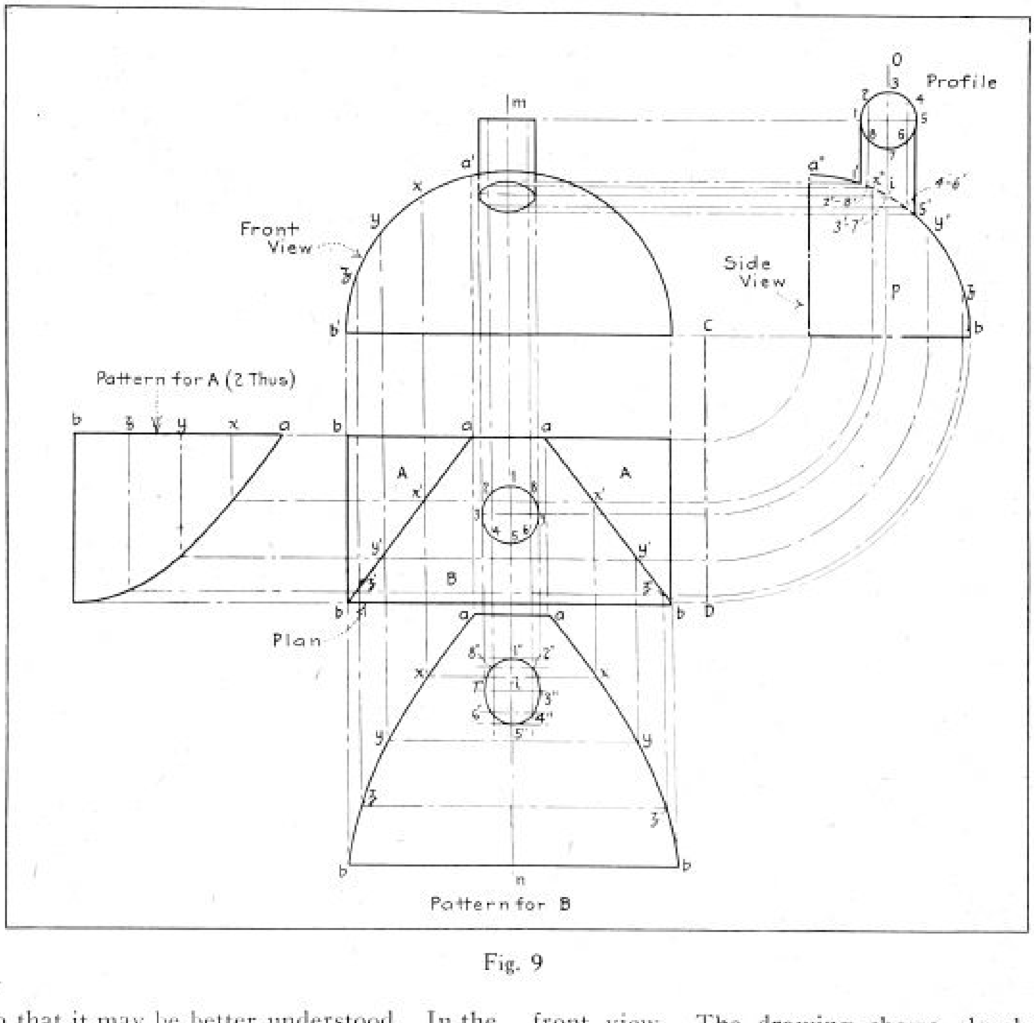


Fig. 9

it is produced so that it may be better understood. In the plan view the intersection is a circle. To develop the patterns, divide the arc between points $a'b$ into equal divisions as at x, y and z. From these points draw vertical lines parallel with axis m-n to intersect the miter a-b in the plan at x', y', z'. By projection the points x', y', z' may be located on the arc side view at x'', y'', z'' by revolving them about *CD* as an axis until they lie on line C-b''. From this position they are projected to the arc $a''b''$, as shown.

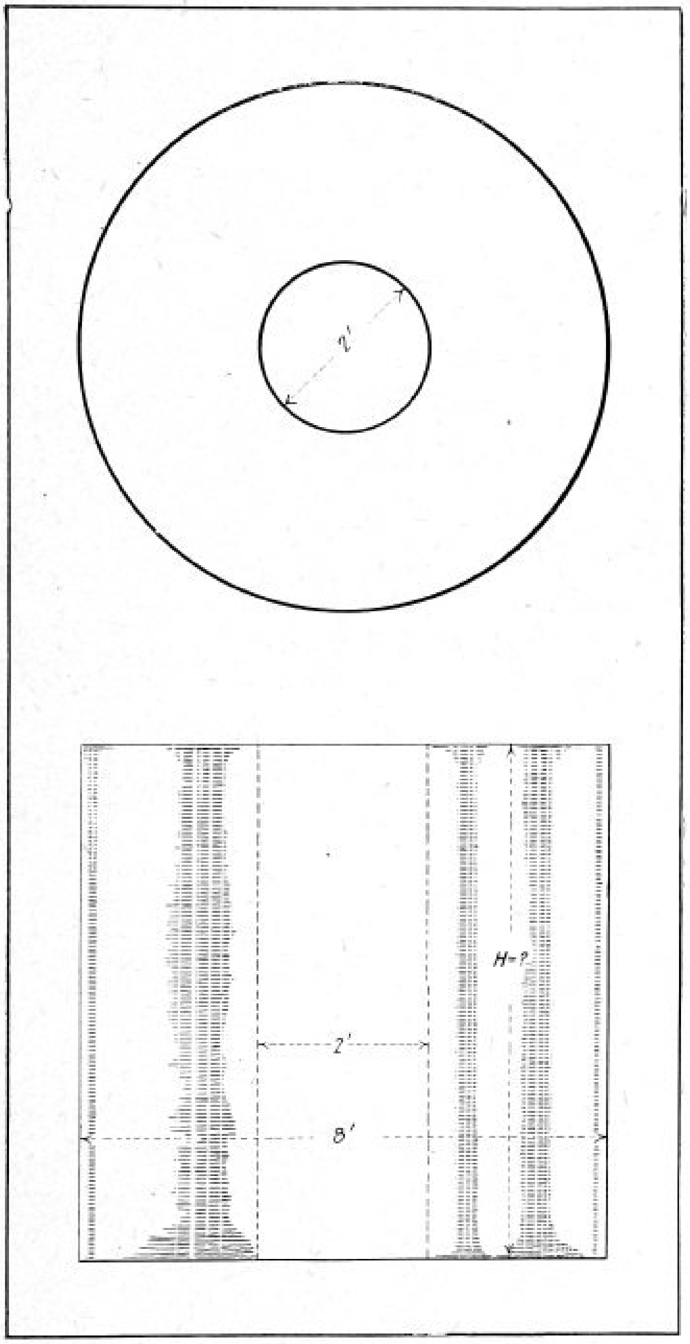
Construction of Patterns. On line m-n lay off the stretchout for section *B* equal to the arc length $a''b''$ of front view. The drawing shows clearly the completed pattern. Two patterns like *A* are needed. In pattern *B* the opening to receive the cylinder must be made. Its development is made by first fixing the center of the pipe opening at i. Measure off from line a-a on line m-n a distance equal to the arc length a''-i of the side view. From point i in the pattern set off the arc distances between i'-1,-2'-8', etc., of the side view. Where the verticals drawn from the points 2, 3, 4, 5, etc., in the plan intersect at 2'', 3'', 4'', 5'', fixes the position of the points through which the outline of the opening is drawn.

Letters from Practical Boiler Makers

This Department is Open to All Readers of the Magazine —All Letters Published are Paid for at Regular Rates

Five-Thousand Gallon Tank

We had a problem in the tank shop recently that kept the boys figuring for quite a while. It was required to find the height of a circular tank that would hold 5,000 gallons of water. The diameter had to be 8 feet, and there was to



Sketch of Circular Tank

be a 2-foot standpipe up the center (see sketch). The height was found to be 14 feet 2½ inches, and Dick Sample, one of the night school boys, made the shortest computation as follows:

The area of the bottom of the tank; that is, the ring having an outside diameter of 8 feet and a center of 2 feet, is equal to the difference between these two circles,

$$(4^2 - 1^2) \times 3.1416 = 15 \times 3.1416 = 47 \text{ square feet.}$$

One cubic foot has a capacity of 7½ gallons; therefore, the first foot of water in the tank will have a volume of $7\frac{1}{2} \times 47 = 352$ gallons. Then, in order to hold 5,000 gallons, the height must be

$$5{,}000 \div 352 = 14.21, \text{ or } 14 \text{ feet } 2\frac{1}{2} \text{ inches.}$$

Scranton, Pa. F. W. B.

Boiler Compounds

A boiler is an elastic vessel used for raising and containing steam under pressure. Another definition from a thermal standpoint is that it is a heat exchange. To read some of the advertising matter which reaches an engineer it might be supposed it was a chemical factory.

No doubt some of the specifics offered for the prevention of incrustation or the removal of scale and the limitation of corrosion are more or less genuine and their vendors believe in their wares.

Illustrative of the potency and magic of the solutions, various proofs are offered as examples, certified copies of analyses (not of contents) showing that the material is not injurious to boiler plate, testimonials from satisfied users, etc. The strangest proof which ever came my way was a piece of scale about 1½ inches in thickness, claimed to have been detached by the specialty the salesman was pushing, with the address where the feat was performed. My answer was to the effect that although I did not doubt the veracity of the statement, the man who let boilers get in that condition was only fit for dismissal, and, in fact, should be criminally prosecuted.

Now, although the claims advanced be sincere and no aspersion is cast upon the merits of the compounds vended by any remarks I have to make, a boiler is a vessel to raise steam and not a place for carrying out chemical changes in the constitution of the feed water. Bad water districts exist, and, short of using distilled water, incrustation is bound to occur. The proper place to treat feed water is before the same gets into the boiler and not when it is in process of ebullition.

Various contributors ascribe defects to bad feed water. *Why should there be any bad feed water?* There are many first rate systems for the elminiation of the deleterious matters which cause trouble, and it is infinitely cheaper to install a system of the kind than to ruin boilers by shortening their effective life added to continual repair costs. Accurate chemical analysis by a competent chemist, the installation of a softening plant using chemical reagents in correct quantity with reaction tanks, settling tanks, precipitation and filtration, give freedom from boiler trouble due to feed water.

It is a mighty poor excuse for breakdown, danger and delay—in short, unreliability—to cite as a cause one so easily removable as bad feed water. Alkalinity or acidity can be neutralized, nearly all carbonates and sulphates precipitated, grease removed by emulsifying and filtration, by the adoption of proper methods the scale is made outside the boiler. It is a business for the specialist and involves the expense of a treament plant, but the results can be scientifically guaranteed and against its cost can be set freedom from boiler trouble and continual tinkering. At present such plants seem to be more or less limited to watertube boilers, where they are a vital necessity, but locomotive boilers are certainly not less important, while, judging from the evidence produced in these pages, more risk is there taken.

The marvel of the whole matter is that, considering the often brute mishandling of the material in the first instance, the combination of chemical factory and steam-raiser, with the devastating energy of dynamite stored therein, the average boiler, even with its factor of safety of five, is so good tempered and operates with safety.

A. L. Haas.

The Whole is Greater Than its Part

It is often small things rather than large which prove troublesome; inadvertence or lack of foresight provide at times amusement as well as an annoyance natural under the circumstances. As instances in point, which are all duly authenticated, I venture to select three which prove the foregoing contention.

In a Rhode Island locomotive works some years ago a recently designed engine, the feature of which was a greatly enlarged steaming capacity given by an increase in size of boiler, was sent out for road test. The new type fulfilled all the expectations of the designer and she arrived back safe and sound, except that the smoke stack was badly damaged.

This was replaced by another which, after a further trial, also suffered in a similar manner to the first. It then dawned on those responsible that the standard stack was higher than the load gage, and to retain the standard stack meant altering a number of bridges spanning the line. As this looked a rather costly proceeding, the smoke stack was shortened to suit the increased diameter of boiler barrel. It spoiled the regulation standard stack built, and other drawings were passed to the boiler shop.

The joke is not that the first stack was damaged, but that it was replaced by a similar one and suffered damage the second time.

The second instance concerns short link crane chain. When an order for a considerable quantity of this material is received, say a matter of 300 fathoms, it is usually made up at the fire by more than one workman; it is also usual, since the manufacturer is unaware of the customer's requirements in use, to deliver in one length. The separate lengths made are connected by joining links. Chain is an awkward material to handle when shipping loose, and the usual procedure is to use an overhead wheel, over which a bight of the chain is slipped. The chain is then run over the wheel until the end is found; this end is then passed on to the lorry and the heap reeled over the wheel to form another heap on the vehicle.

An order for 1000 fathoms of small chain was ready for shipment and the railway lorry stood in the yard. The chain was being placed on it by the usual means, and just before it departed one chainmaker discovered, as he thought, a missing link. Hurriedly he dragged the ends to his fire and welded in the necessary joining link. The lorry departed to the goods depot. After an interval of some hours a 'phone message came through: "We've been trying to reel over your chain on the car for a couple of hours and can't find an end; please send someone here to discover it." Accordingly, a man with a hammer and chisel went down and made the railway staff an end. The joining link put in by the sapient individual made the chain endless.

The third instance also concerns chain: A length of 200 fathoms was despatched to a customer some 300 miles away, and although the senders could prove delivery to the railway, the goods did not reach their destination. Some rather heated correspondence resulted between the senders, the customer and the railway company. A couple of months elapsed and a claim was preferred against the railway for loss in transit, pending the settlement of which the makers refused to remake. By this time the customer had got restive and a business connection of long standing was in imminent danger of rupture. Without any warning or explanation the chain was delivered quite casually in a rather rusty condition to the customer, who at once informed the sender.

It took some persuasion and friendly pressure on the railway officials to get any explanation, but that furnished was rather curious. A foreman platelayer on an intermediate section had written his chief asking when the signal department intended to use a long length of chain, neatly deposited in a straight line between the rails on his section, whose purpose he was at a loss to understand. Evidently it was to be used, as it was extended perfectly straight and neatly laid along. Department inquired of department until the matter reached the traffic superindent, whose office had the matter of the chain in hand. In this wise the chain reached its destination.

What had happened was simple. The car floor had been faulty, the end of the chain had slipped through; when it touched the sleepers its extension had been rapid and, owing to the drawing motion of the train, had laid itself in a dead-straight line along the track.

None of the instances are within the personal knowledge of the writer, but they are all duly authenticated, in the first instance by a man who was employed at the Rhode Island locomotive works, in the second and third instances by a well-known English chain firm, who in the last instance produced documentary evidence for the writer's satisfaction.

Truth is possibly stranger than fiction, and the axiom of Euclid which heads this letter is more truthful still.

Authentic.

The Shop Executive

Between the management and the man in overalls there is a great gulf fixed. Events of recent years and the increase in size of the average concern have served to intensify the division and make it nearly impossible to bridge over.

To fill the gap and act in the position of a buffer state, Providence has placed the shop foreman. Now the position of a buffer state, especially where it separates conflicting elements, is rarely happy or enviable. Tact and discrimination must perforce be cultivated, and neither truculent independence nor cringing servility may be displayed. Yet upon such a state may fall the heavy hand of events without default of its own. In like manner, since the shop foreman represents the management to the men, and the men to the management, and by reason of labor trouble or managerial decree he is likely to earn undeserved odium and his normally difficult position as an intermediary be made more acute than is pleasant.

The first-rate shop executive, like the poet, is born, not made. He is from the nature of his office apt to receive more kicks than halfpence, yet he is an indespensable and valuable unit in any organization, and rarely receives the recognition he deserves.

One such individual, asked to define his job, explained that it consisted in taking drawings and instructions from the office and translating them into terms of finished goods.

He is the man upon whose shoulders most of the blame for incorrect work is apt to rest. His memory is more often than not a thing to marvel at, and no general has need for greater organizing power. Contrary to military usage, his men are subject to no condign punishment for infraction of discipline, yet his personality must be dominant and his justice impartial.

Two sets of critics dog his footsteps and he is of necessity conscious of both: one the management, who are articulate and call him to account often enough for causes beyond his control; the other his men, who though inarticulate are nevertheless severe critics, and who manage to make their adverse verdict felt. Few of the latter stop to consider the troubles incident to his position. Often enough this position is undefined. He is expected as a matter of course to shoulder all the burden of the day for an extra payment of a small margin over that of his men, in most instances incommensurate with the trouble involved.

It is a broad criticism applying to the entire trade that few responsible men in management have had experience in the capacity of foreman. Hence arises more difficulties and much misunderstanding between the office and the shop.

He is expected to be guide, counselor and friend to his men, at the same time a rigid disciplinarian, often without the opportunity of exercising real power, his decisions being overset by superior authority. Through him the management expect to feel the pulse of the shop and forestall trouble. He is expected to safeguard the interests of the management while retaining the confidence and regard of his men, with whom for various reasons he is more or less in sympathy.

He provides the essential link between drawing office and shop, between design and actual practice, and if he were more frequently called into consultation could render efficient first aid. His work takes all his time to perform adequately. Throughout the day's work he must decide offhand, mostly with little or no time for reflection, and his decisions must be binding and correct. In spite of his scant leisure he must exercise foresight, plan ahead, provide for contingency, keeping all hands occupied without wastage of time or material. He certainly lives a full existence if not a satisfying life, prepared at any moment for reproof from above or resentment from beneath.

His actual hours coincide with those of the shop, yet should he fail to scheme and plan all his waking hours his plans will miscarry, the work go awry and be inadequately done. He must set an example, for his rule is by this cause, in alertness, in character, in time-keeping, and his nervous system must be proof against nearly all forms of exasperation. He is expected, whatever his former experience, to allot debatable work, and his force of character must be such that both from above and below he compels respect.

The position demands peculiar abilities and these of high order. It is an unenviable post to any except the man fitted exactly for its duties. The man found adequate and in all respects qualified for the post is certainly fitted by its training to take a more lucrative position.

The wonder is that so many capable men are to be had willing to assume so diverse a multitude of functions, especially seeing that on piecework conditions and without worry the men under his control may and do often earn a wage in excess of that paid him.

Against this must be set the fact that the best work done is apart from cash considerations, yet a man must be altruistic indeed who can neglect the monetary aspect of his avocation.

In spite of any contrary opinion, it is contended that no one in the business has a more anxious and difficult task, whose equipment mentally, morally and physically needs to be of higher caliber, or upon whose activity more depends.

He must be a judge of men, he should be impartial and without prejudice, an assimilator of new ideas, loyal to his employer, able to act without consultation, and keep his dignity upon all occasions.

In spite of all, he rarely develops swelled head. Pressure from above and the influence of criticism from beneath serve to correct any tendency to this end.

For his manifold and sterling qualities the management of most concerns would suffer little if the facts were more openly recognized.

To alter Kipling:

"Now 'is work begins by Gawd knows when, and 'is work is never through.
'E isn't one of the regular staff, and 'e isn't one of the crew.
There isn't a job in the whole of the shop the beggar don't know or can't do.

. . . . .

They think for themselves and they act for themselves, and never ask me nor you.
Ho! they ain't no limping procrastitutes, mechanic and foreman too.

London, England. A. L. H.

"What Constitutes Proof" and "What Kind of Boilers are the Best?"

I note that N. Roberts "takes a dig" at me in one or two or so places in the May issue of The Boiler Maker. I wouldn't make the abrupt statement, though, that "all types of boilers are good, but some are better than others" because the A. S. M. E. committee found it incumbent on them to rule, to some extent, against a certain type I have in mind. And in these days I do not think we could call the old cylindrical type of boiler, made without flues, a "good" type. It will generate steam, true enough.

Yes, I have seen cowless milk wagons. I have also seen rivetless boilers—small ones.

Nor did I say that "the boiler maker of to-day has no thinking cap." I wouldn't think of saying such a thing. That remark was a quotation from a letter from a friend.

All of these things are not of so much moment, anyway, except that they are educative. When I am accused, personally, of having no thinking cap, I get down and dig all the harder. Sometimes I err, but in most cases I do not err. And I am trying to write this with the proper proportion of humility, for doubtless Mr. Roberts knows far more about boilers and boiler making than I do. No doubt he has had much more experience. But this much I do know: I am willing to learn, and whenever I get hold of a stunt that looks good to me, and that I believe is new, and a time saver, I tell the readers of The Boiler Maker about it.

I still believe that some day we will have seamless, rivetless boilers. Present knowledge and practice do not permit of such boilers on a large scale, but I believe even Mr. Roberts will admit that methods of welding are gradually being improved. So, I claim, we will "ultimately get there."

"Yes, Mr. Roberts, in my opinion the greatest man that ever lived was a boiler maker—James Watt. Perhaps Watt didn't actually pound out the boilers himself with a hammer, but he was the great living authority on boilers in his day. I have read some of his orders and specifications, and in many ways they sound just like modern stuff.

Since the advent of the steam engine and the steam boiler (the boiler, of course, being necessary first) civilization has been able to accomplish wonders, and those wonders, it seems, will never cease. I therefore give Watt the credit and herald him as being the "greatest man that ever lived"—a boiler maker.

New York. N. G. Near.

Better Cost Accounting Essential to Efficiency

(*Continued from page 360.*)

says he hasn't any cost system; it costs more than its worth; besides he knows what his goods cost him, carries it in his head. When you speak of depreciation, he asks, "What's that?"

Now, what are you going to do with these three types of manufacturers? The Smith type, of course, gets his loan. But what is your duty to Brown and to Jones? If you give them a loan, don't you think you ought to condition it upon the establishment of an accounting system that will show their real costs and their real financial condition?

I think you ought to do this, not simply for their sakes and to protect your loan to them, but to protect your loan to the man who is sound, and to protect business as a whole. For the man who does not know his true costs is just the man who prices his goods foolishly, and thereby impairs the business of his sound competitors at the same time that he ruins his own. Too low price-making, based on guesswork or on partial costs, is a menace to sound business. Please understand me, the menace is not in underselling, for a business concern must expect to face the low prices that are due to efficiency. But even the most efficient concern may not be able to meet cut-throat prices based on ignorance.

A Plan to Insure Better Cost Accounting

Let me outline, in closing, a suggestion which it seems to me will go far to enable the bankers of the country to give intelligent help in the movement for business efficiency. I hope that in the not very distant future each industry in this country will have developed a basis cost system that will fit its particular needs; that the question of a reasonable and adequate basis for depreciation will be worked out for each industry; and that these basic systems will be approved by the Federal Trade Commission. Moreover, I hope that it will be possible for any public accountant, by conforming to certain tests and rules laid down by the Federal Reserve Board, to have a United States resistry.

Under this plan the balance sheet of to-morrow, as presented to a banker, will have the certificate of a public accountant and, in addition, bear a registration stamp or number of the Regional Reserve Board. When this is brought about the banker will be particularly benefited. It is a well-known fact that the certified public accountants are willing and ready to do their part in seeing that the banker is presented with a statement or balance sheet that will show the real facts in regard to a particular concern whose books they may have examined. The trouble is that many manufacturers are unwilling to agree with their accountants as to what amount shall be charged off to depreciation. When a public accountant attempts to make a proper charge for this he is confronted by the manufacturer with a statement like this: "My machinery and buildings are as good as they were ten years ago, and your charge for depreciation is too high." The accountant, although anxious to do what is right, realizes that unless he is willing to agree with his client he is likely to lose him, and compromises by charging off an insufficient amount for depreciation. The next year similar conditions arise; and after this has continued for two or three years it is a very hard matter to treat this item in such a way that the balance sheets will be on a correct and sound basis. But when we have an officially approved basis for depreciation in that manufacturer's industry the accountant and the banker, working together, will be able to bring the manufacturer into line.

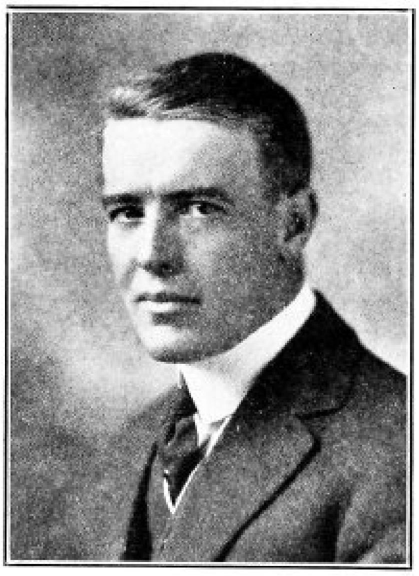
I do not want you to get the impression from this that I am advocating that all books should be kept under governmental supervision, nor that public accountants should not be allowed to certify business accounts without a United States registry. But if a public accountant has his registry number, and if the manufacturer complies with the fundamental system, then let the accountant make and seal his certification in his capacity as a United States registered accountant.

My suggestion may not be popular, and I appreciate that many criticisms will be aimed at it by business men, and even by some accountants. But when we are confronted by such conditions as I have outlined, don't you think something of this kind ought to be done?

In my judgment, such a system of accounting and certification would give much greater assurance to national, State and private banks in financing the business of the United States and would go far toward developing the efficiency and financial soundness that are imperative for the industrial future of this nation.

OBITUARY

Edward Thomas Hendee, secretary of Joseph T. Ryerson & Son, Chicago, died in Minneapolis, Minn., on November 12, aged thirty-six. Mr. Hendee was born on February 22, 1880, at Claremont, N. H. He was graduated from the New York University in 1900 with the degree of B. S., afterwards receiving the degree of M. E. and M. S. In 1901 he received the degree of Sc. D. at Columbia University. From 1901 to 1902 he was assistant professor of mechanical engineering at New York University. In 1902 he became associated with Joseph T. Ryerson & Son, of Chicago, as advertising manager. He built up and became manager of the machinery department and was made assistant to the president in January, 1911. In 1913 he assumed charge of the railway supply department of the firm. In 1913 he was elected secretary and continued in this office to his death. Under his able leadership both the domestic and foreign machinery business and the railway supply business of the company were very widely extended.



Edward Thomas Hendee

Mr. Hendee was vice-president and director of the Lennox Machine Company and director of the American Glyco-Metal Company. Nothing that could be said would exaggerate his loyal and indefatigable service to his company. He inspired with enthusiasm everyone with whom he came in contact. The three qualities of loyalty, energy and enthusiasm were responsible for his remarkable success.

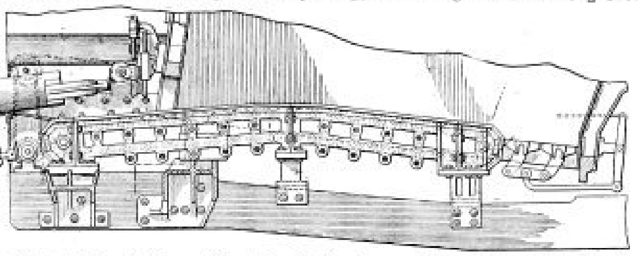
Selected Boiler Patents

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

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

1,181,560. LOCOMOTIVE STOKER. AUGUSTINE R. AYERS, OF CHICAGO, ILL., ASSIGNOR OF ONE-HALF TO JOHN J. BERNET, OF CHICAGO, ILL.

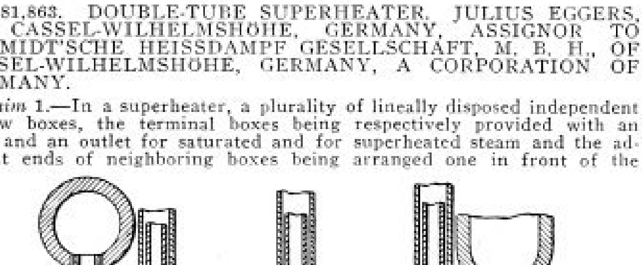
Claim 1.—In a locomotive stoker, the combination of a fire-box having a feeding opening, a deck to the rear of said fire-box and so located as to permit hand firing through said opening, a chain grate extending into



and substantially of the width of said fire-box and beneath said deck, the space beneath the deck and above the grate forming a coal receiving and distributing space and means beneath said deck for laterally distributing fuel delivered onto said grate. Seven claims.

1,181,863. DOUBLE-TUBE SUPERHEATER. JULIUS EGGERS, OF CASSEL-WILHELMSHÖHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF GESELLSCHAFT, M. B. H., OF CASSEL-WILHELMSHÖHE, GERMANY, A CORPORATION OF GERMANY.

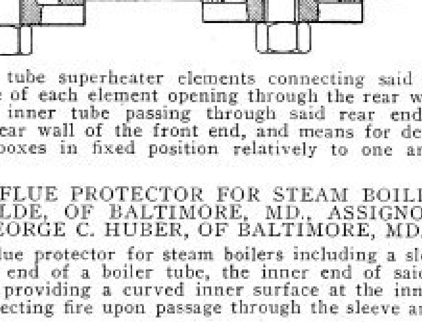
Claim 1.—In a superheater, a plurality of lineally disposed independent hollow boxes, the terminal boxes being respectively provided with an inlet and an outlet for saturated and for superheated steam and the adjacent ends of neighboring boxes being arranged one in front of the



other, double tube superheater elements connecting said adjacent ends the outer tube of each element opening through the rear wall of the rear end and the inner tube passing through said rear end and opening through the rear wall of the front end, and means for detachably maintaining said boxes in fixed position relatively to one another. Three claims.

1,184,936. FLUE PROTECTOR FOR STEAM BOILERS. OSCAR FALKENWALDE, OF BALTIMORE, MD., ASSIGNOR OF ONE-HALF TO GEORGE C. HUBER, OF BALTIMORE, MD.

Claim.—A flue protector for steam boilers including a sleeve for insertion into one end of a boiler tube, the inner end of said sleeve being feathered for providing a curved inner surface at the inner end of the sleeve for deflecting fire upon passage through the sleeve and causing the



same to hug the inner wall of a boiler tube, a plurality of circumferentially spaced spirally arranged ribs formed integrally upon said sleeve and positioned within the bore of the same, the outer end of said sleeve being rolled to form a bead for encompassing the outer end of a boiler tube, and an asbestos ring mounted within said bead for engagement with the end of a boiler tube.

1,181,780. APPARATUS FOR INDUCING FORCED DRAFT IN LOCOMOTIVES. LOUIS C. LOEWENSTEIN, OF LYNN, MASS., ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

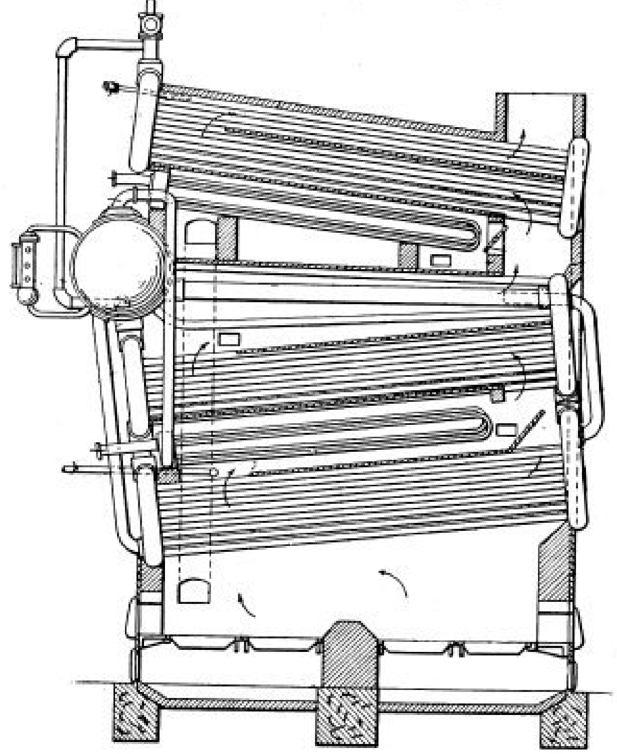
Claim 1.—The combination in a locomotive having a blower for creating forced draft, of a turbine wheel for driving the blower, a fluid directing means for supplying motive fluid thereto, a pipe connecting the fluid directing means with the steam supply of the locomotive, means for controlling the flow through said pipe, and a second fluid directing means located adjacent the first and adapted to have an auxiliary supply of motive fluid connected thereto. Two claims.

1,164,484. SAFETY-GAGE GLASS. GEORGE ERNST, OF N. Y.

Claim 1.—In a safety gage-glass, the combination of a socket member whose socket is counter-bored and internally threaded forming a shoulder, a packing member comprising a pair of metal rings and a compressible ring between them, one of said metal rings being abutted against said shoulder a gage-glass tube extending through said packing member into but spaced from the walls of the socket member, guard means co-operating with the threaded portion of the socket member and acting against the other of said metal rings to put the compressible ring under compression and making a steam-tight joint between the glass tube and the socket member, and means to direct the condensation water into the interior of the tube and out of contact with the inner wall thereof. Three claims.

1,184,977. MULTIPLE HORIZONTAL UNIT BOILER. EDWARD C. MEIER, OF PHŒNIXVILLE, PA.

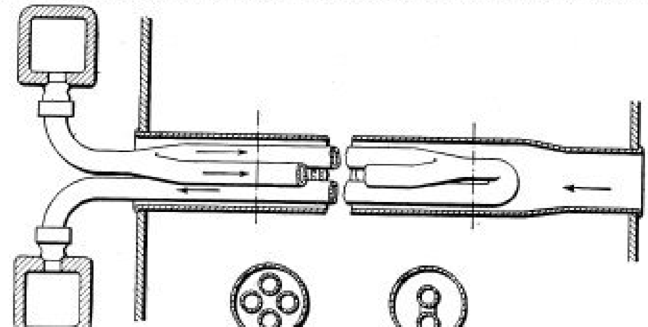
Claim 1.—A boiler, comprising a cross drum, a steam generating boiler unit below the drum and communicating therewith, a pre-heater located



above the drum and communicating therewith, a damper controlled superheating chamber formed between the pre-heater and the steam generating boiler unit below, and a super-heater in said chamber. Nine claims.

1,184,986. SUPERHEATER. HENRY B. OATLEY, OF FLUSHING, AND NEAL TRIMBLE McKEE, OF YONKERS, N. Y., ASSIGNORS TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

Claim 4.—In a boiler provided with heating tubes carrying products of combustion, the combination with one of said tubes of a superheater



unit of the class described located in said tube and comprising two portions carrying steam in directions against and with the current of the products of combustion, respectively, the former portion having a greater cross-sectional area than the latter. Five claims.

1,166,631. WATER GLASS GAGE. JOHN PURCELL, OF TOPEKA, KAN.

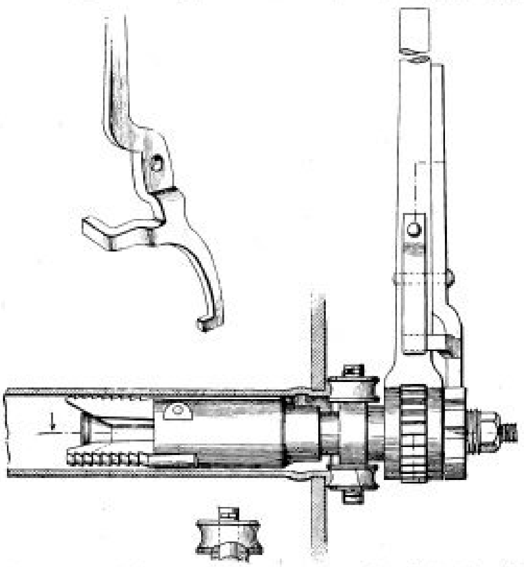
Claim 1.—A water glass gage for boilers, comprising a pair of cocks spaced apart and arranged one above the other, a rotatable plug-valve extending transversely through each of said cocks, members secured to the outer ends of said valves, a link pivotally connected to the free end of each member whereby movement of one valve will be imparted to the other, a lever connected with one of said valves, a spring-controlled latch-member secured to said lever whereby the latter may be locked in its adjusted position, and means mounted on said lever whereby the position of the valves may be determined. Two claims.

1,178,752. FIREBRICK ARCH. JOHN D. ROGERS, OF PRINCETON, W. VA., ASSIGNOR OF ONE-HALF TO H. C. ELLETT, OF PRINCETON, W. VA.

Claim 1.—In a locomotive boiler, a metal bearer disposed at the front of the firebox and formed with a plurality of vertical openings, a plurality of vertical straight material pipes having their lower ends fitted in the vertical openings of the bearer, a plurality of heat resisting members slipped upon the vertical pipes to hold them in fixed relative position and fill the spaces between them to form a bridge wall, said members being supported upon the bearer and a plurality of dampers for controlling the admission of air through the vertical openings of the bearer and the vertical pipes, said dampers being connected for simultaneous operation. Four claims.

1,186,107. APPARATUS FOR BEADING BOILER-TUBES. JOHN E. LIENAU, OF CORDOVA, NEB., ASSIGNOR OF ONE-THIRD TO FRANK M. DORSEY, OF CORDOVA, NEB.

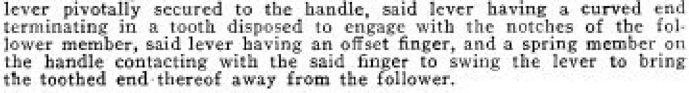
Claim.—In an apparatus for beading tubes, the combination with a stock having gripping jaws thereon, of a carriage loosely arranged upon the stock, said carriage including a substantially rectangular head and a



tubular body, short shafts upon the opposite ends of the head, beading rollers journaled on said shafts, a ratchet wheel upon the tubular body, a handle member having a bifurcated end loosely arranged on the carriage and straddling the ratchet, a spring pressed pawl carried by the handle for engaging the ratchet, a notched follower member threaded on the stock disposed to contact with the tubular end of the carriage, a lever pivotally secured to the handle, said lever having a curved end terminating in a tooth disposed to engage with the notches of the follower member, said lever having an offset finger, and a spring member on the handle contacting with the said finger to swing the lever to bring the toothed end thereof away from the follower.

1,188,912. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

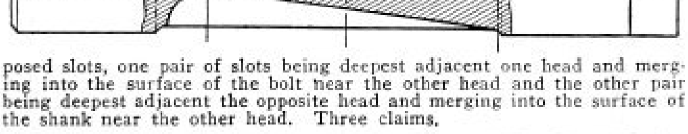
Claim 3.—As a new article of manufacture, a bolt having two heads and an intermediate shank, the latter having two pairs of oppositely dis-



posed slots, one pair of slots being deepest adjacent one head and merging into the surface of the bolt near the other head and the other pair being deepest adjacent the opposite head and merging into the surface of the shank near the other head. Three claims.

1,188,914. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

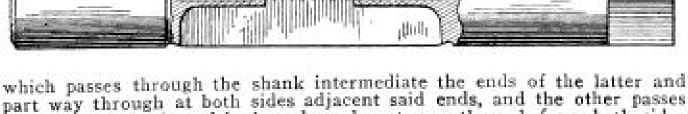
Claim 1.—As a new article of manufacture a staybolt having a head and a shank, the latter having slots at right angles to each other, one of



which passes through the shank intermediate the ends of the latter and part way through at both sides adjacent said ends, and the other passes through the shank and both ends and part way through from both sides at the center. Two claims.

1,188,915. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

Claim 1.—As a new article of manufacture, a staybolt consisting of an enlarged externally threaded head, and a shank, the portion of the latter



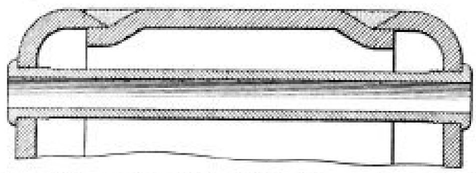
adjacent the head being enlarged and tapered, and the remaining part thereof cylindrical, the tapering part being slotted. Three claims.

1,189,922. WATER GAGE FOR BOILERS. JOHN J. DALY, OF READING, PA.

Claim.—A hollow casing having varied internal diameters, a reduced screw-threaded inner end, a squared outer surface, and being internally screw-threaded at its outer end, in combination with a glass body member having a reduced end and a tapered portion at approximately its longitudinal center, said body being adapted to fit one of said internal diameters; a rubber ring having a tapered inner surface adapted to fit over and engage the tapered portion of said body and its outer surface adapted to engage another of said internal diameters; and a retaining ring, externally screw-threaded for engagement with the threaded portion of the casing and adapted to bear against said rubber ring and to retain said glass body in position in the casing.

1,188,968. BOILER. EDWARD C. MEIER, OF PHŒNIXVILLE, PA.

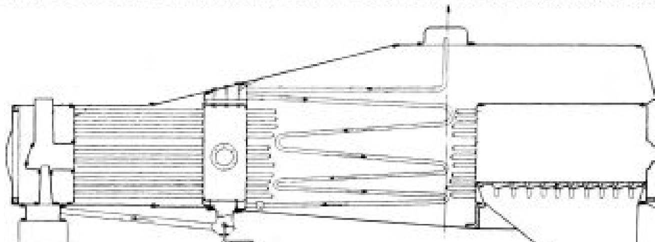
Claim 2.—A water leg or box comprising two members having edge portions engaging each other, one of said edge portions located at an



incline and engaging an edge of the other edge portion, the edge portion of the latter mentioned member being so shaped as to provide a surface inclined at approximately the same angle as the inclined edge portion of the first-mentioned member, whereby a V-shaped trough is formed between the members, and welding material located in the trough and flush with the outer faces of both of said members. Three claims.

1,159,181. SUPERHEATER FOR STEAM BOILERS. CHARLES W. CROWELL, OF SALISBURY, N. C.

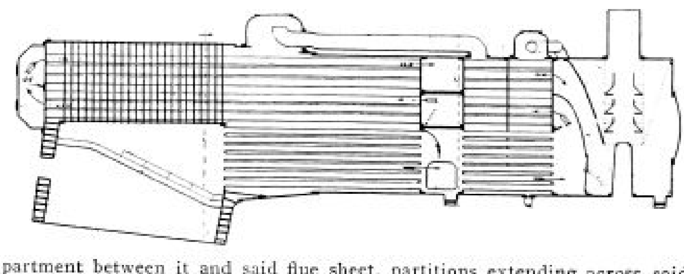
Claim 1.—A firetube boiler having in advance of the fire box, a fire chamber having a substantially round form and spaced within the boiler



so as to provide a steam superheating chamber between the same and the boiler wall, and flues connecting said fire chamber and the fire box. Fifteen claims.

1,196,783. STEAM-DRYING SYSTEM FOR LOCOMOTIVE BOILERS. WILLIAM C. JACOBS, OF PALESTINE, ILL., ASSIGNOR OF ONE-THIRD TO VIVIAN CARTER, OF PALESTINE, ILL.

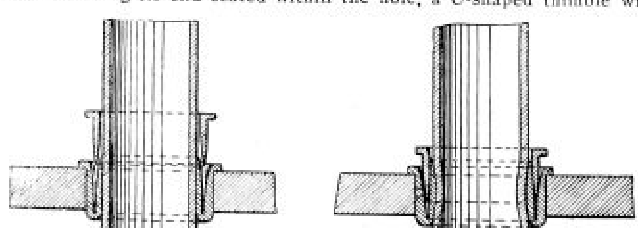
Claim 1.—The combination with a boiler, of a superheater having flues parallel with the boiler flues and located transversely of the barrel of the boiler in advance of the forward flue sheet and leaving a com-



partment between it and said flue sheet, partitions extending across said compartment for the purpose set forth, a regulable hinged baffle sheet in the lower part of said compartment, a baffle sheet forward of said superheater for returning the gases from the fire box toward the rear of the boiler, and a direct draft damper in said baffle sheet. Three claims.

1,192,927. TUBE-JOINT FOR BOILERS, ETC. CHARLES D. MOSHER, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—The combination with a tube sheet having a circular hole, of a tube having its end seated within the hole, a U-shaped thimble with-



in the hole and of sufficiently rigid material to cause distortion of the tube, and a sleeve clamping wedge system adapted to be driven between the walls of the thimble and distort inwardly the inner wall of the thimble and the tube wall. Three claims.

1,188,913. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

Claim 1.—As a new article of manufacture, a staybolt the shank of which is provided with oppositely disposed slots each extending part way through the shank, the slot on one side of the shank being separated from the slot at the other side by a thin web integral with the shank. Three claims.