THE BOILER MAKER

VOLUME XXV

JANUARY TO DECEMBER, 1925

PUBLISHED BY

SIMMONS-BOARDMAN PUBLISHING COMPANY

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

34 VICTORIA STREET, WESTMINSTER, S. W. I., LONDON, ENGLAND

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JANUARY TO DECEMBER, 1925

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THE BOILER MAKER

JANUARY, 1925

Laying Out Locomotive Boilers

By W. E. Joynes*

This is the first of a series of articles on locomotive boiler layout work written for the practical boiler maker and layerout who is interested in the advance of his trade. The articles will be continued through a number of issues of the magazine and, if at any time information is desired by our readers in explanation of the work, the author will be pleased to answer questions in connection with it through our pages.—THE EDITORS.

THOSE boilers which belong to the general class called locomotive boilers, comprise a group of great importance both from the standpoint of numbers and of horsepower generated. Their present design, which may be considered as practically standardized, is the result of a period of evolution dating back to the earliest attempts to use steam for obtaining power. Therefore, a knowledge of the principles involved is of assistance in making clear many of the questions certain to occur to the thoughtful layerout as he pursues his work of developing the various plates which comprise the completed boiler.—The Author.

WITH few exceptions the locomotive boiler of today is constructed along the general lines shown in Figs. 1 and 2, the construction of an average, non-combustion-chamber boiler being illustrated in these two figures. Combustion chamber boilers for all the larger types of locomotives are rapidly growing in number. A boiler with a combustion chamber is shown by Figs. 9 and 10.

It will be observed that the smokebox has ample dimensions to provide space for the self-cleaning arrangement, consisting of an exhaust nozzle, deflecting plates, screening, etc., also the superheater header and the steam pipes. The smokebox shell is made of ½-inch minimum thickness tank steel plate with a seam on the top center consisting of one welt strip on the inside, single riveted with ¾-inch rivets about 3 inches pitch. A more recent design of joint at the top center is a butt-jointed, welded seam with the welt strip omitted. The ring—shown at the front—for strengthening the shell and for bolting on the front door frame is made of solid wrought iron 2⅛ inches by 2⅛ inches or 2⅜ inches by 2⅜ inches. The first size is for smokeboxes under 72 inches outside diameter and the latter for those over 72 inches.

A handhole for cleaning purposes will be noticed at the front end on the left side only and applied on coal burning boilers only; at the back end another hole right and left which is used for inspection of the superheater header and units. Below the boiler center line will be seen the holes for the outside type of steam pipes leading to the cylinders.

In the bottom of the smokebox is an extra plate forming a double bottom. This plate—called the smokebox liner—strengthens the shell and provides extra bearing for the cylinder bolts.

The opening in the bottom of the shell and liner is for the inside type of steam pipe and exhaust pipe bosses and should be made sufficiently large to allow the cylinders to be rolled in a horizontal direction away from the smokebox without interfering with the latter. On large Mallet locomotives the smokebox is flattened to give sufficient clearance for receiving the cylinders and exhaust pipe. The flattened smokebox bottom will also be found on the three-cylinder type of locomotive.

The cylindrical shell of the boiler is constructed with two, three, four and sometimes five rings or courses. When designed with two rings the first ring is usually made in the form of a cone to provide a larger diameter for the second ring which, in turn, provides ample steam space above the crown sheet. When a boiler has three rings the cone is usually the second ring and when four rings are used as for Mallet locomotives, the second course is made a true or irregular cone, which allows a straight course for the high-pressure cylinder saddle and the dome on the third ring and the boiler bearing and centering device bearings on the first ring. The above depends entirely upon the requirements of the locomotive design as sometimes all the rings may be straight.

When possible, the longitudinal seam for all cones (conical connections) is placed on the top center. The top center location on the seam simplifies the plate development to a great extent.

Some of the parts which must be considered when locating the seam are the dome, injector check, longitudinal-brace feet, air pump brackets, hand rails, runboard brackets and other accessories. Sometimes it is necessary to place a brace foot, requiring holes in the shell on a seam. When this is done the efficiency of the seam must be considered. Seams on adjoining rings should not be in the same line and seams on boilers

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with more than two rings should not be on the same side of the boiler.

All circumferential seams are of the lapped, double-riveted type, except for Mallet locomotives when the length of all the courses exceeds 23 feet. It has been found advisable to use triple-riveted circumferential seams on both ends of the course to which the high-pressure cylinder saddle is attached. A liner on the outside of the shell is also added for strengthening the boiler at this point. Liners are also used on the inside of the boiler for strengthening the shell where the boiler bearing and centering device casting are attached.

All holes in the boiler shell and root sheet whose diameters exceed 4½ times the thickness of the plate should be reenforced with an internal liner of sufficient strength to replace an amount of metal equal to the efficiency of the seam, of the ring or stay line of the roof sheet. The thickness of reenforcing liners should not be less than 75 percent of the thickness of the plate to which the liner is riveted. The riveting of such liners should be carefully considered as to spacing and number of rivets and the liner should extend well around the hole.

In combustion chamber boilers, the back ring surrounds the combustion chamber of the firebox, the chamber extending into the ring from about one-third to two-thirds of the length of the ring, and supported by staybolts. The numerous staybolt holes made necessary in the ring reduce its efficiency, but as the stress on the ring is proportional to the steam space between the ring and the combustion chamber, this course need be no thicker than without the combustion chamber. The strength of the longitudinal seam for a ring surrounding a combustion chamber can be greatly reduced in way of the stays. However that part of the seam ahead of the stays must have the regular design of seam required for the ring.

Longitudinal Seams

Four different types of longitudinal seams are in use, viz., sextuple, octuple, decuple and diamond shaped seams, the first three being the most common. In the order named, they have approximately the following efficiencies, 82 to 85 percent, 87 percent, 93 percent and 98 percent. The diamond seam, at almost 100 percent efficiency would appear to be the most advantageous and does reduce the thickness of the shell thereby reducing the weight and cost of the plates, but owing to the fact that the inner welt of this type of seam has to be quite extensive in size the weight saved in the shell itself is replaced by the weight of the inner welt strip. The size of these welt strips is also a disadvantage in that it frequently causes the strip to interfere with some accessory or fitting requiring rivet or stud holes in the shell. Furthermore to place these holes through the seam in line with any of the seam rivets in the inner welt strip would reduce the efficiency of the seam.

Firebox Design

The type of firebox in Figs. 1, 2, 9 and 10 is known as the wide firebox with sloping

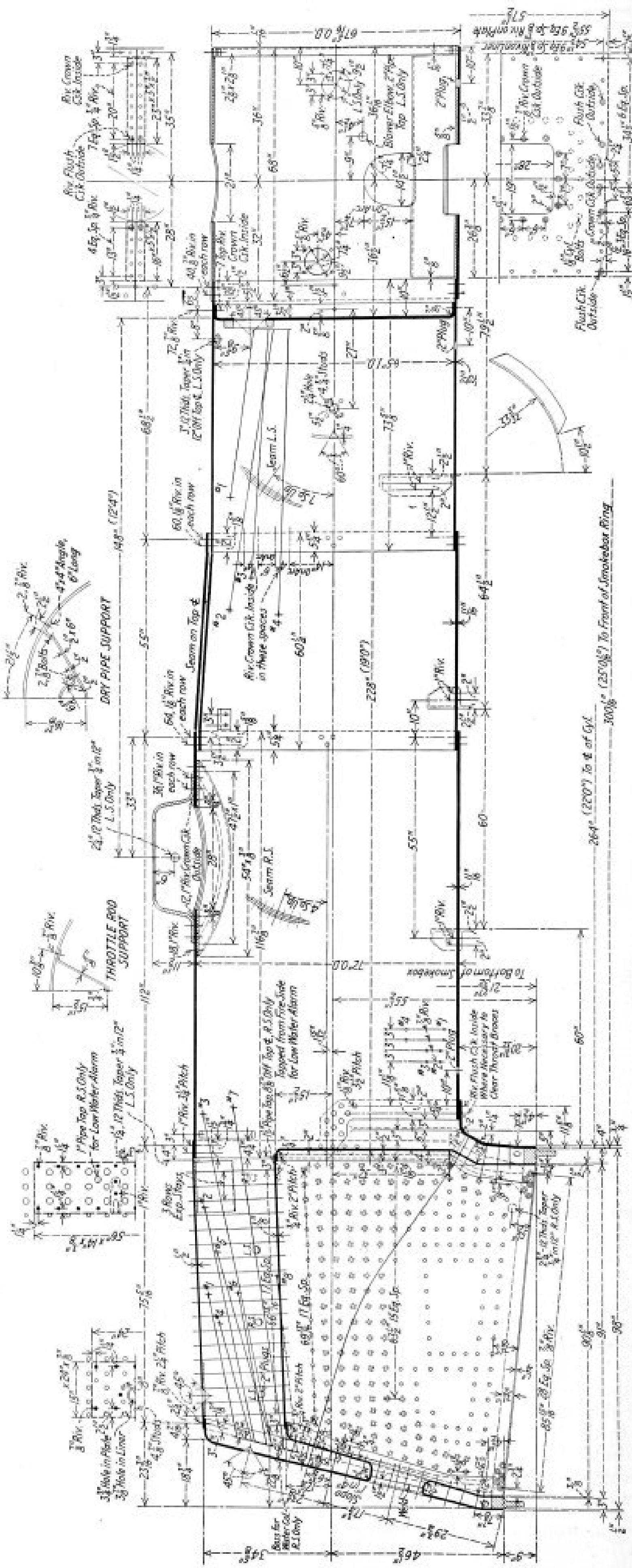


Fig. 1.—Locomotive boiler, longitudinal section

throat and backhead and on most locomotives is behind the driving wheels and over the trailing truck. The throat is sloped to clear the drivers and as required by the weight distribution in locating the boiler on the engine. The depth of the throat below the barrel of the boiler is determined by the fire space required at the front from the top of the grates to the underside of the arch fire brick. This space should not be less than 18 inches vertical.

The depth of the firebox at the back end is determined by the location of the fire-hole and the distance from the bottom of the fire-hole to the top of the grate. This latter dimension should not be less than 14 inches. The fire-hole is located to suit the height of the cab deck on hand-fired boilers.

The back head has a 1-in-6 slope, which allows more room in the cab and also reduces the size of the boiler. The steam space between the crown and roof is made approximately parallel with the crown sheet, the latter being sloped so that its top surface will remain covered with water when the locomotive is going down or backing up a grade. To sheets are used only when the size of the firebox exceeds the manufactured size of the one-piece sheet required.

The locomotive boiler shown in Fig. 1 has a sloped crown, sloped door or firebox back-sheet connection, sloped firebox ring and sloped throat sheet. The cross section of the boiler, Fig. 2, shows that the contour is the same at the front and back, except that it is lower at the door-sheet end, due to the sloping top or crown. In placing these front and back sectional views together as shown on the diagram in Fig. 4, it is seen that the front and back side-lines of the plate are not exactly in the same plane; this is due to the bend in the side sheet being parallel with the firebox ring and also because of the back end being lower than the front end at the top. However, this does not alter the method of development of this sheet and all crown and side sheets of this design, i.e., same width front and back at the firebox ring and at the top and as shown in Fig. 4, by the dimensions j, k, l and m, is known as a "projection job"—the outline of this sheet in the flat plate form is determined by the projection method of development.

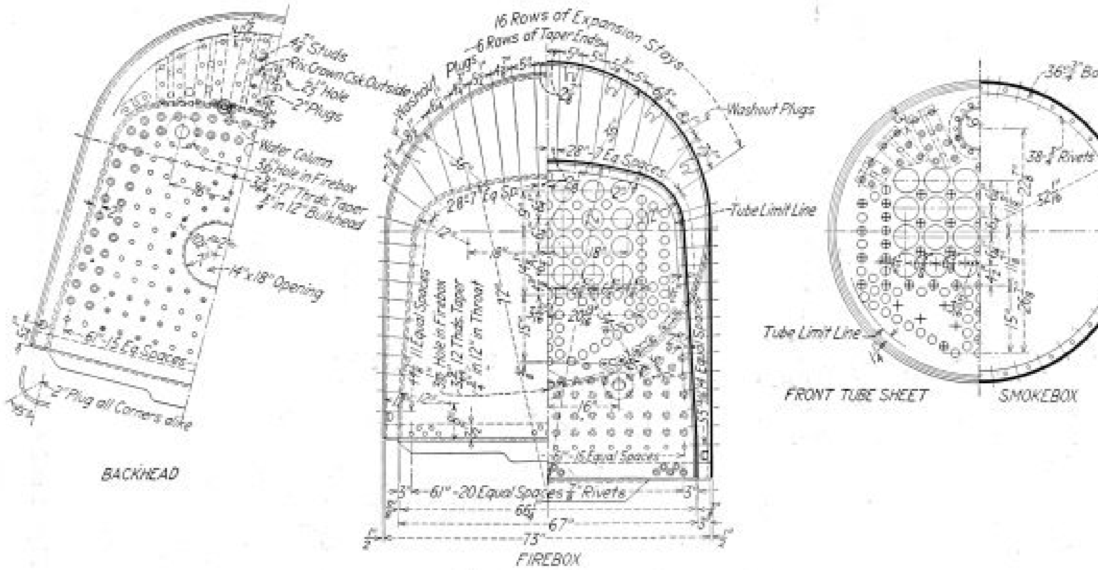


Fig. 2.—Boiler sections

have less than 3 inches of water above the highest point of the crown sheet is dangerous.

DEVELOPMENT OF PLATES

The work of developing the plates of a locomotive boiler may be carried on either in the drafting room or in the shop. If this work is part of the drafting room duties, drawings of the various developed plates are made for transfer to the actual metal plates. If the plates are developed in the shop the construction lines are drawn to full size dimensions and on the plates themselves.

The advantages of the former method consist in greater speed and accuracy. The drafting room has readily available all the information concering the boiler and dimensions, which must be found by calculation, are more accurately and quickly obtained. A further advantage lies in the fact that the development often causes the design of the boiler to be questioned and these questions are promptly and satisfactorily settled.

Development of One-Piece Crown and Side Sheets

(Projection Development)

The practice of making locomotive boiler crown and side sheets in three pieces is practically obsolete, so it will not be necessary to describe that type and design; three-piece

As mentioned above, the first sheet that will be taken to explain and show the development will be a firebox crown and side sheet in one piece.

First, with a straight edge placed a little above the center of the paper carefully draw a horizontal center line; from this erect a perpendicular line which must be at a perfect right angle with the center line. This line represents the back edge of the firebox ring and should be drawn—the first time—to extend well above and below the center; do not go over the line a second time, as it will probably make two lines instead of one. To erect this line, use a good prick-point and, far enough to the left of the paper to allow the back end of the boiler to be laid down, insert a very small hole exactly in the center of the center line, x, Fig. 3. Then with a beam-compass set 6 inches or 7 inches long scribe a short line across the center line, right and left, as x^1. At the intersection of the center line and these short lines, prick a small hole, x^1, and, using these holes as a center, lengthen the tram set and scribe intersecting arcs as shown below the bottom of the boiler x^2, and insert a prick-point hole. This done, lay the straight edge carefully over the center of this hole and the one on the center line and draw in the right angle or perpendicular line.

These two lines are the basis of the accuracy of the object, as in diagram Figs. 3 and 4. This diagram is an exact duplicate of the back end of the boiler shown in Figs. 1

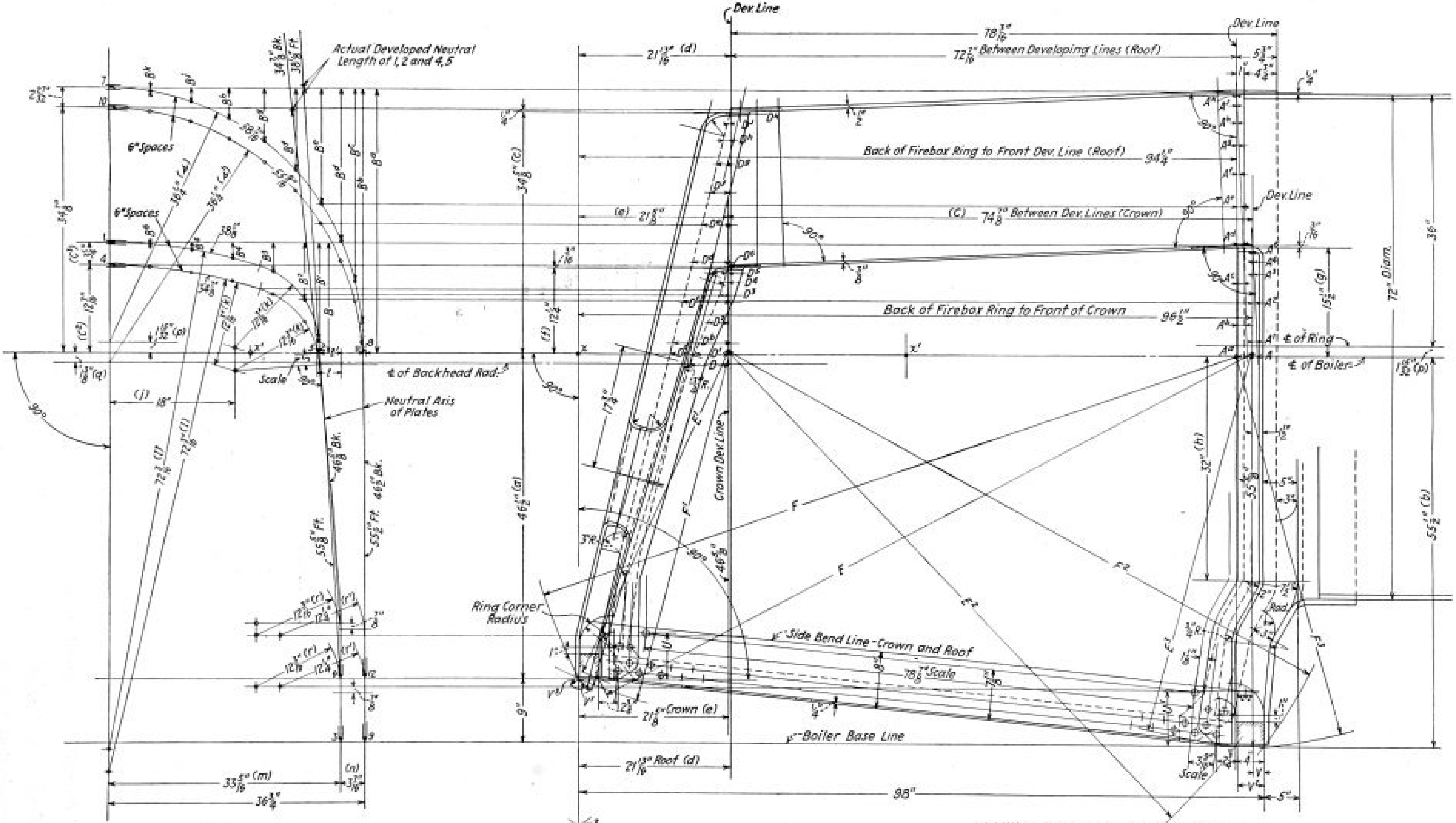


FIG. 4. FIG. 3

Additions have been made to this diagram to cover the work in connection with the flange sheet developments.

Figs. 3 and 4.—Plate development diagram

and 2, but is laid out more accurately to scale and with some extra notes and lines added to facilitate making the necessary explanations for the layout work. The sections, Fig. 4, have also been removed from the center of the longitudinal view, as it will make the drawing more clear and easier to understand. However, for easy projection work, this view, Fig. 4, is always placed in the longitudinal view, Fig. 3, a little nearer to the back end than the front end.

The diagram should be laid down to a scale of 1½ inches to the foot; this size scale is the smallest scale from which sixteenths of an inch can be read. A larger scale such as a 3-inch scale would not require quite so accurate or tedious drawing, but will be found too large to handle this work, therefore, not practical for the drawing board. It would also require more time because the drawing would be larger.

Before proceeding further, look the boiler drawing over carefully; pay close attention to where the arrowheads go, check the boiler dimensions top and bottom, front and back, see that they total correctly. Also, get out the detail card of the firebox ring and the ring corners, look these two cards over for scarfing and make sure that they agree with the boiler for riveting and size.

Note what the corner radii are. It will take some time to thoroughly learn how to make a good job of fitting the outside plate and the firebox sheet about the corners so that they will fit properly.

Keep the edge of the sheets tangent or about tangent with the corner radius, about 1 inch above the top of the ring. Also keep the first rivet in the seams close to the top of the ring, 1 inch minimum for the firebox sheet, 1¼ inches minimum for the outside sheet. If the pitch of the first rivet above the ring is too large to make a tight calking joint, shift the throat seam back or the backhead seam ahead to reduce the pitch, when this does not cause the staybolts to be shifted. The space between these two rivets has caused considerable leakage trouble in the past and, therefore, it is important to have this space the same pitch, when possible, as the seam rivets. However, this trouble of leakage is being eliminated by the modern practice of electric welding along the edge of the seam in this space when necessary. This should not be encouraged, but let the rivets be spaced so they will do their work when the design of the corner permits.

Continue with the development of the diagram, which is truly the frame work of the construction; without it the outline of the plates required to build the firebox end of the the boiler could not be determined.

Starting at the vertical line already drawn exactly square to the center line, measure carefully and accurately (*a*) 46½ inches (use a prick-point for all dimensions); draw a short line; add 46½ inches + 9 inches = 55½ inches; measure this total distance down, which locates the base line. At the front end, keeping the scale at a right angle with the center line, measure off the same dimensions 55½ inches (*b*); use the straight edge between (*a*) and (*b*) and draw in this boiler base-line. Along this base-line measure the length of the firebox ring, 98 inches. Now lay in the firebox ring and a few of the end rivets as shown. Use the firebox ring card to work from, as this will give all the dimensions required. Also give the boiler an occasional study, which will help to avoid making mistakes.

All of the dimensions that it will be necessary to use cannot be shown on the diagram; it would take too much time and also complicate the work too much, therefore it will be necessary to refer directly to the boiler card for the dimensions lacking. In actual production work, in the laying-out of the diagram, Figs. 3 and 4, it is, of course, necessary to refer to the boiler and detail cards for all dimensions.

(To be continued)

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

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

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

Below are given interpretations of the Committee in Cases Nos. 461-471 inclusive, as formulated at the meeting of October 28, 1924, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE No. 461. (In the hands of the Committee.)

CASE No. 462. *Inquiry:* Is it permissible, under the requirements of Par. P-218, to use instead of through stays under the tubes of a horizontal return tubular boiler, diagonal braces? The type of diagonal brace referred to is one that reduces the area of metal in contact with the sheet to a minimum.

Reply: It is the opinion of the Committee that when stays are required below the tubes, through stays must, under the requirements of Par. P-218, be used, and that the use of any stays attached to the boiler shell is not permissible.

CASE No. 463. *Inquiry:* Is it permissible, under Par. P-250 of the Boiler Code to use the prosser method of expanding tubes in firetube boilers provided they are subsequently rolled and beaded as that paragraph specifically requires?

Reply: Attention is called to the fact that the expanding of tubes by the prosser method is permitted in place of rolling only for tubes not exceeding 1½ inches in diameter. It is the opinion of the Committee that there is nothing in the Code to prohibit the prossering of tubes larger than 1½ inches in diameter, provided they are subsequently rolled and beaded, or rolled, beaded, and welded around the edge of the bead, as required by Par. P-250.

CASE No. 464. *Inquiry:* Will a method of supporting horizontal return tubular boilers, 84 inches in diameter and larger, which consists of suspending the shells from properly designed cross-beams resting on pilasters built into the side walls of the setting so as to be entirely free from the firebrick linings thereof, meet the requirements of the Boiler Code?

Reply: Attention is called to the fact that Par. P-323 of the Code requires all horizontal return tubular boilers over 78 inches in diameter to be supported from steel hangers by the outside-suspension type of setting, independent of the side walls. It is the opinion of the Committee that this requirement cannot be met unless the overhead supporting beams rest on piers of either steel, brick, or other substantial construction which are entirely independent of and not bonded into the side walls of the boiler setting.

CASE NO. 465. *Inquiry:* Inasmuch as it has been stipulated in Case No. 453 that the lowest visible point of a water gage shall not, for low-pressure heating boilers, be located lower than the point specified for fusible plugs, an interpretation is requested of Par. H-64 in the Low-Pressure Heating Boiler Section of the Code, which refers to the "lowest safe water line."

Reply: It is the opinion of the Committee that the lowest safe water line of a heating boiler is that at which the heating surfaces of the boiler are either covered with water or are not exposed to products of combustion until these products have passed over not less than 75 percent of the total heating surface of the boiler.

CASE NO. 466. *Inquiry:* An interpretation is requested of the application of that portion of Par. P-253 of the Code which prohibits the punching of "such holes" in material more than 5/8-inch thick. The first sentence refers to "all holes in braces, lugs or sheets for rivets of staybolts," and inquiry is made as to whether the term "sheets" would cover heads, and as to whether holes for other purposes than above named may be punched in material more than 5/8-inch thick.

Reply: It is the opinion of the Committee that the prohibition of punching holes in material more than 5/8-inch thick applies to all rivets or staybolt holes in sheets, whether for use as heads or shell plates. It is pointed out, however, that this prohibition does not apply to holes intended for other purposes than for rivets or staybolts.

CASE NO 467. *Inquiry:* Is it the intent of Par. P-308 to permit the connection or attachment of a blow-off pipe for a boiler to a return connection which is of the same size or larger than that specified for the blow-off pipe, when such blow-off outlet is not and cannot be attached to the shell before the boiler leaves the shop?

Reply: Par. P-308 permits the use of a large opening for a water return connection to the boiler and to this return pipe a blow-off not exceeding 2 1/2 inches pipe size may be connected. It is pointed out by the Committee that it is not ordinarily possible to attach the blow-off outlet before the boiler leaves the shop where the boiler is built, but that this connection is properly made upon installation in the field must be verified by the proper authority.

CASE NO. 468. *Inquiry:* Is it permissible, under the requirements for the construction of steel-plate boilers in the Low-Pressure Heating Boiler Section of the Code, to attach steam outlet and safety-valve flanges to the shell by autogenous or fusion welding?

Reply: It is the opinion of the Committee that in providing for the welding of steel heating boilers, it was anticipated that the welded joints should be considered for the purpose as equivalent to riveted joints under the restrictions outlined therein and therefore that there is no objection to the welding of such outlet flanges for low-pressure heating boilers.

CASE NO. 469. *Inquiry:* An interpretation is requested as to the application of the term "the equivalent" as it appears in the last line of Par P-321. Is it to be understood that brass or other non-ferrous pipe will not be considered the equivalent of steel pipe or tubing or wrought-iron pipe for use at pressures above 200 pounds per square inch?

Reply: It is the intent of the last sentence of Par. P-321 to prohibit the use of brass, copper or other non-ferrous pipe or tubing whose strength is materially reduced or impaired when subjected to the temperatures corresponding to steam pressures above 200 pounds per square inch. Attention is called to a typographical error in the last sentence of this paragraph, the beginning of which should read: "For steam pressures over 200 pounds per square inch, etc."

CASE NO. 470. *Inquiry:* Is it necessary, when using the outside-suspension type of setting as specified in Par. P-323 of the Code for horizontal return tubular boilers less than 78 inches in diameter, to adhere to the requirement therein for the girthwise spacing of rivets in the hangers, or may this requirement be waived in view of the smaller diameters of boilers?

Reply: It is the opinion of the Committee that where the boiler does not exceed 78 inches in diameter, the requirement in Par. P-323 for the girthwise spacing of rivets in the hangers does not apply.

CASE NO. 471. *Inquiry:* Inquiry is made as to whether there is not an error in the second filling material analysis for electric welding in Table H-8 of the Heating Boiler Section of the Code? The phosphorus limit appears to be much too high.

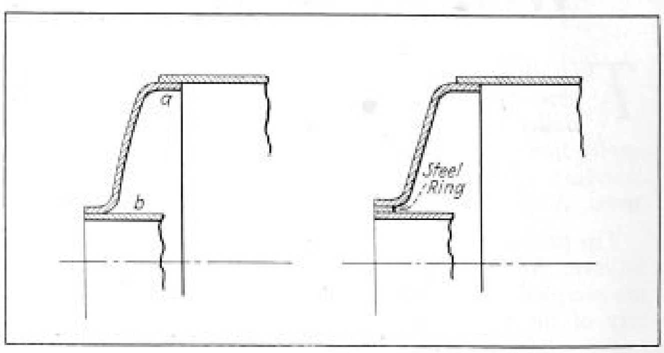
Reply: In the second section of Table H-8 of the Heating Boiler Section of the Code, referring to material for filling rods for electric welding, an obvious clerical error has been made in that the second and third lines should be transposed so as to make the manganese content read "not over 0.40 to 0.60 percent," and the phosphorus "not over 0.06 percent."

Improvements in Fire Tube Boilers—The Case for the Dish End

By Major Johnstone-Taylor

WHILE the various types of boilers built for land service are in most respects entirely satisfactory as steam generators, the so called Lancashire boiler has much to recommend it for supplying steady loads of steam at moderate pressures. Boilers of this type are very extensively used in Britain for general industrial purposes.

For low pressure work, up to 100 pounds the flat end type with its comprehensive system of stays has no serious disadvantages, but for higher pressures, those up to 250 pounds the elimination of the heavy stays and their hundreds of



Correction of grooving action

rivets is greatly in favor of the dish end, a type of boiler becoming very popular with British engineers.

POINTS OF SUPERIORITY

With the dish end, as stated, stays are eliminated as the end becomes self-supporting.

As regards the expansion of the flues, with the flat end boiler any expansion of the flues not taken up by the flue joints must be dissipated in bulging the unstayed portion of the end, hence freedom of expansion is largely dependent upon the flexibility of the end plate.

One of the points argued against the dish end boiler was, that end plates of this kind would be far too rigid, but this contention, along with the fact that grooving would occur as the inevitable result of expansion and contraction of the flues has been proved a fallacy provided a corrugated flue is

(*Continued on page* 15)

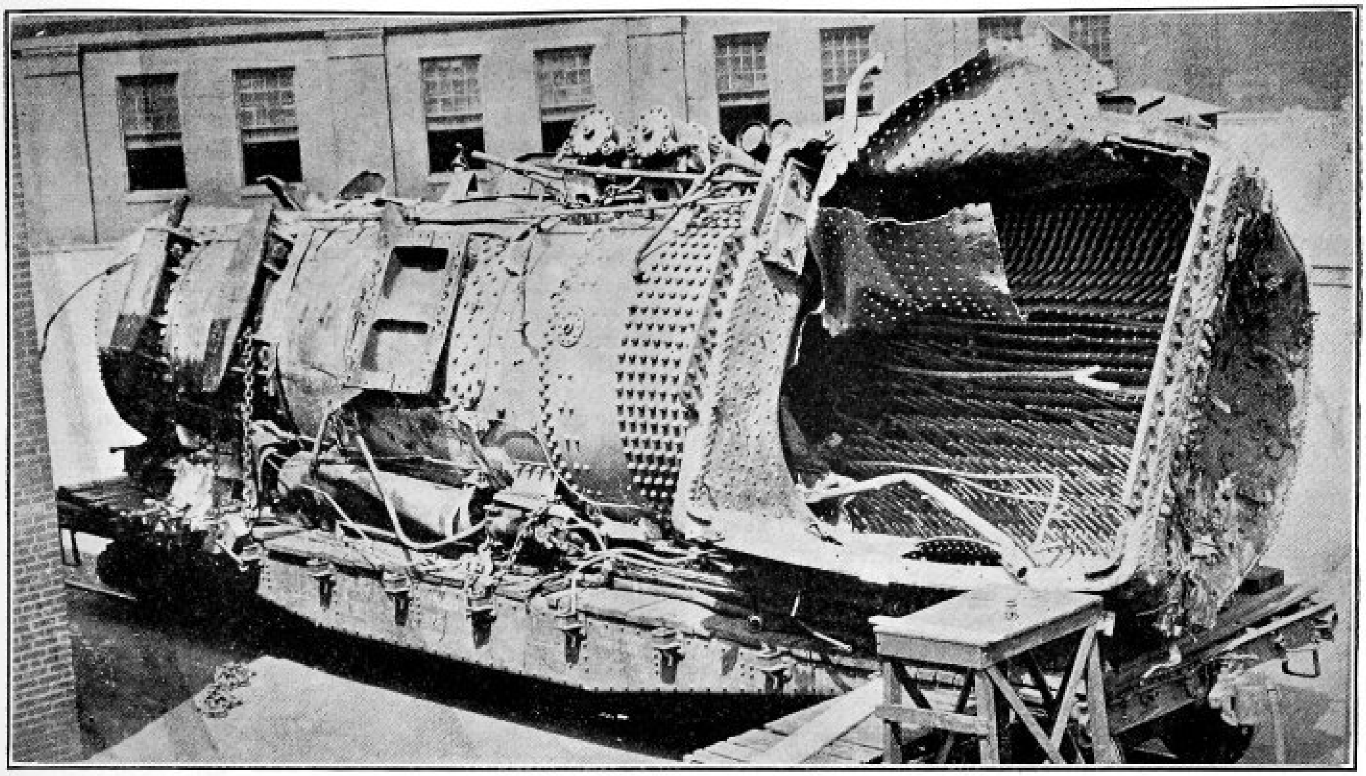


Fig. 1.—Disastrous low water explosion

Locomotive Inspection Bureau Makes Annual Report*

Number of Boiler Explosions Shows Marked Decrease Over Preceding Year—Low Water Again Outstanding Cause of Failure

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

The percentage of locomotives found defective decreased from 65 percent during the year 1923 to 53.4 percent during the last year. This shows an improvement in the condition of motive power during the year, yet below that during the year 1922, when 48 percent of the locomotives inspected by our inspectors were found defective.

The condition of motive power is reflected in the number of accidents and casualities to persons resulting from failures of parts and appurtenances of locomotives and tenders. During the last year there were 1,005 accidents, resulting in the death of 66 persons and serious injury to 1,157 others. While this is a reduction as compared with the previous year, it is a very material increase over the year 1922, when there occurred 622 accidents resulting in the death of 33 persons and the serious injury of 709 others from the same causes.

Explosions

During the year there were 43 boiler explosions, which resulted in death of 45 persons and the serious injury of 59 others. The statement above made with respect to the total number of accidents during the year also applies to accidents due to explosions. The total explosions during the year decreased 24.6 percent as compared with the preceding year, but an increase of 30 percent over the year 1922.

Attention is called to the increased seriousness of explosions as reflected by the loss of life. The effect of a boiler explosion is in direct proportion to the size and suddenness of the initial rupture which causes the explosion and the temperature and volume of the water in the boiler at the time of the accident. The volume of water increases with the size of the boiler and the temperature of the water increases as the steam pressure increases, consequently the failure of the large modern boiler carrying high pressure is

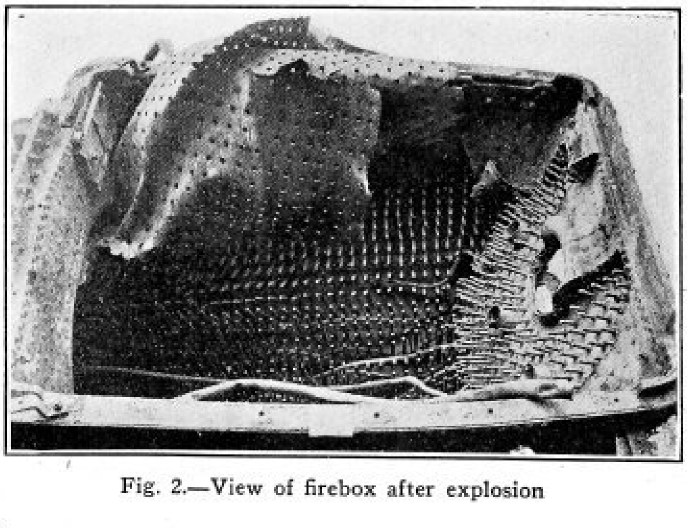


Fig. 2.—View of firebox after explosion

*Abstract taken from annual report of the Bureau of Locomotive Inspection submitted by A. G. Pack, chief inspector of the Bureau, to the Interstate Commerce Commission.

Fig. 3.—Two men were killed in this accident

very much more serious in effect. This is illustrated by the fact that 57 explosions during the year 1923 caused the death of 41 persons, while 43 explosions during the last year caused the death of 45 persons. The reason that more people are not killed and injured by locomotive boiler failures is due to the fact there are usually only two persons on the locomotive at the time of the accident. If such explosions were to occur at stations or other congested places, the results could not be estimated. These facts forcibly demonstrate the necessity for a high standard of construction, maintenance, and operation of the locomotive. Because of defects developing from day to day and trip to trip, the utmost diligence must be pursued if serious accidents are to be avoided.

While most of these explosions were caused by the crown sheet having been overheated due to low water in the boiler, contributory defects or causes were found in 52.4 percent of the cases, which again illustrates the necessity for better construction, inspection, and repair of all parts and appurtenances.

In the ninth, tenth, eleventh, and twelfth annual reports reference is made to investigations and tests made by the bureau on a number of railroads to determine the action

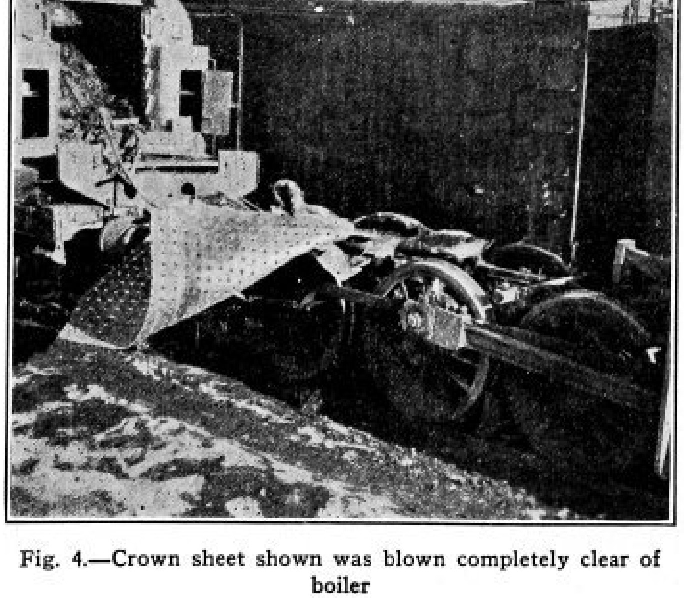


Fig. 4.—Crown sheet shown was blown completely clear of boiler

of water in the boiler and its effect upon the water-indicating appliances, which investigation established without question that gage cocks when screwed directly into the boiler do not correctly indicate the general water level while steam is being rapidly generated and simultaneously escaping from the boiler. It having been made manifest that dependency on gage cocks attached directly to the boiler for registering the general water level creates an unsafe condition and adds to the peril of operation, it was and is recommended that a suitable water column be applied to the boiler with three gage cocks and one water glass attached, with an additional water glass applied on the left side or boiler back head so that those operating the locomotive may have accurate knowledge of the general water level in the boiler under all conditions of service.

The water column as recommended is the most accurate device yet invented for this purpose. Accurate knowledge

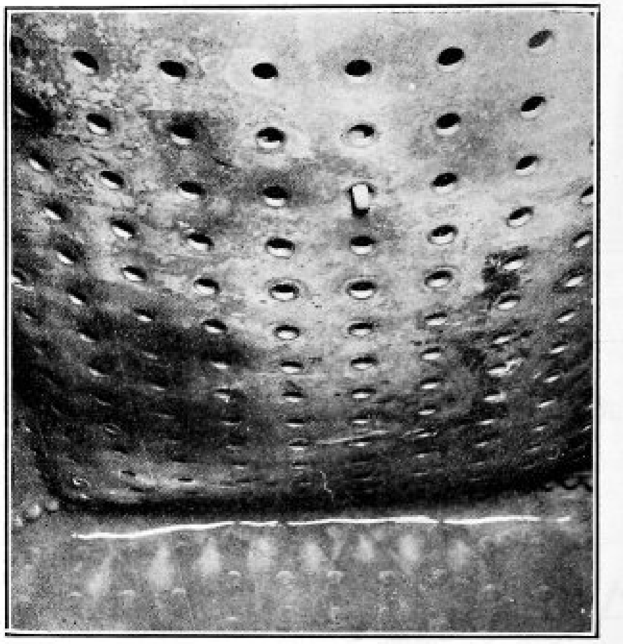


Fig. 5.—Crown sheet failure caused by low water

of the height of the water in the boiler is most essential to safe and economical locomotive operation. Water columns as recommended have been applied to practically all new locomotives constructed since the publication of the report and to a large number of locomotives previously in service.

NUMBER OF ACCIDENTS, NUMBER KILLED, AND NUMBER INJURED CAUSED BY THE FAILURE OF SOME PART OR APPURTENANCE OF THE LOCOMOTIVE AND TENDER, INCLUDING THE BOILER, BY COMPARISON

	Year Ended June 30—				
	1924	1923	1922	1921	1920
Number of accidents	1,005	1,348	622	735	843
Percent increase or decrease from previous year	25.5	[1]117	15.4	12.8	[1]49.2
Number of persons killed	66	72	33	64	66
Percent increase or decrease from previous year	8.3	[1]118	48.4	3	[1]15.8
Number of persons injured	1,157	1,560	709	800	916
Percent increase or decrease from previous year	25	[1]120	11.3	12.6	[1]41.6

[1] Increase.

NUMBER OF ACCIDENTS, NUMBER KILLED, AND NUMBER INJURED AS A RESULT OF THE FAILURE OF PARTS AND APPURTENANCES OF THE LOCOMOTIVE BOILER TO WHICH THE ORIGINAL ACT ONLY APPLIED

	Year Ended June 30—				
	1924	1923	1922	1915	1912
Number of accidents	393	509	273	424	856
Number of persons killed	54	47	25	13	91
Number of persons injured	447	594	318	467	1,005

It is essential to safe and economical locomotive operation that water glasses and gage cocks be so constructed, located, and maintained that they not only register the correct height of the water in the boiler, but that they be conveniently located and easily seen and read by the engineer and fireman from their usual and proper places in the cab. The duties of locomotive engineers are among the most hazardous and exacting; therefore, anything that detracts their attention for any length of time from the track and signals ahead creates an inestimable peril to locomotive and train operation. It is our hope that proper water-indicating appliances, as recommended, will be applied by all carriers with due diligence and without the necessity of an order by the commission making it mandatory.

Autogenous Welding

In view of the number of accidents investigated where welds made by the autogenous process were involved, particular attention should be called to this subject. Due to the many failures, the position has been that this process has not yet reached a stage of development where it can be safely used on any part of the boiler where the strain to which the structure is subjected is not carried by other construction which conforms to the requirements of the law and rules, nor in firebox crown sheet seams where overheating and failure are liable to occur, nor on sheets which have been weakened from any cause to the extent of becoming unsafe, nor seams on the boiler back head; except where the welded seams are covered with a patch applied with patch bolts, studs, or rivets that will prevent the escape of scalding water and steam in the cab to the extent that might cause serious injury to persons should the welding fail, nor on any part of the locomotive or tender subjected to shocks or strains where, through failure, accident an injury might result.

The most prolific source of casualties due to the failure of autogenously welded seams has been in firebox crown sheets and it has been conclusively demonstrated that the loss of life and limb due to firebox failures depends very largely upon whether or not the sheets or seams tear.

From July 1, 1915, to June 30, 1924, autogenously welded seams were involved in 26.9 percent of the crown sheet failures, while 50.7 percent of the total persons killed in such accidents was where the autogenously welded seams were involved. From the viewpoint of safety, this clearly shows the necessity for constructing firebox sheet seams in the strongest practical manner, especially so in the so-called "low water zone," or such seams as may be within 15 inches of the highest part of the crown sheet measured

Table Showing Number of Locomotives Reported, Inspected, Found Defective, and Ordered from Service

Parts Defective, Inoperative or Missing, or in Violation of Rules	Fiscal Years Ended June 30— 1924	1923	1922	1921	1920
1. Air compressors	1,221	1,390	971	692	763
2. Arch tubes	272	468	151	160	150
3. Ash pans or mechanism	257	306	161	147	152
4. Axles	19	21	15	12	10
5. Blow-off cocks	965	1,578	975	969	771
6. Boiler checks	1,329	1,913	949	1,006	877
7. Boiler shell	2,103	2,370	1,598	1,550	1,598
8. Brake equipment	6,920	8,213	4,577	4,836	4,373
9. Cabs or cab windows	1,627	1,423	1,276	1,171	1,361
10. Cab aprons or decks	1,293	1,476	1,098	893	550
11. Cab cards	758	1,449	567	671	816
12. Coupling or uncoupling devices	398	634	423	547	707
13. Crossheads, guides, pistons, or piston rods	3,577	5,527	1,920	2,116	2,107
14. Crown bolts	418	630	331	392	348
15. Cylinders, saddles, or steam chests	5,712	4,875	3,234	3,304	4,212
16. Cylinder cocks or rigging	2,376	1,745	1,201	1,197	1,735
17. Dome or dome caps	494	626	331	396	372
18. Draft gear	1,981	2,613	1,526	1,418	722
19. Draw gear	4,160	4,513	3,042	3,134	2,857
20. Driving boxes, shoes, wedges, pedestals, or braces	3,722	4,269	2,776	3,361	2,128
21. Fire-box sheets	1,471	2,327	1,191	1,185	1,185
22. Flues	698	1,268	521	552	554
23. Frames, tail pieces, or braces, locomotive	2,580	2,683	2,078	1,998	2,921
24. Frames, tender	414	540	352	232	264
25. Gage or gage fittings, air	626	1,062	399	537	248
26. Gage or gage fittings, steam	2,026	3,075	1,595	1,769	1,283
27. Gage cocks	3,835	5,895	3,275	3,657	3,413
28. Grate shakers	1,006	569	425	565	93
29. Handholds	2,241	1,990	1,533	894	593
30. Injectors, inoperative	94	251	94	179	88
31. Injectors and connections	9,985	12,406	7,741	7,606	6,638
32. Inspections or tests not made as required	9,740	7,419	4,114	4.865	3,924
33. Lateral motion	939	1,625	976	1,066	1,052
34. Lights, cab or classification	72	90	80	86	115
35. Lights, headlight	904	1.164	705	539	639
36. Lubricator or shields	565	566	456	427	515
37. Mud rings	1,901	2,711	1,598	1,441	1,515
38. Packing nuts	3,304	4,755	3,151	3,294	3,779
39. Packing, piston rod and valve stem	3,187	3,359	1,756	2,176	2,818
40. Pilot or pilot beams	967	1,294	679	588	374
41. Plugs or studs	1,026	857	443	457	333
42. Reversing gear	1,217	1,272	789	745	470
43. Rods, main or side, crank pins or collars	6,507	10,080	3,915	4,464	4,392
44. Safety valves	138	192	162	144	957
45. Sanders	1,806	1,857	1,165	1,071	891
46. Springs or spring rigging	6,335	7,911	5,497	5,494	4,244
47. Squirt hose	1,221	1,098	935	916	512
48. Staybolts	916	1,313	722	716	541
49. Staybolts, broken	5.320	10,089	4,261	4,871	5.551
50. Steam pipes	2,305	2,467	1,461	1,678	1,320
51. Steam valves	981	1,168	791	792	676
52. Steps	2,829	3,289	2,038	1,917	1,260
53. Tanks or tank valves	3,393	3,788	2,817	2,385	2,064
54. Telltale holes	630	715	630	567	437
55. Throttle or throttle rigging	2,868	2,633	1,880	1,730	1,087
56. Trucks, engine or trailing	3,425	3,899	2,467	2,493	1,927
57. Trucks, tender	5,977	3,714	2,551	2,408	2,240
58. Valve motion	1,269	1,761	710	691	463
59. Washout plugs	3,204	3,641	2,449	2,306	2,221
60. Water-bars or combustion flues	18	24	57	24	82
61. Water glass, fittings, or shields	4,201	5.641	3,640	4,045	2,954
62. Wheels	2,996	4,371	2,410	2,802	2,440
63. Miscellaneous—Signal appliances, badge plates, brakes (hand)	1.342	972	403	504	184
Total number of defects	146,121	173,840	101,734	104.848	95,066
Locomotives reported	73,683	70,242	70,070	70,475	69,910
Locomotives inspected	67,507	63,657	64,354	60,812	49,471
Locomotives defective	36,098	41,150	30,978	30,207	25,529
Percentage inspected found defective	53	65	48	50	52
Locomotives ordered out of service	5,764	7,075	3,089	3,914	3,774

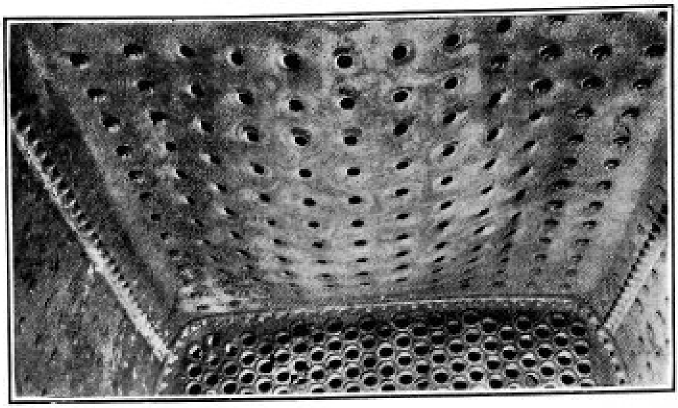


Fig. 6.—Sheet pulled away from 120 stays

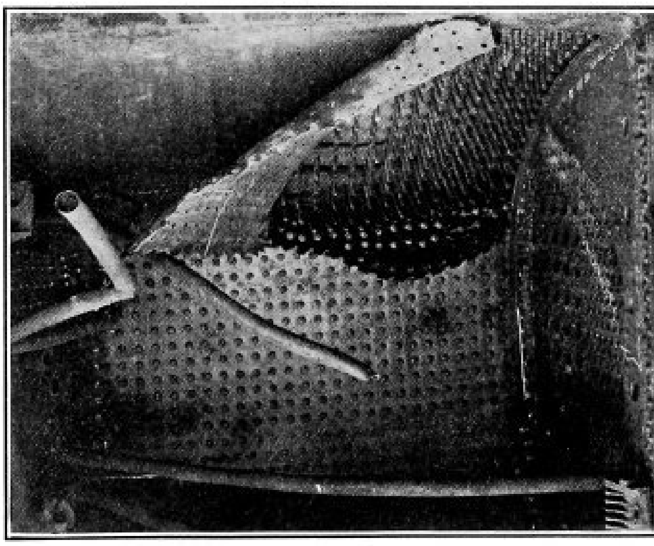


Fig. 7.—Another case of low water

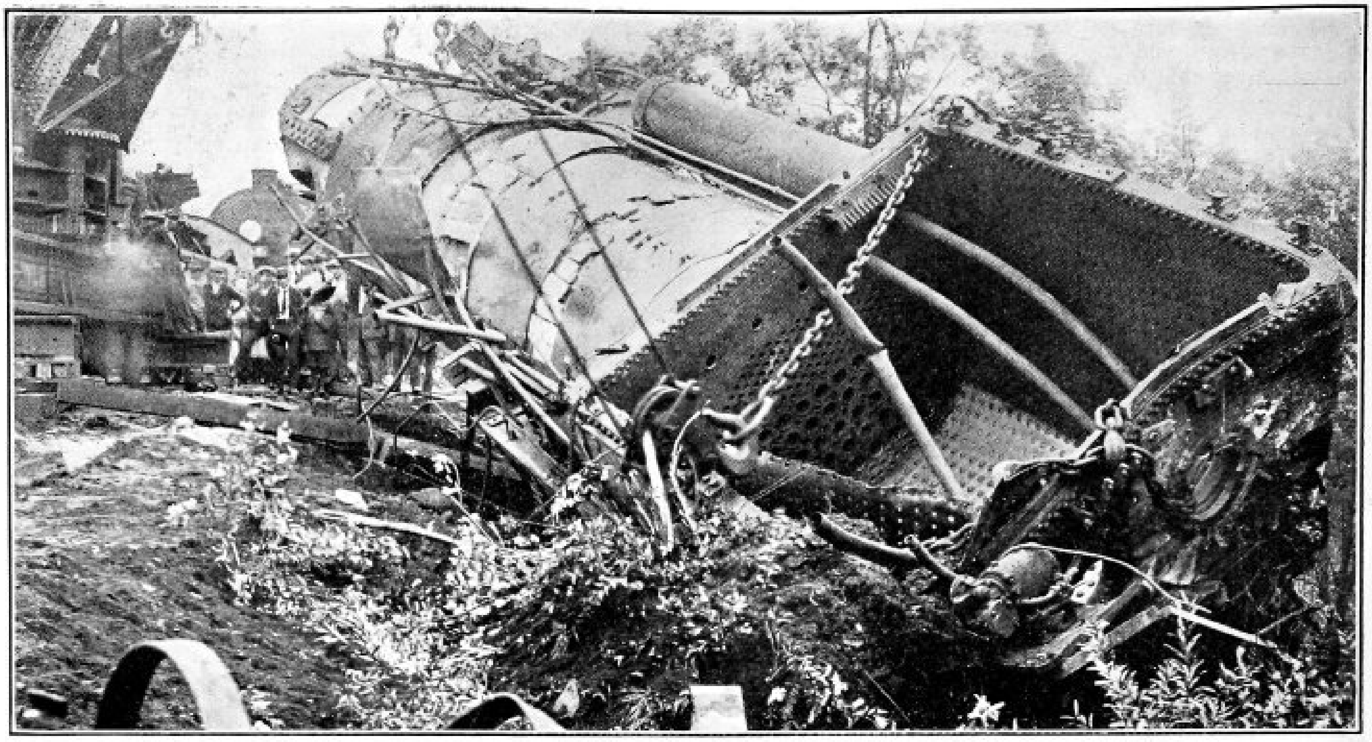


Fig. 8.—The boiler in this case was completely demolished

vertically. Because the autogenous welding process is in a state of development, and due to a desire to avoid hindering the progress or development of any process of such great value when properly and discreetly used, the chief inspector has hesitated to ask the commission to establish or approve rules or regulations restricting its use which might retard its development. However, unless the carriers confine its use to parts and appliances where, through failure, accidents and injuries will not result, he states that he will be compelled to recommend more restrictive measures in the near future.

General Compliance With Requirements

Soon after July 1, 1922, it was brought to the attention of the commission that inspections, tests, and repairs were not being made by many of the carriers as required; therefore it became necessary for inspectors to obtain information to show that locomotives were being used while in violation of the law so that court proceedings could be instituted. It was also necessary that inspectors issue special notices for repairs, in accordance with sections 6 and 9 of the law, withholding 7,075 locomotives from service during that year until proper inspections and repairs were made. During the last year federal inspectors were compelled to issue special notices for repairs ordering out of service 5,764 locomotives because of being in violation of the law. Considerable improvement has been made by a large number of carriers and some improvement has been made by most all of them, yet the condition is far from being satisfactory in so far as a proper compliance with the law is concerned. If due diligence were pursued by the carriers in seeing that locomotives are in proper condition and safe to operate before being offered for service, the commission's inspectors should not find it necessary to order any locomotive from service because of being in violation of the law, thus frequently causing serious inconvenience to the traveling and shipping public and an added burden to the carriers.

Prosecutions

There is now pending in the United States District Court for the Northern District of New York a case involving an inspector charged with perjury in swearing to the correctness of an annual locomotive inspection and repair report rendered this bureau. In this case the inspector swore that the arch tubes in the locomotive were in "good" condition, notwithstanding that the center arch tube did not extend through the throat sheet far enough to be either belled or beaded to secure it in place. It is charged that the inspector did so swear when he did not believe the same to be true. The tube blew out 27 days after the sworn report was rendered, causing serious injury to two employees, report of which was made public by order of the commission.

During the fiscal year 1923-24 evidence was obtained and petitions prepared and transmitted to the proper United States attorneys for prosecution in 46 cases, involving 472 counts. Pleas of guilty were entered by defendants in 294 counts and penalties aggregating $29,400 imposed; 65 counts were dismissed and 113 counts were pending as of June 30, 1924.

Senate Resolution No. 327

In response to Senate Resolution No. 327 of August 3, 1922, calling for information as to whether or not the provisions of the locomotive inspection act were being violated and, if so, the extent of such violations and as to whether inspections of the locomotives were being made in all federal inspection districts and upon the roads of all common carriers engaged in interstate commerce as required by said act, we have been supplying information each month to Congress when in session, and to the President when not in session, showing the number of locomotives inspected, the number found defective, the percentage inspected found defective, number ordered out of service, and the number of accidents, killed and injured, by comparison with previous periods.

Extension of Time for Flue Removals

During the year, 139 applications were filed for extension of time for removal of flues, as provided in rule 10. Our investigation disclosed that in 12 of these cases the condition of the locomotives were such that no extension within the purpose and intent of the law could properly be granted.

Seventeen were in such condition that the full extension requested could not be authorized, but an extension for a shorter period within the limits of safety was allowed. Fifteen extensions were granted after defects disclosed by our investigations had been repaired. Twenty-two applications were withdrawn by the carriers for various reasons and the remaining 73 were granted for the period requested.

Specification Cards and Alteration Reports

In accordance with rule 54, there were filed 3,336 specification cards and 11,795 alteration reports necessary in determining the safe working pressure and other required data for the boilers represented. In order to determine whether or not the boilers covered by these reports were so constructed as to be in safe and proper condition for service and that the stresses were within the allowed limits, these specification cards and alteration reports were carefully checked and analyzed and corrective measures taken with respect to numerous discrepancies found.

Amendment to the Law

The act of June 7, 1924, further amending the locomotive inspection law, extending jurisdiction to all locomotives and tenders, their parts and appurtenances, has placed upon the bureau additional duties and responsibilities. The preparation of rules fixing minimum requirements for all locomotives not heretofore coming under the jurisdiction of the law is being pursued as diligently as conditions will permit, and arrangements are being made to put into effect the additional requirements as soon as possible.

Appropriations

The amount appropriated to carry out the requirements of the law during the year was $300,000, to be spent monthly in equal allotments. In order to keep within this appropriation, it was necessary to curtail materially the travel of the field force and to keep the office force at the lowest consistent minimum. Because of lack of sufficient funds and of a sufficient number of inspectors, there were 2,189 or 47 percent of the total points in the United States where locomotives are stationed, housed, or repaired, where no inspections were made during the year.

Recommendations for Betterment of Service

In the ninth, tenth, eleventh, and twelfth annual reports recommendations were made, in accordance with section 7 of the act, for additional inspectors and appropriation and the application of automatic firedoors, power reverse gear, power grate shaker, automatic bell ringer, horizontal handholds and stirrups on cabs, and water columns, and the reasons therefor given.

In order to save space in this report the bureau has refrained from repeating in detail these recommendations and reasons; however, they are respectfully renewed as being in the interest of safety.

There are several devices now being used and being developed which will apparently give an audible alarm when the water becomes dangerously low in the boiler and prevent serious and fatal explosions, and while these devices have not been in use a sufficient length of time to definitely prove their reliability, it is hoped that the carriers will give due consideration to them and assist in their development and broaden their use in every consistent way.

Fatal Boiler Explosions

In Figs. 1 and 2 are shown the results of an explosion caused by low water in which the engineer, fireman and a brakeman were killed. The explosion occurred in a mountainous district on an ascending grade of 2.2 percent. The road was double tracked and the force of the explosion tore

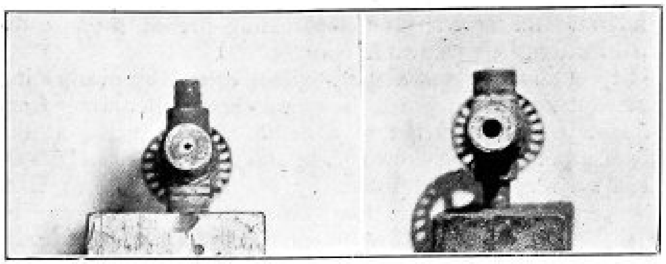


Fig. 9 (left).—Bottom water glass cock filled with hard scale. (Right)—The same cock after being cleaned out

the boiler loose from the frame and hurled it 220 feet ahead where it landed in the center of the adjacent track. An interesting side light to this accident is that the conductor, seeing the reflection of an opposing headlight on the surrounding hills from a train approaching down the grade was able to flag this train, thus averting another serious and probably very fatal accident.

The result of another boiler explosion, in which the engineer and fireman were killed, is shown in Figs. 3 and 4. In this case the boiler came to rest 129 feet ahead of the point of the explosion. Fig. 4 shows the frames and running gear from which the boiler was torn as well as the crown sheet where it was blown out of the boiler and re-

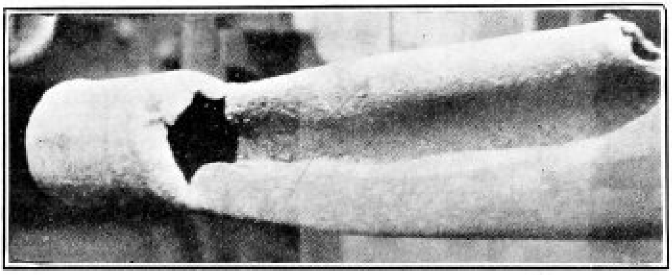


Fig. 10.—Superheater tube which collapsed

mained on the running gear. This boiler was carrying 200 pounds steam pressure. The water at the time of the accident was clearly shown to have been 14 inches below the highest part of the crown sheet, as defined by the line of demarcation caused by overheat. This boiler was equipped with a tubular water glass with top and bottom cocks entering the boiler direct. The top water glass cock was screwed into the boiler head near the knuckle of the backhead flange. Three gage cocks were screwed directly into the boiler glass to the knuckle of the backhead flange. Both water glass cocks were damaged to such an extent by the accident that their previous condition could not be determined.

A bad crown sheet failure is illustrated in Fig. 5. This was another case of low water. The sheet pulled away from 357 stays and pocketed to a depth of 19½ inches at the deepest point. The crown sheet was highly discolored during the overheating and the line of demarcation caused by overheat was clearly defined, showing the water to have been approximately 10 inches below the highest part of the crown sheet at the time of the accident. The fireman was seriously injured in this case. The absence of material damage to the locomotive is to be noted as compared with other accidents of a similar nature where sheets tore. The locomotive was being used at the time of the accident at a large terminal and in a congested area for heating purposes. Had the accident resulted in a serious explosion and the boiler been torn from the frame the destruction would have been inestimable. The firebox was of five-piece construction consisting of a crown sheet, two side sheets, flue sheet and door sheet with all seams riveted. It again illustrates the necessity of constructing firebox sheet seams in the strongest practicable manner.

Fig. 6 shows a crown sheet failure caused by overheating due to low water in which the crown sheet pulled away from 120 stays and pocketed to a depth of 5½ inches at the deepest point. The crown sheet was supported by button-head stays spaced 4¼ inches by 4¼ inches. This firebox was a five-piece construction with all seams riveted. In Figs. 7 and 8 another low water boiler explosion is shown in which one person was killed and another seriously injured. Fig. 7 shows the failure of a portion of the flue sheet, crown sheet seam and side sheet seam where an autogenous welded joint failed. Fig. 8 shows the boiler where it came to rest 250 feet ahead and 85 feet to the right of the point of explosion.

Fig. 9 (a) shows a bottom water glass cock with the opening practically closed with hard scale, while in Fig. 9 (b) the same water glass cock after the hole had been opened is shown. The locomotive in which this cock was fitted had just received monthly inspection and had been fired up and inspected by the federal inspector. The monthly inspection and repair report covering the inspection, which had just been made, showed that the cock and water glass cock spindles had been removed and the cocks cleaned notwithstanding the actual condition, as shown. After the water glass was blown out it took seven seconds for the water to rise 2 inches in the water glass. Some of the most serious explosions on record have been directly caused or contributed to by such conditions.

Fig. 10 shows a superheater tube which collapsed and ruptured while the locomotive was in service because of being reduced in thickness to about 1/32 inch by corrosion. The accident resulted in very serious injury to the fireman. Investigation disclosed that the remaining superheater tubes in this boiler were badly corroded and thin and contained 4 thimbles in the firebox end. They should have been removed at the last removal of the small tubes and given attention.

A. S. M. E. Boiler Construction Code*

Report on Rules for the Construction of Unfired Pressure Vessels

The object of the code covering the construction of Unfired Pressure Vessels is to provide a safe construction for the great variety of pressure containers now manufactured and used for innumerable purposes throughout the country and under an exceedingly wide range of conditions. The efforts to give publicity which have been made in order to obtain as wide a range of opinion as possible, has brought out views which were often times diametrically opposed. In such cases the attempt has been made to frame the rules in accordance with the greater weight of opinion.

It is believed that these rules will not work undue hardship on the manufacturing industries generally, and at the same time will result in the construction of reasonably safe pressure vessels, for it is undoubtedly true that many of the failures which take place are due to the lack of proper restrictions governing both material, workmanship, dimensions and supervision.

Rules for electric induction compression welding are in process of preparation and will be submitted later on for addenda to the Code.

The committee is composed of E. R. Fish, chairman; W. H. Boehm, C. E. Bronson, E. C. Fisher, S. F. Jeter, W. F. Kiesel, Jr., James Neil and H. V. Wille.

U-41. Staybolts. The ends of screwed staybolts shall be riveted over or upset by an equivalent process.

U-42. Structural Reinforcements. When channel or angle sections or other members are securely riveted to the heads for attaching through stays, the transverse stress on such members shall not exceed 1⅛ times the maximum allowable unit working stress in pounds per square inch. In computing the stress, the section modulus of the member shall be used without addition for the strength of the plate. The spacing of the rivets over the supported surface shall be in conformity with that specified for staybolts.

If the outstanding legs of the two members are fastened together so that they act as one member in resisting the bending action produced by the load on the rivets attaching the members to the head of the pressure vessel, and provided that the spacing of these rivets attaching the members to the head is approximately uniform, the members may be computed as a single beam uniformly loaded and supported at the points where the through braces are attached.

U-43. *a.* The maximum spacing between centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined as in Par. U-40, using 135 for the value of *C*.

b. The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the centers of the rivets attaching the crowfeet of braces to the head, shall be determined by the formula in Par. U-40, using 175 for the value of *C*.

c. The maximum distance between the inner surface of the shell and the centers of braces of other types shall be determined by the formula in Par. U-40, using a value of *C* equal to 1.3 times that value of *C* which applies to the thickness of plate and type of stay as therein specified.

d. In applying these rules and those in Par. U-40 to a head or plate having a manhole or reinforced opening, the spacing applies only to the plate around the opening and not across the opening.

U-44. The formula in Par. U-40 was used in computing Table U-3 for steel plate stamped 55,000 pounds per square inch. Where values for screwed stays with ends riveted over are required for conditions not given in Table U-3, they may be computed from the formula and used, provided the pitch does not exceed 8½ inches.

TABLE U-3—MAXIMUM ALLOWABLE PITCH IN INCHES, OF SCREWED STAYBOLTS, ENDS RIVETED OVER

Pressure lb per sq. in.	Thickness of plate, in. 5/16	3/8	7/16	1/2	9/16	5/8	11/16
	Maximum pitch of staybolts, in.						
100	5¼	6⅜	7⅜	...	...	...	...
110	5	6	7	8⅛	...	...	...
120	4¾	5¾	6¾	8	...	...	...
125	4¾	5⅝	6⅝	7¾	...	...	...
130	4⅝	5½	6½	7⅝	...	...	...
140	4½	5⅜	6¼	7⅜	8⅛	...	...
150	4¼	5⅛	6	7⅛	8	...	...
160	4⅛	5	5⅞	6⅞	7¾	...	...
170	4	4⅞	5⅝	6¾	7½	8⅜	...
180	...	4¾	5½	6½	7⅜	8⅛	...
190	...	4⅝	5⅜	6⅜	7⅛	7⅞	...
200	...	4½	5¼	6⅛	7	7¾	8½
225	...	4¼	4⅞	5⅞	6½	7¼	8
250	...	4	4⅝	5½	6¼	6⅞	7⅝
300	...	...	4¼	5	5⅝	6¼	7

U-45. The distance from the edge of a staybolt hole to a straight line tangent to the edges of the rivet holes may

* Continuation of proposed code, the first part of which appeared in the December issue of THE BOILER MAKER, beginning on page 354.

be substituted for p for staybolts adjacent to the riveted edges bounding a stayed surface. When the edge of stayed plate is flanged, p shall be measured from the inner surface to the flange, at about the line of rivets to the edge of the staybolts or to the projected edge of the staybolts.

U-46. The minimum diameter of a screw stay (usually the root of the thread) shall be used.

U-47. The least cross-sectional area of a stay shall be taken in calculating the allowable stress, except that when the stays are welded and have a larger cross-sectional area at the weld than at some other point, in which case the strength at the weld shall be computed as well as in the solid part and the lower value used.

U-48. Holes for screw stays shall be drilled full size or punched not to exceed 1/4 inch less than full diameter of the hole for plates over 5/16 inch in thickness, and 1/8 inch less than the full diameter of the hole for plates not exceeding 5/16 inch in thickness, and then drilled or reamed to the

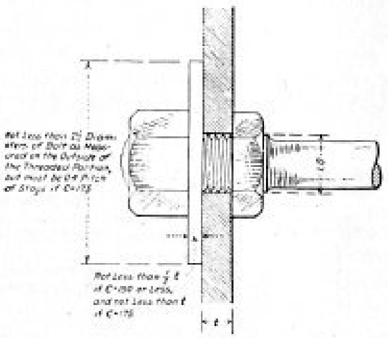


Fig. U-2—Acceptable proportions for ends of through stays

full diameter. The holes shall be tapped fair and true, with a full thread.

U-49. The end of steel stays upset for threading shall be thoroughly annealed.

U-50. *a.* The full-pitch dimensions of the stays shall be employed in determining the area to be supported by a stay, and the area occupied by the stay shall be deducted therefrom to obtain the net area. The product of the net area in square inches by the maximum allowable working pressure in pounds per square inch gives the load to be supported by the stay.

b. The maximum allowable stress per square inch at point of least net cross-sectional area of steel or iron stays and staybolts shall be as given in Table U-4. In determining the net cross-sectional area of drilled or hollow staybolts, the cross-sectional area of the hole shall be deducted.

TABLE U-4—MAXIMUM ALLOWABLE STRESSES FOR STAYBOLTS OR BRACES

Description of Stays	Stresses, lb per sq. in. — For lengths between supports not exceeding 120 diameters	For lengths between supports exceeding 120 diameters
a Unwelded or flexible stays less than 20 diameters long, screwed through plates with ends riveted over	7,500	....
b Hollow steel stays less than 20 diameters long screwed through plates with ends riveted over	8,000	....
c Unwelded stays or braces and unwelded portions of welded stays or braces, except as specified in line *a* and line *b*	9,500	8,500
d Steel through stays or braces exceeding 1½ in. diameter	10,400	9,000
e Welded portions of stays or braces	6,000	6,000

U-51. Where it is impossible to calculate with a reasonable degree of accuracy the strength of a pressure vessel or any part thereof, a full-sized sample shall be built by the manufacturer and tested to destruction in the presence of the Boiler Code Committee or one or more representatives of the Boiler Code Committee appointed to witness such test.

CALKING

U-52. Calking. The calking edges of plates, butt straps, and heads shall be beveled to an angle not sharper than 70 deg. to the plane of the plate, and as near thereto as practicable. Every portion of the unfinished surfaces of the calking edges of plates, butt straps, and heads shall be planed, milled, or chipped to a depth of not less than 1/8 inch. Calking shall be done with a tool of such form that there is no danger of scoring or damaging the plate underneath the calking edge, or splitting the calked sheet.

MANHOLES AND HANDHOLES

U-53. All tanks for use with compressed air, 16 inches in diameter, or over, and not exceeding 36 inches in diameter, shall have a handhole in the shell, or head, or have a manhole.

All such tanks less than 16 inches in diameter may be constructed without a handhole, provided there are at least two pipe connections, or provided they have bolted blank flanged heads.

U-54. All tanks for use with compressed air over 36 inches in diameter, excepting those whose shape or use make it impracticable, shall have a manhole. An elliptical manhole opening shall be not less than 11 by 15 inches, or 10 by 16 inches, in size. A circular manhole opening shall be not less than 15 inches in diameter.

U-55. A manhole reinforcing ring, when used, shall be of rolled, forged or cast steel, shall be at least as thick as the shell plate, and shall have a net cross-sectional area, on a line parallel to the axis of the shell, not less than the cross-sectional area of shell plate removed on the same line.

U-56. Manhole frames on shells shall have the proper curvature and, when the diameter exceeds 48 inches, shall be riveted to the shell with two rows of rivets.

U-57. The strength of the rivets, in shear on each side of a manhole frame or reinforcing ring shall be at least equal to the tensile strength of the maximum amount of the shell plate removed by the opening and rivet holes for the reinforcement on any line parallel to the longitudinal axis of the shell, through the manhole or other opening.

U-58. Manhole plates shall be of rolled, forged, or cast steel, and their strength shall, together with that of the bolts and yokes, be in proportion to the strength of the manhole frames.

THREADED OPENINGS

U-59. A pipe connection 1 inch in diameter or over shall have not less than the number of threads given in Table U-5. Diameters of less than 1 inch pipe size shall have at least four threads.

If the thickness of the material in the pressure vessel is not sufficient to give such number of threads, the opening shall be reinforced by a pressed steel, cast steel, or bronze composition flange or plate, riveted or brazed on, or a boss may be built up by an autogenous welding process for an opening not to exceed 2 inches pipe size, and for a pressure not to exceed 100 pounds per square inch, so as to provide the required number of threads.

When the maximum allowable working pressure exceeds 125 pounds per square inch, a connection attached to the pressure vessel to receive a flanged fitting shall be used for all pipe openings over 3 inch pipe size.

SUPPORTS

U-60. Supports. All vessels must be so supported as to properly distribute the stresses due to the weight of the vessel and contents.

Lugs or brackets when used to support a vessel shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on material used for attaching the lugs or brackets shall not exceed 40 percent of the maximum allowable working stresses given in Pars. U-15 and U-16.

TABLE U-5—MINIMUM NUMBER OF PIPE THREADS FOR CONNECTIONS

Size of pipe connection in.	1 and 1¼	1½ and 2	2½ to 4 inclusive	4½ to 6 inclusive	7 and 8	9 and 10	12
Number of threads per inch	11½	11½	8	8	8	8	8
Minimum number of threads required in opening	4	5	7	8	10	12	13
Minimum thickness of material required to give above number of threads, in.	0.0348	0.435	0.875	1	1.25	1.5	1.625

U-61. In laying out the plates care must be taken to leave one of the stamps required in the Specifications for material used, so located as to be plainly visible when the vessel is completed; or in case these are unavoidably cut out, the heat number, quality of plate, minimum tensile strength and maker's name shall be accurately transferred as to form by the pressure-vessel manufacturer, to a location where these stamps will be visible. The form of stamping shall be such that it can be readily distinguished from the plate maker's stamping.

U-62. Vessels over 12 inches in diameter must be so arranged that the interior and exterior of the vessel may be inspected. In the case of vertical cylindrical vessels subject to corrosion, the bottom head, if dished, must be with the pressure on the concave side to insure complete drainage.

U-63. Every pressure vessel shall conform in all details with these rules, and when so constructed shall be stamped with the legend provided for in Par. U-66.

U-64. Hydrostatic Test. Each vessel constructed under these rules shall be tested under hydrostatic pressure to 50 pounds in excess of the maximum allowable working pressure when same does not exceed 100 pounds and to 1½ times the maximum allowable working pressures above 100 pounds, except that vessels with fusion-welded joints shall be tested to three times the working pressure, and enameled vessels shall not be tested in excess of the working pressure.

U-65. Every pressure vessel shall be inspected at least once by a state or municipal inspector of boilers, or an inspector employed regularly by an insurance company which is authorized to do a boiler-insurance business in the state in which the vessel is built, and in the state in which it is to be used, if known, which inspection shall be made when the hydrostatic pressure test is on. A data sheet shall be filled out and signed by the manufacturer and the inspector, which data sheet, together with the stamping on the vessel, will denote that it is constructed in accordance with these rules. Every pressure vessel fabricated in whole or in part by a welding process, shall, when the size of the shell permits, be internally inspected before being finally closed to inspection.

U-66. Each such pressure vessel shall be marked in the presence of the inspector, A. S. M. E. Std. P. V., the class, and with the manufacturer's name and serial number and working pressure These markings shall be stamped with letters and figures at least 5/16 inch high on some conspicuous portion of the vessel, preferably near a manhole, if any, or handhole. These stamps shall be arranged substantially as follows:

A. S. M. E. STD. P. V.
Serial No. . . . .
Max. W. P. . . . . .lb.
Mfrs. No. . . . .
. . . .
(Mfrs. Name)

and shall not be covered with insulating or other material. The symbol authorized for use on power boilers shall not be used on pressure vessels.

RULES FOR THE FUSION PROCESS OF WELDING

U-67. Processes. The fusion process, so-called, shall consist of welding by means of either the oxy-acetylene process or the electric-arc process, using a metallic electrode, either bare, coated, or covered.

U-68. When properly welded by the fusion process, the strength of a joint may be calculated on a maximum unit working stress (S) of 5,600 pounds per square inch. (See Par. U-20.)

U-69. The term "base metal" shall mean the metal or metals of which the vessel is constructed and which are joined together by the welded seam.

U-70. Material for Base Metal. The base metal shall not exceed ⅝ inch thickness, shall be of good weldable quality, and when of steel shall be made by the open hearth process, conforming to the requirements of the Specifications for Forge Welding, Pars. U-110 to U-125.

CONSTRUCTION

U-71. Method of Welding. Longitudinal seams shall be of the double--V type, that is, welded from each side halfway through the sheet. Girth and head seams may be of the single-V type, that is, welded entirely through from the outside. Double-V welds shall be reinforced at the center of

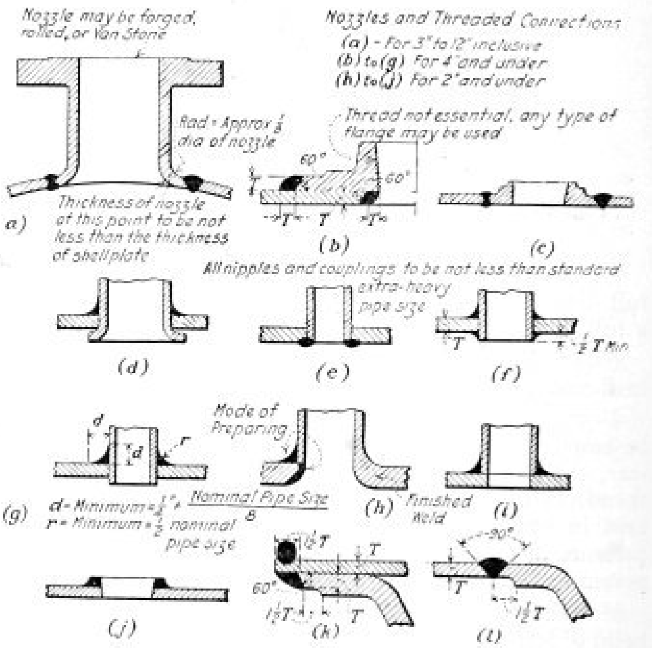


Fig. U-3—Methods of autogenous welding nozzles

the weld on each side of the plate by at least 25 percent of the plate thickness. Single-V welds shall extend entirely through the plate and shall be reinforced at the center of the weld by not over 20 percent of plate thickness. All welds shall be of sound metal, thoroughly fused to the sides of the V its entire depth. Sheets must not be allowed to lap during welding in material ¼ inch or less in thickness, the longitudinal seams need not be beveled. In material less than ¼ inch thick, beveling the heads will be sufficient, and the shell need not be beveled at the head seams. One side of each girth seam shall be beveled.

There shall be no valley either at the edge or in the center of the joint, and the weld shall be so built up that the welded metal will present a gradual increase in thickness from the surface of the sheet to the center of the weld.

At no point shall the sheet on one side of the joint be offset with the sheet on the other side of the joint in excess of one-quarter of the minimum thickness of the sheets, or plates.

U-72. Longitudinal Joints. Where vessels are made up of two or more courses with welded longitudinal joints, the joints of adjacent courses shall be not less than 60 degrees apart.

U-73. Distortion. The cylinder or barrel of a vessel shall be substantially circular at any section, and to meet this requirement shall be reheated, rerolled or reformed.

U-74. Dished Heads. Dished heads convex to the pressure shall have a flange not less than 1½ inches long and shall be inserted into the shell with a driving fit in excess of the full length of the flange welded to the shell with a V'ed weld, heated to the annealing point, the shell to be constricted on the end to a diameter not less than 1 inch smaller than the original diameter.

Dished heads concave to the pressure shall have a length of flange not less than 12 percent of the diameter for shells 24 inches in diameter or less, but in no case less than 1 inch. For tanks over 24 inches diameter this length shall be not less than 1½ inches.

U-75 Hemispherical Heads. Hemispherical heads concave to the pressure shall have a flange not less than 1 inch long, and shall be attached to the cylinder by a butt weld.

U-76. Nozzles in heads or shells not to exceed 12 inches nominal diameter shall be of forged or rolled steel, and shall be formed and welded in accordance with Fig. U-3*a*. The nominal diameter of the nozzle shall not exceed one-half the nominal diameter of the shell.

U-77. Threaded connections shall be made as shown in Fig. U-3*b* to U-3*j*. In all cases thread connections shall be not less than extra-heavy pipe size, and shall be set into the shell plate with sufficient clearance to allow of thorough fusing completely through the shell plate, V'ing out the shell plate for this purpose, if necessary.

U-78. Hydrostatic and Hammer Tests. While subject to the hydrostatic pressure herein before specified, a thorough hammer or impact test shall be given. This impact test shall consist of striking the sheet on both sides of the welded seam a sharp vibratory blow with a 2- to 6-pound hammer with a handle similar to a blacksmith's striking hammer, the blows to be struck 2 to 3 inches apart and within 2 to 3 inches of, and on each side of, the seam—the blows to be as rapid as a man can conveniently strike a sharp, swinging blow, and as hard as can be struck without indenting or distorting the metal of the sheet. During this test the shell shall be completely filled with water.

U-79. Defective Welds. Welded seams, or joints, which do not pass this test without leaks, distortion, or other signs of distress, shall be corrected and a further test applied which shall be successfully passed before the vessel is accepted. Defective sections of a welded seam may be cut out and rewelded provided the value of the sheet has not been definitely lowered.

(To be continued)

Improvements in Fire Tube Boilers

(Continued from page 6)

used, the corrugations providing for all the expansion necessary.

As a matter of fact, this supposed rigidity of the end plate does not really exist. There is an expansive movement although it is not very apparent owing to its being distributed over the whole area of the plate. This fact has been proved by tests made to ascertain the deflection under hydraulic pressure, a gradually increasing pressure applied during an interval of 1½ hours showing, at a maximum of 195 pounds, deflections at eight different positions varying from 5/64 inch to 13/64 inch.

Dish ends with projecting furnace flanges are now made up to 12 feet in diameter in a single hydraulic press which dishes, flanges and bungs the plate, the ends and edges being turned for efficient fitting and calking.

The ends being flanged there is no necessity for any angle ring and, as the rivets securing the end plate are all in shear, there is no risk of leakage due to springing of the plate as is the case when rivets are in tension. Two faults, however, which became apparent with the earlier designs are illustrated in the accompanying diagram. At the point *a* there was a tendency for grooving to occur at the root of the radius of the end plate flange, too small a radius being responsible. At the point *b* overheating occurred due to the method shown of securing flues to the end plate. This latter trouble has been overcome by the insertion of a steel ring between the flue and the end plate, enabling the water to be in contact with the flue at the point where overheating is wont to occur.

The adoption of the corrugated flue, which may be regarded as an essential part of a dish end boiler, besides taking up a large part of the expansion gives considerably increased evaporation. A flat-ended boiler 30 feet by 8½ feet has a total evaporation of about 8,000 pounds per hour, with a total heating surface of some 1,040 square feet, the effective heating surface of the plain flues being 600 square feet. With boilers of this class the flues account for some 75 percent of the evaporation, say, in the present case 6,000 pounds, giving an average rate of evaporation of 10 pounds per square foot of flue heating surface per hour.

A dish-end boiler of the same size will have an effective flue heating surface of 750 square feet. Taking the average rate of evaporation as 9½ pounds per hour, this allows a generous reduction for the additional heat that will be taken out of the flue gas and the consequent slight reduction in average temperature through the flues. As corrugated flues are usually slightly thinner than plain ones then the evaporation produced by the flues will be $750 \times 9\frac{1}{2} = 7{,}125$ pounds, an increase of 15½ percent on the total evaporation of the plain flue boiler. The corrugations act as a baffle to the gases, breaking them up and assisting in the completion of combustion.

Moreover, although presenting a greater area for scaling in the case of bad water, it is found in practice that less scale is actually deposited, due probably to the "concertina" action of the flue breaking it up.

Transport of a Large Gas-Boiler

By G. P. Blackall

THE transport of an exceptionally large gas-boiler from Lincoln to London, a distance of approximately 120 miles, recently provided the London, Midland and Scottish Railway with a difficult traffic problem. The load weighed 13 tons, and had an overall height when entrained of 13 feet 8 inches.

Owing to the great width there was a danger of fouling structures on depot platforms, and to avoid such a risk the boiler had to be loaded "out-of-center" on a well trolley. By this arrangement any projection on the platform side was prevented, but the projection on the other side was increased, and rendered necessary special traffic arrangements.

The load was accordingly conveyed during a Sunday via Leicester instead of the normal route through Manton, this detour considerably lengthening the journey. Throughout its journey the boiler travelled under the most careful supervision, and at a slow rate of speed, and during its transit the opposite line was blocked in sections. It arrived at St. Pancras depot, London, without mishap, and from there was road-hauled to its final destination at Bromley Gas Works, a distance of about seven miles.

A STUDY OF BOILER SEAM DESIGN

82% QUADRUPLE RIVETED BUTT JOINT

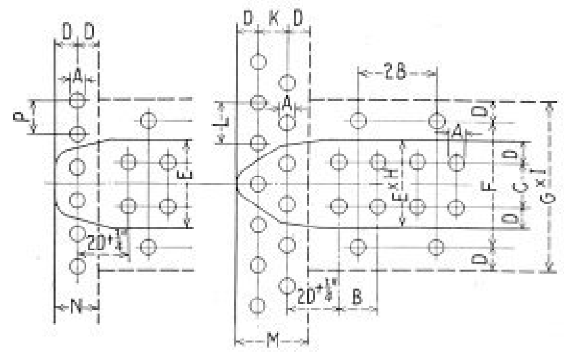
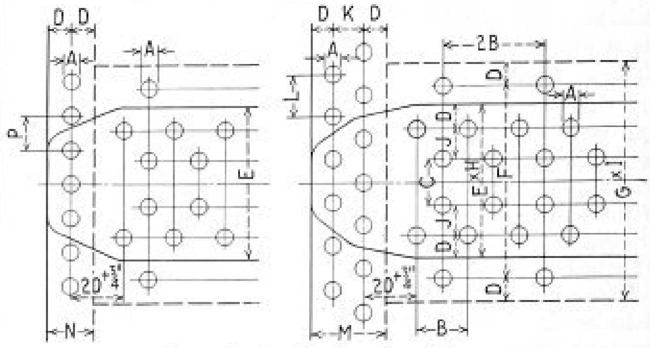


Plate	Hole A	B	C	D	E	F	G	H	I	K	L	M	N	P	Eff. %	Double Seam Value
5/16"	13/16	2 1/4	2 7/16	1 7/32	4 3/8	7 3/8	9 1/16	1/2	1/2	1 5/8	2 3/8	4 1/16	2 7/16	2	81.9	28153
3/8"	13/16	2 1/4	2 7/16	1 7/32	4 3/8	7 3/8	9 9/16	5/16	5/16	1 5/8	2 3/8	4 1/16	2 7/16	2	81.9	33784
7/16"	15/16	2 5/8	2 11/16	1 13/32	5 5/8	8 3/8	11 3/16	3/8	3/8	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	82.1	39511
1/2"	15/16	2 5/8	2 11/16	1 13/32	5 5/8	8 3/8	11 3/16	7/16	7/16	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	82.1	45155
9/16"	1 1/16	2 7/8	3 3/16	1 19/32	6 3/8	9 3/8	12 9/16	1/2	7/16	2 1/8	3	5 5/16	3 3/16	2 1/2	81.5	50428
5/8"	1 1/16	2 7/8	3 3/16	1 19/32	6 3/8	9 3/8	12 9/16	9/16	1/2	2 1/8	3	5 5/16	3 3/16	2 1/2	81.5	56031
11/16"	1 3/16	3 1/4	3 9/16	1 25/32	7 1/8	10 3/8	13 15/16	5/8	1/2	2 3/8	3 1/2	5 15/16	3 9/16	2 3/4	81.7	61786
3/4"	1 5/16	3 1/2	3 15/16	1 31/32	7 7/8	11 3/8	15 5/16	11/16	9/16	2 5/8	3 3/4	6 9/16	3 15/16	3	81.2	66990
13/16"	1 5/16	3 1/2	3 15/16	1 31/32	7 7/8	11 3/8	15 5/16	3/4	5/8	2 5/8	3 3/4	6 9/16	3 15/16	3	81.2	72573
7/8"	1 7/16	3 7/8	4 5/16	2 5/32	8 5/8	12 3/8	16 11/16	13/16	11/16	2 7/8	4	7 3/16	4 5/16	3 1/4	81.4	78347

Calculations Based on:
55,000 Lb. Tensile Strength of Steel Plate
44,000 Lb. Shearing Strength of Steel Rivets, Single Shear
88,000 Lb. Shearing Strength of Steel Rivets, Double Shear
95,000 Lb. Crushing Strength of Steel Plate

87% SEXTUPLE RIVETED BUTT JOINT



** Use next larger size rivet for circumferential seams*

Plate	Hole A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	Eff. %	Double Seam Value
3/8"	13/16	3 1/4	2 7/16	1 7/32	8 1/8	10 5/8	13 7/16	5/16	5/16	1 5/8	1 5/8	2 3/8	4 1/16	2 7/16	2	87.4	36053
7/16"	15/16	3 1/2	2 11/16	1 13/32	9 1/8	12 1/8	14 15/16	3/8	3/8	1 7/8	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	86.6	41676
1/2"	15/16	3 1/2	2 11/16	1 13/32	9 1/8	12 1/8	14 15/16	7/16	7/16	1 7/8	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	86.6	47630
* 9/16"	15/16	3 3/4	2 11/16	1 13/32	9 3/8	12 1/8	14 15/16	1/2	7/16	1 7/8	2 1/8	3	5 5/16	3 3/16	2 1/2	87.5	54140 *
5/8"	1 1/16	4 1/8	3 3/16	1 19/32	10 5/8	13 5/8	16 7/16	9/16	1/2	2 1/8	2 1/8	3	5 5/16	3 3/16	2 1/2	87.1	59881
11/16"	1 3/16	4 1/2	3 9/16	1 25/32	11 7/8	15 1/8	18 11/16	5/8	1/2	2 3/8	2 3/8	3 1/2	5 15/16	3 9/16	2 3/4	86.8	65642
* 3/4"	1 5/16	4 1/2	3 9/16	1 25/32	11 7/8	15 1/8	18 11/16	11/16	9/16	2 3/8	2 3/8	3 3/4	6 9/16	3 15/16	3	86.7	71528 *
13/16"	1 5/16	4 3/4	3 15/16	1 31/32	13 1/8	16 5/8	20 9/16	3/4	5/8	2 5/8	2 5/8	3 3/4	6 9/16	3 15/16	3	86.1	76952
7/8"	1 7/16	4 7/8	4 5/16	2 5/32	14 3/8	18 1/8	22 7/16	13/16	11/16	2 7/8	2 7/8	4	7 3/16	4 5/16	3 1/4	85.2	82005
15/16"	1 1/2	5	4 1/2	2 1/4	15	18 7/8	23 3/8	7/8	11/16	3	3	4 1/4	7 1/2	4 1/2	3 3/8	85.0	87656
1"	1 9/16	5 1/4	4 11/16	2 11/32	15 5/8	19 5/8	24 5/16	15/16	3/4	3 1/8	3 1/8	4 1/2	7 13/16	4 11/16	3 1/2	84.8	93280

Calculations Based on:
55,000 Lb. Tensile Strength of Steel Plate
44,000 Lb. Shearing Strength of Steel Rivets, Single Shear
88,000 Lb. Shearing Strength of Steel Rivets, Double Shear
95,000 Lb. Crushing Strength of Steel Plate

91% SEXTUPLE RIVETED BUTT JOINT

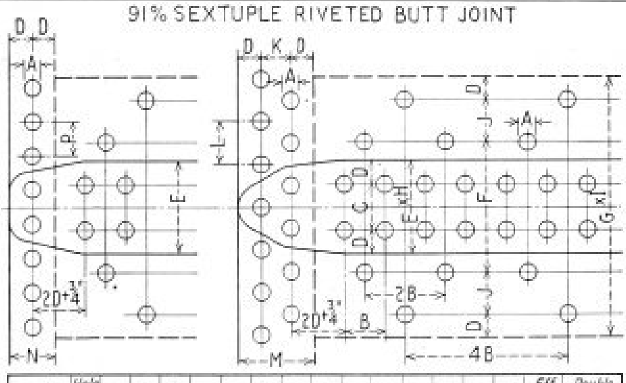


Plate	Hole A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	Eff. %	Double Seam Value
11/32"	13/16	2 1/8	2 7/16	1 7/32	4 3/8	7 3/8	14 9/16	5/16	5/16	2 1/8	1 5/8	2 3/8	4 1/16	2 7/16	2	91.4	34560
3/8"	13/16	2 1/8	2 7/16	1 7/32	4 3/8	7 3/8	14 9/16	5/16	5/16	2 1/8	1 5/8	2 3/8	4 1/16	2 7/16	2	91.4	37702
13/32"	15/16	2 5/8	2 11/16	1 13/32	5 5/8	8 3/8	16 5/16	3/8	3/8	2 5/8	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	91.0	40665
7/16"	15/16	2 5/8	2 11/16	1 13/32	5 5/8	8 3/8	16 5/16	3/8	3/8	2 5/8	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	91.0	43794
15/32"	15/16	2 5/8	2 11/16	1 13/32	5 5/8	8 3/8	16 5/16	7/16	7/16	2 5/8	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	91.0	46921
1/2"	15/16	2 5/8	2 11/16	1 13/32	5 5/8	8 3/8	16 5/16	7/16	7/16	2 5/8	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	91.0	50050
17/32"	15/16	2 5/8	2 11/16	1 13/32	5 5/8	8 3/8	16 5/16	1/2	7/16	2 5/8	1 7/8	2 5/8	4 11/16	2 11/16	2 1/4	91.0	53177
9/16"	1 1/16	2 7/8	3 3/16	1 19/32	6 3/8	9 3/8	18 5/16	1/2	7/16	2 7/8	2 1/8	3	5 5/16	3 3/16	2 1/2	90.7	56121
19/32"	1 1/16	2 7/8	3 3/16	1 19/32	6 3/8	9 3/8	18 5/16	9/16	1/2	2 7/8	2 1/8	3	5 5/16	3 3/16	2 1/2	90.7	59238
5/8"	1 1/16	2 7/8	3 3/16	1 19/32	6 3/8	9 3/8	18 5/16	9/16	1/2	2 7/8	2 1/8	3	5 5/16	3 3/16	2 1/2	90.7	62356
21/32"	1 3/16	3 1/4	3 9/16	1 25/32	7 1/8	10 3/8	20 5/16	5/8	1/2	3 1/4	2 3/8	3 1/2	5 15/16	3 9/16	2 3/4	90.8	65545
11/16"	1 3/16	3 1/4	3 9/16	1 25/32	7 1/8	10 3/8	20 5/16	5/8	1/2	3 1/4	2 3/8	3 1/2	5 15/16	3 9/16	2 3/4	90.8	68667
23/32"	1 3/16	3 1/4	3 9/16	1 25/32	7 1/8	10 3/8	20 5/16	5/8	1/2	3 1/4	2 3/8	3 1/2	5 15/16	3 9/16	2 3/4	90.8	71788
3/4"	1 5/16	3 1/2	3 15/16	1 31/32	7 7/8	11 3/8	22 9/16	11/16	5/8	3 1/2	2 5/8	3 3/4	6 9/16	3 15/16	3	90.6	74745
25/32"	1 5/16	3 1/2	3 15/16	1 31/32	7 7/8	11 3/8	22 9/16	11/16	5/8	3 1/2	2 5/8	3 3/4	6 9/16	3 15/16	3	90.6	77858
13/16"	1 5/16	3 1/2	3 15/16	1 31/32	7 7/8	11 3/8	22 9/16	3/4	5/8	3 1/2	2 5/8	3 3/4	6 9/16	3 15/16	3	90.6	80973
27/32"	1 7/16	3 7/8	4 5/16	2 5/32	8 5/8	12 3/8	24 5/16	13/16	5/8	3 7/8	2 7/8	4	7 3/16	4 5/16	3 1/4	90.7	84180
7/8"	1 7/16	3 7/8	4 5/16	2 5/32	8 5/8	12 3/8	24 5/16	13/16	5/8	3 7/8	2 7/8	4	7 3/16	4 5/16	3 1/4	90.7	87299
29/32"	1 1/2	4	4 1/2	2 1/4	9	12 7/8	25 3/8	7/8	11/16	4 1/8	3	4 1/4	7 1/2	4 1/2	3 3/8	90.6	90318
15/16"	1 1/2	4	4 1/2	2 1/4	9	12 7/8	25 3/8	7/8	11/16	4 1/8	3	4 1/4	7 1/2	4 1/2	3 3/8	90.6	93431
31/32"	1 9/16	4 1/4	4 11/16	2 11/32	9 3/8	13 3/8	26 11/16	15/16	3/4	4 3/8	3 1/8	4 1/2	7 13/16	4 11/16	3 1/2	90.8	96758
1"	1 9/16	4 1/4	4 11/16	2 11/32	9 3/8	13 3/8	26 11/16	15/16	3/4	4 3/8	3 1/8	4 1/2	7 13/16	4 11/16	3 1/2	90.3	99330

Calculations Based on:
55,000 Lb. Tensile Strength of Steel Plate
44,000 Lb. Shearing Strength of Steel Rivets, Single Shear
88,000 Lb. Shearing Strength of Steel Rivets, Double Shear
95,000 Lb. Crushing Strength of Steel Plate

93% OCTUPLE RIVETED BUTT JOINT

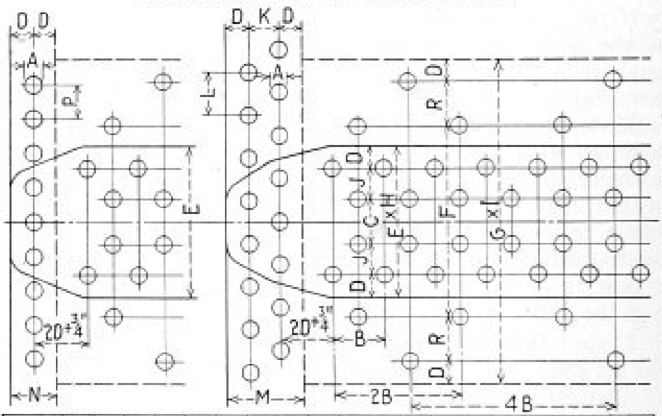


Plate	Hole A	B	C	D	E	F	G	H	I	J	K	L	M	N	P	R	Eff. %	Double Seam Value
1/2"	13/16	3 1/4	2 7/16	1 7/32	9 3/8	12 3/8	20 5/16	7/16	7/16	1 5/8	1 5/8	2 3/8	4 1/16	2 7/16	2 1/2	2 5/8	93.7	51535
17/32"	13/16	3 1/4	2 7/16	1 7/32	9 3/8	12 3/8	20 5/16	1/2	7/16	1 5/8	1 5/8	2 3/8	4 1/16	2 7/16	2 1/2	2 5/8	93.7	54754
9/16"	1 1/16	4	3 3/16	1 19/32	10 5/8	13 5/8	23 1/16	1/2	7/16	2 1/8	2 1/8	3	5 5/16	3 3/16	2 1/2	3 1/8	93.3	57729
19/32"	1 1/16	4	3 3/16	1 19/32	10 5/8	13 5/8	23 1/16	9/16	1/2	2 1/8	2 1/8	3	5 5/16	3 3/16	2 1/2	3 1/8	93.3	60936
5/8"	1 1/16	4	3 3/16	1 19/32	10 5/8	13 5/8	23 1/16	9/16	1/2	2 1/8	2 1/8	3	5 5/16	3 3/16	2 1/2	3 1/8	93.3	64144
21/32"	1 3/16	4 1/2	3 9/16	1 25/32	11 7/8	15 1/8	25 7/16	5/8	1/2	2 3/8	2 3/8	3 1/2	5 15/16	3 9/16	2 3/4	3 1/8	93.0	67133
11/16"	1 3/16	4 1/2	3 9/16	1 25/32	11 7/8	15 1/8	25 7/16	5/8	1/2	2 3/8	2 3/8	3 1/2	5 15/16	3 9/16	2 3/4	3 1/8	93.0	70331
23/32"	1 3/16	4 1/2	3 9/16	1 25/32	11 7/8	15 1/8	25 7/16	5/8	1/2	2 3/8	2 3/8	3 1/2	5 15/16	3 9/16	2 3/4	3 1/8	93.0	73528
3/4"	1 5/16	4 1/2	3 15/16	1 31/32	13 1/8	16 5/8	28 1/16	11/16	5/8	2 5/8	2 5/8	3 3/4	6 9/16	3 15/16	3	3 3/4	92.7	76477
25/32"	1 5/16	4 1/2	3 15/16	1 31/32	13 1/8	16 5/8	28 1/16	11/16	5/8	2 5/8	2 5/8	3 3/4	6 9/16	3 15/16	3	3 3/4	92.7	79663
13/16"	1 5/16	4 1/2	3 15/16	1 31/32	13 1/8	16 5/8	28 1/16	3/4	5/8	2 5/8	2 5/8	3 3/4	6 9/16	3 15/16	3	3 3/4	92.7	82851
27/32"	1 7/16	4 7/8	4 5/16	2 5/32	14 3/8	18 1/8	30 7/16	13/16	5/8	2 7/8	2 7/8	4	7 3/16	4 5/16	3 1/4	4 1/8	92.6	85944
7/8"	1 7/16	4 7/8	4 5/16	2 5/32	14 3/8	18 1/8	30 7/16	13/16	5/8	2 7/8	2 7/8	4	7 3/16	4 5/16	3 1/4	4 1/8	92.6	89128
29/32"	1 1/2	5	4 1/2	2 1/4	15	18 7/8	32 3/8	7/8	11/16	3	3	4 1/4	7 1/2	4 1/2	3 3/8	4 3/8	92.5	92210
15/16"	1 1/2	5	4 1/2	2 1/4	15	18 7/8	32 3/8	7/8	11/16	3	3	4 1/4	7 1/2	4 1/2	3 3/8	4 3/8	92.5	95391
31/32"	1 9/16	5 1/4	4 11/16	2 11/32	15 5/8	19 5/8	33 5/16	15/16	3/4	3 1/8	3 1/8	4 1/2	7 13/16	4 11/16	3 1/2	4 1/2	92.5	98570
1"	1 9/16	5 1/4	4 11/16	2 11/32	15 5/8	19 5/8	33 5/16	15/16	3/4	3 1/8	3 1/8	4 1/2	7 13/16	4 11/16	3 1/2	4 1/2	92.1	101310
1 1/32"	1 9/16	5 1/2	4 11/16	2 11/32	15 5/8	19 5/8	33 5/16	1	3/4	3 1/8	3 1/8	4 1/2	7 13/16	4 11/16	3 1/2	4 1/2	91.8	104134
1 1/16"	1 9/16	5 1/2	4 11/16	2 11/32	15 5/8	19 5/8	33 5/16	1	3/4	3 1/8	3 1/8	4 1/2	7 13/16	4 11/16	3 1/2	4 1/2	91.2	106590

Calculations Based on:
55,000 Lb. Tensile Strength of Steel Plate
44,000 Lb. Shearing Strength of Steel Rivets, Single Shear
88,000 Lb. Shearing Strength of Steel Rivets, Double Shear
95,000 Lb. Crushing Strength of Steel Plate

A Study of Boiler Seam Design

By H. J. Blanton*

AFTER careful study of many types of domestic and foreign boiler seams the four types of seams shown on the opposite page have been designed to meet all conditions such as calking distances, die clearances and so forth. Primarily they have been designed for locomotive boilers, but they may be applied to any boiler that requires the butt joint construction. Lap seams of the longitudinal type have been omitted since they are seldom used in modern construction. All of these seams meet the requirements of the Power and Locomotive Codes of the American Society of Mechanical Engineers.

Under the heading "Double Seam Value" will be found values which, when divided by the product of the internal diameter of the cylinder under consideration and the working pressure, will give the factor of safety of the construction.

Criticism of these seams is invited from all who are interested and will be forwarded to the writer if addressed in care of THE BOILER MAKER.

*Elevation department, H. K. Porter Company, Pittsburgh, Pa.

An Error of Misplaced Confidence*

IN this day of "Safety First," it is strange what chances some workmen will take when performing work with which they are supposed to be entirely familiar, and, what is none the less alarming, is the general lack of appreciation of the danger involved in attempting to make repairs on a vessel of any description while the vessel is under pressure. A recent accident which the writer had the opportunity to investigate furnishes a most glaring example.

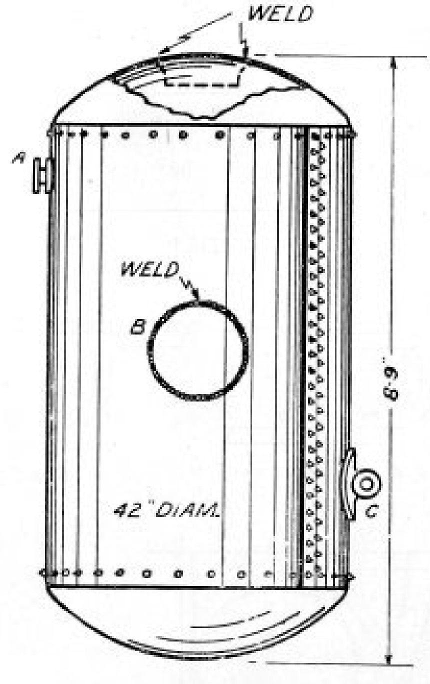
A tank of the dimensions shown in Fig. 1, formerly used as a container for compressed air and which had seen but very little service, was purchased for installation on the low pressure side of an ammonia refrigeration system of the absorption type. For some reason it was decided to remove the lower 3-inch cast iron nozzle, which was done by means of an oxy-acetylene cutting torch. A hole 10 inches in diameter in the side of the tank resulted, indicated by B in Fig. 1. Into this aperture there was inserted, flush with the shell, a piece of steel plate formed to the contour of the vessel and attached to the shell of the tank by the process of electric arc welding. The manhole frame pressed in the top head had also been cut out and into the elliptical opening 15 inches by 20 inches, there had been inserted, flush with the head, a piece of steel plate fashioned to conform to the radius of the head and electrically welded to same. On completion of this work, the vessel was subjected to an air pressure test of 50 pounds per square inch and was pronounced tight. The welder then left the premises considering his work finished.

FURTHER TESTS MADE

A day or two afterwards the plant engineer subjected the tank to a further air pressure test, under which leakage was revealed in the welded area on the top head. On discovering this defect, the matter was referred to the concern that had done the work, which sent the welder back to make the vessel tight. On his arrival at the plant, the tank was subjected to an air pressure test of 100 pounds per square inch, and by applying soapy water the leaks were located. The welder then proceeded to stop this leakage by calking the defectively welded area, using a pneumatic calking tool. Just how long he continued calking, nobody seems to know. On hearing a loud noise, some of the plant operators started to investigate, and upon entering the part of the building where this tank was located, were horrified to find the unfortunate welder decapitated and lying at the base of the tank. The piece of plate which had been inserted in the top head, having been suddenly and violently blown from its welded fastening, was found lying on the floor.

WELDING IMPROPERLY DONE

Examination of the top head showed that no effort had been made to dress the material in order to remove that ever present enemy, oxide, with which welders must contend previous to, and during, welding, as the marks of the cutting torch were plainly seen on the edge of the opening at all points. Furthermore, it revealed that at no point had the welding penetrated to the full depth of the material. In fact, the maximum depth of the welding did not exceed one half of the thickness of the material, and even this condition was found only at scattered points. It was also



Details of tank which exploded

quite apparent that for nearly one half the distance around the opening hardly any metal at all had been holding. Like beauty, it was only skin deep.

An interesting point brought out in this investigation is the fact that the patch in the shell had been welded from both inside and outside, whereas no provision had been made for welding the patch in the head on the inside. In fact the only openings remaining were the inlet and outlet connections shown at A and C in Fig. 1. These were respectively 3 inches and 2 inches in diameter. It seems unnecessary to point out that even when welded on both sides there is no assurance that the weld is sound unless the work has been carefully done.

The result of this investigation clearly sets forth the advisability of refraining from the use of autogenous welding in the fabrication of pressure vessels where the safety of the vessel is dependent on the soundness of the weld. Welding of this description, however, can be satisfactorily resorted to when the parts so treated are relieved of stress and strain by being supported by suitable mechanical means, the welding being used merely to make the vessel tight against leakage.

*From an article by E. Mason Parry, chief inspector of the New York department, Hartford Steam Boiler Inspection and Insurance Company, appearing in the *Locomotive*.

Inspecting Marine Boilers

Outline of methods developed in Holland for carrying out external and internal inspections of two-furnace Scotch boilers

By D. Kooyman

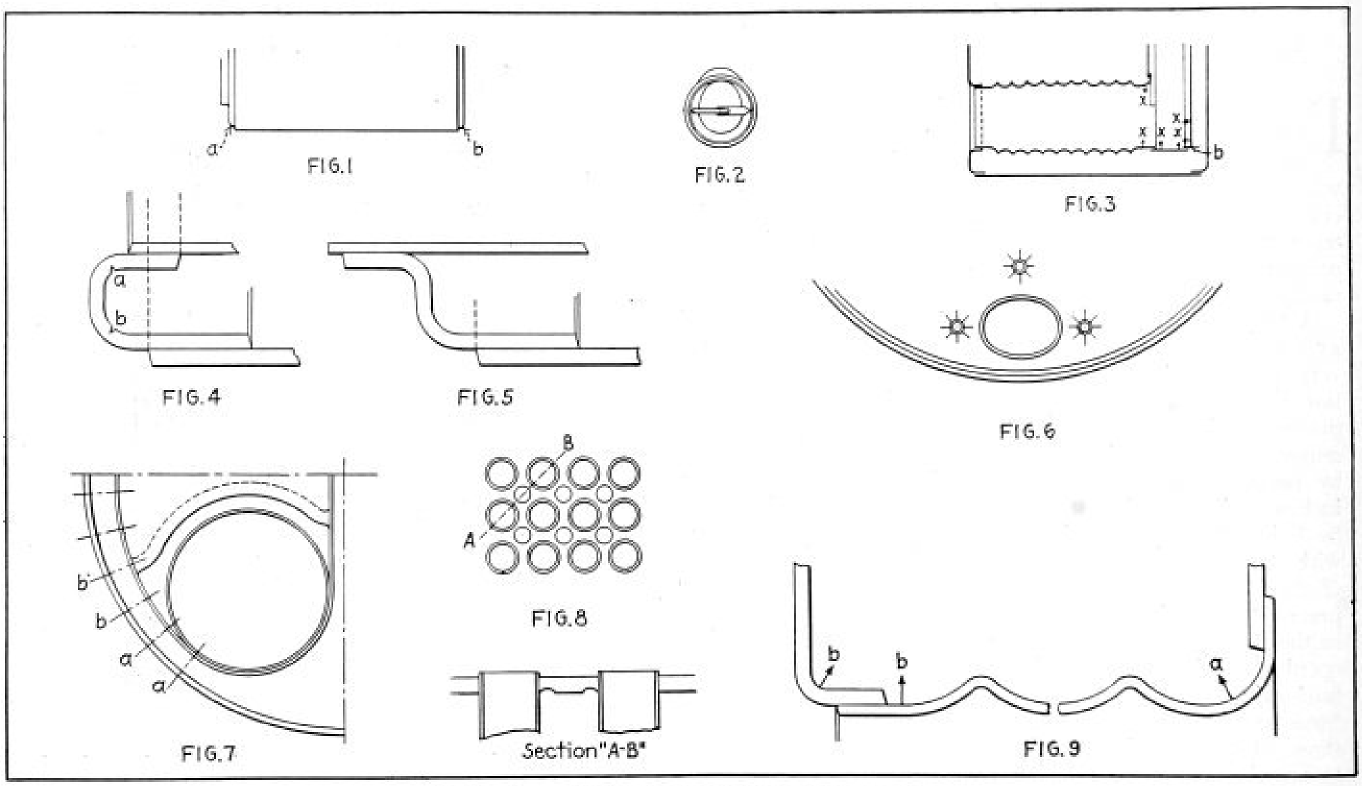
FOR boiler inspection very much care must be exercised, but sometimes in spite of precautions serious faults are overlooked.

It is best to follow a fixed line of procedure in order not to forget any point. The following is an example of inspecting a Scotch marine boiler with two furnaces. It is supposed that an inspector has been sent to a tug about 15 years old by a tugowner who intends to buy it.

It is first necessary to know whether the boiler has been designed well, therefore the following proportions are to be ascertained:

Then comes the inspection, which work can be divided as follows:

1. Outside of boiler.
2. Port furnace, tube ends, inside of combustion chamber.
3. S. B. furnace, etc.
4. Inside of boiler as far as possible through bottom manhole.
5. Inside of boiler through top manhole.
6. Boiler mountings.
7. Furnace fittings
8. Uptake and funnel.



Points to watch for in marine boiler inspection

a. Heating surface (the drawing must be obtained).
b. Grate surface.
c. The relation of heating surface to grate surface (to be 30 to 35).
d. The clear area above the fire bridge.
e. The relation of grate surface to clear area above bridge (to be 6 to 8).
f. The clear area through tubes.
g. The relation of grate surface to clear area through tubes (to be 4.25 to 5).
h. The clear area through funnel.
j. The relation of grate surface to clear area through funnel (to be 4.5 to 5).
k. The steam room per indicated horsepower (to be about 0.55—0.65 cubic foot).

Outside of Boiler

Serious corrosion may often be detected at the bottom of the end and shell plates as indicated in Fig 1 at *a* and *b* and between the rivet heads.

At the front end plate this is mostly caused by badly fitted ash guarding plates, not preventing wet ash coming in touch with the boiler. At the back end the cause is the leaking of rivets and seams, the engineers and firemen neglecting to inspect those places, often owing to the limited space between boiler and bulkhead.

All rivet heads and seams are inspected to detect leaking places and corrosion, especially near the straps where the shell plates butt.

The smokebox doors are opened and the thickness of the tube ends and the pitch of the stay tubes examined, leaking of the tubes seldom occurring here.

The heads and nuts of the stays on the end plates are examined for which it is necessary to remove the back end lagging. It is also good to see whether the back end plate has been deflected between the stays.

For inspecting the butt straps, the shell lagging has to be removed. This is generally not done if the straps are in the steam space, leaking there seldom occurring.

The bottom manhole cover must be observed. It must be a good fit in the hole.

Port Furnace

It is necessary that all firebars, bridges, central bearer bars, dead plates and furnace fronts are now removed and the furnaces and chambers be thoroughly cleaned.

The first thing is to measure and note the horizontal and vertical diameters of the furnace. This is done with two small flat bars of iron or wood, the end of one bar being marked on the other one, Fig. 2.

Any difference can thus easily be detected (a difference of ¾ inch is allowed).

The rivets and seams of furnaces and chamber plates are examined and the thicknesses of the plates at the seams, especially at the bottom, controlled. It will often be observed that only ¼ of the plate thickness and of the rivet heads is left owing to heavy corrosion.

For fixing the thickness of the combustion chamber bottom plates it is best to drill small holes in several places, but this is only done if the inspector believes the plate thickness to be very small. The plates are first examined by hammer blows. These are applied at several places, as indicated by x in Fig. 3. The sound of the blow gives only little indication, one may better rely on the impression made by a heavy blow. If the inspector is in doubt about the thickness, the drilling of small holes is a necessity.

Deflection of the back plates between the screw stays may sometimes be seen; the thicknesses of the under parts of these plates are often very small, especially near the seam at *b*, Fig. 3. The thickness of the tubes must be looked at and any leaking noted.

Broken screw stays may be detected by hammer blows. All stays must be examined in this manner. Deflection of the combustion chamber top plates between the bolts may often be observed.

Inside of Boiler Bottom

For this inspection the boiler bottom must be dry and cleaned. The number of stays around the manhole must be noted, three stays being a necessity if the furnaces are provided with Gourley ends. Cracks may be detected near the seams at *a* and *b* in Fig. 4. They are seldom observed if the flanges for furnaces and shell are made as indicated in Fig. 5. If made as to Fig. 4 serious stresses are sometimes set up in the material. Especially if treated at too low a temperature, a small crack may be the result, which crack grows owing to fatigue of the material. The writer has often seen cracks ⅜-inch deep. The end plates around the stays have also to be controlled, deep grooves as indicated in Fig. 6 may be detected, sometimes they are also seen around the screw stays.

Pitting of the shell plate, under sides of chambers and furnaces, sides of furnaces, corrosion of stays, rivet heads, calking seams may here be observed, applying a scaling hammer everywhere.

In this connection it is necessary to know where the feed-water is let into the boiler, inside feed pipes running to the boiler bottom being no rarity.

Broken screw stays may here be seen, mostly they break at the shell side. Hammer blows often will disclose a break.

It must not be forgotten, if the bottom stays *a*, as indicated in Fig. 7, are broken, to renew also the stays *b*, as the material of those will be fatigued, owing to the enlarged stress after the breaking of stays *a*.

Inside of Boiler Through Top Manhole

The inspection of the shell and steam space stays will generally not disclose any fault, but the combustion chamber top plate must be accurately examined as very serious corrosion may occur here, especially around the girders where they touch the plate and around the staybolts. If there is any doubt about this plate the inspector must insist on taking off all girders and cleaning the plates, as the renewal of these plates is an expensive job.

The combustion chamber back plates and the tube plates may also show signs of corrosion but only a small part of them may be examined. It must be as well done as possible as the visible part is most liable to corrosion.

Curious corrosion is often seen on the tube plates, the material having been corroded around the tubes as shown in Fig. 8, leaving nearly circular parts of original thickness.

The screw stays also need careful inspection.

To detect all these corrosions the scaling hammer must be applied on all parts.

The tubes must be inspected for corrosion and hammer blows applied, the impression of which into the material may give some indication of the thickness.

The tops of the furnaces and, if possible, both sides must not be forgotten; serious corrosion may often be seen at *a* and *b*, Fig. 9, application of hammer blows from the inside of the furnace being very necessary.

The inside steam and feed pipes have also to be looked after.

Boiler Mountings

It is often impossible to detect some faults, any leaking of pads and rivets may be noted and it may be necessary to renew one or more studs. The mountings must be of heavy construction.

Before the new owner puts the boiler in use it is always advisable to take off all mountings, to grind all valves and test them by water pressure.

Any alterations necessary for a new classification may be made at the same time.

Furnace Fittings

It is necessary to find the number of burned fire bars. Usually the side bars are to be renewed and the bridge to be repaired, each part has to be inspected, quickly but carefully. Thickness of bars and air spaces between them must be controlled, also the slope of the grate.

Uptake and Funnel

The plates can only be tested by hammer blows which give a good indication of the thickness. The funnel damper and gear are to be inspected.

The age of the boiler is usually indicated on the boiler and often the captain has a book or list in his possession on which the results of inspections are noted.

All this must be taken up in the report.

The best way is to clean the boiler and make it free from scale before the inspection.

A hydrostatic test after the inspection is necessary to detect hidden faults.

Locomotive and train cost statistics dispensed with

The Interstate Commerce Commission has amended its order relating to the compilation of monthly operating statistics, to annul the requirement of the reports of locomotive and train costs, selected accounts, except as to the reports to complete the twelve months of 1924.

Why Use Inefficient Boilers?

WITH the advent of extreme cold weather comes the realization on far too many northern railroads of the existence of a shortage of steam for heating and thawing purposes. This condition in itself is bad enough, but the remedy that is so often applied is worse. The installation of old locomotive boilers for stationary service is a practice that has very little to commend it. There is no condition, either from an operating or economical standpoint, that justifies a deliberate attempt to see how much coal can be burned in a given time and get so little from it. A locomotive boiler is an admirable steam generator when used on a locomotive with a strong induced draft, but when transferred to stationary service with natural stack draft or even mechanical forced draft, it leaves much to be desired as a means of efficient combustion. It will be argued that most installations of this kind are purely emergency ones and that the old locomotive boiler, even with its admitted inefficiency, satisfactorily meets the immediate demand because it can be quickly and cheaply put into service. The cost of operation, apparently, is not given very much consideration.

A suggestion in connection with this practice may not be entirely inappropriate at this time. A broad survey of the conditions surrounding the use of steam in yards and around engine terminals will very often disclose sources of enormous loss that are ordinarily overlooked. If proper attention is given to steam leaks at valves, hose connections, etc., as well as to the thorough lagging of all open steam lines, the present steam consumption may be materially reduced. A carefully prepared statement showing the distribution of steam uses, with particular attention to losses from leakage and radiation, will do more than any other one thing to emphasize the possibility of minimizing steam losses. If this subject is intelligently and thoroughly analyzed, the surprising discovery may be made that, by the expenditure of a comparatively small sum in proper maintenance and repairs, when the next season of cold weather approaches, the old locomotive boiler, instead of being drawn into the service where it can perform but poorly to say the least, may be consigned to the scrap pile where it belongs.—*Railway Mechanical Engineer.*

The Rewards of Carelessness Toward Fire Insurance Policies

By Elton J. Buckley

IN this article I shall discuss fire insurance. My object now, as always, is to emphasize the slenderness of the hair by which fire insurance often hangs, and the disaster that frequently overtakes the failure to do some one little thing.

One of the jokers in every fire insurance policy is the following:—

> This entire policy, unless otherwise provided by agreement indorsed hereon or added hereto, shall be void * * * if the interest of the insured be otherwise than unconditional and sole ownership * * * or if any change, other than by the death of the insured, take place in the interest title or possession of the subject of insurance * * * whether by legal process or judgment or by voluntary act of the insured or otherwise. * * *

This means that the insurance is void if the person to whom the policy is issued parts with all or any part of the title to the insured property. It also means that the person who buys the insured property, or the interest in it, must, if he is to get any benefit from the insurance, not only notify the insurance company of the change in title, but must get the company's written consent to the transfer. It means third that where there is a mortgage on the property, and the holder of the mortgage has a provision added to the policy that his share of the loss shall be payable to him, he can't get anything (if the title changes) unless he has seen to it that the policy is transferred to the new owner.

Details of Transaction

Listen to a very moving tale. A man named Iverson owned a store building on which there was a mortgage held by Bernard. On the building there was fire insurance of $5,000; and in the policy a provision was inserted, as is usual with insurance on mortgaged property, that "any loss under this policy that may be proved due the assured (Iverson) shall be payable to the assured and Cress I. Bernard, subject, however, to all the terms and conditions of the policy."

Iverson sold the building to Ruddy, subject to Bernard's mortgage. Ruddy knew he had to get the policy transferred, so he wrote the company as follows: "Mr. Cox, of Howe, Neb., told me to write you in regard to insurance policy 17,660 on a brick building, Howe, Neb. I bought this building and wish to notify you in regard to transfer, etc. Kindly give me date of expiration, amount, rate, etc."

The company replied, acknowledging receipt of the letter and giving the requested information. Then it said:—

> We presume you will wish this insurance transferred to you, therefore kindly have assignment blank filled out on the policy and forward same to this office, and we will consent to the transfer.

This letter was dated December 8 and on January 29 a fire destroyed the property. Meanwhile Ruddy hadn't done anything in the way of carrying out the instructions of the insurance company's letter. He said he thought the company's statement "we will consent to the transfer" was enough.

Without going into the long-drawn out and complicated law suit that followed when the insurance company refused to pay anything either to Ruddy the owner or to Bernard, the mortgagee, it will be enough to say that the court finally decided that nobody could collect anything under this policy. Iverson couldn't because he had parted with the title, Ruddy couldn't because he had never got the company's written consent to the transfer of the policy, and Bernard, the mortgagee, couldn't because the clause which was inserted in the policy to take care of him provided that he should be paid only "any loss under this policy that may be proved due the assured," and nothing, under the court's decision, was due the assured.

Court Decision

So that of the three parties to this contretemps, only Iverson could regard the situation with equanimity; Ruddy lost $5,000 and Bernard lost the amount of his mortgage. The court said:

> The unfortunate position of Mr. Ruddy has been brought about by his own carelessness in not acquainting himself with the terms of the policy at the time he bought the property. Had he mailed the transfer of title until arrangements were made for a transfer of the policy, and the acceptance of the company secured and indorsement thereof made upon this policy, this situation would not have arisen. He failed to do these things and now asks a court to construct a new contract by making him a party to it, which he was not. It is not within the province of the court to create contracts. * * * Is Bernard, the mortgagee, entitled to recover, notwithstanding the situation as to Ruddy? The mortgage clause here is what is known as the standard mortgage clause and is as follows: "Any loss under this policy that may be proved due the assured shall be payable to the assured and Cress I. Bernard."
>
> We think it the almost universal voice of authority that under such a clause the mortgage recovers only on the theory that he is the appointee of the insured to receive the money, or a portion thereof. If the insured cannot recover, he cannot recover. Iverson cannot recover because he has parted with his insurable interest. Ruddy cannot recover for the reasons we have hereinbefore set forth. Hence the mortgagee cannot recover.

The Boiler Maker

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

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Cable address: Urasigmec, London

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Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent office.

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

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

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CONTENTS

This year the mid-winter meeting of the American Boiler Manufacturers' Association will be held in Cleveland, February 12. As it will only be a one day session, arrangements have been made to utilize the facilities of the Mid-Day Club located in the Union Trust Building.

A number of important matters will be discussed and, as the session is intended solely to cover technical phases of the boiler manufacturing industry, no outside speakers have been invited to address the meeting. The results of the meeting of the horizontal return tubular boiler section of the association, held on October 29 in Chicago, will be taken up. The meeting of this section was held to discuss the simplification and standardization of boilers as suggested by the Division of Simplified Practice of the United States Department of Commerce. Another subject to be dealt with is that of sales promotion in the field of boiler users. It is to be hoped that representatives of all member companies of the American Boiler Manufacturers' Association will make it a point to be present at the meeting.

The series of articles on "Laying Out Locomotive Boilers," advance notices of which have appeared in preceding issues of THE BOILER MAKER, begins publication this month. A great amount of care has been exercised by the author in the preparation of this material, so that it might in a practical manner serve as a text for layerouts and all boiler makers who wish to advance in their trade. It is possible that some discrepancies may creep into the work—in the making of cuts from the original drawings, for example, slight errors in reduction may occur. These have been avoided insofar as it is possible to control the process. The author, as well as the magazine will appreciate any of our readers calling attention to errors that may be found in the work and explanations will be published of any points not clearly understood by those working out the problems.

It should be borne in mind, however, in using the material that it is intended to serve only as a guide and that each individual following the work must develop the detail drawings to a large scale in order to gain the greatest benefit from it.

The annual report of the chief inspector of the Bureau of Locomotive Inspection has recently been issued. An abstract of it appears elsewhere in this number. Of all documents made public by the Bureau in the course of the year, this is probably the most important, not only to the officers of the railroads of the country but to every man having to do with the maintenance and repair of locomotives.

From the standpoint of interest to the boiler maker the report indicates that boiler explosions decreased 24.6 percent as compared with the preceding year—which is a creditable showing. It also states that the number was 30 percent greater than in 1922. These accidents have, however, been accompanied by an increased number of fatalities. Greater sizes of boilers and higher pressures carried are given as the causes for the greater loss of life. If this is true, the condition must be corrected by a more careful inspection and more painstaking workmanship in the shop.

No man on whose shoulders rests the responsibility of the lives of many hundreds of people can ever afford to become lax in his work. For this reason every suggestion made in the report for improving conditions should be given the most careful attention and followed to the letter—not because the suggestions can be enforced if necessary but because the safety of the service depends on it.

The need for modern machine tools in the railroad boiler shop received some recognition from the mechanical officers during the past year. A survey of the field indicates that 108 punches and shears, flange presses, and the like, were purchased as well as 64 flue shop machines. Forming rolls and a few riveters were also included in the equipment added to the facilities of various shops. Of the flue shop machines, electric flue welders constituted the greatest item.

However, when it is considered that the railroads spent approximately $14,400,000 for machine tools during the year, it would seem that more attention might be given to the replacement of low-production machines which are in evidence in nearly every boiler shop.

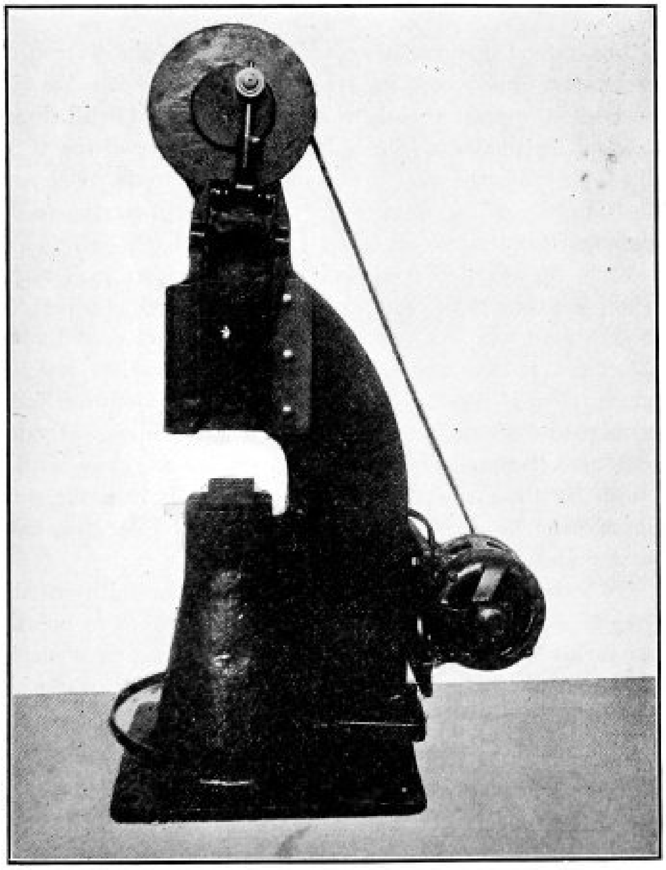
Engineering Specialties for Boiler Making

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

Self-Contained Utility Hammer

THE Beaudry Company, Inc., Everett, Mass., is now marketing a low-priced utility hammer especially suitable as a general service tool for shops where there is not enough blacksmith work to warrant a large investment in a power hammer. These machines are built in three sizes in which the weights of the rams are 25, 50 and 100 pounds respectively. They are cast in one piece and require no extensive foundation.

The ram or hammer head is of steel and runs in external elliptical-shaped tracks. Two steel spring arms with steel rollers at the lower end and a helical spring at the top, operate on the curved tracks which lift and throw the ram, which, with an increased speed of the hammer acquires increased travel and force of blow. The full stroke can be had on varying thicknesses of stock and no change of adjustment is necessary excepting for unusually heavy or special work. The hammer has an exceptionally long stroke and may be operated at a very high rate of speed.



Beaudry utility hammer provided with an offset anvil

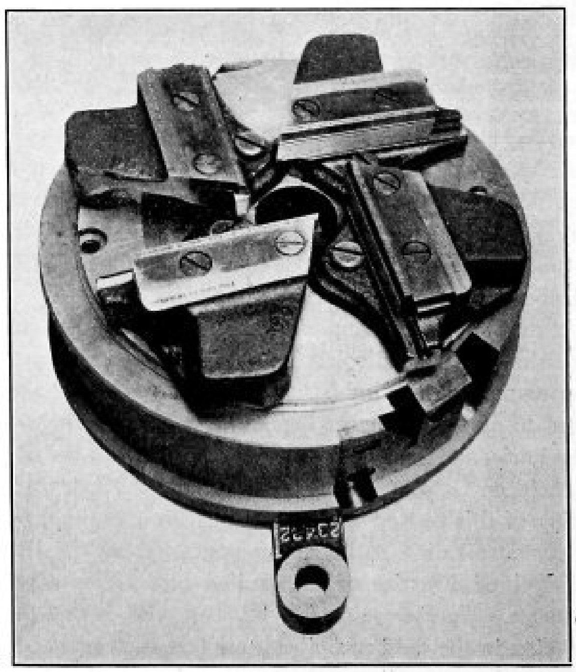
The hammer is started, stopped and regulated by a foot treadle extending around the base of the machine. The treadle throws in or out a cone clutch fitted in the hammer pulley and clutch surfaces which are fitted with a brake lining. The ram is carefully machined and fitted to heavy V-shaped guides and is adjustable on its connecting rod for varying heights above the dies. It has an adjustable taper gib for taking up wear. These hammers may be worked to equal advantage from all sides, as the anvil is offset, clearing the main frame casting, which allows bars of any length to be worked either way.

As regularly furnished these hammers may be operated by an overhead belt running at any angle or by a motor attached to the frame as shown. They may be turned into a motor-drive at any time without any mechanical change except for the bolting on of the motor bracket and the attaching of the motor to it.

Some of the principal specifications of the largest size hammer are as follows: length of stroke, 10 inches; maximum size of stock worked 3 square inches; number of blows per minute 300; size of dies $2\frac{1}{2}$ inches by 5 inches; height over all 60 inches; size of motor 3 horsepower.

Reverse Die Head for Cutting Taper Threads on Crown Bolts

THE Landis Machine Company, Waynesboro, Penna., has placed on the market a reverse taper die head for cutting tapered threads on crown bolts from the big end to the small end. When cutting these threads the usual practice is to thread from the small end to the large end. This usually causes the nicking of the body of the bolt, which



Reverse taper die head for cutting threads on crown bolts, threading from the large to the small end makes the bolt unfit for service, or at least creates a tendency for the bolt to break at the place where it is nicked during the threading operation. The Landis die head was designed to overcome this condition.

Another important feature is that the square on the end of the crown bolt does not have to be true with the body for the die head grips the body of the bolt. The die head is furnished in the 1½ inch size only. Its diameter is 11⅞ inches and its length is 7 5/16 inches. The maximum diameter of the bolt which can be threaded is 1⅞ inches, while the maximum taper of thread is 2 inches per foot. The head can be applied to any Landis threading machine having a capacity of 1½ inches or more. The machine must be equipped with a lead screw attachment to insure a thread of perfect form and correct lead. A special carriage front or trip rod brackets will be required to accommodate the two trip rods which are supplied with the head.

The die head is operated by two trip rods attached to the carriage in front of the machine. These rods are fitted with adjustable nuts which engage the lugs of the yoke ring. The lugs are located diametrically opposite each other. The adjustable nuts are placed in contact with the lugs on the yoke ring when the work is about to enter the die head. As the work advances, the yoke ring is pushed back, taking with it the operating ring to which the cam shoes are attached. The cams are designed so that, as the cam shoes slide over the cams, the die head is closed gradually to correspond to the taper of the thread. A set of cams is required for each thread taper.

The travel of the cam shoes must equal the length of the thread. The die head opens when the crest of the cam shoe passes the crest of the cam. Stop screws are provided to limit the opening of the head which is automatically brought to the threading position as the carriage is withdrawn.

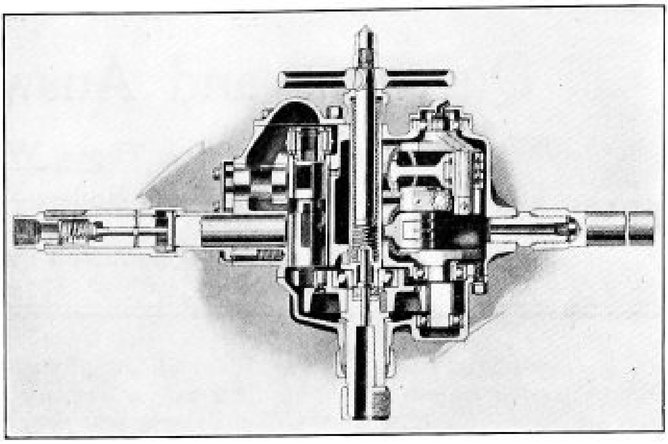
Pneumatic Drill Provided with a Speed Governor

THE Ingersoll-Rand Company, New York, has recently added to its list of pneumatic tools a four cylinder pneumatic drill equipped with a speed governor to eliminate the racing of the machines when running free. This governor is set so that the machine will do the maximum amount of work at the proper working speed. In addition to the governor, the valve mechanism consists of one valve of a gear timed construction. This valve is balanced at all times and there is, therefore, practically no wear on the valve or on the valve bushing.

All the cylinders have special steel liners, fitted into the steel casing, which are easily removed and renewed. With this construction, it is said to be practically impossible to dent the cylinder liner as the wall of the casing on the outside protects it, there being a chamber between the casing wall and the cylinder proper.

The crank pins are fitted with sleeves which are held stationary so that all of the wear takes place on the sleeve instead of the crank pin. Therefore, if a crank pin bearing becomes worn, instead of renewing the entire crank shaft, it is only necessary to renew the one sleeve. The crank pin bearings are lubricated from the inside of the crank pin out, instead of by revolving in a grease-filled crank case. It has been found that the centrifugal force of a high speed crank shaft throws the grease away to such an extent that the crank pin usually receives very little lubrication. With this method, the centrifugal force aids lubrication by throwing the grease from the inner part of the crank shaft out through the crank pin bearings.

A helical type of gearing is used for the crank pinion and the main driving gear. With this type of gearing, there are always two teeth engaged instead of only one as



Sectional view of pneumatic drill equipped with a speed governor

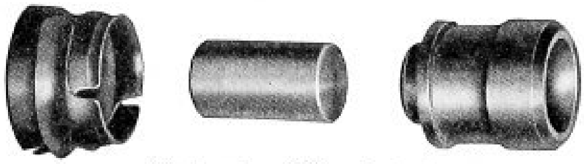
with the spur gear type. This considerably reduces the tooth pressure on the gears. The crank pinion is also renewable. A new method of venting the casing through the crank shaft is used, which gives a better venting for the casing and still will not throw out the grease which is used to lubricate the machine.

The dead handle is screwed onto a stud which is set into the crank cap of the drill. This eliminates the wear which occurs when a dead handle is screwed directly into the crank cap proper as it is necessary to take out the dead handle frequently in order to properly lubricate the drill. The drill is fitted with a new type reversible throttle which has a rotating reverse throttle in addition to a poppet throttle. This is said to give excellent service and eliminate leaking. The throttle is fitted with a spring center with notches for the full forward speed, full reverse and dead center and is very easily regulated by the operator.

The crank parts can be completely assembled outside of the drill case and then inserted in the case. This feature saves time and assembling and assures the work being properly done. It avoids lost time from working on small parts if the crank has to be assembled inside the case.

Mack Rivet Sets Guaranteed for 25,000 Rivets

A COMPLETE series of tests on Mack unbreakable rivet sets has caused the Lovejoy Tool Works, Chicago, to announce that these sets will be guaranteed for a total life of 25,000 rivets or more. This set is made in two pieces and it has been found that the only result of using the rivet



Mack unbreakable rivet set

set is to somewhat batter the front end. This is easily corrected by recupping the set with a Mack recupping tool which straightens up the cup without annealing or other treatment. It requires only a few minutes for the operation and the set is ready to drive rivets again.

The result of making the set in two pieces, the company states, is to increase the force of the blow over that when a one-piece set is used. The rivet set is held together and to the pneumatic hammer by a special Mack clip.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Safe Ending

Q.—In reading in the October issue of THE BOILER MAKER I noticed a device illustrated, a roller operated by foot pressure in welding superheaters and other small flues, and I would like to know if it is permissible to butt weld safe ends on superheaters and other small flues for a locomotive boiler with an oxy-acetylene torch? Also, if the Thomson process of electric welding boiler flues employs butt welding or lap welding?—A. P.

A.—There are two general methods used in safe ending tubes—the *forging process* and the *electric welding process.* For either process the tubes are first cleaned in a rattler and then cut for safe ending.

For the forging process, the safe ends should be scarfed on one end ½ to ⅝ inch, as shown in Fig. 1. The tube end should be expanded or belled out to receive the safe

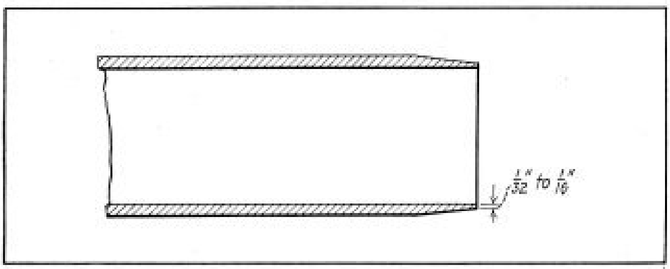


Fig. 1.—Safe end for forge welding

end. The safe end is then placed in the expanded end of the tube and both heated to a welding heat. They are then removed quickly to the welding machine where the overlapping edges are forced together, taking care to see that the weld is smooth on both inside and outside of the tube. Each safe end should then be tested to a hydrostatic pressure of 300 pounds per square inch.

For welding steel tubes the metal should be heated to a temperature of 2,500 degrees to 2,600 degrees F., and for iron 2,800 degrees to 3,000 degrees. A temperature device called a *pyrometer* is installed on the furnace for observing the intensity of the heat.

An efficient flue welding shop should include the following equipment:

(1) Cutting off tube or flue ends and expanding.
(2) Heating tube and safe end and welding.
(3) Testing and cutting off tubes to length.
(4) Cutting and scarfing safe ends.

ELECTRICAL METHOD OF SAFE ENDING TUBES

The tubes or flues are first cleaned and the ends cut off square removing all burrs. The safe end and tube are placed in the welding machine. The tube is held by the head and the safe end by a clamp which bring the two together for welding. When the electrical current is turned on, the butting ends are heated and forced together by the movement of the clamps. When the current is turned off and the pressure released on the clamps the tube is pushed forward until the weld in the safe end is in the rolls *C*, which roll the weld down on a mandrel.

The claim is made that a better weld is obtained by chamfering the safe end to an angle of 30 degrees and then insert it in the tube 3/16 to ¼ inch, the weld is then performed which gives a stronger joint.

The welding of tubes with an oxy-acetylene torch can be done, but the method is more expensive and slower.

Firebrick Arches

Q.—As a constant reader of your valuable journal, THE BOILER MAKER, I take the liberty to ask you for information concerning firebox arches of locomotive boilers. I would like to know if there is any other kind of arch in use in locomotive boiler fireboxes, except the sectional brick arches such as are manufactured by the American Arch Company. If you know of other kinds, please describe same.—P. B.

A.—The American Arch Company makes special forms of brick as required for the different types of locomotive fireboxes. There are other firebrick manufacturers that produce arch brick of practically the same material. The form of the arch depends on the character of fuel burned and methods of firing as for oil powdered or pulverized fuel and run of mine.

Write to Combustion Engineering Corporation, New York, N. Y. Ætna Combustion Company, New York.

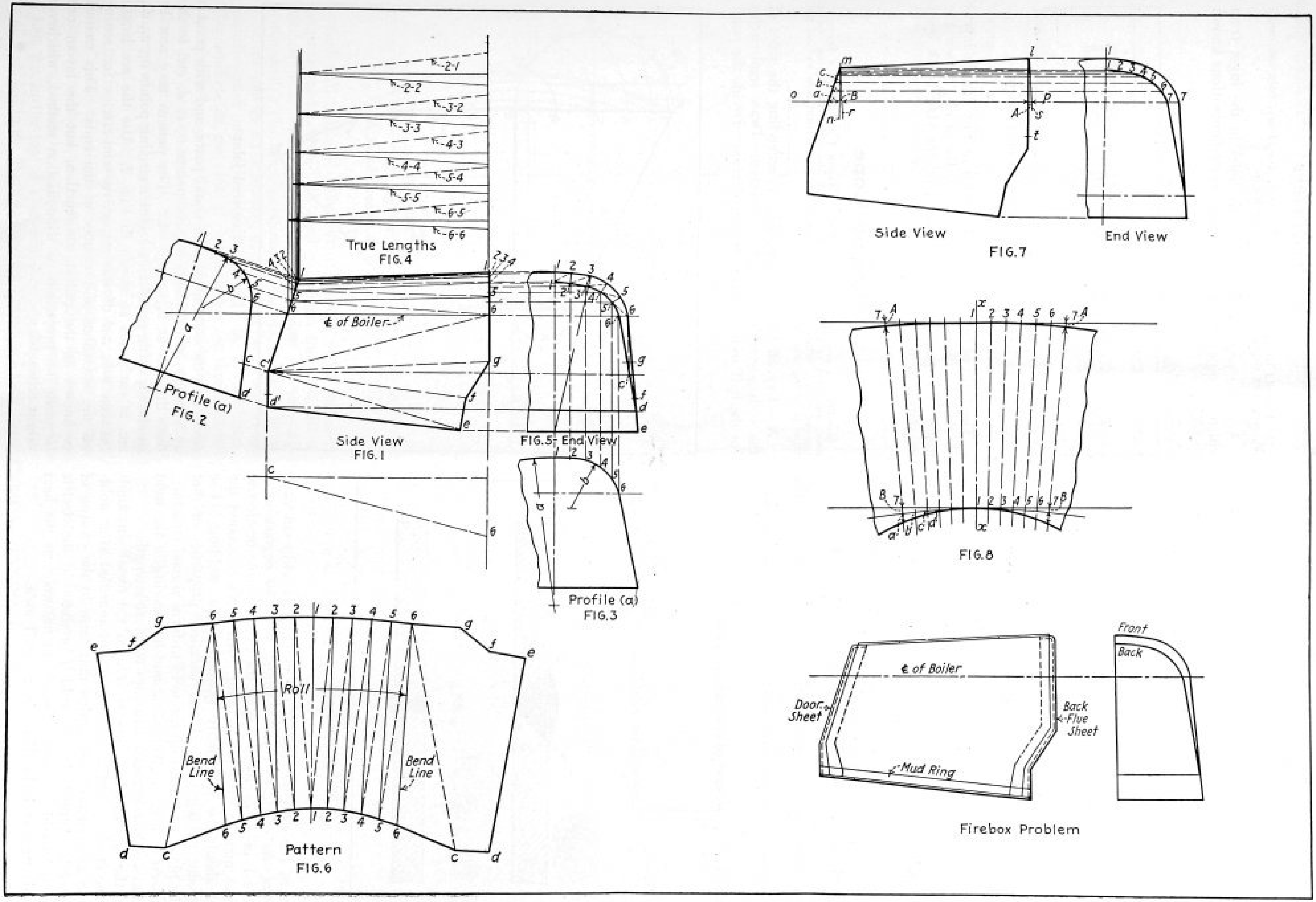
Firebox Development

Q.—I am inclosing a sketch of a locomotive firebox made in one piece with sloping crown sheet and sloping back, for which I wish you would outline the method for laying out by projection. I recently laid out one by triangulation and had a perfect fit, but I believe it is much easier and quicker to lay out by projection.—D. M. D.

A.—In the accompanying drawings, Figs. 1 to 6, are represented the respective steps in the development of a tapered firebox by the triangulation method. It will be seen in this case that the door sheet end, profile (a) Fig. 2 is a full view showing the curvature of the crown sheet. The end view is a projection of the door sheet end and shows the curvature foreshortened. By the use of Figs. 2 and 3 the end projection is made. Since all of the construction lines are numbered then assembly in the pattern, Fig. 6, should be readily understood. This development is made to the center line of rivet holes, to which must be added the required allowances for lap.

The end view, Fig. 7, shows the curvature of the firebox on *m-n* in full view section, as the plane *m-n* is perpendicular to the center line *o-p*.

The camber on *m-n* and *l-t* is obtained by projecting lines



Details of problem in firebox layout

at right angles to *m-l*, as *m-r* and *l-s* thus locating distances *A* and *B* on the center line *o-p*.

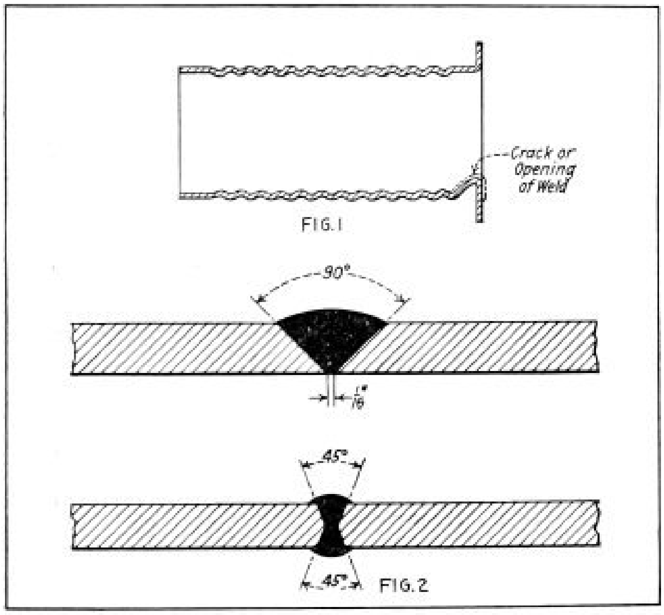
The outline for the curved part of the crown sheet may now be laid off as in Fig. 8. Lay off the center line *x-x*, making it equal to *m-l* of Fig. 7. From points *x-x* draw the lines 7-1-7 and at right angles to *x-x*. Make 1-7 at top and bottom equal respectively to the arc lengths of the large and small end of the crown sheet, and from point 7 lay off the camber lengths *A* and *B*. With a batten draw the camber lines. From points *x* and with the circular measuring wheel set off the required stretchout on the camber lines. Radial lines in the pattern are located for setting off the lengths *a*, *b*, *c* and *d*. The straight part of the firebox may now be laid off as shown for Fig. 6.

Furnace Repairs by Welding

Q.—Kindly let me know the approved method of repairing cracks or weld openings in the bottom of a Morison furnace, as indicated by sketch. If electric welded, please describe each step, from the beveling of cracks to the finish of the weld. Your magazine is of distinct advantage to anyone in the boiler trade.—M. M.

A.—Repairs may be made by welding where the weld is not subjected to tensile strain. The United States Board of Supervising Inspectors permits welding of longitudinal or circumferential cracks in plain or corrugated furnaces, provided such cracks do not exceed 16 inches in overall length.

In welding such cracks, first drill a hole through the plate at the extreme ends of the crack; then chip out each side of the crack to form a single *V* of 90 degrees or a double *V* of 45 degrees. Either the oxy-acetylene or electric process may be used for welding. All surfaces around the weld should be thoroughly cleaned before welding. Use electrodes having physical and chemical properties of that of the plate, and build up the weld to form a good structure, as shown in Fig. 2. Annealing and hammering of the weld produces a homogeneous structure of great strength.



Detail for furnace welding

If the oxy-acetylene process is used the metal surrounding the crack should be pre-heated and annealed after welding so as to remove all strains that arise in the cooling of the metal. Anneal also the weld if produced by the electric process, but this is only necessary in the weld, as the heat by this process is localized in a small area.

Pipe Blisters

Q.—I would like to know what makes each pipe blister, only one month old, also very clean. Is it in the steel?—H. B.

A.—The presence of slag or air holes in the ingot from which the pipe is drawn or rolled, causes laminations known as *blisters*.

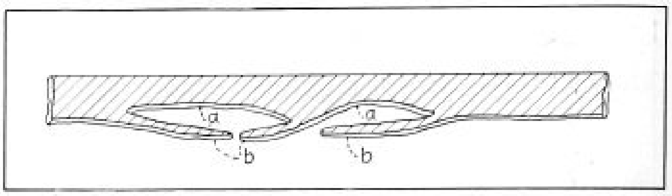


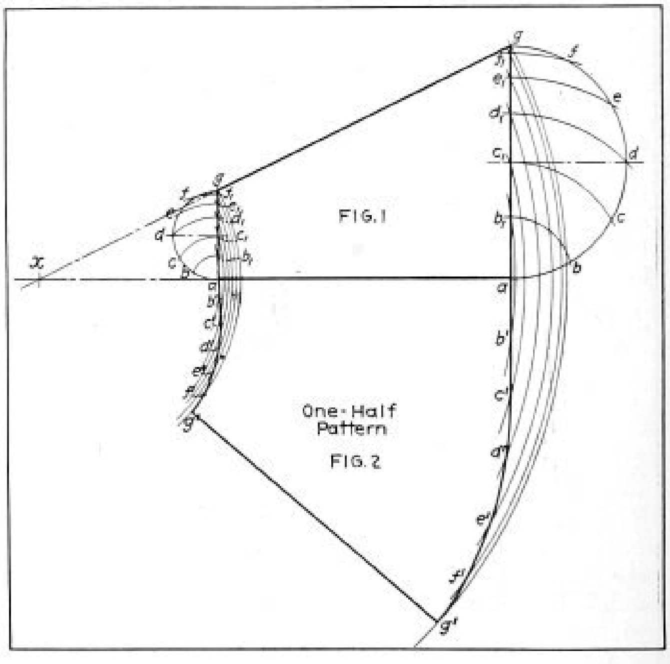
Fig. 1.—Showing the formation of a blister

The form of blistered steel is shown in Fig. 1, thin layers of slag *a-a* lie under the surface of the steel. When the metal is heated the blisters caused by the slag break open as shown at *b*.

Scalene Cone

Q.—Being a new reader of THE BOILER MAKER I am asking a favor at once, and that is if you will kindly publish the rules for laying out a tapered joint. When it is standing up, it has one vertical side and all the taper is on the other side.—L. M. C.

A.—Lay off the elevation, Fig. 1, extending the sides of the scalene cone to intersect at point *x*. Draw semi-circles for the half section of the respective bases. Divide the semi-circle into the same number of equal parts, and with point *a* as a center at each end revolve points *b*, *c*, *d*, etc. to the base lines as at b_1, c_1, d_1, etc. The pattern may now be produced, using point *x* as a center circling points b_1, c_1, d_1, etc. at each end as shown in Fig. 2. Use the arc length between *a-b*, *c-d* of the respective semi-circles for setting off the stretchout and camber of the ends. This method is known as the radial construction, but the layout can be made by projection or triangulation method, whichever seems advisable.



Layout of tapered joint

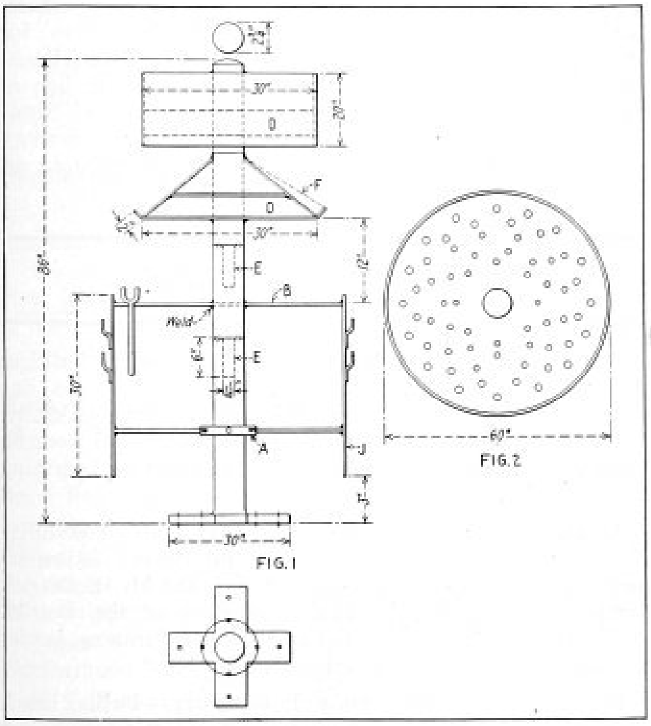
Letters from Practical Boiler Makers

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

A Handy Tool Rack

In line with your announced policy of publishing shop kinks, the accompanying sketch and details of a revolving tool rack may be of interest and benefit to your readers, as we recognize that it is just as essential to have the proper means for storing and distributing tools as it is to have a supply of good and useful tools.

Fig. 1 shows the elevation of a tool rack with a central shaft $2\frac{3}{4}$ inches in diameter in three sections turned down and bored out as shown at *E* and recessed as shown for



A handy boiler shop tool rack

$\frac{1}{2}$-inch ball bearings. The circular shell *J* is 60 inches in diameter made of $\frac{1}{8}$-inch steel plate and the head, *B*, of $\frac{1}{4}$-inch plate welded in just a little below the top edge of the shell. The head, as shown in Fig. 2, has holes burnt in at random to accommodate single ended wrenches, socket wrenches and any other tools that can be placed there. The brackets on the side of the shell are for double-ended box wrenches and such tools. *A* is a wrought iron collar, bored for an easy fit around the shaft, drilled and tapped out for four $\frac{7}{8}$-inch rods, which are adjusted to the inside diameter of the shell and welded, as shown, thus supporting the side of the shell.

At the top are shown the front and end views of two shelves made of $\frac{1}{8}$-inch steel plate, with the two shelves welded in as shown at *D* for the storing of any small tools that are convenient. The shelf is made in one piece with a hole cut in the top of V to slip down on the shaft. This is also welded to the shaft, the shelves having a 2-inch flange along the bottom edge. A taper flange is also welded on at each end, as shown by the dotted line *F*. The shelves are used for staybolt taps, spindle taps and reamers.

The base, which is fastened to the floor by wood screws, is made of 4-inch by 1-inch flat iron, one piece being offset to fit over the other piece and then bored out to fit the bottom of the shaft and welded. In assembling the shaft, a liberal supply of lubricant should be applied in the bore and at the ball bearings. This rack has proved very serviceable, as an attendant can reach any tool by simply turning the rack.

Lorain, Ohio. JOSEPH SMITH.

Patching Boilers

In reference to P. R. V.'s answer in the September issue of THE BOILER MAKER, I suggest that the portion of flange be cut out, and replaced instead of beading the patch as shown. In nine cases out of ten a patch could not be made tight as the space to work in in the wings of a boiler is very limited. These fractures usually occur in the wings of the boiler on the bar line, so I fail to see how a good job could be made without renewals of flange.

In reference to Joseph Smith's letter in the October issue, may I suggest that it is far better to remove the fracture in Adamson rings than to cover up with a dry patch. Sooner or later the fracture will have to be taken out. A better method than J. S's. is to put the patch on the wet side.

Hull, England. F. SNOWDEN.

A Word in Favor of Charcoal Iron

In the July number of THE BOILER MAKER there was published an abstract of a report of the committee on "Pitting and Grooving in Boilers" of the Master Boiler Makers' Association in which it was stated that: "It is generally believed that charcoal iron is more homogeneous than steel and that iron tubes are, therefore, more resistant to corrosion than are drawn steel tubes. Whether or not this is true, the writer is not prepared to say. It would seem as if steel could be made as homogeneous as iron and it is evident that if it were so made, it would be just as good."

There is another important reason for the superiority of charcoal iron boiler tubes, namely, the presence of slag, which is thoroughly distributed throughout the metal. The product of the charcoal knobbling fire is a sponge consisting of globules of practically pure iron, the pores of the sponge being filled with molten slag. The subsequent heating and mechanical operations necessary to convert the crude iron into a finished product, draw the slag out into filaments or thin strips which, while not continuous for the length of the tube, overlap to such an extent that every cross section of a charcoal iron boiler tube, will show a remarkably complete distribution of slag. An analysis of a finished tube or sheet of charcoal iron will reveal a surprising chemical uniformity.

Steel on the contrary is purposely freed from slag before it is poured into the molds where, on account of varying densities and gas pressure, the mass is in constant ebullition until it freezes. Due to this internal motion and the fact that the impurities are lighter than iron, they are found to be segregated, generally towards the top center, but also to a certain extent, throughout the entire ingot.

The presence of the slag or cinder filaments in wrought iron is responsible for the well known fibrous appearance of its fracture when nicked and broken. The resistance to fatigue shown by wrought iron, which is greater than that possessed by steel of an equal or even considerably higher tensile strength, is also very likely due to this subdivision of the cross section. In other words, the iron possesses to some degree, the greater resistance to repeated bending. This may be illustrated by a wire cable as compared with a solid bar of the same cross sectional area.

It is true that corrosion due to pitting is less likely to take place in a homogeneous metal than in one in which the impurities are segregated, by reason of the fact that chemical uniformity results in balanced electrical potentials. It is also recognized that no metal can be absolutely homogeneous and that under certain conditions pitting will occur. However, the point I wish to stress is that slag, being non-metallic, is definitely more resistant to the action of acids and to decomposition by electrolysis and consequently to corrosion in general, than pure iron. If corrosion does start, it is obviously of advantage to have within the metal barriers or obstacles of high resistance to corrosion to impede and check its progress so as to postpone failure or prevent it entirely.

This structural resistance to corrosion, possessed by charcoal iron, is of equal if not greater importance than the homogeneity of the metal in comparison with steel, in respect to the greater service that may reasonably be expected of charcoal iron.

S. H. WOODROFFE,
Metallurgical Engineer, Parkesburg Iron Co.
Parkesburg, Pa.

BUSINESS NOTES

The Pawling & Harnischfeger Company, Milwaukee, Wis., has changed its name to the Harnischfeger Corporation.

The Cleveland Twist Drill Company, Cleveland, Ohio, plans the construction of one, two and four-story plant addiations to its factory at Cleveland.

T. E. Beddoe has been appointed industrial sales engineer of the Cutler Hammer Manufacturing Company, with headquarters at Philadelphia, Pa.

W. S. Campbell has been appointed manager of domestic machinery sales in the eastern district for Joseph T. Ryerson & Company, Inc., with headquarters at Jersey City, N. J.

J. F. Kroske has been appointed manager of pneumatic tool sales for the Ingersoll-Rand Company, in the Pittsburgh territory. Mr. Kroske's headquarters are at Pittsburgh, Pa.

The Linde Air Products Company has opened a branch office at Salt Lake City, Utah, in charge of R. L. Strobel and another office at Seattle, Wash., in charge of C. E. Rheim.

The Southwark Foundry & Machine Company, Philadelphia, Pa., has discontinued its Cleveland office. This office is now located at 100 East South street, Akron, Ohio, in charge of F. H. Smith.

The Gibb Instrument Company, Bay City, Mich., has changed its name to the Gibb Welding Machine Company. The company is now engaged exclusively in the manufacture of electric welding and heating machines. There has been no change in organization.

The sales force at the Cleveland office, 7829 Euclid avenue, of the Burke Electric Company, Erie, Pa., which is in charge of L. L. Myers, has been increased by the appointment of O. P. Hanchette, welding engineer. Mr. Hanchette will specialize in the sale of electric arc welding equipment and engineering service in connection with it.

The Milburn Sales Company, distributors in the Philadelphia territory for the Alexander Milburn Company, Baltimore, Md., makers of oxy-acetylene welding and cutting apparatus and portable carbide lights, has taken over the Metropolitan New York district with headquarters at 309 Fifth avenue. E. P. Boyer, D. Keyser and other assistants will be in charge of the New York City office.

E. A. Thornwell has been appointed representative of the Premier Staybolt Company, Pittsburgh, Pa., in the southeastern district, with headquarters in the Chandler building, Atlanta, Ga., and E. B. Corbett has been appointed representative in the southwestern district, with headquarters at the corner of Sawyer and Winter streets, Houston, Tex. The company was previously without representation in these districts.

The Smith and Woodbury Company, 55 Second street, Portland, Oregon, have been appointed distributors for Oregon and Southwest Washington by the Chicago Pneumatic Tool Company. They will stock a complete line of Pneumatic and Electric Tools, Air Compressors and Semi-Diesel Oil Engines to meet the requirements of the territory covered by this arrangement. They will also maintain an up-to-date service department in Portland.

TRADE PUBLICATIONS

ELECTRIC EQUIPMENT FOR CRANES.—A 35-page bulletin, No. 48732, description of electric equipment for cranes, has been issued by the General Electric Company, Schenectady, N. Y. Particular reference to crane motors and control, brakes, etc., is made and information is given on operating characteristics.

ARCHES.—A 50-page catalogue showing the adaptability of its arches to all types of boilers and stokers, industrial furnaces and oil stills, has been issued by the M. H. Detrick Company, Chicago, Ill. The application of the Detrick section supported wall to pulverized fuel furnaces is described for the first time in this catalogue.

ELECTRIC TOOLS AND SHOP EQUIPMENT.—Drills, bench and pedestal grinders, tappers, screw drivers, socket wrenches, post and bench drill stands, etc., are among the electric tools and shop equipment illustrated and described in the attractive 32-page catalogue, No. 8, recently issued by the Black & Decker Manufacturing Company, Towson, Md.

BOLT HEADING MACHINE.—The Ajax Manufacturing Company, Cleveland, Ohio, has just issued bulletin No. 50, which is well illustrated and tells the complete story of the new heavy duty continuous motion heading machines for making bolts and rivets. This new machine contains some important improvements which should interest those who have anything to do with machinery of this type.

EXHAUST STEAM INJECTORS.—A 23-page illustrated booklet giving description and instructions for the installation and operation of the Elesco exhaust steam injector, has just been issued by the Superheater Company, New York. The theory and advantages of the injector are also briefly covered and test results from the New York, Ontario & Western and foreign roads are given on inserts in the back of the book.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

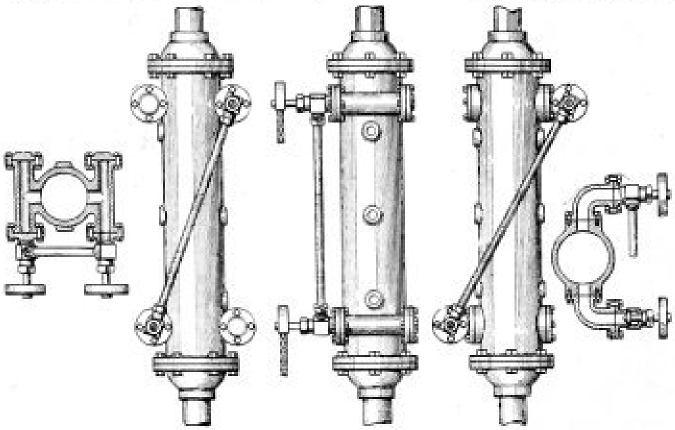
SELECTED BOILER PATENTS

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

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

1,511,325. COMBINED WATER COLUMN AND INCLINED GAUGE GLASS. GEORGE ERNST, OF NEWARK, NEW JERSEY.

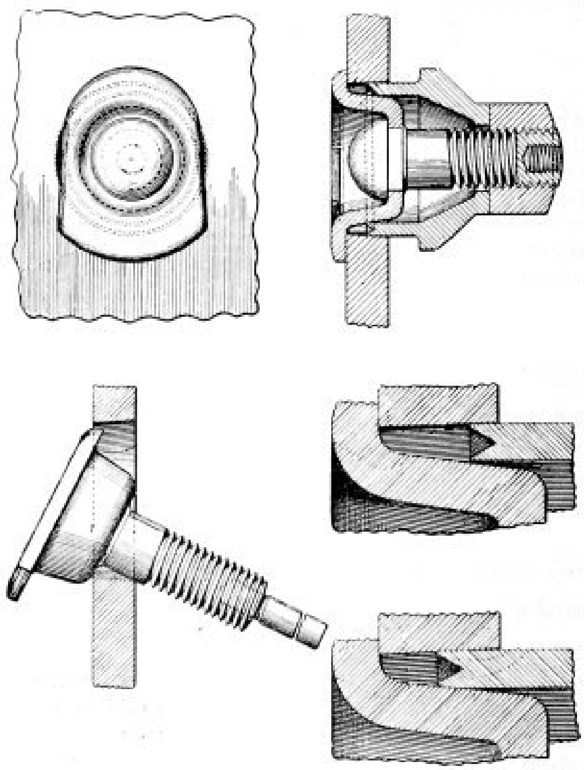
Claim 1.—The combination with a steam boiler water column, of a sight glass, attaching means for attaching the ends of the glass, and means on



the water column to receive the aforesaid attaching means and secure the same to opposite end portions of the column and on opposite sides of the column. Three claims.

1,507,739. FREDERICK E. KEY, OF ST. LOUIS, MISSOURI, ASSIGNOR TO KEY BOILER EQUIPMENT COMPANY, OF EAST ST. LOUIS, ILLINOIS, A CORPORATION OF MISSOURI. BOILER PLUG.

Claim 1.—In a closure for tapered holes, a closure member adapted to lie in the tapered hole, said closure member having a tapered outer face adapted to lie opposite to the tapered wall of the hole to be closed, so as to provide converging tapering faces in the hole, a sealing member having

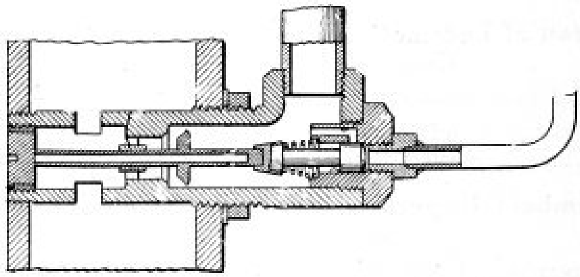


an inner margin adapted to lie between said converging tapering faces, said inner margin having a groove in its end face to provide a contractible outer flange to contract directly with the tapered face of the hole and an expansible inner flange contacting directly with the tapered face of said closure member, and means whereby said flanges are wedged between and forced toward each other on said converging faces.

Three Claims.

1,511,978. SAFETY DEVICE FOR BOILERS. JOHN J. MUHLEBACH, OF NEW YORK, N. Y.

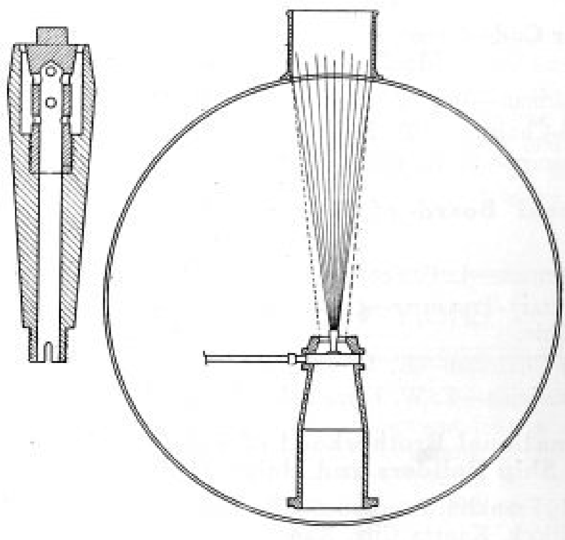
Claim 1.—In a safety device for boilers, a body normally having communication with the water compartment of a boiler, a valve-controlled inlet pipe for feeding water through said body into said compartment, a normally



closed by-pass pipe connecting said inlet pipe with said body, and means in said body operable upon the level of water in said compartment falling below a predetermined point for closing communication between said inlet pipe and compartment and for opening said by-pass to permit water to flow through said body without entering said compartment. Six claims.

1,511,308. BLOWER NOZZLE AND EXHAUST SPREADER. ANDREW THOMPSON, OF BIRMINGHAM, ALABAMA.

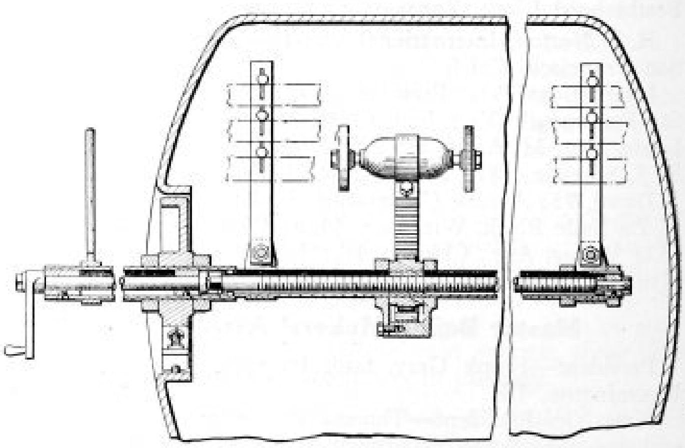
Claim 1.—A blower nozzle and exhaust spreader for locomotives, comprising a nozzle having a live steam supply and a jet orifice formed between



inner and outer members which flare upwardly, and means to mount the blower nozzle in the locomotive exhaust nozzle. Six claims.

1,505,084. DALE L. BREED, OF TICONDEROGA, NEW YORK. APPARATUS FOR REMOVING SCALE FROM BOILERS.

Claim 1.—A boiler cleaning apparatus comprising a rotatable shaft, supporting means therefor, a reciprocable carrier actuated by said shaft, an abrading member supported by said carrier and operable independently of the shaft



and the carrier, means for rotating said shaft, and means for adjusting said carrier longitudinally of the shaft. A boiler cleaning apparatus comprising a rotatable shaft, supporting means therefor, a gear mounted to rotate with said shaft, a reciprocable carrier having teeth meshing with said gear, an abrading member supported by said carrier and operable independently of the shaft and the carrier, means for rotating said shaft, and means for adjusting said gear and said carrier longitudinally of the shaft.

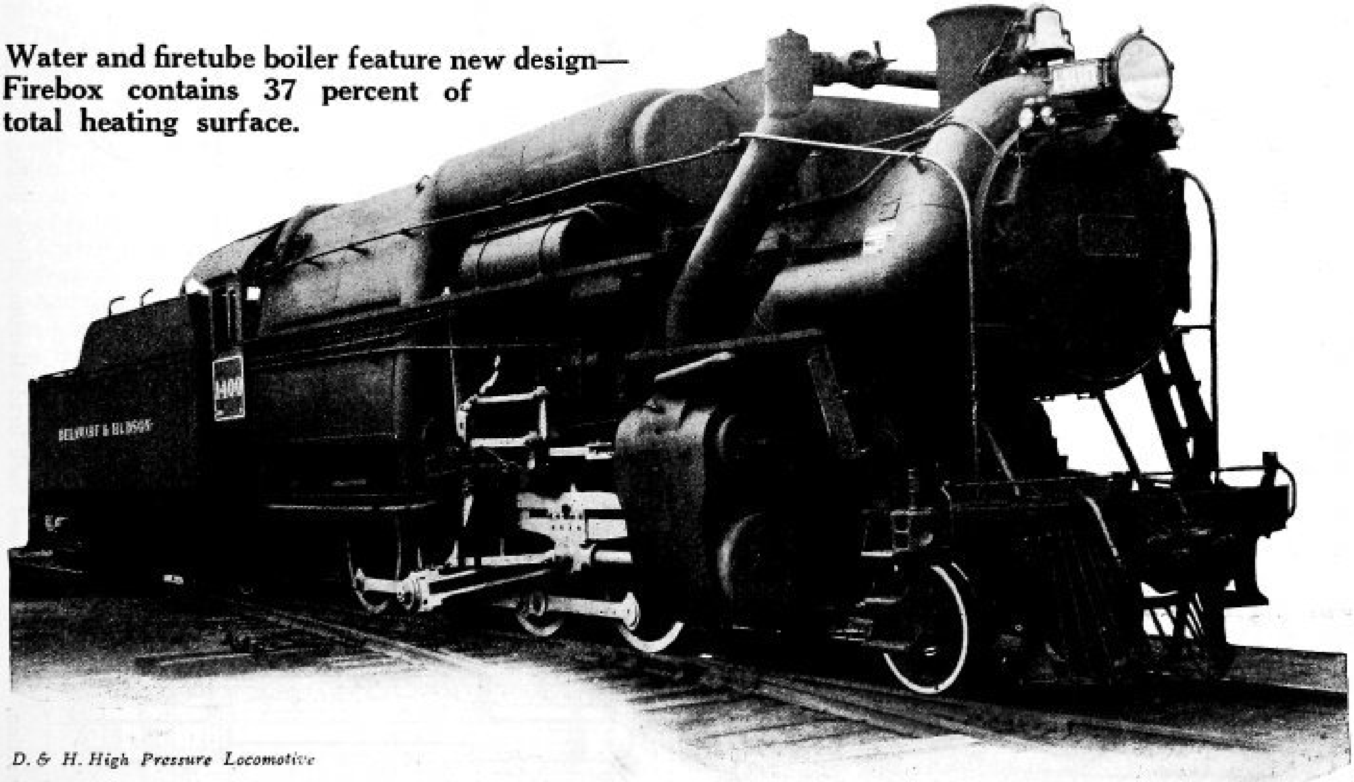
Fifteen Claims.

THE BOILER MAKER

FEBRUARY, 1925

The "Horatio Allen" a High Pressure Locomotive

Water and firetube boiler feature new design—Firebox contains 37 percent of total heating surface.



D. & H. High Pressure Locomotive

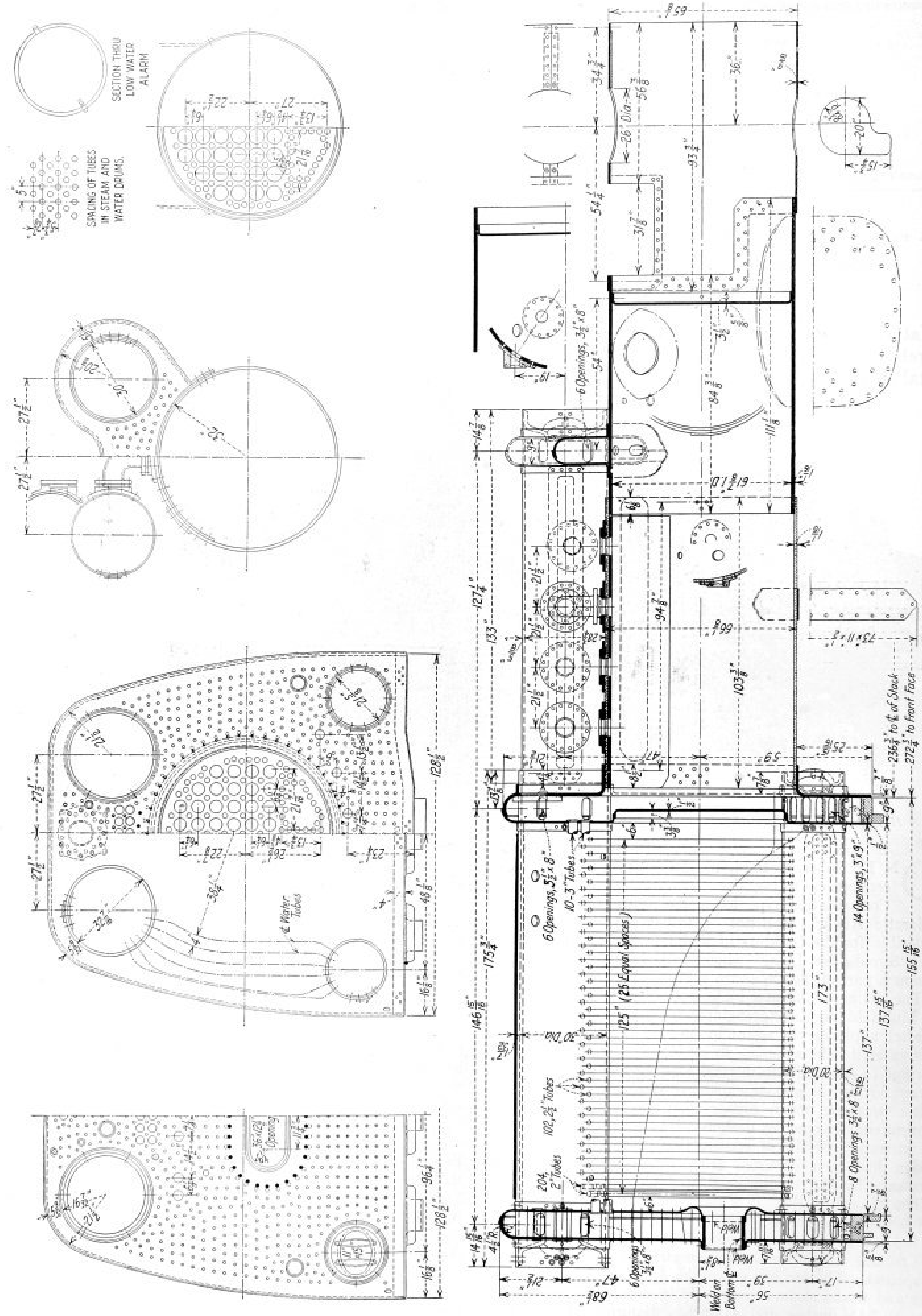
ON December 4, 1924, the Delaware & Hudson, with ceremonies fitting the occasion, christened a new Consolidation type locomotive of unique design, the "Horatio Allen," in honor of the engineer who was responsible for the building of and was the first operator of the "Stroubridge Lion," which went into service on what is now a part of the Delaware & Hudson on August 8, 1829.

The design of the new locomotive was developed by John E. Muhlfeld, consulting engineer for the railroad. Naming it after a pioneer in steam locomotive development is suggestive of its character as, in effect, it represents a pioneer attempt to increase the thermal efficiency of the locomotive by employing the greater expansive range made possible by steam pressures much higher than are now employed in conventional locomotive designs. There are also a number of interesting details of construction in which conventional design has been departed from, aside from those made necessary by the employment of high steam pressure.

The "Horatio Allen" is of the Consolidation type weighing 297,000 pounds on the drivers; with tractive force ratings of 104,000 pounds, simple including the tender booster, 84,300 pounds simple for the engine alone, and 70,300 pounds compound. The locomotive carries 350 pounds boiler pressure and works steam expansively in cross-compound cylinders of 23½-inches and 41-inches diameters, respectively, by 30-inches stroke. The driving wheels are 57 inches in diameter. In actual service the locomotive has developed drawbar pulls of 105,000 pounds at starting simple with the booster cut in; 95,000 pounds in simple gear at 4 miles an hour; 75,000 pounds in compound gear at 5 miles an hour; 65,000 pounds in compound gear at 10 miles an hour, and 53,000 pounds in compound gear at 18 miles an hour.

The Boiler

The boiler represents a complete departure from customary locomotive design. Its construction is clearly shown in the drawings and photographs. The back head and rear tube sheet connections of the firebox are both of similar construction. They are 9-inch water leg headers composed of parallel stayed sheets, flanged and riveted together around the top and sides and secured to steel foundation castings at the bottom. Circular openings through each of these members near the lower corners receive water drums, 20 inches in inside diameter. These drums pass completely through both of the headers, and ports are cut through their shells in the header water spaces. The 30-inch steam drums are secured to the front and back headers in the same manner. These drums are in two courses, the front course fitting inside the rear course and extending 133 inches along the



Longitudinal section, cross sections and back head elevation of the boiler

boiler shell. The front ends pass through a stayed saddle secured to the top of the boiler barrel. Ports through the drums and through the boiler shell provide for communication through the saddle between the drums and the boiler barrel. The ends of all four drums are closed with internally projecting heads and hand-hole covers. Referring to the boiler drawing, it will be seen that four pipe connections lead out from the top of the boiler barrel between the forward extensions of the steam drums. These lead alternately into the two drums and add considerably to the freedom of communication between the boiler barrel which is completely filled with water, and the drums on top of the barrel, the upper parts of which constitute the steam space of the boiler.

The front sheet of the forward firebox header is flanged outward to receive the back course of the two-course boiler barrel, which is 66⅛ inches in outside diameter. The inside sheet of this header is flanged inward to receive the firebox tube sheet.

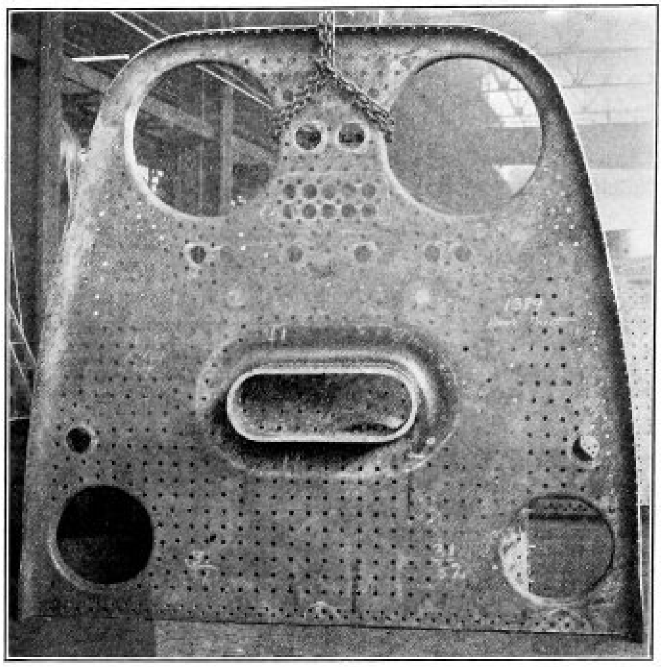
The heating surfaces at the sides of the firebox are composed of 306 tubes, 102 of which are 2½ inches in diameter and 204 of which are 2 inches in diameter. These tubes are expanded into the top and bottom drums. It is thus evident that the amount of stayed surfaces have been considerably reduced and are flat, parallel surfaces with the exception of the small area of the firedoor flange. The drum and header construction, with the top headers carried forward and securely attached to the boiler barrel, also provides an extremely rigid structure.

Additional heating surface is provided in the firebox by ten 3-inch longitudinal watertubes which lie between the upper drums and connect the front and back stayed headers. There are also six 3½ inch arch tubes.

The arch in this locomotive is unbroken from the tube sheet to the door sheet, thus completely dividing the unobstructed firebox volume into two parts. This directs the hot gases and flame outward at either side and up through the staggered rows of water tubes, thence inward to the combustion chamber volume above the arch and into the fire tubes.

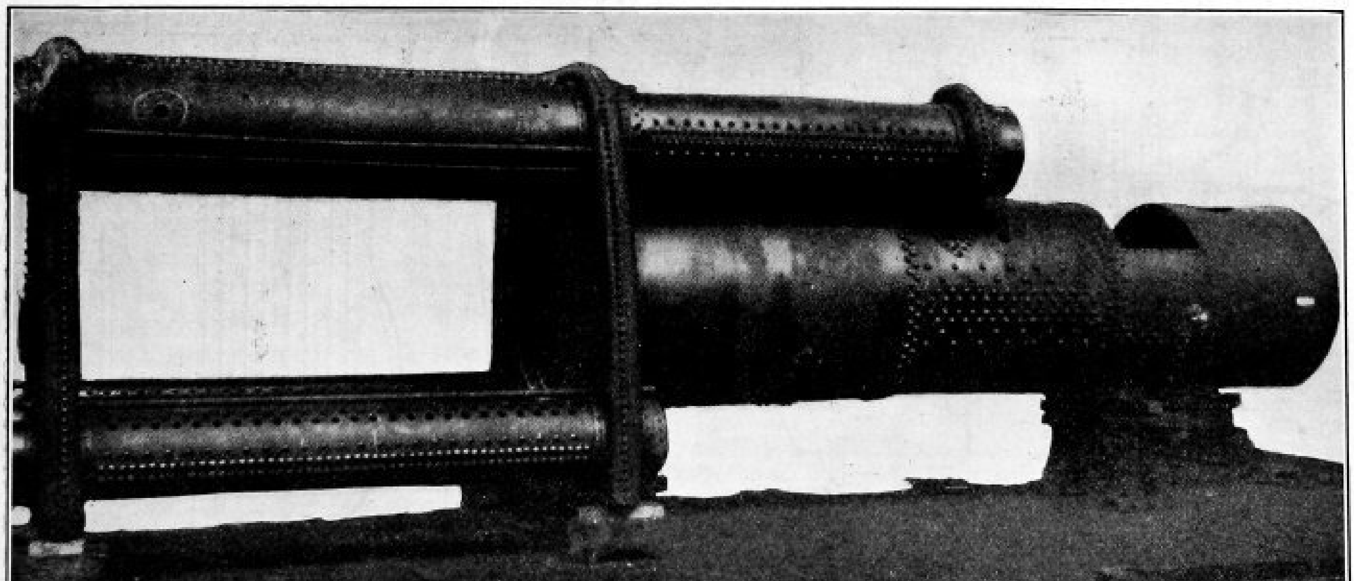
Steam Distribution

Steam is taken from the tops of the forward sections of the steam drums. A welded collector pipe of ¼ inch steel, 6 inches in outside diameter and 79 inches long, is suspended



The inside sheet of the back firebox header

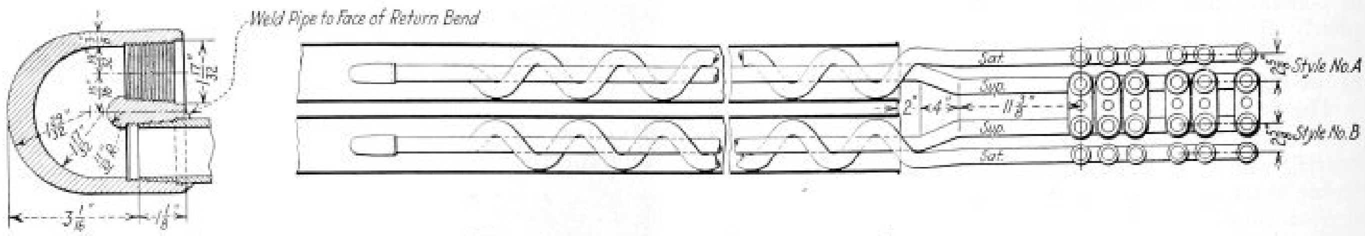
from the top of each drum. The upper surface of each of these pipes is perforated with several rows of ½-inch holes, through which the steam enters, thus distributing the gathering of the steam over a large water surface and removing any tendency for a local surge of steam to lift the water. From these pipes the steam passes out of the drum into a yoke header casting, to the front flange of which is bolted a Sanford-Riley Stoker Company's desaturator. This is of the centrifugal type, the whirling of the steam through a spiral passage causing the water to be thrown off and collected at the bottom of the casting, from whence it is trapped back into the boiler. The front flange of the desaturator is bolted directly to the throttle casing. The perforated steam collector has proved so effective in service that very little water is removed by the desaturator and some question has arisen as to whether or not it is actually needed. The overall effect of both the collector and the



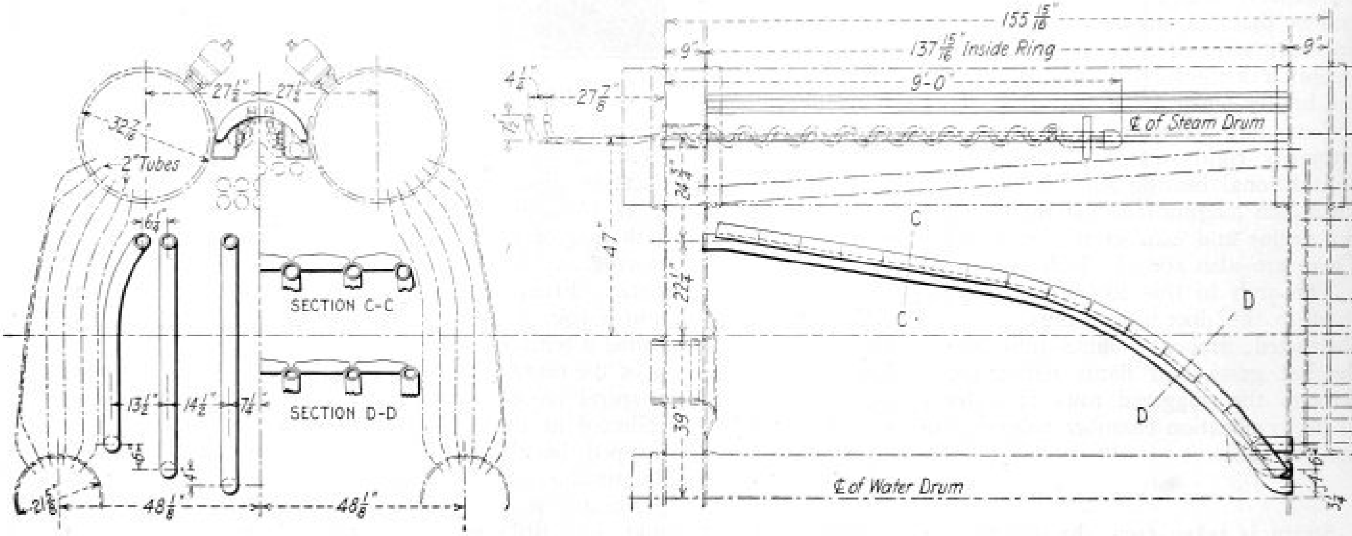
The boiler before the application of the water tubes desaturator has been found by calorimeter readings to limit the maximum moisture content of the steam to two or three percent.

Superheaters

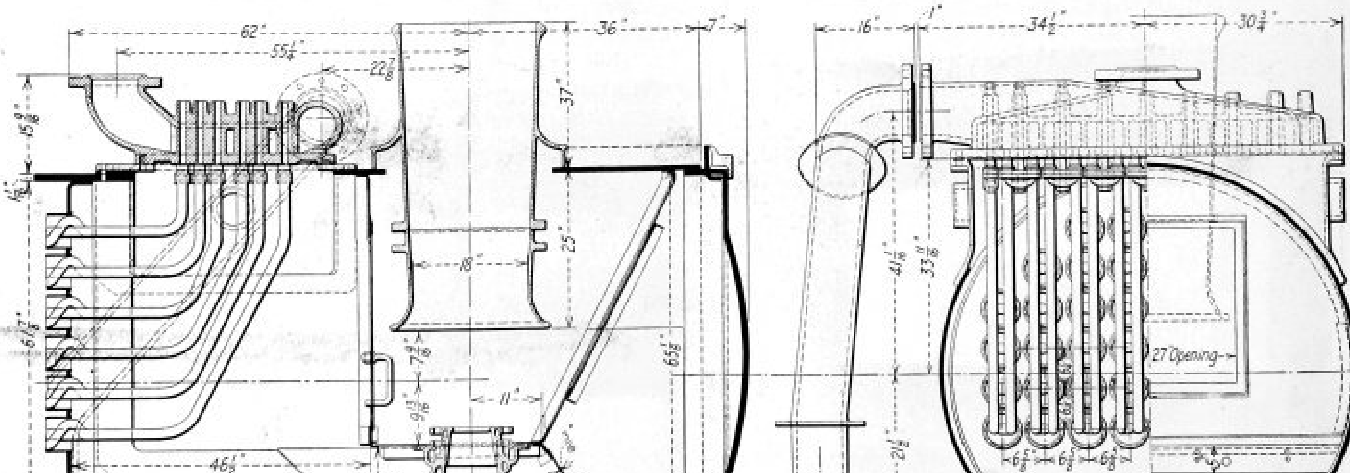
From the throttle the steam flows directly into the superheater header, which is mounted on a cast base over the smokebox. The unit bolts are applied with the nuts at the top of the header, where they are accessible for tightening without opening the smokebox front. This arrangement is clearly shown in one of the drawings. There are 42 superheater units, each of which consists of a single loop. The unit pipe leading from the saturated steam header is twisted above the return pipe in a spiral and the two pipes are



How the superheater units are arranged



Details of the firebox arch—The location of the auxiliary superheater units is also shown



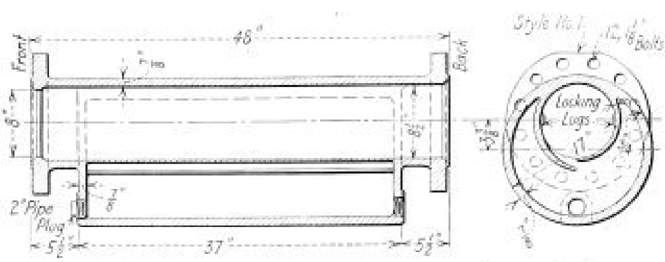
The front end arrangement, showing the outside superheater header

threaded and welded into a cast steel return bend which is located 12 inches from the back flue sheet. The whirling motion imparted to the saturated steam is designed to bring such moisture as the steam may contain into intimate contact with the unit surface, thus producing a more effective heat transfer. It also serves to equalize the expansion strains on the return bend joints.

A flange on the right side of the superheater header leads the superheated steam into a branch pipe connection to the high pressure steam chest. In the design of this cylinder close attention has been given to providing unobstructed flow to and from the valve chamber.

Superheated steam for the tender booster is taken from the high pressure branch pipe where it connects to the main superheater header. Superheated steam for the other auxiliaries is also provided by an auxiliary superheater, the units of which pass into the upper part of the firebox through the tubes in the back header.

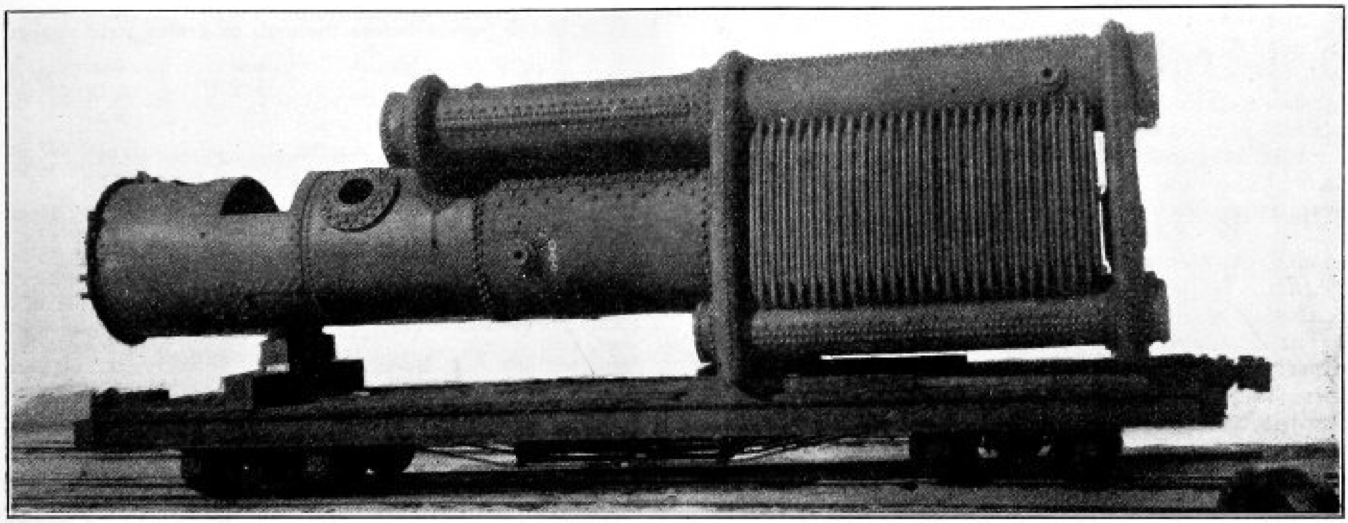
The smokebox saddle fit is made in a separate casting,



The desaturator—The steam passage contains a spiral core

One of the drawings shows the detail construction of the exhaust nozzle. This provides a direct passage for the low pressure exhaust, the diameter of which is 10 inches at the base, reducing to 8¼ inches at the nozzle tip fit. The diameter of the tip at the outset was 5½ inches, although this may since have been subjected to adjustment.

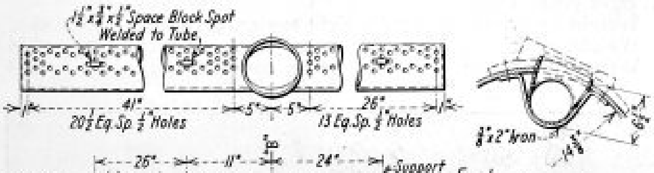
The high-pressure exhaust, when operating simple, is car-



The complete boiler before the application of the firebox lagging—The man-hole in the front barrel course gives access to the interior in the absence of a dome

which is bolted to the top of the main casting. This permits the removal of the boiler without disturbing either the smokebox saddle fit or the main frame splice. The details of the main casting are clearly shown in one of the drawings.

The only steam passage cored through the steel saddle casting leads from the exhaust passage of the low-pressure cylinder to the front face of the saddle casting on the center



The steam collector—One of these is located in the top of each steam drum

line of the locomotive. From this point an outside exhaust pipe carries the steam forward and up into the exhaust nozzle in the smokebox. The center line of the exhaust nozzle is located 65½ inches forward of the transverse center plane through the cylinders.

ried from the intercepting valve through a 3½-inch pipe to an opening in the base of the exhaust nozzle casting outside the smokebox. This opening leads to an annular chamber outside the main exhaust passage and discharges through suitable annular openings which are provided in the top of the casting.

The tender, which has a capacity of 9,000 gallons of water and 15¼ tons of coal, is carried on a Franklin tender truck at the front end and an M & L tender booster truck at the rear end.

What is Expected of the "Horatio Allen"

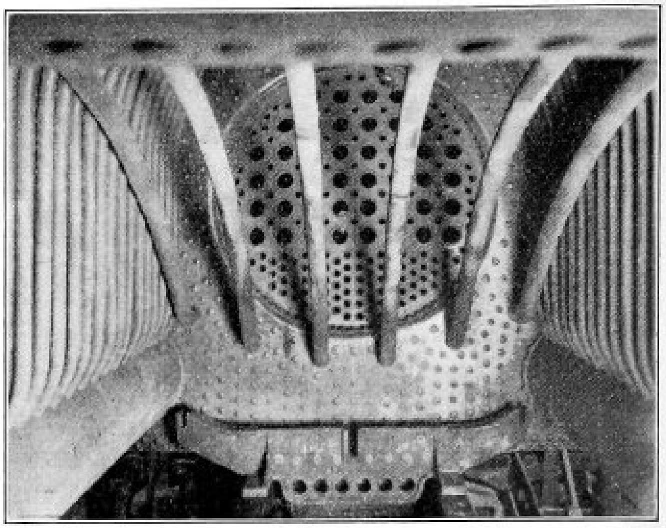
Probably the outstanding difference in the proportions of the "Horatio Allen" as compared with locomotives of conventional design will be found in the distribution of the heating surface in the boiler. Out of a total heating surface of 3,200 square feet, 1,187 square feet, or 37 percent, is located in the firebox. This is the result of the watertube construction. Considering the much greater evaporative value of the firebox heating surface as compared with that of the fire tubes, the capacity of the boiler is much greater than indicated by the total heating surface when compared with the same total amount in a boiler of conventional design, where probably less than 10 percent of the total would be contained in the firebox. Another factor of interest is the comparatively small amount of superheating surface, the total of which is 579 square feet. The purpose in this case, however, was to limit the maximum steam temperature to approximately 620 degrees and this temperature became the controlling factor in the design rather than the amount of superheat. With a boiler pressure of 200 pounds per square inch, the superheater starts to build up the temperature of the steam from a saturated temperature of 388 degrees F. With the pressure increased to 350 pounds, however, the saturated steam temperature is raised to approximately 436 degrees and the amount of heat which can be imparted to the steam within a limit of 620 degrees is correspondingly reduced. Until it is determined what effect will be produced by a combination of high pressures and high temperatures, it was considered safer not to exceed the above maximum temperature.

The main purpose throughout the design of this locomotive has been to make available the increase in economy and capacity provided by the greater expansion range of pressures considerably higher than those commonly employed in steam locomotive design. Considering the latent heat of evaporation as a fixed charge which must be distributed over the additional heat applied to build up the pressure to its working point, it is evident that considerable thermal advantage is to be gained by increasing the working pressure and thus decreasing the amount of latent heat which must be charged against each pound of useful pressure. The total heat in one pound of steam at 200 pounds pressure, is 1,199 British thermal units, but 1,150 British thermal units remain in the steam after it has expanded down to atmospheric pressure, a difference of 49 heat units per pound. To raise the steam from 200 to 350 pounds requires a fraction over 7 additional heat units while the expansion range has been increased 75 percent.

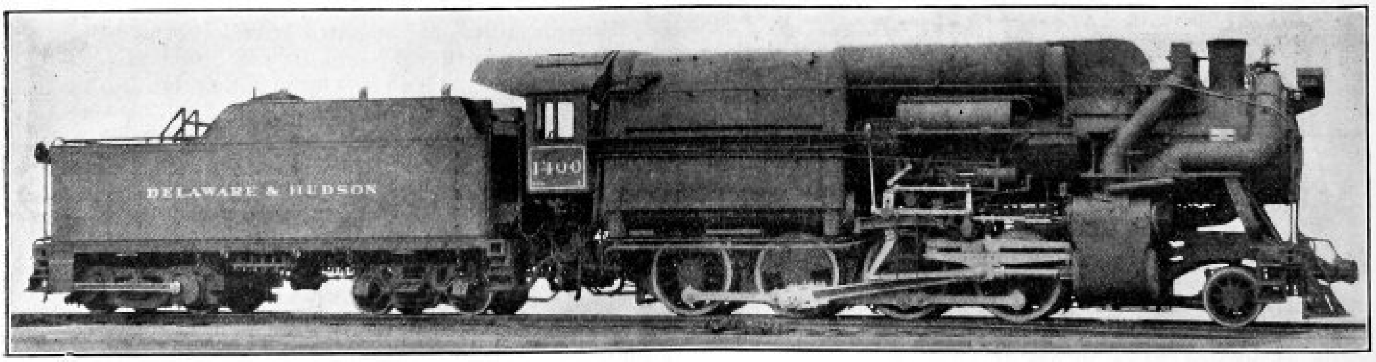
The calculated improvements in economy, which are expected from this design, are 15 percent less fuel per drawbar horsepower-hour and a reduction of 12 percent in fuel per drawbar horsepower-hour attributable to the boiler, because of the generation of 75 percent instead of 40 percent of the steam in the firebox, and the improved circulation in the watertube type of construction. This amounts to a combined estimated saving of approximately 39 percent in the fuel consumption per drawbar horsepower-hour. The principal dimensions and proportions are as follows:

TABLE OF DIMENSIONS, WEIGHTS AND PROPORTIONS

Builder	American Locomotive Co.
Railroad	Delaware & Hudson
Type of locomotive	2-8-0
Service	Freight
Cylinders, diameter and stroke	23½ in. by 41 in. by 30 in.
Weights in working order:	
On drivers	298,500 lbs.
On front truck	49,500 lbs.
Total engine	348,000 lbs.
Tender	197,800 lbs.
Wheel bases:	
Driving	18 ft.
Rigid	18 ft.
Total engine	29 ft.
Total engine and tender	65 ft. 7¾ in.
Wheels, diameter outside tires:	
Driving	57 in.
Front truck	36 in.
Journals, diameter and length:	
Driving, main	12 in. by 14 in.
Driving, others	11 in. by 14 in.
Front truck	7 in. by 15 in.
Boiler:	
Type	Combined water and fire tube
Steam pressure	350 lb.
Fuel, kind	Bituminous and anthracite mixed
Diameter, first ring, inside	61⅞ in.
Firebox, length and width	137 in. by 74⅝ in.
Arch tubes, number and diameter	6—3½ in.
Fire tubes, number and diameter	145—2 in.
Fire flues, number and diameter	42—5⅜ in.
Length over tube sheets	15 ft.
Grate area	71.4 sq. ft.
Heating surfaces:	
Firebox	1,124 sq. ft.
Arch tubes	63 sq. ft.
Tubes	1,132 sq. ft.
Flues	881 sq. ft.
Total evaporative	3,200 sq. ft.
Superheating	579 sq. ft.
Combined evaporative and superheating	3,779 sq. ft.
Tender:	
Water capacity	9,000 gal.
Fuel capacity	15¼ tons
General data estimated:	
Rated tractive force, simple	84,300 lb.
Rated tractive force, compound	70,300 lb.
Booster	19,700 lb.
Weight proportions:	
Weight on drivers ÷ total weight engine, per cent	86
Weight on drivers ÷ tractive force, simple	3.54
Weight on drivers ÷ tractive force, compound	4.24



Interior of the firebox before the arch or grates were applied



The "Horatio Allen" develops 104,000 pounds maximum tractive force, including the tender booster

Calculating Reinforced Tube Ligament Efficiency*

Methods of reinforcing tube sheets to replace metal cut out for the installation of tubes

THE strongest part of a steam boiler is the original solid plate, and whenever this plate is cut, no matter what well designed joint is substituted, the boiler is weakened. It is readily apparent, therefore, that in the cross drum type of boiler, where rows of tubes running the full length of the drum must enter the drum, and the efficiency is to be increased, some reinforcement must be provided to replace the metal cut out to accommodate these tubes. For instance, if we have a four-inch tube (4 1/32-inch hole) entering the drum every seven inches of its length, there would be but 7 — 4 1/32 = 2 31/32 inches of metal left intact between the tubes. The efficiency of such a tube ligament, as we call it, would be

$$\frac{P - D}{P} = \frac{7 - 4\,1/32}{7} = 42.4 \text{ percent.}$$

Without some form of reinforcing, our boiler would then be good for only about one-half of the pressure that it might otherwise safely carry. These ligaments are usually reinforced by riveting on one or two cover plates or straps, and it is the purpose of this article to consider one or two typical cases and show the method of computing the efficiencies.

It is assumed that those who will attempt to follow our methods and calculations are already familiar with the approved methods of computing the efficiencies of riveted joints, and so definitions will be dispensed with here. Some of the fundamental laws of mathematics with which, by the way, every engineer should become acquainted and which will be of material assistance in enabling us to use formulae and thereby present our work more clearly and concisely, will be briefly reviewed.

These laws can best be considered in connection with an expression of which we will make much use, that is $[(P - nd)\ t \times TS]$. Each letter in this expression stands for a certain number or numerical value, and when two letters are written together, as nd, it simply means that the corresponding numbers are to be multiplied together, just as if written $n \times d$.

Likewise, the t placed next to the parentheses, ( ), without any intervening sign means that the t is to be multiplied by the "value of the parentheses."

The parentheses point out to us that the operations indicated by the signs within them must be performed first and a single number or numerical value be thus arrived at, which is called the "value of the parentheses." It is this value that is multiplied by t.

In the same way, the brackets, [ ], mean that the operations indicated by the signs within them must be performed before removing the brackets so as to obtain a value for the bracketed expression.

Let us first consider a case of reinforced tube ligaments such as the one illustrated in Fig. 1. Here we have a single row of tubes entering a drum, and the reinforcing is by means of an inside cover plate, triple riveted. For all of our calculations we will assume the following values which are approved by authority of the A. S. M. E. Boiler Construction Code.

Construction Code

TS = tensile strength of boiler plate = 55,000 pounds per square inch.

s = shearing strength of rivet in single shear = 44,000 pounds per square inch.

S = shearing strength of rivet in double shear = 88,000 pounds per square inch.

c = crushing strength of boiler plates = 95,000 pounds per square inch.

From the sketch, Fig. 1, we obtain the following values:

P = unit distance, that is, the shortest distance, measured along the drum, that will include a whole number of tubes and a whole number of rivets = 7 inches.

D = diameter of tube holes = 4 1/32 inches = 4.031 inches.

d = diameter of rivet holes = 1 5/32 inches = 1.156 inches.

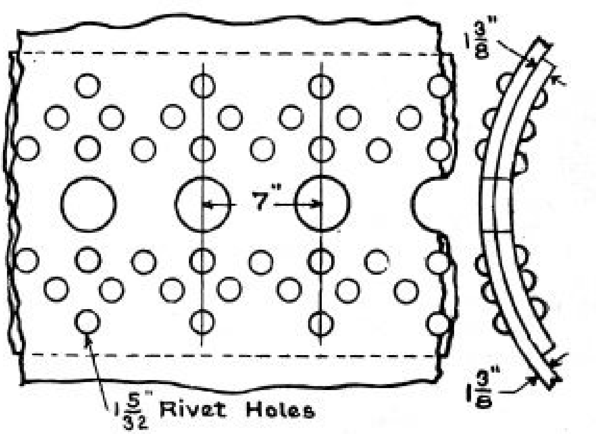


Fig. 1

a = cross-sectional area of rivet after driving = 1.049 inches

t = thickness of plate = 1 3/8 inches = 1.375 inches.

b = thickness of cover plate = 1 3/8 inches = 1.375 inches

n = number of rivets in outer row per unit distance = 1

m = number of rivets in second row per unit distance = 2

In obtaining the efficiency of reinforced tube ligaments, the procedure at first is exactly like that of obtaining the efficiency of riveted joints. The joint must be analyzed, that is, all the various ways in which it might fail are thought out, and then the force that would be required in each instance to make it fail is computed. The mode of possible failure that proves the weakest is then compared in strength with the strength of the solid plate. The result, expressed in percentage, is the efficiency of the ligament.

The strength of the solid plate in this instance is

$$\begin{aligned} A &= (P \times t \times TS) \\ &= (7 \times 1.375 \times 55{,}000) \\ &= 530{,}000 \text{ pounds} \end{aligned}$$

As the first possible mode of failure, let us consider failure of the plate along the outer row of rivets. The force required

* From an article by G. H. Stickney, superintendent of the boiler department, and B. C. Cruickshanks, editor, appearing in *The Locomotive*, published by the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

for this type of failure, or what is the same thing, the strength of the drum along this line, is the strength of the net section of plate, or

$$B = (P - d)t \times TS$$
$$= (7 - 1.156)1.375 \times 55{,}000$$
$$= 442{,}000 \text{ pounds}$$

Consider next the possibility of failing along the second row of rivets. If failure occurs along this line, not only will the strength of the net section of plate have to be overcome, but also the outside row of rivets must be accounted for. Thus we may have

C = [strength of net section of plate between rivets in 2nd row] + [shearing strength of rivets in outer row]
$= [(P - md)t \times TS] + [n \times a \times s]$
$= [(7 - 2 \times 1.156)1.375 \times 55{,}000] + [1 \times 1.049 \times 44{,}000]$
$= [354{,}500] + [46{,}200]$
$= 400{,}700$ pounds

or D = [strength of net section of plate between rivets of 2nd row] + [crushing strength of shell in front of rivets in outer row]
$= [(P - md)\ t \times TS] + [n \times t \times d \times c]$
$= [(7 - 2 \times 1.156)1.375 \times 55{,}000] + [1 \times 1.375 \times 1.156 \times 95{,}000]$
$= [354{,}500] + [151{,}000]$
$= 505{,}500$ pounds

Failure along the third or inside row of rivets will not be considered because it is quite apparent that the drum is stronger here than at the second row. Having the same number of rivets per unit distance in each row, the net section of plate is the same in each case, but a break along the inner row has the additional (second) row of rivets to be also overcome by shearing or crushing.

The next mode of failure would then be through the plate between the tubes. The strength here is not only that of the net section of plate remaining between the tubes, but also the failure of all rivets in one way or another is required. This might be either

E = [strength of net section of shell plate between tubes] + [shearing strength of all rivets]
$= [(P - D)t \times TS] + [n \times a \times s]$
$= [(7 - 4.031)1.375 \times 55{,}000] + [5 \times 1.049 \times 44{,}000]$
$= [224{,}500] + [230{,}600]$
$= 455{,}100$ pounds

or F = [strength of net section of shell plate between tubes] + [crushing strength of plate in front of all rivets]
$= [(P - D)t \times TS] + [n \times t \times d \times c]$
$= [(7 - 4.031)1.375 \times 55{,}000] + [5 \times 1.375 \times 1.156 \times 95{,}000]$
$= [224{,}500] + [755{,}000]$
$= 979{,}500$ pounds

Formula "F" can usually be neglected without computing its value because its value, as a rule, is high. It is not advisable to do this, however, until one is thoroughly acquainted with riveted joint calculations.

A comparison of the various values of B, C, D, E and F shows C to be the smallest. The efficiency of the construction shown in Fig. 1, is therefore

$$\frac{C}{A} = \frac{400{,}700}{530{,}000} = 75.6 \text{ percent.}$$

Another type of reinforced tube ligament which is quite frequently met is shown in Fig. 2. Here we have two rows of tubes entering the drum running parallel to, and alongside of, the butt seam. In this way double use is made of the cover plates, first, as butt straps for the seam, and second, as reinforcement for the tube ligaments. The method to be followed in analyzing this construction for efficiency is similar to the one above. It should be noted, however, that some of the rivets here are in double shear.

From the sketch, Fig. 2, we obtain the following dimensions:

P = unit distance, that is, the shortest distance, measured along the drum, that will include a whole number of tubes and a whole number of rivets = 7 inches
d = diameter or rivet holes = 1 5/32 inches = 1.156 inches
a = cross-section area of rivets = 1.049 square inches
t = thickness of shell plate = 1⅜ inches = 1.375 inches
b = thickness of inside cover plate = 1½ inches = 1.50 inches
b_0 = thickness of outside cover plate = 1¼ inches = 1.25 inches
n = number of rivets per unit distance in outer row = 1
m = number of rivets per unit distance in second row = 2
N = total number of rivets per unit distance in double shear = 4

The strength of the solid plate is found as in the previous case.

$$A = (P \times t \times TS) = (7 \times 1.375 \times 55{,}000)$$
$$= 530{,}000 \text{ pounds}$$

As a possible mode of failure, let us again consider first failure along the outer row of rivets. The strength of the vessel at this line is

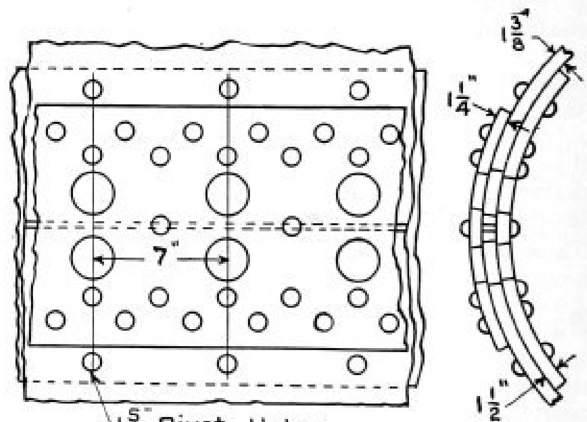


Fig. 2

$$B = [(P - d)\ t \times TS]$$
$$= [(7 - 1.156)\ 1.375 \times 55{,}000]$$
$$= 442{,}000 \text{ pounds}$$

Next consider failure along the second row of rivets. The strength here is

C = [strength of net section of plate between rivets in second row] + [shearing strength of rivets in outer row]
$= [(P - md)\ t \times TS] + [n \times a \times s]$
$= [(7 - 2 \times 1.156)\ 1.375 \times 55{,}000] + [1 \times 1.049 \times 44{,}000]$
$= [354{,}500] + [46{,}200]$
$= 400{,}700$ pounds.

or D = [strength of net section of plate between rivets in second row] + [crushing strength of shell or strap (whichever is thinner) in front of rivets in outer row]
$= [(P - md)\ t \times TS] + [n \times d \times t \times c]$

$= [(7 - 2 \times 1.156)\ 1.375 \times 55{,}000] + [1 \times 1.156 \times 1.375 \times 95{,}000]$
$= [354{,}500] + [151{,}000]$
$= 505{,}500$ pounds.

As explained previously, failure along the third row is very unlikely as the strength of the vessel here would be that of C or D above plus the additional strength due to the extra (second) row of rivets.

The next mode of failure considered is by separation of the seam where the two edges of the shell meet. Tearing between the tubes is not considered because there is nothing holding the portion of the shell which projects beyond the tubes. The single row of rivets down the middle of the seam is placed there merely to tie the three thicknesses of

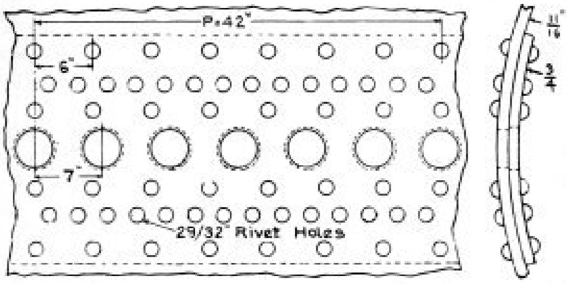


Fig. 3

plate together and prevent buckling because of the wide space between the two inner rows of rivets. It should furthermore be noted that no allowance will be made for any strengthening effect due to the tubes, as a safe value for the resistance of the tubes against crumpling would be very small. Considering separation at the seam, the strength would be

$E =$ [shearing strength of all rivets]
$= (N \times a \times S) + (n \times a \times s)$
$= (4 \times 1.049 \times 88{,}000) + (1 \times 1.049 \times 44{,}000)$
$= (369{,}000) + (46{,}200)$
$= 415{,}200$ pounds.

$F =$ [crushing strength of plate in front of all rivets]
$=$ (total rivets $\times d \times t \times c$)
$= (5 \times 1.156 \times 1.375 \times 95{,}000)$
$= 755{,}000$ pounds.

$G =$ [crushing strength of plate in front of rivets of inner and second rows] + [shear of rivets in outer row]
$= (N \times d \times t \times c) + (n \times a \times s)$
$= (4 \times 1.156 \times 1.375 \times 95{,}000) + (1 \times 1.049 \times 44{,}000)$
$= (604{,}000) + (46{,}200)$
$= 650{,}200$ pounds.

or $H =$ [strength of net section of both inner and outer straps at second row of rivets] + [shearing strength of 2 rivets, in double shear, in inner row]
$= [(P - md)\ (b + b_0) \times TS] + [N \times a \times S]$
$= [(7 - 2 \times 1.156)\ (1.50 + 1.25) \times 55{,}000] + [2 \times 1.049 \times 88{,}000]$
$= [710{,}000] + [184{,}600]$
$= 894{,}600$ pounds.

A comparison of the results shows C to be the lowest. Therefore the efficiency of the construction shown in Fig. 2 is

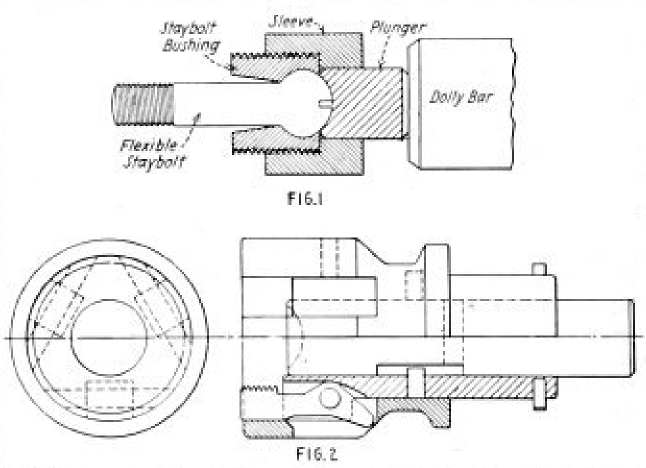
$$\frac{C}{A} = \frac{400{,}700}{530{,}000} = 75.6 \text{ percent.}$$

A slight variation of the problem is presented by the construction shown in Fig. 3. This is similar to Fig. 1, but it will be noted that the pitch of the tubes is 7 inches and the maximum pitch of the rivets is 6 inches. In order to obtain a value for P, a distance that will contain a whole number of tubes and a whole number of rivets, it will be necessary to find the least common multiple of 7 inches and 6 inches, or 42 inches. With this value of P and the proper corresponding values for the other letters in our formulae, the efficiency of this joint should be approximately 82 percent.

Holding on Flexible Staybolts

It has long been known that the old method of holding on flexible staybolts for driving was slow and inefficient. A number of devices have been developed with a view to eliminating some of the drawbacks. Many of these have been found exceedingly helpful and in the list can be included the one described below which was developed at the Boston and Maine shops, Billerica, Mass. In the old method, as shown in Fig. 1, it is necessary to screw on the bushing sleeve for directing the plunger and for holding it in place. After the driving operation, time is required to remove it and fit it to another bushing. In driving a complete installation of bolts a great deal of valuable time is thus wasted in an operation that might be eliminated.

In the case of the new holder-on, as shown in Fig. 2, the operation can be done instantly. The opening sleeve which slides on the body of the device, when drawn back moves the cams actuating the 3 threaded gripping dogs and allows the holder-on to be easily slipped into place on the bushing. When the sleeve is moved back to its normal position these dogs grip the bushing threads securely and the operation can go forward. The plunger, which also moves in the body of the tool, is backed up by the dolly bar exactly as in the case of the old type holder-on.



Old and new type holder-on

To remove the device from the bushing after the driving operation is completed, it is only necessary to draw back on the control sleeve and the grips are instantly released. The device can of course be made of any practicable size—the one shown in Fig. 2 being designed to fit 1¾-inch bushings having 12 threads per inch.

Would Abandon Present Boiler Inspection Department.—Representative Weinbroer, in the house of representatives, Colorado state legislature, has submitted a Bill No. 455, wherein it is provided that a state department of labor be created, the new department to replace the present minimum wage commission, plumbing inspector and boiler inspector.

Laying Out Locomotive Boilers—II*

In this issue the development of the backhead and roof sheet of a boiler are discussed

By W. E. Joynes†

THE next part to lay out is the backhead. Referring to the boiler, measure up 4½ inches from the bottom of the firebox ring (back end), and draw in the 12-inch backhead bend radius, also the 12-inch + ⅜-inch (sheet thickness); firebox backsheet bend radius = 12⅜ inches. Above the center line measure 34⅝ inches dimension, (*c*), draw in a light line. All lines should be light and full; none are to be dotted on the diagram as shown in Fig. 3, which was done to make the drawing clear, but which is not practical nor necessary. Measure ahead on this line 18¾ inches, then with a large triangle or a straight edge draw in the inside edge of the backhead plate, tangent with the 12-inch radius at the bottom. Draw a line for the thickness of the backhead flange at the top and carefully scribe in the backhead corner radius, 3 inches. The tangent point of this radius is to be used later on for a scale dimension in connection with the backhead development.

Roof Sheet

The front developing line of the roof sheet is taken 1 inch back of the roof and ring seam and the front developing line of the crown sheet is the front edge of the sheet itself. These are the two lines wanted next and are found and laid-in as follows: Length of firebox ring 98 inches + 5 inches slope of throat sheet, equals 103 inches — (3 inches + 4¾ inches seam + 1 inch) equals 94¼ inches from the back of firebox ring to the roof front developing line. The crown and side sheet developing line is 103 inches — (5 inches + 1½ inches) = 96½ inches from the back of firebox ring. These developing lines must be measured, top and bottom, from the back of the firebox ring vertical line, and laid-in to extend a little below the firebox ring and above the top of the boiler and the crown sheet top. The back developing line of the crown and of the roof is taken at the back edge of the sheet, at the intersection of the top of the backhead flange and the inside edge of the sheet, for the roof. The crown sheet is taken in the same way, with reference to the firebox back sheet flange and the crown sheet.

Dimension, (*d*), 21 13/16 inches, locating the roof, back developing line is found by using the boiler dimension 23 3/16 inches minus half the width of the backhead seam 1⅜ inches. The crown back developing line is found by first laying-in the firebox back sheet. To do this, draw a light line (at top) 5½ inches parallel to the backhead and scribe in the 2 inches radius plus thickness of sheet, ⅜ inch = 2⅜ inches radius, the radius to strike tangent with the 12¼ inches, (*f*), and the 5½-inch dimensions. Draw in the thickness of the firebox back sheet ⅜ inch connecting the lines tangent with the radii above the firebox ring and the 2⅜ inch and 2 inch radii at the top. Now lay in the flange of the back tube sheet 15½ inches above the center line of boiler and 32 inches below the center line, dimensions, (*g*), and (*h*). Draw the inside line of the thickness of the top of the crown sheet tangent with the top flange radii. Lay in the width of the back sheet flange 4½ inches parallel with the back of the sheet; seam, 2 inches and the rivet center line 1 inch. Erect a short vertical line representing the center of the top crown rivet, to intersect the top of the flange and underside of crown sheet. Now scale from the back of firebox ring a vertical line to the vertical rivet center line which should be 22⅝ inches (see boiler) or nearer to 22⅝ inches than to 22 9/16 inches. If the scale shows a line which is not exactly on a 1/16-inch or ⅛-inch division, etc., use the nearest dimension. Omit thirty-seconds (1/32 inch) in all cases when determining a boiler or plate dimension; thirty-seconds are to be used only in totaling a dimension when the plate thickness is in thirty-seconds.

From the 22⅝ inches subtract half the width (1 inch) of the seam, which gives 21⅝ inches, dimension, (*e*), the location of the back developing line of the crown.

Laying Out Last Course

Now lay in the last course or ring of the boiler. The outside diameter according to the boiler card, Fig. 1, is 72 inches. The center line of this ring is not the same as the boiler center line due to the fact that the ring ahead of this one is an irregular cone which gives it an off-set of 1 15/32 inches. The throat sheet has a 5-inch offset ahead of the front edge of the firebox ring and the front edge of the roof to ring seam is 3 inches back of this set. The width, 4¾ inches, of the seam added should check 1 inch ahead of the roof front developing line. Lay-in the sloped part of the throat sheet and part of the seam connecting the throat to the boiler ring course, also the sloped part of the back tube sheet and continue laying-in the seam below the throat sheet bend dimension (*h*). If this throat sheet did not have two bends or sets above the firebox ring instead of one (one bend is the

TABLE 1

Example: To find Circumference of Circle, 71 9/16" Diam.
Circum. of 71" Circle = 223.05
Circum. of 9/16" Circle = 1.767
Total Circum. of 71 9/16" Circle = 224.817

Dec. Equiv.	Diam.	Circum.	Diam.	Circum.	Diam.	Circum.	Diam.	Circum.	Diam.	Circum.
.03125	1/32	.098	1	3.14159	31	97.39	61	191.64	91	285.88
.0625	1/16	.196	2	6.28	32	100.53	62	194.78	92	289.03
.09375	3/32	.294	3	9.42	33	103.67	63	197.92	93	292.17
.125	1/8	.393	4	12.56	34	106.81	64	201.06	94	295.31
.15625	5/32	.491	5	15.71	35	109.96	65	204.20	95	298.45
.1875	3/16	.589	6	18.85	36	113.10	66	207.34	96	301.59
.21875	7/32	.687	7	21.99	37	116.24	67	210.49	97	304.73
.25	1/4	.785	8	25.13	38	119.38	68	213.63	98	307.88
.28125	9/32	.884	9	28.27	39	122.52	69	216.77	99	311.02
.3125	5/16	.982	10	31.42	40	125.66	70	219.91	100	314.16
.34375	11/32	1.080	11	34.56	41	128.81	71	223.05	101	317.30
.375	3/8	1.178	12	37.70	42	131.95	72	226.19	102	320.44
.40625	13/32	1.276	13	40.84	43	135.09	73	229.34	103	323.58
.4375	7/16	1.374	14	43.98	44	138.23	74	232.48	104	326.73
.46875	15/32	1.473	15	47.12	45	141.37	75	235.62	105	329.87
.5	1/2	1.571	16	50.27	46	144.51	76	238.76	106	333.01
.53125	17/32	1.670	17	53.41	47	147.66	77	241.90	107	336.15
.5625	9/16	1.767	18	56.55	48	150.80	78	245.04	108	339.29
.59375	19/32	1.865	19	59.69	49	153.94	79	248.19	109	342.43
.625	5/8	1.964	20	62.83	50	157.08	80	251.33	110	345.58
.65625	21/32	2.062	21	65.97	51	160.22	81	254.47	111	348.72
.6875	11/16	2.160	22	69.12	52	163.36	82	257.61	112	351.86
.71875	23/32	2.258	23	72.26	53	166.50	83	260.75	113	355.00
.75	3/4	2.356	24	75.40	54	169.65	84	263.89	114	358.14
.78125	25/32	2.454	25	78.54	55	172.79	85	267.04	115	361.28
.8125	13/16	2.553	26	81.68	56	175.93	86	270.18	116	364.42
.84375	27/32	2.651	27	84.82	57	179.07	87	273.32	117	367.57
.875	7/8	2.749	28	87.96	58	182.21	88	276.46	118	370.71
.90625	29/32	2.847	29	91.11	59	185.35	89	279.60	119	373.85
.9375	15/16	2.945	30	94.25	60	188.50	90	282.74	120	376.99
.96875	31/32	3.043								

*The first installment of this series appeared on page 1 of the January issue.

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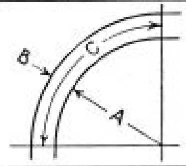
Table 2 - Quarter Circumference "C"

Thickness of Plate "B"

A	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	11/16"	3/4"	13/16"	7/8"	15/16"	1"	1 1/16"	1 1/8"	1 3/16"	A
3/8"	13/16"	7/8"	7/8"	15/16"	1"	1 1/16"	1 1/16"	1 1/8"	1 3/16"								3/8"
1/2"	1"	1 1/16"	1 1/16"	1 1/8"	1 3/16"	1 1/4"	1 5/16"	1 5/16"	1 3/8"								1/2"
5/8"	1 3/16"	1 1/4"	1 5/16"	1 5/16"	1 3/8"	1 7/16"	1 1/2"	1 1/2"	1 9/16"								5/8"
3/4"	1 3/8"	1 7/16"	1 1/2"	1 1/2"	1 9/16"	1 5/8"	1 11/16"	1 3/4"	1 3/4"								3/4"
7/8"	1 9/16"	1 5/8"	1 11/16"	1 3/4"	1 3/4"	1 13/16"	1 7/8"	1 15/16"	2"	2"	2 1/16"	2 1/8"	2 3/16"	2 1/4"	2 1/4"	2 5/16"	7/8"
15/16"	1 11/16"	1 3/4"	1 3/4"	1 13/16"	1 7/8"	1 15/16"	2"	2"	2 1/16"	2 1/8"	2 3/16"	2 1/4"	2 1/4"	2 5/16"	2 3/8"	2 7/16"	15/16"
1"	1 3/4"	1 13/16"	1 7/8"	1 15/16"	2"	2"	2 1/16"	2 1/8"	2 3/16"	2 1/4"	2 1/4"	2 5/16"	2 3/8"	2 7/16"	2 1/2"	2 1/2"	1"
1 1/16"	1 7/8"	1 15/16"	2"	2"	2 1/16"	2 1/8"	2 3/16"	2 1/4"	2 1/4"	2 5/16"	2 3/8"	2 7/16"	2 1/2"	2 1/2"	2 9/16"	2 5/8"	1 1/16"
1 1/8"	2"	2"	2 1/16"	2 1/8"	2 3/16"	2 1/4"	2 1/4"	2 5/16"	2 3/8"	2 7/16"	2 1/2"	2 1/2"	2 9/16"	2 5/8"	2 5/8"	2 11/16"	1 1/8"
1 3/16"	2 1/16"	2 1/8"	2 3/16"	2 1/4"	2 1/4"	2 5/16"	2 3/8"	2 7/16"	2 1/2"	2 1/2"	2 9/16"	2 5/8"	2 5/8"	2 11/16"	2 3/4"	2 13/16"	1 3/16"
1 1/4"	2 3/16"	2 1/4"	2 1/4"	2 5/16"	2 3/8"	2 7/16"	2 1/2"	2 1/2"	2 9/16"	2 5/8"	2 5/8"	2 11/16"	2 3/4"	2 13/16"	2 7/8"	2 7/8"	1 1/4"
1 3/8"	2 3/8"	2 7/16"	2 1/2"	2 1/2"	2 9/16"	2 5/8"	2 5/8"	2 11/16"	2 3/4"	2 13/16"	2 7/8"	2 7/8"	2 15/16"	3"	3 1/16"	3 1/8"	1 3/8"
1 1/2"	2 9/16"	2 5/8"	2 5/8"	2 11/16"	2 3/4"	2 13/16"	2 7/8"	2 7/8"	2 15/16"	3"	3 1/16"	3 1/8"	3 1/8"	3 3/16"	3 1/4"	3 5/16"	1 1/2"
1 5/8"	2 3/4"	2 13/16"	2 7/8"	2 7/8"	2 15/16"	3"	3 1/16"	3 1/8"	3 1/8"	3 3/16"	3 1/4"	3 5/16"	3 5/16"	3 3/8"	3 7/16"	3 1/2"	1 5/8"
1 7/8"	3 1/8"	3 3/16"	3 1/4"	3 5/16"	3 5/16"	3 3/8"	3 7/16"	3 1/2"	3 9/16"	3 9/16"	3 5/8"	3 11/16"	3 3/4"	3 3/4"	3 13/16"	3 7/8"	1 7/8"
1 15/16"	3 1/4"	3 5/16"	3 5/16"	3 3/8"	3 7/16"	3 1/2	3 9/16"	3 9/16"	3 5/8"	3 11/16"	3 3/4"	3 3/4"	3 13/16"	3 7/8"	3 15/16"	4"	1 15/16"
2"	3 5/16"	3 3/8"	3 7/16"	3 1/2"	3 9/16"	3 9/16"	3 5/8"	3 11/16"	3 3/4"	3 3/4"	3 13/16"	3 7/8"	3 15/16"	4"	4"	4 1/16"	2"
2 1/16"	3 7/16"	3 1/2"	3 9/16"	3 9/16"	3 5/8"	3 11/16"	3 3/4"	3 3/4"	3 13/16"	3 7/8"	3 15/16"	4"	4"	4 1/16"	4 1/8"	4 3/16"	2 1/16"
2 1/8"	3 9/16"	3 9/16"	3 5/8"	3 11/16"	3 3/4"	3 3/4"	3 13/16"	3 7/8"	3 15/16"	4"	4"	4 1/16"	4 1/8"	4 3/16"	4 1/4"	4 5/16"	2 1/8"
2 3/16"	3 5/8"	3 11/16"	3 3/4"	3 3/4"	3 13/16"	3 7/8"	3 15/16	4"	4"	4 1/16"	4 1/8"	4 3/16"	4 1/4"	4 5/16"	4 5/16"	4 3/8"	2 3/16"
2 1/4"	3 3/4"	3 3/4"	3 13/16"	3 7/8"	3 15/16"	4"	4"	4 1/16"	4 1/8"	4 3/16"	4 1/4"	4 5/16"	4 5/16"	4 3/8"	4 7/16"	4 1/2"	2 1/4"
2 3/8"	3 15/16"	4"	4"	4 1/16"	4 1/8"	4 3/16"	4 1/4"	4 5/16"	4 5/16"	4 3/8"	4 7/16"	4 1/2"	4 1/2"	4 9/16"	4 5/8"	4 11/16"	2 3/8"
2 1/2"	4 1/8"	4 3/16"	4 1/4"	4 5/16"	4 5/16"	4 3/8"	4 7/16"	4 1/2"	4 1/2"	4 9/16"	4 5/8"	4 11/16"	4 3/4"	4 3/4	4 13/16"	4 7/8"	2 1/2"
2 5/8"	4 5/16"	4 3/8"	4 7/16"	4 1/2"	4 1/2"	4 9/16"	4 5/8"	4 11/16"	4 3/4"	4 3/4"	4 13/16"	4 7/8"	4 15/16"	4 15/16"	5"	5 1/16"	2 5/8"
3"	4 15/16"	4 15/16"	5"	5 1/16"	5 1/8"	5 3/16"	5 1/4"	5 1/4"	5 5/16"	5 3/8"	5 7/16"	5 7/16"	5 1/2"	5 9/16"	5 5/8"	5 5/8"	3"
3 1/8"	5 1/8"	5 3/16"	5 1/4"	5 1/4"	5 5/16"	5 3/8"	5 7/16"	5 7/16"	5 1/2"	5 9/16"	5 5/8"	5 5/8"	5 11/16"	5 3/4"	5 13/16"	5 7/8"	3 1/8"
3 1/2"	5 11/16"	5 3/4"	5 13/16"	5 7/8"	5 7/8"	5 15/16"	6"	6 1/16"	6 1/16"	6 1/8"	6 3/16"	6 1/4"	6 5/16"	6 5/16"	6 3/8"	6 7/16"	3 1/2"
3 5/8"	5 7/8"	5 15/16"	6"	6 1/16"	6 1/16"	6 1/8"	6 3/16"	6 1/4"	6 5/16"	6 5/16"	6 3/8"	6 7/16"	6 1/2"	6 1/2"	6 9/16"	6 5/8"	3 5/8"
4"	6 1/2"	6 1/2"	6 9/16"	6 5/8"	6 11/16"	6 3/4"	6 13/16"	6 13/16"	6 7/8"	6 15/16"	7"	7"	7 1/16"	7 1/8"	7 3/16"	7 1/4"	4"
4 1/2"	7 1/4"	7 5/16"	7 3/8"	7 7/16"	7 1/2"	7 1/2"	7 9/16"	7 5/8"	7 11/16"	7 3/4"	7 3/4"	7 13/16"	7 7/8"	7 15/16"	7 15/16"	8"	4 1/2"
5"	8 1/16"	8 1/8"	8 3/16"	8 3/16"	8 1/4"	8 5/16"	8 3/8"	8 7/16"	8 1/2"	8 1/2"	8 9/16"	8 5/8"	8 5/8"	8 11/16"	8 3/4"	8 13/16"	5"
5 1/2"	8 13/16"	8 7/8"	8 15/16"	9"	9 1/16"	9 1/16"	9 1/8"	9 3/16"	9 1/4"	9 1/4"	9 5/16"	9 3/8"	9 7/16"	9 1/2"	9 1/2"	9 9/16"	5 1/2"
6"	9 5/8"	9 11/16"	9 3/4"	9 3/4"	9 13/16"	9 7/8"	9 15/16"	10"	10"	10 1/16"	10 1/8"	10 3/16"	10 1/4"	10 1/4"	10 5/16"	10 3/8"	6"
7"	11 3/16"	11 1/4"	11 5/16"	11 3/8"	11 3/8"	11 7/16"	11 1/2"	11 9/16"	11 5/8"	11 5/8"	11 11/16"	11 3/4"	11 13/16"	11 13/16"	11 7/8"	11 15/16"	7"
8"	12 3/4"	12 13/16"	12 7/8"	12 15/16"	12 15/16"	13"	13 1/16"	13 1/8"	13 3/16"	13 3/16"	13 1/4"	13 5/16"	13 3/8"	13 7/16"	13 7/16"	13 1/2"	8"
9"	14 5/16"	14 3/8"	14 7/16"	14 1/2"	14 1/2"	14 5/8"	14 5/8"	14 11/16"	14 3/4"	14 3/4"	14 13/16"	14 7/8"	14 15/16"	15"	15"	15 1/16"	9"
10"	15 15/16"	15 15/16"	16"	16 1/16"	16 1/8"	16 3/16"	16 3/16"	16 1/4"	16 5/16"	16 3/8"	16 3/8"	16 7/16"	16 1/2"	16 9/16"	16 9/16"	16 5/8"	10"
A	1/4"	5/16"	3/8"	7/16"	1/2"	9/16"	5/8"	11/16"	3/4"	13/16"	7/8"	15/16"	1"	1 1/16"	1 1/8"	1 3/16"	A

Thickness of Plate "B"



more typical design) the outside edge of the seam or roof sheet would be joined tangent with the bend radius at the top and the radius around the rivet at the bottom. The second bend in this throat is necessary to provide sufficient clearance for the spring over the driving wheel. The edge of the seam should be carried down 3 inches parallel with the throat sheet to this second bend and connected tangent with the radius at that point.

The under side of the roof sheet at the top is laid-in tangent with the backhead radius and connected in line with the outside of the boiler back ring at the developing line.

The crown sheet seam is brought down in the same way with reference to the back tube sheet. The flange of the tube sheet is carried around the first two, through the firebox-ring rivets with a 1⅛ inch radius, for the upper rivet and sometimes more or less for the lower rivet, in this case 1⅛ inch radius for both, which is good design—and connected tangent with the lower bend radius. The rivet line in the firebox seam is carried up from the center of the upper ring rivet to the bend radius and the outside edge of the seam is laid-in 1 inch ahead of the rivet line, so that the lower part of the seam is just above the firebox ring a little more than 2 inches wide. The back corner of the crown sheet is designed in the same way as the front corner, except that the break in the sheet begins 13 inches above the bottom of the firebox ring. This 13-inch dimension is found to be a convenient point from which to taper-off the corner radius of the flange at the ring, to the smaller ¾ inch radius at the 13-inch point.

The upper part of this firebox back or door sheet also has a tapering flange radius. The point of the taper at the top is at the tangent point of the crown radius, 72 3/16 inches and the corner radius, 12 3/16 inches. The bottom part of the taper is the tangent part of the side line and the 12 3/16-inch radius, Fig. 4. These points are projected over (parallel with the boiler center line) to the back edge of the partial crown sheet lines that have already been made, which will give the extent of this tapered corner. Connect the two projected points with a straight line. Adding the width of the seam, 2 inches, between these two points will serve to make the diagram look complete, it being of no value in developing the crown or the back sheet. The lines of the sheets themselves, forming the firebox end of the boiler as shown in Figs. 3 and 4, are representative of what a diagram should be and to finish a diagram as shown, Figs. 3 and 4, with the principal dimensions added, will facilitate and check the work of developing these sheets.

Lay in the bottom staybolt line 7⅛ inches up from the bottom of the firebox ring and locate the extreme end staybolts according to the boiler card, 1⅛ inches from the edge of the firebox flange sheets. The scaled distance between these two staybolts is (to the nearest sixteenth) 78⅛ inches. Also, the distance between the first front firebox ring rivet and the front staybolt is found to scale 3 9/16 inches.

Lay in a light parallel line 8 inches up from the bottom of the firebox ring, extending from front to back as shown in Fig. 3. The side sheets are perpendicular to the firebox ring up to this 8-inch point and then bend to a 12-inch radius (inside of sheets) and connect with a straight line tangent to the top part of the crown sheet and roof sheet (see boiler cross section Fig. 2). Lay in the firehole from the boiler card, Fig. 1. This completes the longitudinal view of the diagram, Fig. 3.

The cross section of the diagram, Fig. 4, will now be laid out. The lines of the cross section, Fig. 4, representing the crown sheet and the roof sheet are taken at the front and back developing lines of Fig. 3. These lines are taken on the neutral axis or the middle of the thickness of the plate.

Dimensions (*f*) 12¼ inches + 3/16 inch (half the thickness of the crown sheet) = (C^2), or 12 7/16 inches, the distance from the center line of the boiler to the neutral line of the crown sheet at the vertical center line of the boiler at the back end. Dimension (*g*), 15½ inches + 3/16 inch is the required dimension at the front. Scribe-in the crown radii, 72 inches + 3/16 inch = 72 3/16 inches (*l*). By referring to the boiler cross-section, Fig. 2, dimension (*j*), 18 inches, will be found which locates the crown corner radius, 12 inches + 3/16 inch (half thickness of crown sheet) = 12 3/16 inches or (*k*).

Measure down 12 3/16 inches radially from the front and back crown line and using the crown radius points as centers, scribe two light short lines intersecting the 18-inch (*j*) vertical line. These intersection points are the centers for the (*k*) 12 3/16 inches corner radii and will swing these corner radii to connect the crown radius exactly tangent.

The boiler cross-section, Fig. 2, shows 66¼ inches inside of the firebox crown side sheet + 3/16 (half thickness of the sheet is allowed at each side) ÷ 2 = 33 5/16 inches (*m*), from the vertical center line of the boiler to the neutral line of the side sheet. Width of firebox ring, 3 inches + half the thickness of the crown and roof side sheets, 3/16 inch + ¼ inch = 3 7/16 inches (*n*), the neutral line of the roof side sheet.

Now, in Fig. 3, half way between the crown and the roof front developing lines and intersecting the 8 inches side bend line, project to the section Fig. 4, the side bend line as shown, parallel with the boiler base line. This operation also applies to the back developing lines and the side bend line. In order to have these projected lines exactly correct, there would be two lines, one from each developing line, projected from the front and two from the back for the crown and roof respectively. This only complicates the work as the small difference it would make in the side bend point, would not appreciably alter the side sheet lengths. Therefore, to facilitate the work, this projected point is taken half way between the developing lines.

Scribe in the side bend line radii, 12 inches + 3/16 inch for the crown and 12 inches + ¼ inch for the roof, equal to (*r*), 12 3/16 inches and (r^1), 12¼ inches, respectively, front and back. These radii are to center on the projected bend lines as shown and connect the straight side line tangent with radius (*r*), and the crown corner radius(*k*), front and back.

The roof or extreme upper half of the section is yet to be laid-in. By referring to the boiler cross-section again, this is found to be semi-circular in shape with 36 inches radius to the underside or water side of the sheet. Dimension (*c*), 34⅝ inches, is smaller than the backhead radius, 36 inches, therefore, the center point of this radius will be 36 inches — 34⅝ inches = 1⅜ inches (*q*) below the center line of boiler. The neutral radius equals 36 inches + ¼ inch (half thickness of the roof sheet) = 36¼ inches radius (s^1), the front radius (*s*) of the roof is also 36¼ inches (front and back radii for projection work must be equal), and its center, the center of the boiler ring or the back course, is 1 15/32 inches dimension (*p*)) above the boiler center line. The back ring is 72 inches in outside diameter. Draw-in the straight side line tangent with the roof radii (*s*), (s^1) and the side bend radii (r^1), front and back.

This completes the outline of both views of the diagram, namely, the longitudinal section, Fig. 3, and the cross section, Fig. 4, but, the cross-sectional lengths of the crown-and-sides and roof-and-side sheets are yet to be found, also other points and lines necessary in the development of these sheets are to be laid-in.

Crown Sheet Widths

The widths of the crown sheet from the vertical boiler center line to the boiler center line, front and back and indicated by symbols 1 to 2 and 4 to 5, will now be determined.

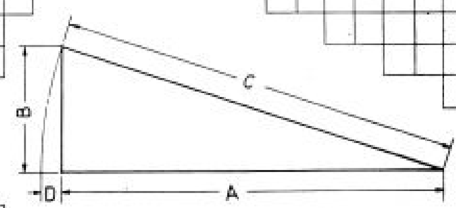
Extend above the boiler center a light straight line tangent with the corner radius at the boiler center line or tangent with the side line as the case may be at this point. Set a

TABLE 3—PROPORTIONS OF TRIANGLES

VALUES OF "B" / VALUES OF "D"

A	3	3½	4	4½	5	5½	6	6½	7	7½	8	8½	9	9½	10	10½	11	11½	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
40	.111	.151	.196	.25	.309	.375	.45	.522	.615	.695	.79	.89	1.00	1.12	1.25	1.36	1.50	1.63																								
42	.106	.144	.188	.236	.294	.355	.42	.50	.58	.661	.75	.85	.95	1.06	1.18	1.29	1.42	1.55	1.70																							
44	.101	.136	.180	.226	.281	.34	.40	.47	.55	.631	.72	.81	.91	1.01	1.12	1.24	1.36	1.46	1.62																							
46	.097	.132	.172	.216	.269	.325	.39	.45	.53	.605	.69	.78	.875	.97	1.08	1.18	1.30	1.42	1.55	1.82																						
48	.093	.126	.165	.209	.257	.312	.37	.44	.51	.58	.66	.75	.84	.93	1.03	1.13	1.25	1.36	1.48	1.74																						
50	.089	.121	.158	.201	.247	.30	.36	.42	.49	.56	.64	.72	.80	.89	.99	1.09	1.20	1.31	1.43	1.67																						
52	.086	.117	.152	.193	.238	.29	.34	.40	.47	.53	.61	.69	.77	.86	.95	1.05	1.15	1.26	1.37	1.61	1.87																					
54	.083	.112	.147	.186	.23	.28	.33	.39	.45	.52	.59	.66	.74	.83	.92	1.00	1.11	1.21	1.32	1.55	1.80																					
56	.08	.108	.142	.179	.221	.27	.32	.37	.43	.50	.57	.64	.72	.80	.89	.98	1.07	1.17	1.27	1.49	1.73	1.99																				
58	.077	.105	.137	.173	.214	.26	.31	.36	.42	.48	.55	.62	.69	.77	.86	.94	1.04	1.13	1.23	1.44	1.67	1.92																				
60	.075	.101	.132	.168	.206	.25	.30	.35	.41	.46	.53	.60	.67	.75	.83	.91	1.00	1.09	1.19	1.40	1.62	1.86	2.11																			
62	.072	.098	.128	.162	.20	.24	.29	.34	.39	.45	.51	.58	.65	.72	.80	.88	.97	1.06	1.15	1.35	1.57	1.80	2.05																			
64	.07	.095	.124	.157	.194	.23	.28	.33	.38	.43	.50	.56	.62	.70	.78	.85	.94	1.02	1.12	1.31	1.52	1.75	1.97																			
66	.068	.092	.120	.152	.188	.23	.27	.32	.37	.42	.48	.54	.61	.68	.75	.82	.91	.99	1.08	1.27	1.47	1.69	1.93	2.20																		
68	.066	.089	.117	.148	.182	.22	.26	.31	.36	.41	.47	.53	.59	.66	.73	.80	.89	.96	1.05	1.23	1.43	1.64	1.87	2.11	2.37																	
70	.064	.087	.113	.144	.177	.22	.25	.30	.35	.40	.45	.51	.57	.64	.71	.78	.86	.94	1.02	1.20	1.39	1.60	1.82	2.05	2.30																	
73	.061	.083	.109	.138	.17	.21	.24	.29	.33	.38	.44	.49	.55	.61	.68	.75	.83	.90	.98	1.15	1.33	1.53	1.74	1.97	2.20	2.45																
76	.059	.08	.104	.132	.163	.20	.23	.28	.32	.37	.42	.47	.53	.59	.66	.72	.79	.87	.94	1.10	1.28	1.47	1.67	1.89	2.12	2.36																
79	.057	.077	.101	.127	.157	.19	.23	.27	.31	.35	.40	.45	.51	.57	.63	.69	.76	.83	.91	1.06	1.23	1.41	1.61	1.82	2.04	2.27	2.52															
82	.055	.074	.097	.123	.151	.18	.22	.26	.30	.34	.39	.44	.49	.55	.61	.67	.73	.80	.87	1.03	1.19	1.36	1.55	1.75	1.97	2.19	2.42															
85	.053	.072	.093	.118	.146	.18	.21	.25	.29	.33	.37	.42	.47	.53	.59	.65	.71	.77	.84	.99	1.15	1.32	1.50	1.69	1.90	2.11	2.34	2.56														
88	.051	.069	.090	.114	.141	.17	.20	.24	.28	.32	.36	.41	.46	.51	.57	.62	.69	.75	.82	.96	1.11	1.27	1.45	1.63	1.83	2.04	2.26	2.49														
91	.049	.067	.087	.111	.136	.16	.20	.23	.27	.31	.35	.40	.44	.49	.55	.60	.66	.72	.79	.93	1.07	1.23	1.40	1.58	1.77	1.97	2.19	2.41	2.65													
94	.048	.065	.084	.107	.132	.16	.19	.22	.26	.30	.34	.38	.43	.48	.53	.58	.64	.70	.76	.90	1.04	1.19	1.35	1.53	1.72	1.91	2.12	2.33	2.56													
97	.046	.063	.082	.104	.128	.15	.18	.22	.25	.29	.33	.37	.42	.46	.52	.56	.62	.68	.74	.87	1.00	1.15	1.31	1.48	1.66	1.85	2.05	2.26	2.48	2.71												
100	.045	.061	.079	.101	.124	.15	.18	.21	.24	.28	.32	.36	.40	.45	.50	.55	.60	.66	.72	.84	.98	1.12	1.27	1.44	1.61	1.80	1.99	2.18	2.41	2.63												
103	.044	.059	.077	.098	.121	.15	.17	.20	.24	.27	.31	.35	.39	.43	.49	.53	.59	.64	.69	.82	.95	1.08	1.23	1.40	1.56	1.74	1.93	2.12	2.34	2.56	2.78											
106	.042	.057	.075	.095	.117	.14	.17	.20	.23	.26	.30	.34	.38	.42	.47	.52	.57	.62	.68	.79	.92	1.06	1.20	1.35	1.52	1.70	1.88	2.06	2.27	2.49	2.70											
109	.041	.056	.073	.092	.114	.14	.16	.19	.22	.25	.29	.33	.37	.41	.46	.50	.55	.60	.66	.77	.90	1.03	1.17	1.32	1.48	1.65	1.83	2.01	2.21	2.41	2.63	2.85										
112	.04	.054	.071	.090	.111	.13	.16	.19	.22	.25	.28	.32	.36	.40	.45	.49	.54	.59	.64	.75	.87	1.00	1.14	1.28	1.44	1.60	1.78	1.96	2.15	2.35	2.56	2.77										
115	.039	.053	.069	.088	.107	.13	.16	.18	.21	.24	.28	.31	.35	.39	.43	.48	.52	.57	.63	.73	.85	.97	1.11	1.25	1.40	1.56	1.73	1.91	2.09	2.29	2.50	2.71	2.93									
118	.038	.052	.067	.085	.105	.13	.15	.18	.21	.24	.27	.30	.34	.38	.42	.47	.51	.56	.61	.71	.83	.95	1.08	1.22	1.37	1.52	1.69	1.86	2.04	2.23	2.43	2.64	2.85									
121	.037	.050	.066	.083	.103	.12	.15	.17	.20	.23	.26	.30	.33	.37	.41	.45	.50	.54	.59	.70	.81	.93	1.05	1.19	1.33	1.49	1.65	1.81	1.99	2.18	2.37	2.57	2.78	3.00								
124	.036	.049	.064	.081	.100	.12	.14	.17	.20	.23	.26	.29	.33	.36	.40	.44	.49	.53	.58	.68	.79	.90	1.03	1.16	1.30	1.45	1.61	1.77	1.94	2.13	2.31	2.51	2.71	2.93								
127	.035	.048	.063	.079	.097	.12	.14	.16	.19	.22	.25	.28	.32	.35	.39	.43	.48	.52	.56	.67	.77	.88	1.00	1.13	1.27	1.42	1.57	1.73	1.90	2.07	2.26	2.45	2.65	2.86	3.07							
130	.035	.047	.061	.078	.096	.12	.14	.16	.19	.22	.25	.28	.31	.35	.38	.42	.46	.51	.55	.65	.75	.86	.98	1.11	1.24	1.38	1.53	1.69	1.86	2.03	2.21	2.39	2.59	2.79	3.00							
133	.034	.046	.060	.076	.094	.11	.14	.16	.18	.21	.24	.27	.30	.34	.37	.41	.45	.49	.54	.63	.73	.84	.96	1.08	1.21	1.35	1.50	1.65	1.81	1.98	2.16	2.34	2.53	2.73	2.94	3.15						
136	.033	.045	.059	.074	.092	.11	.13	.15	.18	.21	.23	.26	.30	.33	.37	.40	.44	.48	.53	.62	.72	.82	.94	1.06	1.19	1.32	1.46	1.62	1.77	1.94	2.11	2.29	2.47	2.67	2.87	3.08						
139	.032	.044	.057	.073	.090	.11	.13	.15	.18	.20	.23	.26	.29	.32	.36	.39	.43	.47	.52	.60	.70	.81	.92	1.03	1.16	1.29	1.43	1.58	1.74	1.90	2.06	2.24	2.42	2.61	2.81	3.02	3.23					
142	.032	.043	.056	.071	.088	.11	.13	.15	.17	.20	.22	.25	.28	.32	.35	.39	.43	.46	.50	.59	.69	.79	.90	1.01	1.13	1.27	1.40	1.55	1.70	1.86	2.02	2.19	2.37	2.56	2.75	2.95	3.15					
146	.031	.042	.054	.069	.085	.10	.12	.14	.17	.19	.22	.25	.28	.31	.34	.38	.41	.45	.49	.58	.67	.77	.88	.99	1.10	1.23	1.36	1.51	1.65	1.81	1.96	2.13	2.31	2.49	2.67	2.87	3.07	3.28				
150	.030	.041	.053	.067	.083	.10	.12	.14	.16	.19	.21	.24	.27	.30	.33	.37	.40	.44	.48	.56	.65	.75	.85	.96	1.07	1.20	1.33	1.47	1.61	1.76	1.91	2.08	2.24	2.42	2.60	2.79	2.99	3.19				
154	.029	.040	.052	.065	.081	.097	.12	.14	.16	.18	.21	.23	.26	.29	.32	.36	.39	.43	.47	.55	.63	.73	.83	.93	1.05	1.17	1.29	1.43	1.56	1.71	1.86	2.02	2.18	2.36	2.53	2.72	2.91	3.11	3.32			
158	.028	.039	.050	.064	.079	.095	.11	.13	.16	.18	.20	.23	.26	.28	.32	.35	.38	.42	.45	.53	.62	.71	.81	.91	1.02	1.14	1.26	1.39	1.53	1.67	1.82	1.97	2.13	2.30	2.47	2.65	2.84	3.03	3.23			
162	.028	.038	.049	.062	.077	.093	.11	.13	.15	.17	.20	.22	.25	.28	.31	.34	.37	.41	.44	.52	.60	.69	.79	.89	1.00	1.11	1.23	1.35	1.49	1.63	1.77	1.92	2.08	2.24	2.41	2.58	2.77	2.96	3.15	3.35		
166	.027	.037	.048	.060	.075	.091	.11	.13	.15	.17	.19	.22	.24	.27	.30	.33	.36	.40	.43	.51	.59	.68	.77	.87	.97	1.08	1.20	1.32	1.45	1.59	1.73	1.88	2.03	2.19	2.35	2.53	2.71	2.89	3.08	3.27		
170	.026	.036	.047	.059	.073	.089	.11	.12	.14	.16	.19	.21	.24	.26	.29	.32	.36	.39	.42	.49	.57	.66	.75	.85	.95	1.06	1.17	1.29	1.42	1.55	1.69	1.83	1.98	2.14	2.30	2.47	2.64	2.82	3.00	3.19	3.39	
174	.026	.035	.046	.058	.072	.087	.10	.12	.14	.16	.18	.21	.23	.26	.29	.32	.35	.38	.41	.48	.56	.65	.73	.83	.93	1.03	1.14	1.27	1.39	1.52	1.65	1.79	1.94	2.09	2.24	2.41	2.58	2.75	2.95	3.12	3.32	3.51
178	.025	.035	.045	.057	.070	.085	.10	.12	.14	.16	.18	.20	.23	.25	.28	.31	.34	.37	.40	.47	.55	.63	.72	.81	.91	1.01	1.12	1.25	1.36	1.48	1.61	1.75	1.89	2.04	2.19	2.36	2.52	2.69	2.87	3.05	3.24	3.43
182	.024	.034	.044	.055	.068	.083	.10	.12	.13	.15	.18	.20	.22	.25	.28	.30	.33	.36	.40	.46	.54	.62	.70	.79	.89	.99	1.09	1.21	1.33	1.45	1.58	1.71	1.85	2.00	2.15	2.31	2.47	2.65	2.81	2.98	3.17	3.35
186	.024	.033	.043	.054	.067	.081	.10	.11	.13	.15	.17	.19	.22	.24	.27	.29	.33	.35	.39	.45	.53	.60	.69	.78	.87	.97	1.07	1.19	1.30	1.42	1.54	1.67	1.81	1.95	2.10	2.26	2.41	2.58	2.75	2.92	3.10	3.29
190	.024	.032	.042	.053	.066	.079	.09	.11	.13	.15	.17	.19	.21	.24	.26	.29	.32	.35	.38	.44	.51	.59	.67	.76	.85	.95	1.05	1.16	1.27	1.39	1.51	1.64	1.77	1.91	2.06	2.21	2.36	2.53	2.69	2.86	3.04	3.21
194	.023	.031	.041	.052	.064	.078	.09	.11	.13	.14	.16	.19	.21	.23	.26	.28	.31	.34	.37	.43	.50	.58	.66	.74	.83	.93	1.03	1.14	1.24	1.36	1.48	1.61	1.73	1.87	2.01	2.16	2.31	2.47	2.63	2.80	2.97	3.15
198	.023	.031	.040	.051	.063	.076	.09	.10	.12	.14	.16	.18	.20	.23	.25	.28	.30	.33	.36	.43	.49	.57	.65	.73	.82	.91	1.00	1.11	1.22	1.33	1.45	1.57	1.70	1.84	1.97	2.12	2.27	2.42	2.58	2.74	2.91	3.08
202	.022	.030	.039	.050	.062	.075	.09	.10	.12	.14	.16	.18	.20	.22	.25	.27	.30	.33	.36	.42	.48	.56	.63	.71	.80	.89	.99	1.09	1.19	1.30	1.42	1.54	1.67	1.80	1.94	2.08	2.22	2.38	2.55	2.69	2.86	3.02

VALUES OF "D" / VALUES OF "B"



$C = A + D$

$D = \frac{B^2}{2A+1}$ $\quad C = A + \frac{B^2}{2A+1}$

WITHIN LIMITS SHOWN.

small pair of dividers about 2½-inch space, 1½-inch scale. Prick-punch a very small hole intersecting the crown and center lines 1-2, 4-5. Start at the top, 1, and step-off carefully on the crown line, counting each step or space around to the tangent point of the extended line and the corner radius. Then, keeping the lower leg of the dividers on the paper, shift the upper leg to the extended line and step the same number of spaces up on the extended line. Scale the distance between this point and the side center line point, 2, which will be the length required, 1 to 2, or half the width of the crown sheet above the boiler center line. Check this length by starting at the side, 2, and stepping around to the center, 1, and out on a horizontal line, which is already shown and is to be used for another operation that will be explained when the crown sheet is developed. If this length is the same as the first length the work is correct and it is possible to proceed with finding the width of sheet at the back, 4 to 5.

The determining factor in setting the dividers for spacing-off is the size or the sharpness of the corner radius. The space should be small enough so that when the dividers are stepped around this radius the chord of the arc will amount practically to naught so far as the result of the dimension required is concerned and which should be scaled to the full or largest 1/16 inch even though it looks to be on the short side of the nearest 1/32 inch to the full sixteenth; or in other words, if the dimension should scale exactly on a sixteenth or other even dimension not smaller than a sixteenth, use that dimension. However, if it should scale even a very slight amount more than an even sixteenth do not use the shortest sixteenth, but use the next greater one which will compensate for any loss that might have been made by the chords in stepping around the sharp curve. Attention should also be called to the danger of making the space too small, as experience has taught that a space too small will give even more inaccurate results than one a little too large. Great care should be taken not to bear on the dividers nor step over the same line without slightly changing the set of the dividers, as each time the dividers are used very small pin holes are left in the paper and the divider points will fall on the edge of these holes, thereby pulling the divider into the center of the hole when the back leg is raised clear of the paper.

To give a rule for this space-set for the crown sheet, it may safely be said (depending upon the sharpness of the curve) the space should not be less than 2 inches nor more than 3 inches of the scale used. The lengths of all curved or irregular lines of the boiler are to be found by this stepping-off method, which will prove to be the most rapid as well as the most accurate method for drawing room work; quarter-circles, half-circles, etc., should be calculated.

Lengths of Sides

The lengths of the crown sheet sides from the boiler center line to the bottom of the firebox ring, front and back, 2 to 3 and 5 to 6, are the next dimensions to determine. When the side line is approximately parallel to the vertical boiler center line, the lengths required will be equal to dimensions, *a* and *b*, Fig. 3; but if the side slopes enough to increase the sloped length this increase must be added to the straight length. Such is the case of this crown side line as shown in Fig. 4.

To find the increase, use a scale or project a point to the boiler center line, equal to the distance from the vertical center line to the straight part of the side line, i.e., dimension *m*, 33 5/16 inches. Scale from this point to the side line front and back—extend straight line of the side if corner radius draws the side in at the boiler center—which will give the length of the opposite sides, dimensions, *t*, and t^1 of the triangles for which the hypotenuse is to be calculated. The adjacent side of the triangles equals the scaled vertical distance from the boiler center line to a point of intersection of the sloped side line and the vertical straight side line. This point, of course, will be a little above the point from which the side bend line radius, *r*, 12 3/16 inches is struck. For this boiler the sides of the triangles scale 3¼ inches, *t*; 40 inches—adjacent side—back; 3 inches, t^1, and 47 inches long side front. Scale the opposite side to the nearest ¼ inch and the adjacent side to the nearest even inch.

By referring to Table 3, it will be found that the hypotenuse of the triangle or the length of the side, front and back, increases approximately ⅛ inch. This gives a length of 46⅝ inches for the back and 55⅝ inches for the front. Mark the lengths of the top part of the crown and the sides on the diagram Fig. 4, as shown, i.e., 34⅞ inches, 38⅛ inches, 46⅝ inches, and 55⅝ inches, sides.

Lengths of Roof Sheet

The front top half of the roof sheet is equal to the half-circumference of a 36¼ inches circle (see Table I) + *p*, 1 15/32 inches = 58 7/16 inches. The back half equals the half-circumference of a 36¼ inches circle — *q*, 1⅜ inches = 55 9/16 inches. The quarter-circumference of a 72½-inch circle — 2 × 36¼ inches = 72½ inches — will, of course, give the same result, but it will readily be seen that the former method is much shorter. This boiler has only ½ inch roof side line slope, which of course can be neglected as it is not enough to give any increase to the side lengths, 2 inches and 3 inches slope, as a rule, being necessary to give more than a 1/32 inch increase, which should be used as 1/16 inch. The side lengths then equal dimensions, *a*, 46½ inches and *b*, 55½ inches. Mark these lengths on the diagram, Fig. 4, as shown. When the sides have an extreme slope which is quite often the case, dimensions, *p*, and *q*, will have an increase due to this slope. This increase should be added to the length of the quarter-circle.

This completes the diagrams, Figs. 3 and 4, up to the starting point of laying-out and finding the outline of the actual crown-and-sides and the roof-and-sides sheets. Any other measuring points or lines necessary on the diagram, will be added only as needed to explain and perform the various operations required in connection with the laying-out of these sheets.

(*To be continued*)

New Roadless Tractor Boiler

By G. P. Blackall

TRIALS which aroused widespread interest among transport users all over Europe were recently held at an engineering works in the Northern Midlands of England. They served to introduce an altogether new type of track-laying tractor—a vehicle, which, it is safe to assert, is unquestionably the best thing of its kind yet produced.

(*Continued on page* 57)

Tractor in service

A. S. M. E. Boiler Construction Code*

Report on Rules for the Construction of Unfired Pressure Vessels

The object of the code covering the construction of Unfired Pressure Vessels is to provide a safe construction for the great variety of pressure containers now manufactured and used for innumerable purposes throughout the country and under an exceedingly wide range of conditions. The efforts to give publicity which have been made in order to obtain as wide a range of opinion as possible, has brought out views which were often times diametrically opposed. In such cases the attempt has been made to frame the rules in accordance with the greater weight of opinion.

It is believed that these rules will not work undue hardships on the manufacturing industries generally, and at the same time will result in the construction of reasonably safe pressure vessels, for it is undoubtedly true that many of the failures which take place are due to the lack of proper restrictions governing both material, workmanship, dimensions and supervisions.

Rules for electric induction compression welding are in process of preparation and will be submitted later on for addenda to the Code.

The committee is composed of E. R. Fish, chairman; W. H. Boehm, C. E. Bronson, E. C. Fisher, S. F. Jeter, W. F. Kiesel, Jr., James Neil and H. V. Wille.

Rules for Forge Welding

U-80. The plate for any part of a forge-welded vessel, on which welding is done, shall be of forge-welding quality in accordance with the specifications for Forge Welding, Pars. U-110 to U-125.

Construction

U-81. The minimum thickness of any shell plate shall be ¼ inch, but the thickness of shell plate shall be not less than the inside diameter of the vessel divided by 200.

U-82. When properly welded by the forging process the strength of a joint may be calculated on maximum unit working stress $S = 7{,}650$ pounds per square inch. (See Par. U-20.)

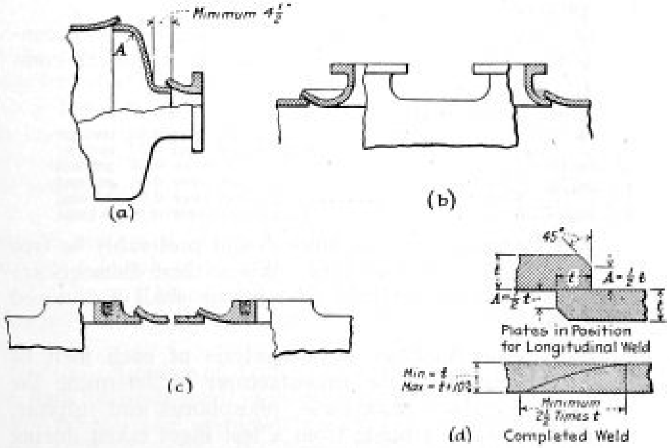


Fig. U-4.—Methods of forge welding

U-83. Corner Radius of Dished Heads. The corner radius of a dished head measured on the concave side of the head shall be not less than 6 percent of the inside diameter of the head (see *A*, Fig. U-4*a*).

U-84. Depth of Flange. The depth of flange on the flanged and dished head measured from a point tangent to the corner radius of the head to the end of the flange, shall be not less than 5 inches.

U-85. Heating. The heating agent shall be suitably prepared water gas or other heating medium by which equivalent or superior results will be obtained, and shall be applied to both sides of the section and adjacent surfaces, and precaution shall be taken to see that the flame is of a character that will minimize the possibility of burning or oxidizing the metal and that it be free from all impurities which would tend to introduce foreign elements into the steel. The temperature of the flame for heating the surfaces shall be under constant and close control.

U-86. Welding. The edges that are to be welded together shall be lapped a distance at least equal to the thickness of the plate to be welded. All plates ⅞-inch thick and under shall be welded without scarfing; plates more than ⅞-inch thick, if desired by the manufacturer, may be scarfed, the scarf to start at least one-half the thickness of the plate from the side next to the weld (see *A*, Fig. U-4*d*). When the material has been brought to the proper welding temperature, it shall be placed between an anvil and a hammer, or between rolls, or mandrel and roll, or between mandrels, and the plates welded together by a pressure applied by the hammer, rolls, or mandrels, which will actually displace the material while the welding action is occurring. The metal in and adjacent to the weld shall not be worked at what is termed the critical blue-heat temperature of the steel, that is, between about 400 and 800 degrees F.

The thickness of the weld for all longitudinal and circumferential seams of special welds (see Fig. U-4*d*) shall be as follows:

Minimum $= t$
Maximum $= t$ plus 15 percent

The contact line of completed forge weld shall be equal to at least two and one-half times the thickness of the plate (t) as shown at (d), Fig. U-4.

U-87 Annealing. After welding, the whole vessel or cylinder shall be heated to a temperature sufficient to remove the internal strains and then allowed to cool slowly in the air. Where this is impracticable on account of size or shape of vessel, all longitudinal and transverse welds shall be heated to the proper temperature for not less than 8 inches on each side of weld and allowed to cool slowly in the air. If any vessel has been distorted out of shape it must be reformed and then annealed or reformed at a proper annealing temperature. In a finished cylindrical shell the variation in diameters shall not exceed 1 percent of the mean outside diameter when measured at any section. When a straight edge two diameters long is laid longitudinally on the outside of a shell, it shall be possible to so set the straight edge that no part of the edge will come farther than 1 per cent of the mean outside diameter from the outer surfaces of the shell.

U-88. Inlet and Outlet Connections. All connections less than 5 inches standard pipe size may be attached by fusion welding as specified in the code for fusion welding (Pars. U-76 and U-77). Nozzles 5 inches and over shall be attached by forge welding or by riveting.

Nozzles which are attached by forge welding shall be of forged or rolled steel material, seamless tubing or forge-welded pipe, using either of the two methods shown at (b), Fig. U-4, or attached to a head by forge welding as shown at (a), Fig. U-4. Either the nozzle or shell may be flared for this purpose.

U-89. Saddle flanges may be used if made of forged steel

*Continuation of proposed code, the first sections of which appeared on page 354 of the December issue, and page 12 of the January issue of The Boiler Maker.

and may be attached by forge welding by either of the two methods at (*c*), Fig. U-4, or by riveting.

U-90. All dished heads may be attached to shell by forge welding as shown at (*a*), Fig. U-4, or by riveting. (Note corner radius *A* referred to in Par. U-83.)

Rules for Brazing

U-91. Material. Steel plates for the shells of brazed vessels shall be made by the open-hearth process and shall not exceed 3/8 inch in thickness. Plates 1/4 inch thick or heavier shall be of either flange or firebox quality as provided for in the Specifications for Boiler Plate Steel. Sheets lighter than 1/4 inch shall have the properties as provided in Pars. U-126 to U-131.

U-92. When the safety of the structure does not depend upon riveting in the joints, rivet holes may be punched full size.

U-93. For threaded openings, if the thickness of material in the pressure vessel is not sufficient to give the number of threads specified in Par. U-59, the openings may be reinforced by a plate brazed to the shell, by a forged boss with inside flange welded or brazed to the shell or head, or any of the methods shown in Fig. U-3 may be used.

U-94. When properly brazed the strength of a joint may be calculated on a maximum unit working stress $S = 8{,}550$ pounds per square inch (see Par. U-20).

U-95. Longitudinal seams shall have the edges of the plate lapped a distance of not less than eight times the thickness of the metal. The lap shall be held closely in position substantially metal to metal, by stitch riveting or other sufficient means. The brazing shall be done by placing the flux and brazing material on one side of the joint and applying heat until this material comes entirely through the lap and shows uniformly along the seam on the other side. Sufficient flux must be used to cause the brazing material to so appear promptly after reaching the brazing temperature. The brazing material used shall be such as to give a joint which has a shearing strength of at least 10,000 pounds per square inch.

U-96. Head Seams. Heads shall be driven into the shells with a tight driving fit, and shall be thoroughly brazed in approximately the same manner as the longitudinal seam for a depth or distance from the end of the shell equal to at least four times the thickness of the shell metal.

Enameled Vessels

U-97. Material. All pressure vessels intended to be coated with glass or other enamel shall be made of steel or iron not under 3/16 inch nor more than 5/8 inch in thickness and may be welded by the oxy-acetylene, electric, or forge-welding processes. If forge welding is used the requirements of Pars. U-80 to U-90 shall be followed. All plates shall conform to the Specifications for Steel for Forge Welding, Pars. U-110 to U-125, and any plate not conforming thereto may be rejected.

U-98. The maximum allowable working pressure for single-shell vessels shall be determined by the following formula:

$$P = \frac{5000}{R} t$$

where t = thickness of plate, inches
R = inside radius, inches.

U-99. The formula given in U-36 shall be used in calculating the minimum thickness of heads necessary for the various pressures and diameters.

U-100. The ratio of diameter of the vessel to thickness of plate shall in no case exceed 320.

U-101. Any brand of welding wire which has been found by practice to give good results may be used, and may be bare, coated or covered.

U-102. Vessels of this class will be considered under two types, viz., single-shell vessels and jacketed vessels.

U-103. Longitudinal seams of single-shell vessels welded by either the oxy-acetylene or electric processes or both shall be double-V welded.

The weld on all surfaces to be enameled may be ground flush with the surface of the plate.

U-104. Jacketed or double-shell vessels may be of two types, one in which one of the heads of the inner vessel forms the sealer apron for the jacket, and one in which the sealer apron is joined to the shell of the inner tank at some point between the heads, forming a partially jacketed vessel.

U-105. The inner tank of a jacketed vessel shall be of the same construction as a single-shell vessel.

The thickness of the inner shell shall be at least 1.65 times the required thickness of the outside shell.

U-106. The longitudinal seam of the jacket shall be double-V welded. The circumferential seam in the jacket joining the head to the shell may be single-V welded.

U-107. In jacketed vessels where the sealer apron is welded to the shell of the inner tank, and also where sealer apron is welded to the shell of the jacket, the weld may be made from outside only, provided the thickness of the metal deposited is equal to or greater than the thickness of the apron or plate.

U-108. In jacketed vessels where the top head of the inner tank forms the sealer apron, the head may be welded to the shell of the inner tank from the inside only, provided the thickness of the weld after grinding is equal to or greater than the thickness of the shell.

U-109. All cylinders shall be rerolled after welding.

Specifications for Steel Plates of Flange Quality for Forge Welding

U-110. Material Covered. These specifications cover steel plates of flange quality suitable for forge welding without the addition of fluxes.

U-111. Process. The steel shall be made by the open-hearth process.

U-112. Chemical Composition. *a.* The steel shall conform to the following requirements as to chemical composition:

Carbon	for plates 3/4 in. or under in thickness	not over 0.15 percent
	for plates over 3/4 in. in thickness	not over 0.17 percent
Manganese		0.35 to 0.60 percent
Phosphorus	Acid	not over 0.06 percent
	Basic	not over 0.04 percent
Sulphur		not over 0.05 percent

b. The composition of the steel should preferably be free from silicon, nickel, or chromium. Where these elements are present the maximum quantity of any one shall not exceed 0.05 percent.

U-113. Ladle Analyses. An analysis of each melt of steel shall be made by the manufacturer to determine the percentages of carbon, manganese, phosphorus and sulphur. This analysis shall be made from a test ingot taken during the pouring of the melt. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified.

U-114. Check Analyses. An analysis may be made by the purchaser from a broken tension-test specimen representing each plate as rolled. The chemical composition thus determined shall conform to the requirements specified.

U-115. Tension Tests. *a.* The material shall conform to the following minimum requirements as to tensile properties:

Tensile strength (T. S.), lb. per sq. in.	45,000
Yield point, lb. per sq. in.	0.5 T. S.
but in no case less than	24,000 lb. per sq. in.
Elongation in 8 in., percent	30

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

U-116. Modifications in Elongation. *a.* For material over ¾ inch in thickness a deduction from the percentages of elongation specified in Par. U-115 (*a*) of 0.25 percent shall be made for each increase of 1/32 inch of the specified thickness above ¾ inch.

b. For material under 5/16 inch in thickness, a deduction from the percentage of elongation in 8 inches specified in Par. U-115 (*A*) of 1.25 percent shall be made for each decrease of 1/32 inch of the specified thickness below 5/16 inch.

U-117. Bend Tests. The test specimen shall withstand being bent cold through 180 degrees without cracking on the outside bent portion, as follows: For material 1 inch or under in thickness, 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.

U-118. Test Specimens. *a.* Tension-test specimens shall be taken longitudinally from the bottom of the finished rolled material, and bend-test specimens shall be taken transversely from the middle of the top of the finished rolled material. The longitudinal-test specimens shall be taken in the direction of the longitudinal axis of the ingot, and the transverse-test specimens at right angles to that axis.

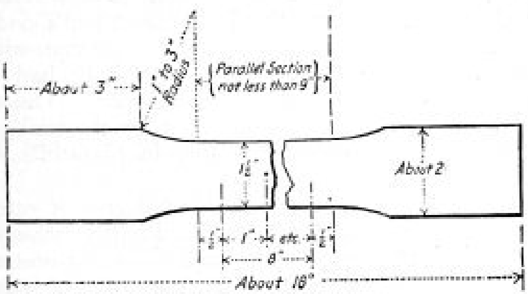


Fig. U-5.—Standard form of test specimen required for all tension tests of steel plate of flange quality for forge welding

b. Tension, and bend-test specimens shall be of the full thickness of material as rolled, and shall be machined to the form and dimensions shown in Fig. U-5; except that bend-test specimens may be machined with both edges parallel.

c. Test specimens for plates over 1½ inches in thickness may be machined to a thickness or diameter of at least ¾ inch for a length of at least 9 inches.

d. The machined sides of rectangular bend-test specimens may have the corners rounded to a radius not over 1/16 inch.

U-119. Number of Tests. *a.* One tension and one bend test shall be made from each plate as rolled.

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

c. If the percentage of elongation of any tension-test specimen is less than that specified in Par. U-116 (*a*) and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

U-120. Permissible Variations. The thickness of each plate shall not vary more than 0.01 inch under that ordered.

U-121. Finish. The finished material shall be free from injurious defects and shall have a workmanlike finish.

U-122. Marking. *a.* The name or brand of the manufacturer, melt or slab number, class, and lowest tensile strength for its class specified in Par. U-115 (*a*) shall be legibly stamped on each plate. The melt or slab number shall be legibly stamped on each test specimen.

b. When specified on the order, plates shall be match-marked as defined in section (*c*) so that the 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, and 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.

U-123 Inspection. The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the material ordered. The manufacturer shall afford the inspector, without charge, all reasonable facilities to satisfy him that the material is being furnished in accordance with these specifications. All tests (except check analyses) and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

U-124. Rejection. *a.* Unless otherwise specified, any rejection based on tests made in accordance with Par. U-114 shall be reported within five working days from the receipt of samples.

b. Material which shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

U-125. Rehearing. Samples tested in accordance with Par. U-114 which represent rejected material shall be preserved for two weeks from the date of the test report. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

SPECIFICATIONS FOR STEEL PLATE FOR BRAZING

U-126. The steel shall conform to the following requirements as to chemical composition:

Carbon	not over 0.24 percent
Manganese	not over 0.60 percent
Phosphorus	not over 0.04 percent
Sulphur	not over 0.05 percent

U-127. Ladle analyses and check tests shall conform to the provisions of Pars. U-113 and U-114.

U-128. Tension Tests. The material shall conform to the following requirements as to tensile properties:

Tensile strength, max. lb. per sq. in.	70,000
Yield point, min. lb. per sq. in.	28,000
Elongation min. percent	1,500,000
	Tensile Strength

The elongation shall be measured on gage length of 24 times the thickness of specimen, except that this may be reduced by 2½ percent for each 1/16 inch under 5/16 inch.

U-129. Bend Test. The bend-test specimen shall bend cold through 180 degrees without cracking on the outside of the bent portion, around a pin the diameter of which is equal to the thickness of the specimen.

U-130. Number of Tests. Two tension tests and two bend tests shall be taken from each heat, but not both tension or both bend tests from the same slab.

U-131. Sheets less than ¼ inch in thickness shall not be required to be stamped at the mill on account of the small size and light weight of the sheets. The manufacturer must mark each tank in some permanent manner which will enable him to identify the heat from which the sheet in each tank has been rolled.

Legal Aspects of Boiler Explosions*

CONSIDERING the frequency with which juries have found owners of steam boilers to be negligent in failing to discover defects resulting in explosions, and that engineers have been negligent in managing boilers, an outsider might assume that both owners and engineers are sometimes inclined to take fiendish delight in the bursting of boilers. But it is gratifying to note that the assumption is not universal, for the opinion of the Kentucky Court of Appeals in the case of Branham's Administrator vs. Buckley, 166 Southwestern Reporter, 618, has this to say concerning a verdict exonerating defendants from liability for a fatal accident to a visitor in a grist mill power plant:

"The jury evidently felt some doubt as to the exact cause of the accident; and, having in mind the fact that there is a general disposition among men to preserve their property, and among operators of steam boilers to preserve their own lives, and that ordinarily these motives will secure that degree of care which the defendants were charged with under the law, the jury doubtless believed that the injuries to plaintiff's intestate were occasioned, not as plaintiff contends, by negligence of the defendants, but rather by one of those unfortunate casualties which ordinary care and prudence will not always prevent."

In that case it appeared that a boy went to the mill with corn to be ground. While waiting for the meal he went into the boiler room to warm himself, and was fatally injured through explosion of the boiler.

Plaintiff's Contention Overruled

The court overruled a contention made by the attorneys for the plaintiff, who sought an award of damages on account of the accident, that the mere fact that the boiler burst raised a presumption of negligence, making it incumbent upon defendants to prove that they had exercised the highest degree of care in operating the boiler and in maintaining it in safe condition. It was decided that, although defendants had invited the boy to warm himself by the boiler, the case was nevertheless governed by these rules:

"The owner or occupant of premises who induces others to come thereon by invitation, express or implied, owes them a duty of using reasonable or ordinary care to keep the premises in safe condition; but he is not an insurer of the safety of such persons. . . .

"And, where the defendant owes plaintiff no duty other than the exercise of ordinary care to prevent injury, the fact of an explosion of a steam boiler creates no presumption of negligence. 36 Cyc., 1265; Veith vs. Hope Salt Co., 51 W. Va.; 96, 41 S. E., 187, 57 L. R. A., 410; Cosulich vs. Standard Oil Company, 122 N. Y., 118, 19 A. S. R., 475; Huff vs. Auston, 46 Ohio St., 386, 21 N. E., 864; 15 A. S. R., 613. . . .

"Thomas Buckley, one of the defendants, testified that at the time the crown sheet gave way, the boiler was two-thirds full of water; that he was carrying only 95 pounds steam pressure; and that he did not know what caused the crown sheet to fail. The evidence for plaintiff tended to show that Buckley had permitted the boiler to become dry, and then started the injector, forcing cold water into the boiler and thereby causing it to burst. The evidence was conflicting; but we cannot say that the verdict [in favor of defendants] is flagrantly against the evidence."

It appears that the only theory on which the engineer could account for the explosion was that the bolts securing the crown sheet had "failed to be bradded good." However, the Court of Appeals decided that counsel for plaintiff had failed to properly preserve any right to recover on a theory of negligence on the part of the defendants in maintaining the boiler.

* From an article by A. L. H. Street appearing in *Power*.

Another Case Cited

In the case of Corbett vs. Lymansville Company, 69 Atlantic Reporter, 69, the Rhode Island Supreme Court took a less favorable view of the right of the defendant in an action of this kind to immunity from liability until negligence is expressly proved. That court said:

"When it is shown that a machine adapted to retain steam under pressure is apparently in good condition and capable of withstanding an ordinary pressure, and suddenly explodes with violence, it is a fair inference that the explosion was caused by an extraordinary pressure from the steam supplied. If the explosion was from other causes, the means of ascertaining the fact were entirely within the power of the defendant."

Connecticut Supreme Court Decision

What the Connecticut Supreme Court of Errors has decided (Temple vs. Gilbert, 85 Atlantic Reporter, 380) concerning the liability of a locomotive engineer for injury to another caused by explosion of a boiler managed by him undoubtedly accurately applies to stationary engineers as well. Evidence for plaintiff tended to show that the explosion was due to defendant engineer's failure to keep sufficient water in the boiler. On the other hand, defendant's evidence tended to disprove that fact, and tended to show that, without his fault or knowledge, the boiler previously had been weakened, and that that caused the explosion. The court approved the following instructions given by the trial judge to the jury, whose verdict for $5,000 in plaintiff's favor was sustained:

"Negligence is the failure to use that degree of care for the protection of another that the ordinarily reasonably careful and prudent man would use under like circumstances. The defendant in this case was an engineer. So, as applied specifically to this case, negligence would be the failure on his part to use that degree of care and caution to keep the water at the proper point in the boiler, which the ordinarily careful and prudent engineer would use under those circumstances under which he was situated. The defendant is liable or not according as he came up, in the management of that engine, to the standard of care that the law imposes. Did he, in managing that engine at the time the explosion happened and at the time just prior to the time it happened, exercise that degree of care and caution that the ordinarily prudent and careful engineer, under similar circumstances, was bound to exercise?

"Had that boiler before it was delivered into the hands of the engineer on that morning ever been overheated so as to weaken it, and was it delivered into his hands in that condition? . . . . There is no testimony that he knew anything about this himself. It was a new engine to him. . . . He had a right to assume when he took that engine . . . that the boiler was in good and sound working order. He had the right to go ahead and handle that engine on the presumption that it was properly constructed and in proper repair."

Error in Deflection Formula

In August issue of THE BOILER MAKER (page 244) the following formula is given for the deflection of flat heads:

$$f = Kr^4 \frac{P}{t^3} E$$

The formula should read:

$$f = \frac{Kr^4 \dfrac{P}{t^3}}{E}$$

The Boiler Maker

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

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San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London

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Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent office.

Subscription price: United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. Foreign subscriptions may be paid through our London office, 34 Victoria Street, S. W. 1, in £/s/d.

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

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CONTENTS

The experiment being carried out by the Delaware and Hudson Railroad in the case of the new locomotive described elsewhere in this issue marks a pioneer effort in the field of design. Undoubtedly higher pressures than those now employed will be utilized in locomotives of the future to provide a more efficient use of fuel. The boiler of the "Horatio Allen" working at 350 pounds is the first definite step in this direction. The fact that the experiment has so far been successful beyond expectations promises well for the future development of steam power of the railroads.

Two marked departures from conventional design have been made in the present boiler—one of these is the replacing of the stayed surfaces in the firebox with watertubes; the second is the reintroduction of cross compound cylinders. The first of these in which readers of THE BOILER MAKER are most interested is probably the most radical departure in practice that has been made in this country since the advent of the steam locomotive. The entire construction and proportions of the boiler are so different from former designs that it is difficult to predict its performance as a steam producer or its upkeep.

Once the test has been carried to a sufficient length to determine these and other results, it still remains to decide how far the underlying principles can be developed and most effectively adapted to general conditions in this country. From theoretical determinations and operating data available on this and other types, it has been estimated that the special features of this locomotive should effect a combined economy of about 39 percent in fuel consumption per horsepower hour as compared with locomotives of conventional design and proportion. It is vitally important to the future development of the locomotive that accurate data be obtained to determine how far this estimate is justified.

In 1886 a committee appointed by The American Society of Mechanical Engineers formulated a code for the testing of steam boilers which soon became the standard practice of the profession and the basis upon which performance guarantees were drawn and settled.

At that time there were no other recognized rules for practice extant in this country. The Institution of Civil Engineers of Great Britain appointed a Committee on Tabulating the Results of Steam Engine and Boiler Trials in 1897 and their report, made in 1902, is now under revision by a Joint Committee of the Institutions of Civil and Mechanical Engineers.

In the thirty-eight years that have elapsed since the adoption of the original A.S.M.E. Code it has undergone several revisions made necessary by the progress of the art. Such a revision has just been completed and the code is now available in the thoroughly up-to-date form in which it has been adopted by the Council of the A.S.M.E. as the approved standard practice of the profession.

The committee in charge of this 1923 revision consists of Edwards R. Fish, vice-president, Heine Boiler Co., chairman; Arthur D. Pratt, Babcock & Wilcox Co., secretary; Alex D. Bailey, superintendent of generating stations, Commonwealth Edison Co., Chicago; Albert A. Cary, consulting engineer, New York; and Edwin B. Ricketts, assistant to chief operating engineer, New York Edison Co.

The earlier 1915 draft of the code for stationary steam boilers related primarily to tests made with coal, while the latest (1923) revision covers in a complete way tests with (*a*) solid fuels, (*b*) liquid fuels, and (*c*) gaseous fuels. The use of each of these types of fuel is treated when stokers, superheaters, economizers and air preheaters are attached to the boiler.

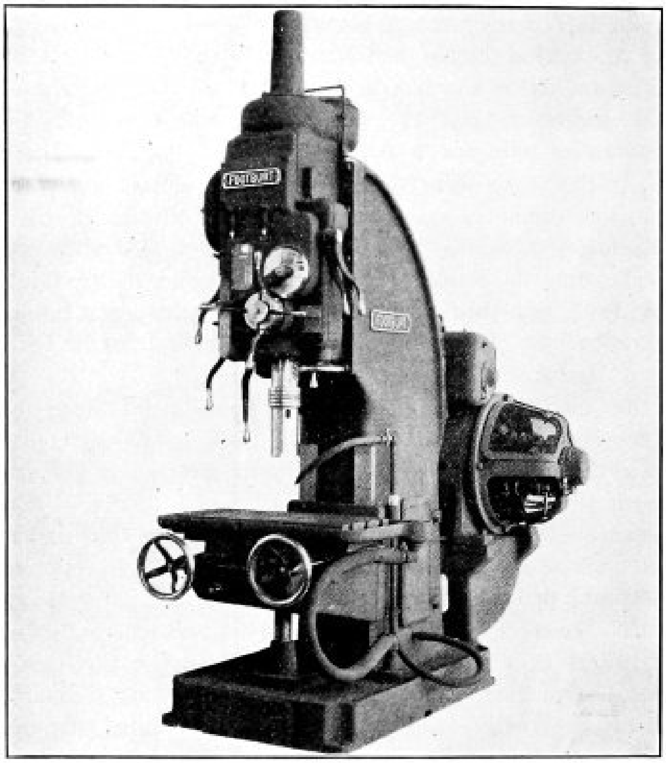
The text of the code has been completely rewritten and the Data and Results section has been developed in an entirely new form. It now contains separate tables for each combination of apparatus, each item of which is covered by an item in a corresponding section devoted to computations. As a result of this arrangement considerable time will be saved in computing tests made according to this standard code. To further facilitate the computations and record of stationary steam boiler tests the A.S.M.E. is planning to issue in separate pad form the various data, heat balance, and computation sections.

Engineering Specialties for Boiler Making

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

Heavy Duty Drilling Machine

A DRILLING machine which has a rated drilling capacity of 5 inches in solid steel, made possible by its rigidity of design, has been placed on the market by The Foote-Burt Company, Cleveland, Ohio. Some of the outstanding features of the machine are that the head unit can be entirely detached from the upright and that the speed changes can be easily obtained through a sliding gear arrangement.



The head unit, containing all mechanism, can be detached from the upright of this Foote-Burt drill

The head of the machine is bolted to the face of the upright, so that the bolts are in shear instead of in tension. This assists in giving unusual strength to the head and upright construction, and tends to prevent any deflection at the point of the drill through additional rigidity secured with this arrangement.

This is a feature which is essential for production work.

Another interesting feature is that the head unit can be entirely detached from the upright, as the entire mechanism of the machine is contained in the head proper. This construction provides for a pump lubrication system, thereby eliminating the necessity of hand oiling. It also permits the removal of the complete head without disturbing the balance of the machine. This is particularly important when a number of these machines are used close together, as it is possible to remove the head holding bolts and by hooking the crane to the top of the head, lift it from the balance of the machine without interfering in any way whatever with the machines in its vicinity.

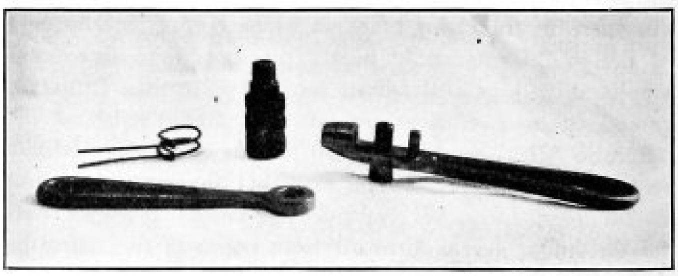
The speed changes are obtained through a sliding gear arrangement similar to that used in the modern automobile transmission. Nine speed changes are easily obtained by manipulating the speed change levers. By transposing one set of pick-off gears, a total of eighteen feed changes can be secured. Steel gears are used throughout. With the exception of the sliding gears, which are stub-toothed, spiral gears are used, including spiral bevel gears for the main drive of the machine. With only one exception roller bearings are used throughout the machine, which reduce frictional wear to a minimum. The spindle bearing is of a high grade bronze.

Some of the general specifications are as follows: The distance of the nose of the spindle to the top of the plain table is 35 inches; the distance of the center of the spindle to the face of the column is 18 inches; the diameter of the spindle bearing in the sleeve is 3 inches; the diameter of the spindle nose is 5 inches, the spindle is equipped with a No. 6 Morse taper; the working surface of the plain table is 24 inches by 24 inches, the table vertical adjustment is 18 inches; there are 18 feed changes from 0.100 inch to 0.140 inch; nine speed changes from 25 to 201 revolutions per minute, the net weight of the machine with the plain table is approximately 10,000 pounds; with the compound table approximately 11,000 pounds.

A Compact Hose Clamping Tool

A COMPACT device for attaching a wire band to any size of hose has been put on the market by the Gunn Manufacturing Company, Keene, N. H. Only three lengths of bands are required to fit any size of hose from ¼-inch to 3½ inches.

To apply the clamp, bend the wire band around the hose, pulling the ends of the wire through the nose of the tool and continuing it through the slot in the turning pin. Tighten the band by use of the wrench, then twist the ends of the wire until they break off. This leaves a small upright part of the band to be folded over and pounded flat. The result is a tight, smooth clamp, gripping the hose in a perfect circle and having no projecting parts. It may be tightened until it is indented into the hose itself, if so required, this operation depending only upon the strength of the wire used. The clamping can be completed in half a minute.

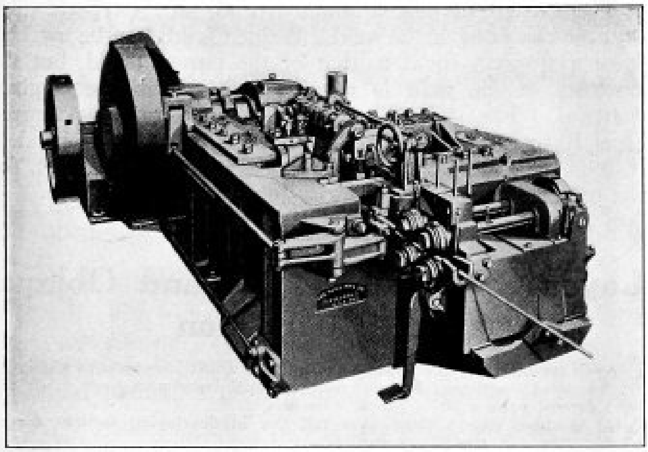


A device for clamping a wire band on any size of hose

Automatic Bolt and Rivet Heading Machine

A CONTINUOUS motion bolt and rivet making machine which is designed for either hand or automatic feed and belt or motor drive has recently been developed by The Ajax Manufacturing Company, Cleveland, Ohio. The general arrangement has been improved by transferring the die-slide operating mechanism from the left to the right hand side, making it possible for the operator to feed the stock, watch the quality of the bolts or rivets as they come through the discharge port on the left, and adjust the stock gage all from one position. This arrangement leaves the left side of the machine clear, materially expediting the setting of the dies and tools.

With the hand feed machine, rods heated to four or five feet in length are fed into the machine against the stock gage by the operator by hand, the machine shearing off a blank, heading and ejecting it. Outputs range from 14,000 to 18,000 counts every 10 hours. With the automatic roll feed, mill length rods are heated in a long furnace set about three feet from the front of the machine. The operator need only start the rod into the rolls, which feed it into the machine so that a piece is produced on each revolution. Outputs vary from 30,000 to 50,000 counts every 10 hours, depending on the length and size of rivets produced. The automatic roll feed mechanism is operated from an adjustable crank pin at the end of the crankshaft. The eccentricity of this pin is changed by means of an adjusting screw so that the rolls feed the correct amount of stock to produce any given length bolt or rivet.



Automatic roll feed, motor driven, heavy duty, continuous motion heading machine

The gears of this mechanism are completely enclosed in the feed housing. The ratchet arm is fitted with two dogs, staggered to give refinement of feed. The feed rolls which carry the heated bar stock consist of rings with the circumference grooved to suit the various sizes of stock. They are mounted in holders on the roll shafts so as to be easily changed for different sizes of stock and adjusted laterally for different shear center distances. The roll pressure is controlled by removable weights mounted on the bearings of the upper roll shafts which are movable vertically. In case of a sticker the feed can be stopped and locked out by depressing the foot pedal. An adjustment of distance between the feed rolls and the backing plate reduces waste from crop ends to a minimum. Finished pads on the front of the hand feed machines make it possible to attach this automatic roll feed mechanism at any time.

The belt driven machines are not geared, the flywheel being mounted directly on the end of the crankshaft. A clutch countershaft is provided as a standard accessory with all belt driven machines. Motor drive by direct gearing is provided for by extending the main bed casting to the rear to carry the pinion shaft and motor. A safety friction clutch coupling between this shaft and the main drive pinion cushions the motor from shocks and protects both the machine and the motor from damage should anything prevent a complete revolution of the crankshaft. The steel bed is of the ribbed type with continuous housings for the crankshaft bearings. It is extremely heavy and its deep sections and liberal flanges make it so rigid between crankshaft and backing plate, that it is not necessary to pack up excessively behind the heading tool to bring rivet or bolt heads down to the proper thickness. All wearing surfaces are suitably bushed and lined so that there is no direct wear of moving parts on the bed proper.

The header slide is top-suspended from V-type bearings. The trough ways of the bed, in which the header-slide bearings operate, are above the scale line. They are roll lubricated from two reservoirs and drain at the front, so that good lubrication with clean oil is maintained. The bearings on the header-slide and the ways in the bed are both removable for re-alinement. The die slide is top-suspended from plain bronze-faced bearings. A wedge liner on the crankshaft side, adjustable without removing any parts, makes it possible to keep the moving die back tight on the cutter, so as to shear the stock squarely. The self-adjusting side arm relief of the die slide actuating mechanism fully protects the machine in case a bolt or rivet lodges in or is caught between the faces of the dies. As soon as the obstruction is removed, the side arm automatically resets itself. The ejector is of the walking beam type operated from a cam on the inside of the flywheel. The cam is adjustable to control the time of kick-out and to offset any wear.

The stock gage can be adjusted by means of the hand wheel while the machine is running. The hand wheel is convenient to the operator as he watches the product being headed so that adjustments can be made quickly, for a slight variation in the stock diameter so that all heads will be properly filled out. The cam on the head-slide which actuates this gage is adjustable to change the timing for different shear center distances. Three types of gage arms are furnished for use when making short, medium and long rivets. Intermediate lengths are secured by adjusting the gage stem.

The power of the motor required is from 7½ to 20 horsepower for machine sizes varying from ¾ to 1½ inches in the case of hand feed, and from 10 to 30 horsepower for the same sizes in the case of automatic feed.

Pittsburgh's Giant Boiler

A MAMMOTH boiler, thought to be the largest boiler in the world, has just recently been put into operation in the Cecil Plant of the Allegheny County Steam Heating Company, Pittsburgh, Pa. It is a watertube boiler of the cross drum type. Some idea of its huge proportions may be obtained from a consideration of its principal dimensions. The drum, for instance, is 60 inches in diameter by 34 feet long. There are 1,173 tubes each 24 feet long which, together with wall cooling tubes, gives approximately six miles of 4-inch tubing. The heating surface amounts to 32,750 square feet. Based on the heating surface, the boiler is nominally rated at 3,000 horsepower, but it is capable of operating continuously at 300 percent of the rated capacity. The maximum rate of evaporation is approximately 200 tons per hour or about 400 percent of rating.

The shell is of 11/16-inch plate, triple riveted butt seam construction, being designed for 190 pounds working pressure. The heads are of ⅞-inch plate.

(*Continued on page 54*)

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

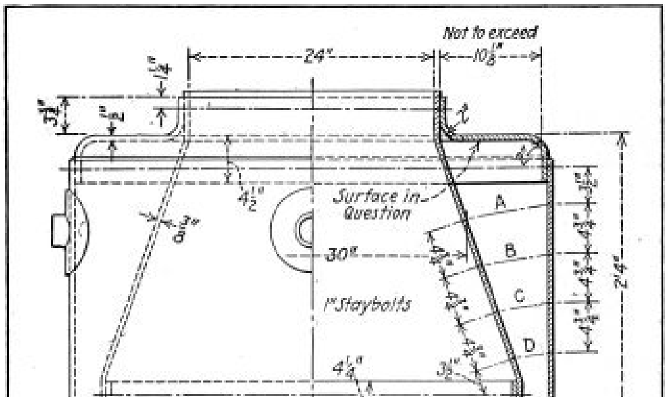
This department is open to subscribers of THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary. Inquiries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

Rules Governing Staying of Flat Surface of Upper Head of Submerged Type Vertical Boilers

Q.—I have been reading your articles in THE BOILER MAKER with considerable interest, being connected with boiler design, and would appreciate very much if you will explain the following situation: You will note on the attached sketch dimension marked "not to exceed 10⅛ inches." This dimension probably is the reason why it is not necessary to apply braces, staying outside head and shell. I was under the impression that all flat surfaces under pressure should be braced, and would like to know why it is not necessary to brace this head; what part of the A. S. M. E. Code does this come under, and to what limit can this dimension be extended to before bracing becomes necessary, and how is it obtained?—H. P. G.

A.—Refer to case No. 308 of the A.S.M.E. Code.

There is no rule in the code specifically applying to such construction. However, in Par. 216, an allowance is made for surfaces located between tubes and shell. It is the opinion of the "Boiler Code Committee" that it would be entirely safe to permit similar allowance in this case, that is, the distance between the supported parts could be made 3 inches greater than the permissible spacing of staybolts for the corresponding plate thickness and pressure as given in Table 4.



Problem in staying vertical boiler

Welded or Riveted Stack Tees

Q.—Please let me know through THE BOILER MAKER what you consider the stronger construction in attaching tee to stack, welded or riveted, assuming, of course, perfect welding. See sketch.—T. B. S.

A.—The welded construction produces a better job to handle at a smaller cost. A good welded seam would also be stronger in this case, for the riveted joints in such designs are not made to obtain a high efficiency in the joint.

The strength of welded seams depends on the type of joint and the character of the weld. Welded joints can be made to have a strength equal to that of the parent metal, but the ductility of the weld is not the same as in the original material. The strength of welded seams may be figured from 50 to 75 percent of the strength of the original metal.

It is impossible to know the exact strength of a weld, for the personal factor and materials used vary.

Layout of Camber Line and Oblique Pipe Connection

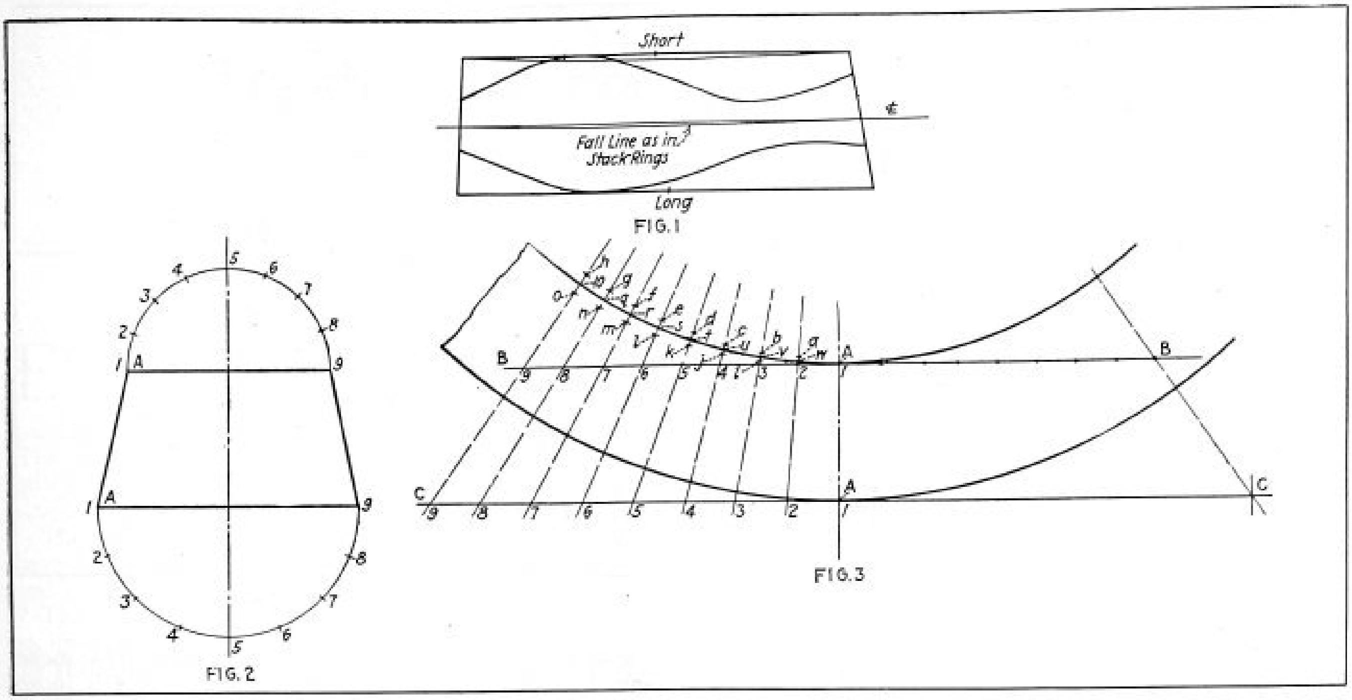
Q.—I am inclosing two rough sketches and would like to have the information noted on them. I enjoy reading your department very much and have derived quite a bit of benefit from it.

(1) Is there such a thing as a fall line in developing sections for an elbow; if so, can you give a method?

(2) Can you give me a method for developing a double miter, as per sketch?—W. B. S.

A.—(1) You refer evidently to the curve obtained in the development of regular tapered sections, commonly called the *camber line*. The camber line in patterns for elbow sections of heavy plate should be developed, otherwise the rivet holes will not line up and the fit between the pipe sections will not be good. To illustrate a simple way of laying off the camber sections having a slight taper, the development of Fig 2 is shown in Fig. 3. Fig. 2 is a frustum of a cone. In Fig. 3 the center line *A-A* is drawn equal in length to *A-A* of Fig. 2. At right angles to *A-A* lay off the lines *B-B* and *C-C*. Make the length *B-B* equal to the circumference of the small end of the frustum; and the length of *C-C* equal to the circumference of the large end. Divide *A-B* into 8 equal parts and also the length *A-C* as indicated from *1* to *9* inclusive, Fig. 3. Draw in the radial lines as *1-1*, *2-2*, *3-3*, etc. With the use of a square locate the points *a* to *h* inclusive and *i* to *o* as follows:

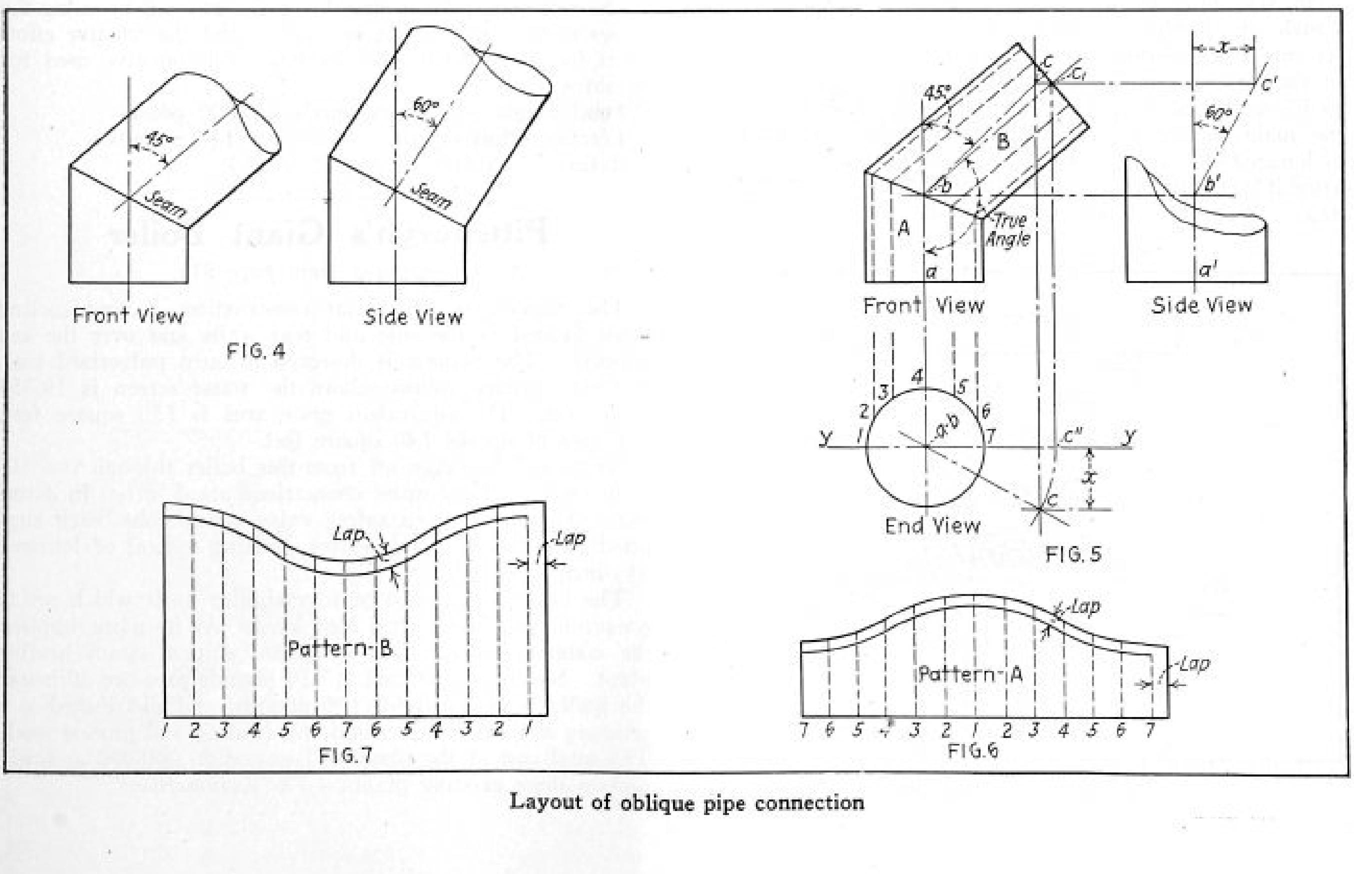
Place the blade of the square on line *2-2* so that the tongue passes through the point *1* on line *A-A* and mark point *a* on line *2-2*; then place the blade on line *3-3*, so that the tongue passes through point *a*, mark point *b* on line 3. Continue in this manner, using the radial lines until points *c* to *h* are located. Next, locate points *i* to *o* as follows: Place the blade on line *2-2*, with the corner at point 2 and mark point *i* where the tongue crosses line *3-3*; then place the blade on line *3-3* with the corner of the square at *i* and where the tongue crosses line *4-4* mark point *j*. This process is continued to locate the remaining points. Midway between the points so located, as for example between the points *o-h* set off the point *p*. The



Development of camber for elbow sections

upper camber line lies in the points p, q, r, s, t, u, v, w. The camber for the large end is laid off by setting the trammels to the length A-A and from the points p to w inclusive set off this length on the radial lines. The stretch-out of the pattern is laid off with a graduated circular wheel.

The solution to your second inquiry is shown in Figs. 5, 6 and 7. Fig. 5 is a front, side and end view of the oblique pipe connection. To develop the required patterns, the oblique pipe B must be revolved parallel to one of the principal planes of projection. This view shows the foreshortened pipe in its true length and also the true angle and miter line between the connecting pipes. To obtain this view draw the end view about a center line as Y-Y. The position of the axis a-c is obtained by projection and the use of distance x which shows how far point c on the center line is from line y-y. The distance x is measured as shown in the side view. Having located the end view projection, revolve the line a-c to the line y-y thus locating point c''. Project c'' to the front view to intersect the horizontal line drawn from point c thus locating point c_1. Connect c_1 with b which gives the true length of the axis of the oblique



Layout of oblique pipe connection

pipe and shows also the true angle a-b-c_1. The miter can now be drawn in and the patterns for the sections *A* and *B* laid off as shown in Figs. 6 and 7.

Design of Dies for Hydraulic Flanging

Q.—Please furnish us with sketch or sketches showing how to make a set of dies to make 48-inch outside diameter flanged and dished boiler or tank heads on a hydraulic flanging machine.—E. G. K.

A.—Figs. 1, 2 and 3 illustrate the design and how the dies are used in flanging and dishing heads in one operation. The male die, Fig. 3, which is also shown in section Fig. 2, is made of segments *a*, *c* and a cone *b*. The purpose of the cone is to facilitate the release of the male former when the pressure on the hydraulic ram is released. The block may be used in flanging heads by removing the dishing block *d*. In the design of the blocks, the thickness of the castings must be made sufficient to form the heaviest material that may be used in the shop. Due allowance must also be made for the thickness of plate, and shrinkage of the head. It is customary to allow from 1/32 to ⅛ inch to the foot for shrinkage. A good rule is to allow 0.008 of the diameter of the finished head to the female die for heads up to 60 inches in diameter, and 0.01 for heads larger in diameter. The outside diameter of the male die may be found by subtracting twice the plate thickness plus 1/16 to ¼ inch for clearance from the outside diameter of the finished head.

It is very important in flanging and dishing light heads of 3/16 inch material, that the plate is heated to a dull red heat, as a higher heat causes buckling. Also bear in mind that the deeper the flange the tendency of the plate is to gather or buckle.

Refer to Fig. 1 which shows the dies *A*, *B* and *C* in position for the forming operations. The space *x* which receives the plate *D* should for light plate be from 1/16 to ⅛ inch deeper than the thickness of the head. For heavier plate a greater clearance should be allowed so as to allow the head to move out while the male die is forming the dish.

In the flanging operation the upper platen carries the female die *A* which is lowered after the plate is heated and set into the clamping die *B*. When the dies *A* and *B* are in the position shown in Fig. 1 the plunger is then raised as illustrated in Fig. 2 to dish and flange the plate. After the male former has completed the flanging operation, it is lowered, the cone *b*, Fig. 2, descends with the ram and, after it has traveled a short distance, the segments will also drop. When the plate cools, it contracts and also drops.

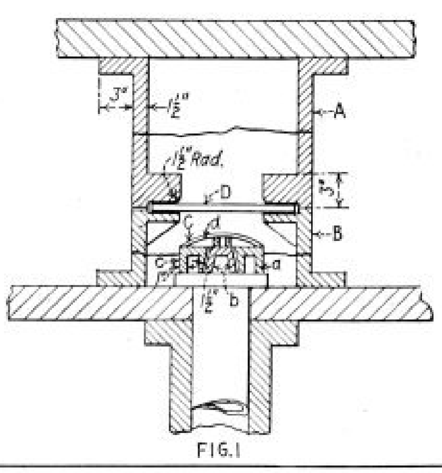


FIG. 1

Section of flanging dies

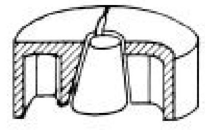


FIG. 3

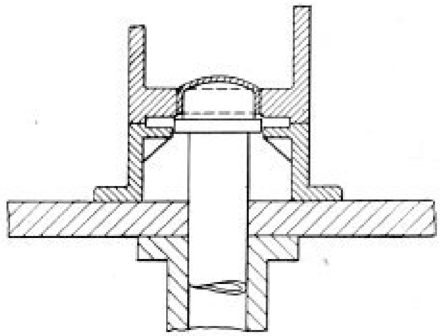


FIG. 2

Details of dies

The height of the male die is usually made 7½ inches with the cones having a diameter of from 3 to 4½ inches at the top and 8 to 9⅜ inches at the bottom.

Locomotive Ratios

Q.—I have your reply of December 3 to my inquiry regarding calculation of locomotive rating. You have evidently misunderstood my question. The rating required is the overall percentage such as is sometimes stamped on the locomotive cab: viz: 30 percent or 35 percent depending on, I think, the weight on drivers as against the tractive effort. It is the method of arriving at this percentage which is required.—A. McD.

A.—If you have use for data on locomotive type boilers relative to design, proportions of the different types, locomotive ratios, etc., I would suggest that you purchase the "Locomotive Encyclopedia" published by Simmons-Boardman Publishing Company, 30 Church street, New York.

The ratio you refer to may be best illustrated by using the values of the total weight on drivers and the tractive effort given for the Mikado (2-8-2) type of locomotive used for freight service.

Total weight on drivers equals 320,500 pounds.
Tractive effort equals, 56,147 pounds.
Ratio = 320,500 ÷ 56,147 = 5.7.

Pittsburgh's Giant Boiler

(*Continued from page 51*)

The furnace is of special construction, having cooling tubes located in the side and rear walls and over the ash hoppers. The furnace is designed to burn pulverized coal, and the furnace volume above the water screen is 19,350 cubic feet. The equivalent grate area is 550 square feet, and area of uptake 140 square feet.

Steam will be taken off from this boiler through two 10-inch nozzles. Feed water connections are 6 inches in diameter. There are seven safety valve connections, each supplied with two 4½-inch valves, making a total of fourteen 4½-inch safety valves.

The boiler is the first of four similar units which are to constitute this plant when completed. As its name implies, the company operates as a central station steam heating plant. Steam is generated at 150 pounds pressure, although the boiler is designed for 190 pounds, and distributed at a pressure of from 3 to 5 pounds for heating and process work. The total cost of the plant will exceed $2,000,000 and will replace three existing plants.—*The Locomotive*.

Letters from Practical Boiler Makers

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

An Electric Welding Job

ELECTRIC welding is now very much applied on boiler repairing work in Holland and the boiler maker foreman so readily takes up this expedient that boiler repairing is no longer to be imagined without the electric arc. The result is that difficult boiler jobs, which formerly required skilled workmen, can now be carried out in a much simpler manner.

The following example shows how a boiler repair would have been performed before the invention of the welding arc and how it is now done.

The front plate of the boiler of the tug "M" was cracked as indicated in Fig. 1. The cracks in the flange to which the shell plate is riveted running from *a* to *b* and the cracks in the flange near the furnaces from *c* to *d* and from *e* to *f*.

Twenty years ago it should have been necessary to renew part of the front plate, Fig. 4, which would have been a very difficult job as the patch had to be fitted under the remaining plate, for which job it would have been necessary to take the boiler out of the boat and to remove a number of the boiler tubes.

Now there were slots cut with the autogenous flame from *c* to *d* and from *e* to *f*, ½-inch wide, through these slots the front plate cracks were thoroughly cleaned and filled, the welding being put in through the slots.

Then the slots themselves were welded for which a ½-inch rod was inserted. The whole job took 2 days, no tubes were taken out and the boiler remained in the ship.

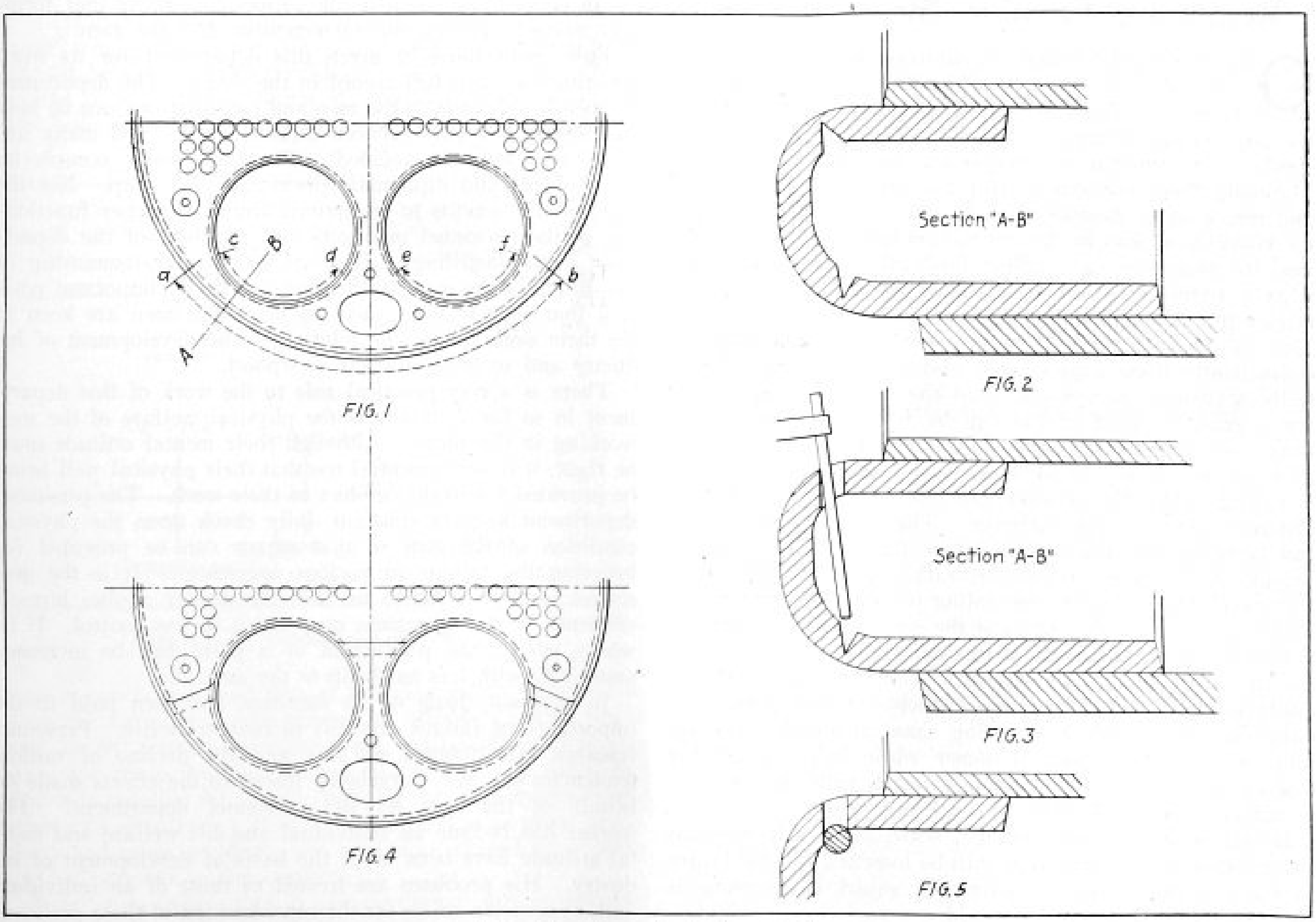
Dordrecht, Holland. D. Kooijman.

Precautions for Personal Safety When Entering Boilers

AN accident of unusual occurrence was recently reported where an inspector of boilers was seriously injured by an explosion of gaseous matter while making an internal inspection with an open flame torch in a horizontal tubular boiler.

The boiler in question was the center one of a battery of five of the same type, operating mechanical underfeed type stokers with open top coal hoppers between fire doors in front of each boiler.

After having made a thorough investigation on the premises of the accident, and from the information de-



Examples of marine boiler welding

rived, it appears the boiler had been out of service for several weeks prior to the time of inspection. When the fire was withdrawn at the time, the boiler was cooled and drained, the bottom manhole was removed, all accumulated scale and matter on the bottom of the sheet was cleaned out and the manhole was left off until the time of inspection.

There was no evidence of a direct cause, excepting a mere theory which the solution offered to those concerned and accepted as the most logical one possible to ascertain, which is as follows: The coal gas and smoke emitting from all the coal hoppers of the stokers on the other boilers were gradually and continually accumulating in the boiler through the open manhole in the front at the bottom of the head. Had the top manhole been removed, a means affording the release of the gas concentrating in the boiler by a current of air would have been effected. In this condition, it proved to be a gas filled storage tank ready to explode its contents when flame was applied.

An opinion was also expressed that the standing gas inside of the boiler may have been formed by the use of oil or compound which was used while the boiler was in service, or some decomposed substance, which in combination with the former theory, expressed above, created an explosive mixture and was ignited by the inspector's open flame torch while entering said boiler.

This unusual accident demonstrates the necessity of extreme care and alertness of mind of all concerned, to first determine the hazards that may be present before entering any boiler.

Therefore, the use of a flashlight is advisable in attempting all such entries for all around efficiency and safety.

Jersey City, N. J. M. BRAUMAN.

Removing Flexible Staybolt Caps

ONE of the most important subjects in railway locomotive boiler shops is the strict and keen inspection required by the Interstate Commerce Commission and the supervising officers of the railways relative to flexible staybolt cap removal for flexible staybolt inspection.

Among those concerned with the supervising, inspecting and removing of flexible staybolt caps, an understanding of the lawful exactions in this connection is well borne in mind, and its provisions are rather faithfully carried out,—but what a tremendous source of annoyance this execution entails, especially with the removal of the *screwed-in* type caps. This job is often disliked by the average boiler maker, and consequently done haphazardly and carelessly due to partially obstructed accessibility and the mean provision made for a grasp or hold of the cap by wrenches which would screw out these caps with definite precision, without ill-effecting results to the sleeves.

Various methods for these cap removals are employed at different shops of the railways. The best of these which has been noticed is a simple square bar wrench of various lengths (as is found desirable), with a round shank turned for a very light chipping or scaling pneumatic hammer, and forged at the opposite end to fit the grasp or hold of the cap it is to fit with the outside of this end turned so it will clear the inside threads of the sleeve. When removing the cap apply hold of bar tool to cap (whichever type it may be, either square or holes) vibrating same at shank end with light blows of pneumatic hammer while helper turns bar tool as near to cap as is possible to reach with an S wrench of sufficient leverage—thereby loosening cap.

By the above method the rust, scale, dried salt, asbestos or any other element adhering, will be loosened without injury to the cap or sleeve. Sometimes a squirt of kerosene is given to a very tight cap as an aid.

Question might be raised concerning the effect of the vibration, upon the screwed or welded tightness of the sleeve to the plate. After giving all the details of other methods of removal thorough consideration, it will be found that in most cases, no matter what amount of caution is given or taken, the cap receives the seemingly inevitable punishing bangs of the hand hammer, which is the cause of nearly all the injury inflicted either upon the cap or sleeve, only to necessitate its complete renewal.

Jersey City, N. J. T. P. TULIN.

The Influence of the Personnel Department

THE results obtained in the development of modern industrial life are being closely brought home to the men working in the shops. The one department which above all others has brought about a better understanding of the requirements of the industries is the personnel department. The writer has had a practical demonstration of this in the operation of the personnel department at the shops of the Kansas City Southern Railroad at Pittsburg, Kansas.

Most of us have no doubt witnessed during past years the turmoil brought about between employers and employees through misunderstanding. Such conditions in certain cases not only jeopardized the effectiveness of production methods but became actually destructive through the spirit of antagonism and slander that was created. With such a spirit in the minds of the men actually doing the work, incentive was practically destroyed and with it industrial growth. The personnel department stepped in at this point and, according to the writer's observation, it has been instrumental in eliminating much of the misunderstanding that formerly existed between the management and the men.

Full credit must be given this department for its work in bringing about full accord in the shops. The department is open at all times to the men and consultations can be held to promote harmony between the two groups and many unpleasant conditions avoided. The department occupies a very critical and diplomatic position in the shop. Not the least of the benefits to be derived from the proper functioning of the personnel managers and members of the department is the instilling of the true spirit of craftsmanship in the minds of the men based upon the vitally important position that they hold in their trades. The men are keen to see their work in its true relation to the development of industry and to broaden their viewpoint.

There is a very practical side to the work of this department in so far as it affects the physical welfare of the men working in the shops. Although their mental attitude must be right, it is very essential too that their physical well being be provided for in the conduct of their work. The personnel department keeps a constant daily check upon the physical condition of the men so that means can be provided for lowering the fatigue in various operations. It is the personnel manager's job to see that the worker applies himself efficiently to the operations over which he has control. If he works wisely, the production of a plant can be increased materially with less hardship to the men.

In the past, little or no attention has been paid to the importance of fatigue analysis in industrial life. Personnel research has changed all this and the decline of radical tendencies can very largely be traced to the efforts made on behalf of the men by the personnel department. The worker has become an individual and his welfare and mental attitude have been made the basis of development of industry. His problems are treated as those of an individual and, as occasion arises for the consideration of these problems with the employer, he is assured of consideration through the advocacy of the personnel manager. The employer realizes the importance of providing the best possible living conditions for his men for their physical as well as mental being and the tendency in industry today is to promote a common understanding between the two groups through the medium of the personnel department.

Pittsburg, Kansas. W. J. BURMAN.

More About Welded Pressure Vessels

I AM in receipt of an interesting letter in reference to my short article in the November issue of THE BOILER MAKER concerning the precautions that should be exercised in buying welded pressure vessels. The writer of the letter has not given permission to reproduce it exactly as written, consequently I will omit all names. He writes practically as follows:

"It is certainly true in welding as in any business that the best workmen and the company with the highest ideals give the best results. While I do not agree with you at all about harmful results of internal stresses in steel being set up due to welding, yet, there is poor welding done, but this is no part of the reason in my opinion.

"For instance, most tanks are rolled or flanged or formed and certainly internal stresses are set up by bending and pulling the material beyond its elastic limit in so forming, and thus, far more than it would be pulled or stretched or bent by any kind of welding, even gas welding.

"Furthermore, it does not hurt the steel to stretch it beyond its elastic limit. In fact, it improves its physical properties. Keep in mind that forging, rolling, bending and working steel in any manner increases its strength and improves its other physical properties."

I am endeavoring to show graphically in the sketches herewith why internal stresses are harmful and why joints should be annealed after welding.

Fig. 1 is a representation of a straight joint which has not been annealed. When the vessel is under slight pressure it can be assumed that at the four points indicated we have the variable tensile stresses of 40,000, 25,000, 50,000 and 25,000 pounds per square inch respectively. It is possible for these internal stresses to exist in the same way that it is possible for them to exist in cast iron flywheels and other cast structures. It is well known that flywheel explosions and other accidents are sometimes caused by existing internal stresses in the castings.

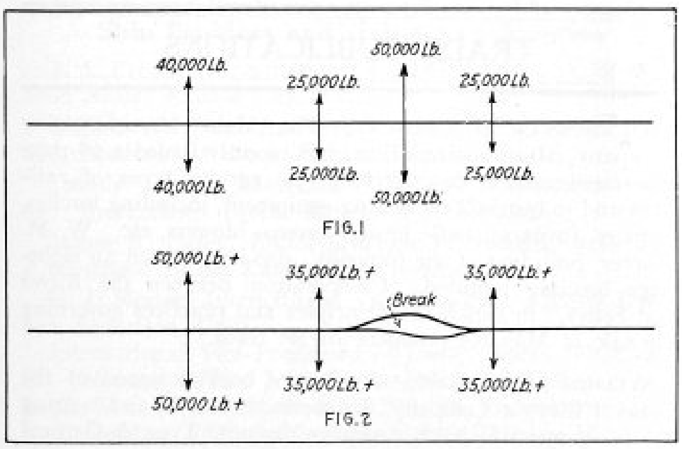


Diagram of stresses on welded joints

Now let us assume that as soon as the pressure is increased slightly in the vessel, Fig. 1, by an amount so that the stress in the metal will be increased 10,000 pounds per square inch the unit stress at the four points would increase to 50,000, 35,000, 60,000 and 35,000 pounds per square inch respectively. However, if the breaking strength of the steel lies between 50,000 and 60,000 the seam will part at the point marked 50,000 and load will be thrown onto the remaining intact portion of the joint so that I have marked the other point "plus"; that is, 50,000 plus; 35,000 plus; etc. The 35,000-pound points are still out of danger but the point marked "50,000 plus" is in danger and if it fractures even the slightest amount, additional load will be thrown onto the points marked "35,000." This continues until the unit load becomes so great all along that the entire seam opens—and possibly it may result in an explosion.

It is true that hammering, drawing, and working steel increases the strength but when that is done the entire rod, or tube, or sheet, or whatever it may be, is drawn and worked at the same time so that the unit stress is uniform throughout. If only a portion of a plate is worked the stress becomes non-uniform and failures are liable to result as explained above.

It may be that since the experience related in the November issue of THE BOILER MAKER a better method of welding electrically or by gas has been developed—I do not know. Nevertheless it is a fact that according to my experience after welding and annealing the joints did not part whereas when welding was done without annealing we had trouble due to joints parting. The concern that did the welding frankly admitted after doing it the second time they were not aware of the benefits of annealing and that in all future work they would anneal.

For example, in the drawing of metal tubes the practice is to draw cold, then heat and anneal, then draw cold again, then heat and anneal and so on until the desired result is obtained. So far as the writer knows it is impossible to draw steel from a thick bar into a thin tube without repeated annealing. It is necessary to anneal so that the unit internal stresses will not become higher than the unit strength of the metal. As soon as that occurs there will be incipient breakage or cracking. Annealing softens and at the same time permits the maintenance of a fairly uniform unit stress.

The writer does not pretend to be an expert at welding or annealing but the above is his understanding and if he is wrong he will be glad to be informed. I have no doubt but that many others who have to do with boilers and the welding of pressure vessels will be glad to learn more about the advantages or disadvantages of annealing after welding.

Newark, N. J. W. F. SCHAPHORST.

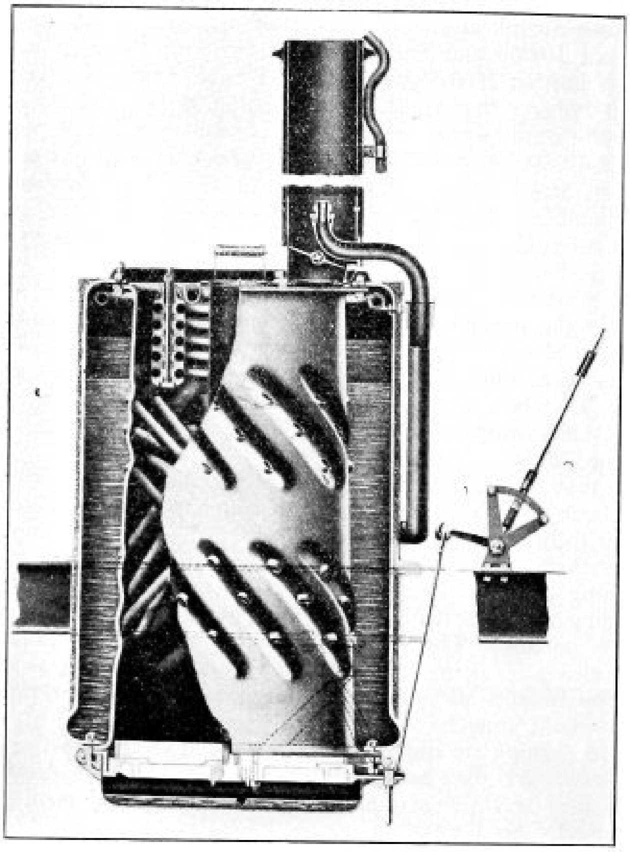
New Roadless Tractor Boiler

(*Continued from page 44*)

Deriving power from a steam engine developing 65 brake horsepower, and having a draw-bar pull of six tons, at the trials referred to the tractor climbed up and down banks of 1 in 1, negotiating 18 inches or two feet of water in a pond with slimy yellow clay at sides and bottom, hauled a load aggregating 85 tons and rode over prostrate tree trunks a foot thick. These feats were performed without the slightest distress, and previous to the demonstration the tractor had run fully 500 miles under working conditions.

BOILER DETAILS

Much of the success of this new tractor during its trials is attributed to its remarkable boiler. This is a steam generator of surprising capacity, having evaporated as much as 1,800 pounds of water per hour. In its quick-steaming properties it is almost in the watertube class, but it is equal in every way to the old Lancashire pattern for standby and reserve capacity. All the inherent weaknesses of the locomotive type have been eliminated. The boiler has been hydraulically tested to 1,100 pounds, although the working pressure is only 230 pounds.



Section of tractor boiler

This boiler consists essentially of a cylindrical outer shell, and an almost cylindrical inner shell or firebox. The two are connected together by two annular faced joints at the top and the bottom of the shell, the top joint being somewhat wider in diameter than the bottom one in order to allow of the ready withdrawal of the firebox.

Across the firebox are a number of straight spirally disposed tubes. These are simply expanded into a series of spiral landings pressed into the flanks of the firebox. No stay tubes are required and no stays. When the boiler was tested up to a hydraulic pressure of 1,100 pounds per square inch, the tube ends leaked and allowed of no further pressure being applied. Nothing worse than this happened and no deformation of the shell or firebox was observable. As the working pressure is merely 230 pounds, it will be seen what an enormous factor of safety has been provided. To guard against low water the firebox is fitted with a fusible plug which can be relied on to melt and put out the fire, thus eliminating one of the most fruitful causes of boiler mishaps.

By undoing the two rings of studs at the two annular joints connecting the firebox and shell, the former can be dropped clear of the latter, and in this condition every portion of the interior of the boiler is open for inspection and cleaning. This can be carried out without disturbing any of the pipe connections. Moreover, opening up of the boiler like this also permits of the tubes being cleaned, withdrawn, or re-expanded as may be required, from time to time.

Owing to the very rapid circulation brought about by the steep angle of inclination of the tubes, the thermal efficiency of the boiler is relatively high, so that it has been found possible to burn in it such varied fuels as coal, charcoal, coke, and wood, and with special fittings oil fuel or plantation refuse such as bagasse can be used.

A superheater which dries and superheats the steam to 150 degrees F. above the saturation temperature is fitted in the top of the firebox. A feedwater heater is also supplied and this uses the remaining heat in the exhaust steam from the engine to preheat the feedwater almost to the boiling point before it enters the boiler. These two accessories save considerably on fuel and undoubtedly add to the life of the installation. In working, the tractor has a weight of approximately eight tons.

Five years of hard experimental work in laboratory and testing shop are responsible for this tractor, and the exhaustive research carried out during this time has evolved a boiler of surprisingly high efficiency.

BUSINESS NOTES

John Heller, for a long time one of the directors of the International Oxygen Company, Newark, N. J., has been appointed sales manager.

Col. Eugene C. Peck, who has served for almost 25 years as general superintendent and later as works manager of the Cleveland Twist Drill Company, Cleveland, Ohio, has retired from active management. He will continue, however, as a stockholder in the company and as a member of the board of directors.

The Chicago Pneumatic Tool Company has entered into an agreement, whereby it will become exclusive distributor in the United States of the Pedwyn balancer. This device provides means for suspending, lifting and balancing of electric and pneumatic portable tools, increasing labor efficiency and decreasing overhead hazards. The company also announces the opening of a branch office in Mexico at Apartado 695, San Juan de Letran, 15 Mexico City, D. F.

TRADE PUBLICATIONS

OIL-BURNING EQUIPMENT.—The Mahr Manufacturing Company, Minneapolis, Minn., has recently issued a 64-page illustrated catalog descriptive of its various types of railroad and industrial oil-burning equipment, including torches, burners, furnaces, ladle heaters, ovens, blowers, etc. W. M. Horner, president of the company, also has written an eight-page brochure entitled, "Co-operation Between the Buyer and Seller," in which the principles and practices governing the sale of Mahrvel products are set forth.

WELDING ELECTRODE.—A 12-page booklet issued by the General Electric Company, Schenectady, N. Y., and bearing the designation Y-2019, describes the new Type A General Electric welding electrode. Details are given on electrode construction and characteristics. Results of tests on welded cast iron specimens and deposited metal specimens are described, and oscillograms demonstrating arc stability are reproduced. Instructions for the use of the electrode are supplied and specifications of the standard sizes given.

STOKERS.—Catalogue E-5, illustrating and describing the Type E single retort underfeed stoker and its principal parts, has been issued by the Combustion Engineering Corporation, New York. The results of typical evaporative tests of Type E stokers are given in tabulated form, and a curve shows the efficiency of the stokers at various boiler ratings, using a good grade of bituminous coal. Representative Type E stoker installations and other products of the Combustion Engineering Corporation are also listed.

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

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

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President—J. P. Moses, Jos. T. Ryerson & Son, Chicago, Ill.; Vice-President—F. H. McCabe, McCabe Manufacturing Co., Lawrence, Mass.; Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

SELECTED BOILER PATENTS

Compiled by

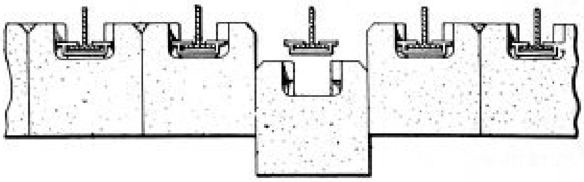
DWIGHT B. GALT, Patent Attorney,

Washington Loan and Trust Building
Washington, D. C.

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

1,506,458. CLARENCE A. STRACHOTA, OF ST. PAUL, MINNESOTA. FURNACE ARCH FOR BOILERS.

Claim 1.—In a furnace arch, laterally spaced beams, block hangers each slidable on a single beam, and arch-forming blocks underlying said beams

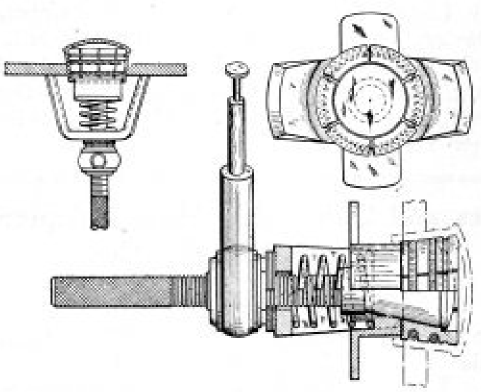


and detachably interlocked to said hangers, said blocks having vertical clearance passages adapting them to be detached from and interlocked with said hangers without sliding said hangers out of the space normally occupied by said blocks.

6 claims.

1,521,008. TOOL FOR INSTALLING BOILER HANDHOLE CAPS. SAMUEL BRAINERD CLAY, OF ST. LOUIS, MISSOURI, ASSIGNOR TO HEINE BOILER COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

Claim 1. A tool for the purpose described, comprising a plurality of expansible jaws that are adapted to be inserted in a hollow element preparatory to moving said element endwise with relation to a part in which it

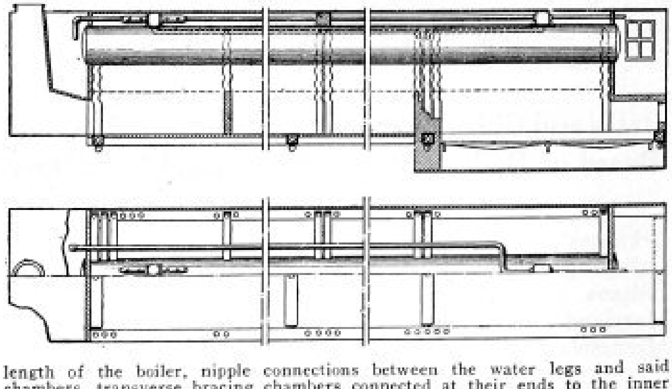


is positioned, a tapered member which said jaws surround, a spring-pressed member moveable relatively to said tapered member and arranged so that it normally exerts pressure on said jaws in a direction tending to hold them expanded, said spring-pressed member being adapted to be moved manually in a direction to permit the jaws to collapse, and means combined with said jaws for collapsing them automatically when said member is moved manually in the direction specified.

Nine Claims.

1,514,685. LOCOMOTIVE BOILER. JOHN J. CAIN, OF BAYONNE, NEW JERSEY.

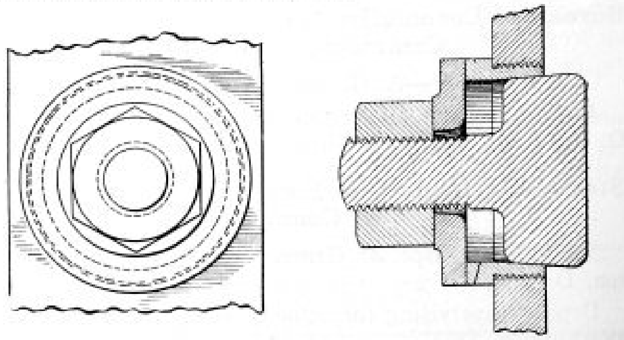
Claim. A locomotive boiler, comprising narrow hollow sections transversely arranged, having water legs at their side edges and spaced apart to afford vertical heating passages between them, a longitudinal chamber beneath the water legs at each side of the sections and extending the full



length of the boiler, nipple connections between the water legs and said chambers, transverse bracing chambers connected at their ends to the inner sides of and spaced apart throughout the length of the longitudinal chambers and a blow-off connection located at the central part of each of the transverse chambers, whereby all parts of a long boiler at both of its sides may be uniformly adequately cleaned.

1,518,326. HANDHOLE PLUG. JOHN HENRY HOFFMAN, OF WEST BRIGHTON, NEW YORK, ASSIGNOR TO POWER SPECIALTY COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1. The combination with a metallic chamber wall formed with an opening of a rigid metallic bushing member insertable into said opening

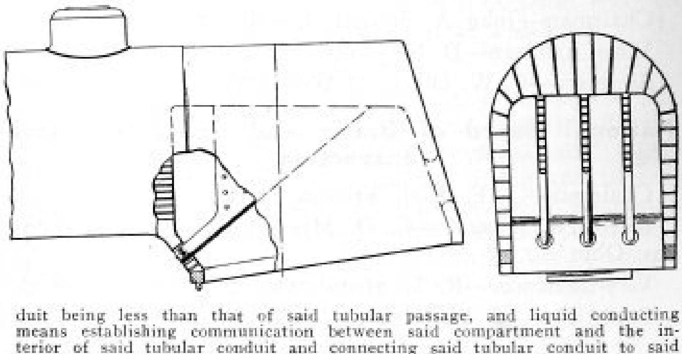


ing from its outer end and firmly secured therein, and a tapered metallic hand hole plug entering the inner end of the passage through said bushing and prevented by its taper from passing axially through the latter but of a maximum external diameter small enough to pass through said opening.

Five Claims.

1,517,344. FLEXIBLE CONNECTION FOR BOILERS. LEWIS W. CRAFT AND JAMES H. BASSETT, OF KANSAS CITY, KANSAS.

Claim 1. In combination, a compartment adapted to receive liquid and having a tubular passage extending therethrough, a tubular conduit extending into said tubular passage, the cross sectional area of said tubular con-

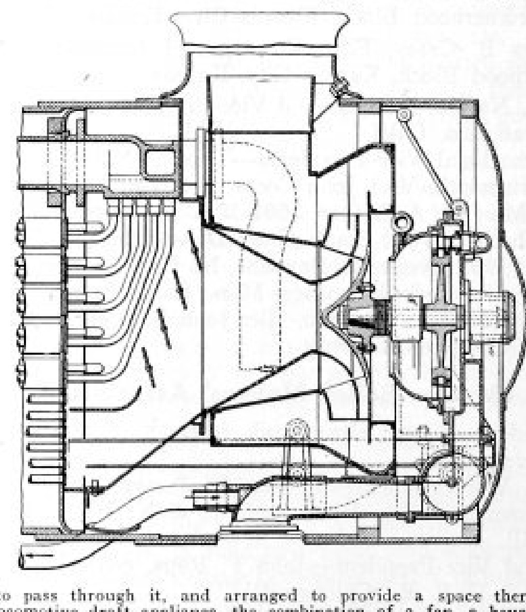


duit being less than that of said tubular passage, and liquid conducting means establishing communication between said compartment and the interior of said tubular conduit and connecting said tubular conduit to said tubular passage, said liquid conducting means comprising two pairs of flexibly connected together aligned sections so that the tubular conduit may have limited movement relatively to the tubular passage.

Five Claims.

1,520,956. LOCOMOTIVE DRAFT APPLIANCE. ANTON K. KUSEBAUCH, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO LOCOMOTIVE STOKER COMPANY, A CORPORATION OF PENNSYLVANIA.

Claim 1. In a locomotive draft appliance, the combination of a fan, a housing about the fan, an inlet member leading to the fan, and a foraminous member in said first member discharging into the fan particles too

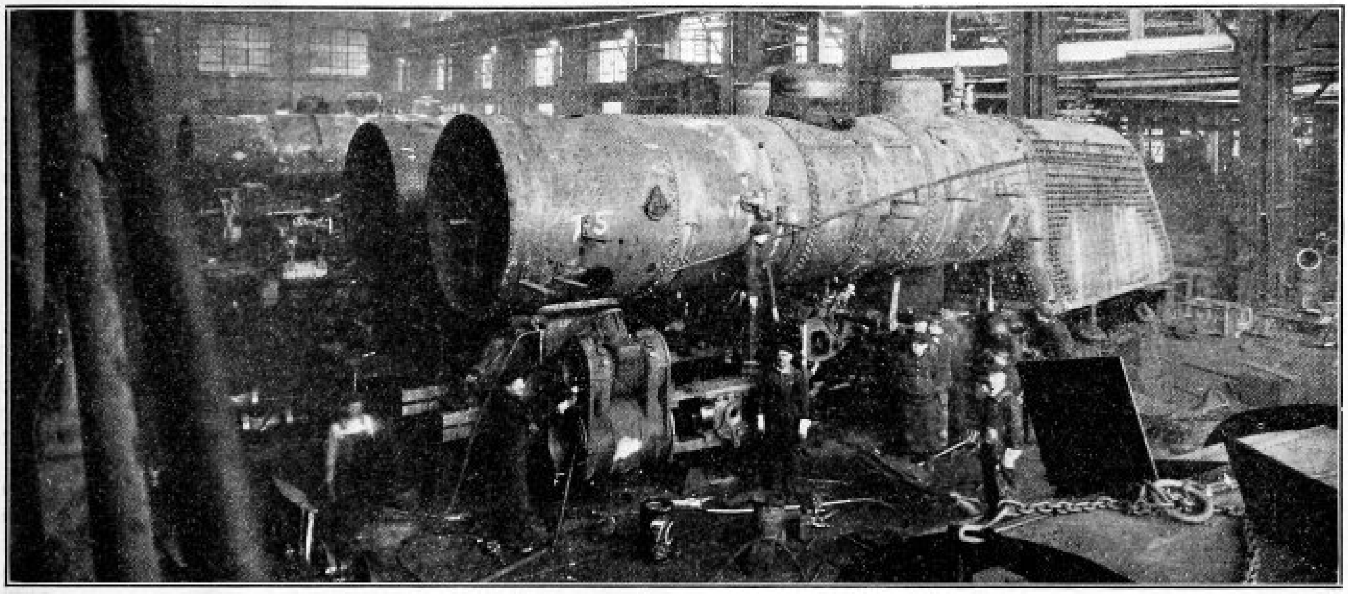


large to pass through it, and arranged to provide a space therebetween. In a locomotive draft appliance, the combination of a fan, a housing about the fan, a cone-shaped inlet member leading to the fan, and a foraminous cone-shaped inlet member in said first member, arranged to provide a space therebetween.

Twelve Claims.

THE BOILER MAKER

MARCH, 1925



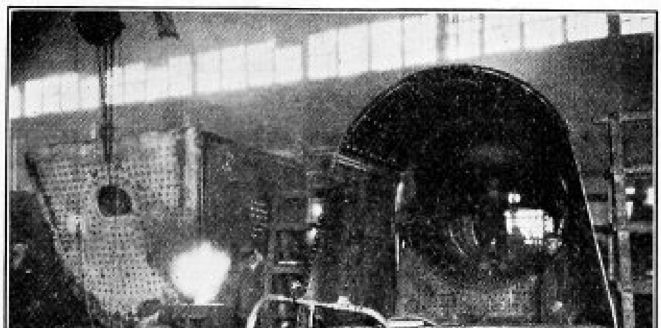
General view of erecting shop at Lima Locomotive Works

Boiler Production at the Lima Locomotive Works

An average production of forty locomotive boilers a month is maintained by a highly organized shop staff

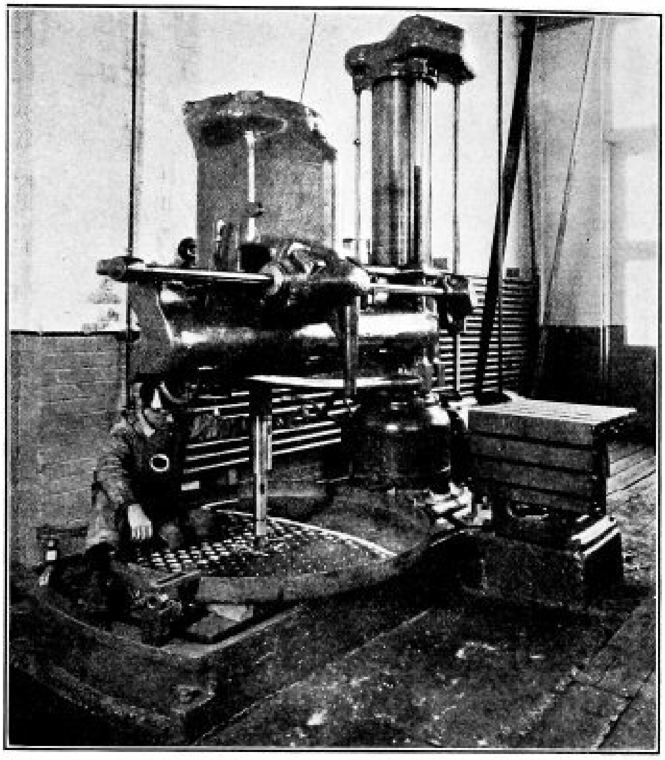
THE boiler shop of the Lima Locomotive Works at Lima, Ohio, offers a number of production features that are unique in the locomotive industry. Although there are much larger plants building boilers, there is probably none that surpasses this plant in quality or thoroughness of workmanship. The building housing the boiler department is an entirely self-contained unit capable of handling all operations entering the construction of the boiler. When a boiler is taken from the test stand at one end of the shop it is ready for immediate connection to the frames and running gear in the erecting shop.

All operations are arranged consecutively so that material once put into the production process follows a straight path through the shop and is gaged to arrive at the assembly floor in the proper order for installation.



Firebox work in the boiler shop

Probably the best way for the reader to follow the working of the plant is to refer to the floor layout of machinery shown on page 62. The building is of brick and steel construction well lighted both by natural and artificial means. It consists of the main shop and a subdivision partitioned from this by a brick wall, in which the preliminary plate layout and plate flanging work is carried out. After work in this department is completed, the plates are brought into the main section of the shop and the barrel sheets rolled and riveted on the bull. The fireboxes are assembled, flange sheets laid out, drilled and fitted, the mud rings machined and installed, fire-



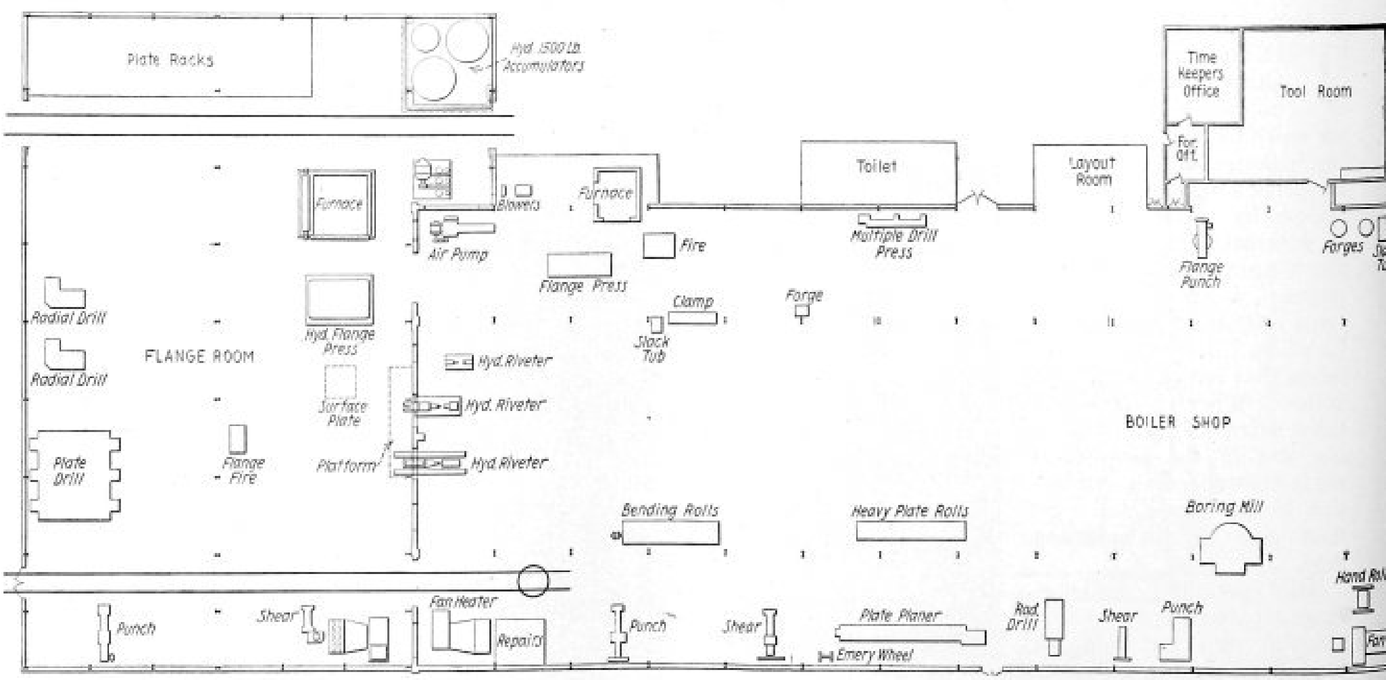
Drilling a tube sheet

box connections made, tubes installed and finally the tests carried out—all in a continuous process. The boiler shop equipment is complete. It consists of the following machines with the locations as shown on the shop layout: In the plate working section and flange department are one vertical type Hilles and Jones shears having a 3-foot gap and capacity for 1-inch sheets with foot lever control; a Cleveland Punch and Shear Company vertical punch having a 3-foot gap, 1½-inch hole, with capacity for 1-inch sheets with hand and foot lever control; a 6-head gang radial drill with a 6-foot travel head, a car type table, 7-foot swing, 2-inch capacity and automatic speed regulator (this machine was made by the Niles-Bement-Pond Company); the vertical hydraulic flanging press in this department is of 790 tons capacity having 7 cylinders, 4 posts, a fixed table, 9 feet 10 inches by 14 feet 10 inches, and a movable table also 9 feet 10 inches by 14 feet 10 inches. It is operated by a hand lever hydraulic control; R. D. Wood Company was the manufacturer. The remaining equipment in this department includes a large furnace, flange fires and surface plates.

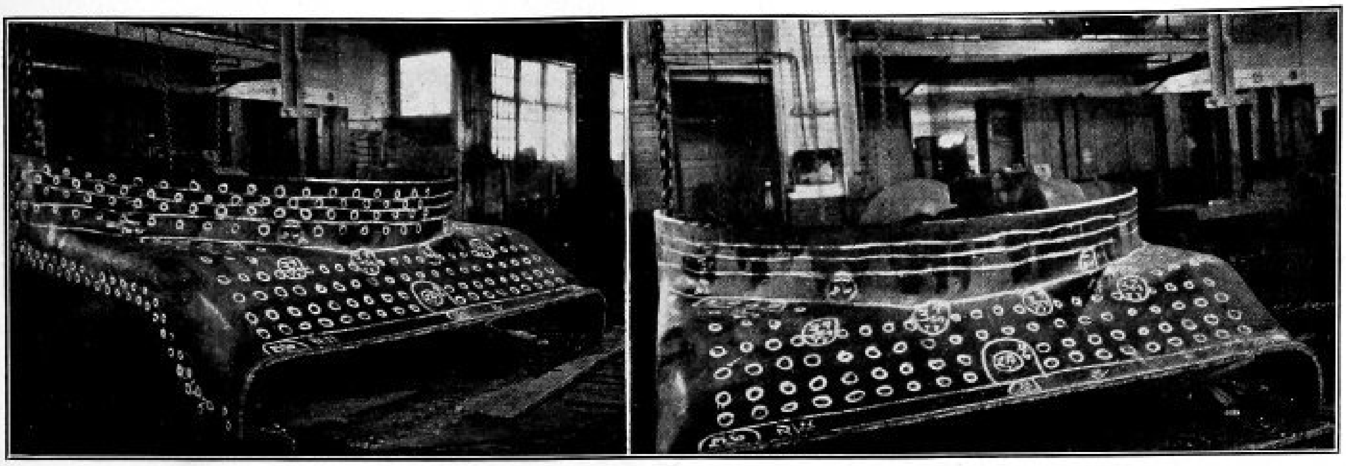
In the main shop, where riveting, flange drilling, fitting, plate bending, and the like, are carried out, the equipment is as follows:

Three hydraulic riveters are used, one made by the Morgan Engineering Company, having a 17-inch gap, 16-inch stroke, 9-foot reach with an operating pressure of 1,485 pounds; a 15-inch gap, 13-foot reach Niles-Bement-Pond Company riveter, also with 1,485 pounds working pressure; a third hydraulic riveting machine has 16-inch gap, 15-inch stroke, 19-foot reach. It was made by R. D. Wood and Company and has a pressure of 1,485 pounds. All these machines have a hand control.

The shop is equipped with two plate rolls. The larger is a horizontal type Niles-Bement-Pond machine with one 22-inch roll, two 15-inch rolls, 14 feet 6 inches between housings, capable of handling 1-inch plate. This machine has a hand clutch control. The second, an electric roll, manufactured by Bertch and Company, has one 15½-inch roll and two 14-inch rolls with 12 feet 2 inches between housings. The capacity is also 1-inch plate. Adjacent to the rolls is a 60-inch vertical boiler plate punch having a 4-inch gap, 1⅜-inch hole, for 1-inch sheets. This was made by the Cleveland Punch and Shear Works. Near the flange department is a goose neck hydraulic flange press of 150 tons capacity having 4 cylinders, 4 feet 1 inch under ram and 4 feet 4 inches from ram to frame of Niles-Bement-Pond Company manufacture. Other equipment includes a 60-inch horizontal type boiler plate shears, 3-inch gap, 18-inch cut, one-inch sheet, foot lever control, manufactured by the Cleveland Punch and Shear Company; a plate planer having a length of bed of 29 feet 6 inches; table, 13 inches by 30 feet 6 inches; one traveling head, one speed, hand clutch control, manufactured by the Niles-Bement-Pond Company; one six-head multiple vertical frame drill, 14-



Floor arrangement



Two views of an outside throat sheet as marked out for drilling

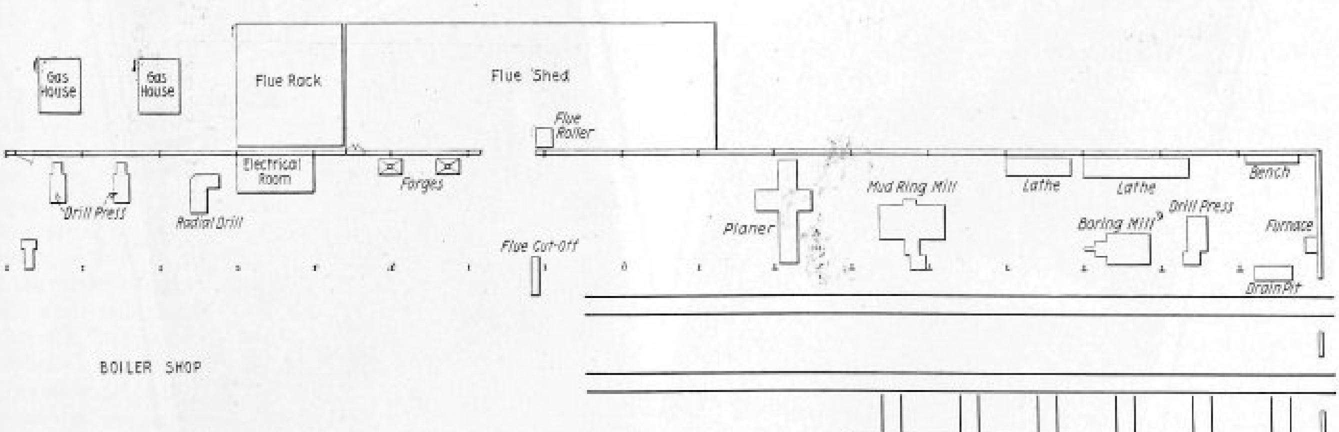
inch spindle travel, 18-inch hand travel, sliding table, 30 inches by 12 feet with a 12-foot bed; pump circulating water system, Niles-Bement-Pond; vertical sheet metal shears, 15-inch cut, ½-inch sheet, 13 inches between housings, 2-inch gap, foot control, Long and Allstatter Company; vertical sheet metal punch, 5-inch gap, 1-inch capacity, 1-inch hole, ½-inch sheet, Cleveland Punch and Shear Company; vertical boring mill, 100 inches, two-spindle, two-heads, head travel horizontal 4 feet 2 inches, vertical 4 feet 5 inches, quick change speeds and feeds, Niles-Bement-Pond Company; horizontal throat punch, 8-inch gap, 2-inch capacity, 2-inch hole, ½-inch sheet, 2-inch stroke, Long and Allstatter Company; horizontal flanging clamp, 8-inch opening, 12 feet 3 inches between housings, air cylinder on end operated by shop compressed air service; two-wheel emery grinder, two 16-inch diameter wheels, one speed; angle iron shears, 1-inch gap, 3-inch cut, 1-inch by 1½-inch bolts, foot control, Reade Machine Company. In this department the remaining equipment includes warm air fans and heaters, furnace flange fires, a forge, a set of hand rolls and flanging clamps.

In the machine department is a 5-foot radial drill press, 2-foot 3-inch by 4-foot 3-inch table, 6-foot 8-inch bed, 6-foot swing, 3-inch drill capacity, Niles-Bement-Pond Company; two 5-foot radial drill presses.

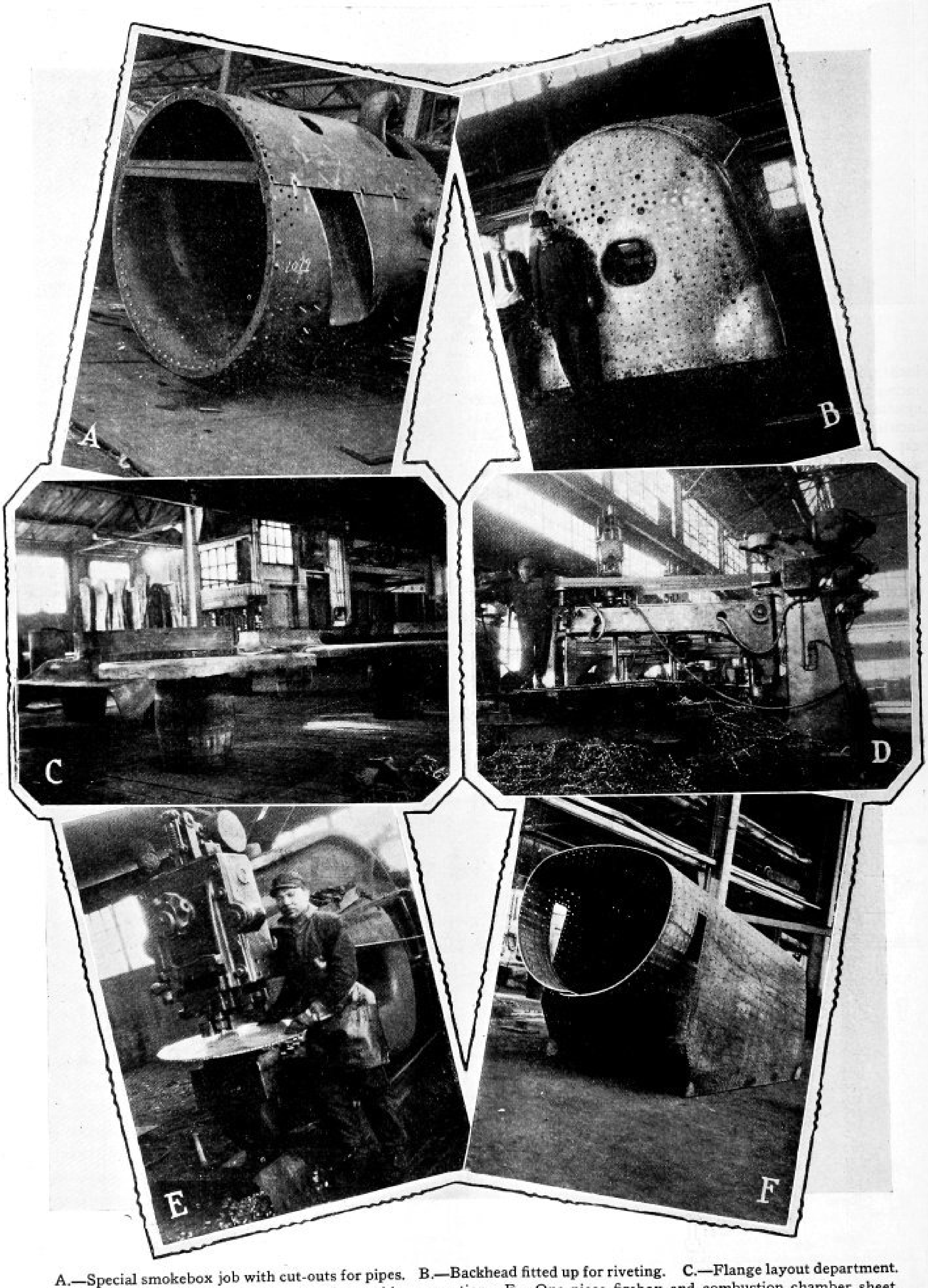
In the flue department is a rotary type flue welder of 6-inch capacity with a foot control manufactured by H. V. Hartz Company. There is also a 6-inch flue cutting off machine having a channel iron bed, 12 inches by 6 feet 6 inches, hand feed and control. This machine was made in the shop.

In the section devoted to mud ring machining are drill presses, planers, boring mills, lathes and the like.

In the staybolt department is a horizontal bolt shears, 1½-inch capacity, 2-inch gap, 7-inch between housings, J. K. Knight Company; 1½-inch horizontal bolt threading machine, two 2-inch heads, two spindles, Acme Machine Tool Company; three-spindle Lassiter telltale drill, two drill heads, ¼-inch capacity; belt-driven oil pump, S. Bliss Company; 10-inch vertical drill press, 16-inch diameter movable table, 10-inch swing, 10-inch spindle, manufactured by W. F. and L. Barnes; vertical Lassiter staybolt threading and reducing machine, five heads, 1⅛-inch capacity, Massey Machine Company; vertical Lassiter staybolt threading and reducing machine, six heads, 1¼-inch capacity, Massey Machine Company; 2-inch threading machine, Landis Machine Tool Company, 36-inch by 63-inch bed, two heads, automatic feed; 16-inch by 8-foot engine lathe, Flather and Morse Tool Company; 2-inch horizontal bolt threading machine, two heads, automatic screw feed, 31-inch by 7-foot



boiler shop equipment



A.—Special smokebox job with cut-outs for pipes. B.—Backhead fitted up for riveting. C.—Flange layout department. D—Six head drilling machines. E.—A punching operation. F.—One piece firebox and combustion chamber sheet.

bed, Acme Machine Tool Company; centrifugal rotary tub type oil separator, 5 gallons capacity; 2-inch horizontal turret lathe, six heads, three turning, one cutting off, one drill holder, one die, one revolving turret, Jones and Lamson Machine Company.

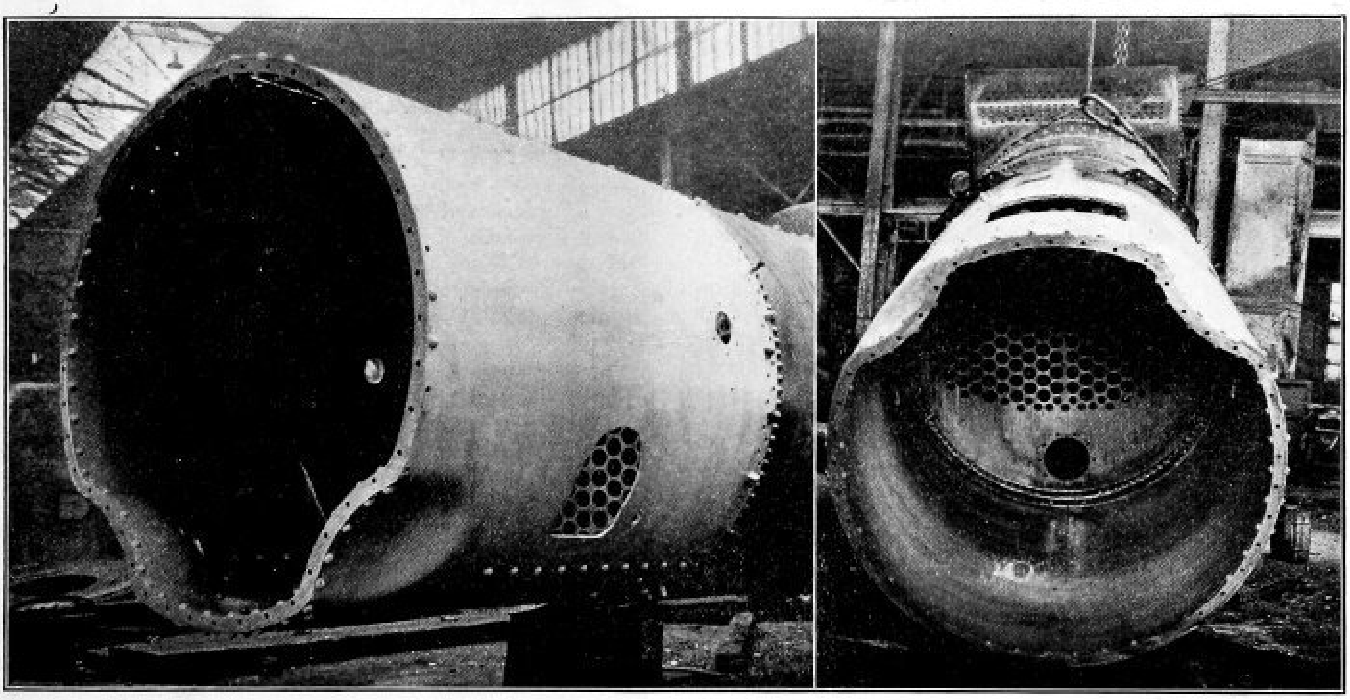
Other miscellaneous equipment in the shop includes a 6-foot radial drill press, plain table, 2 feet 4 inches by 2 feet 4 inches, back geared, 6 feet 6 inches length of bed, 2-inch drill capacity, Niles-Bement-Pond Company; one pin flanging clamp, 6 feet wide, 15-inch opening, air cylinder on each end, Hilles and Jones Company; one pneumatic flue hammer or welder, 2½-inch stroke, Draper Manufacturing Company; two-cylinder pneumatic hammer, 2½-inch stroke, Draper Manufacturing Company; rotary type flue welder, 6-inch capacity, foot control, H. V. Hartz Company; a number of drill grinders and emery wheels, heaters and fans are also included.

Personnel of the Boiler Shop

The working force in the boiler shop is effectively divided into departmental gangs so that the men engaged on the various operations are in effect specialists in their work. The force includes about 350 men, all coming under the supervision of the general boiler foreman. Directly under the general boiler foreman are five assistant foremen—one in charge of each shop department. One foreman has control of the plate layout department, flange tires, punches, shears, rolls and bull riveter. Another takes the boiler as it comes from the bull and applies the firebox, braces, sleeves and staybolts. From his charge the boiler comes under the supervision of a third foreman who supervises the flue application and boiler tests. Still another foreman is in charge of work in the staybolt room. The fifth assistant carries out all sheet metal work, dome casings, sand boxes, ash pans and the like. The working force is divided under these foremen about as follows: Six or seven men are engaged in the plate department on plate layout. Five men carry out drilling and punching operations, fifteen men handle flange fire work, five men shearing and rolling operations and eight men are at work on the bull riveter. In the fit-up gang are sixteen men with two additional on the planers and two on the mud ring drill press. The brace gang is made up of eight men.

The next gang, applying the back head, dropping the firebox, fitting up the mud ring corners, etc., consists of six men. The hand riveting gang includes twelve men. Twenty-two men do the hand reaming and drilling, fourteen are engaged on the sleeve job. The staybolt gang, divided in two shifts of two days and two nights alternately, consists of twenty-four men. About twenty electric welders carry out the welding of sleeves, flues, firebox and other welding jobs. Six men do the staybolt cutting, while there are twelve others on miscellaneous staybolt jobs, such as drilling telltales.

In the next department, twelve men carry out the flue installation; six men the replacement and cap work and ten men do all boiler tests. About ten men in the staybolt room do the threading and cutting while seven others work on the drill presses. In the sheet iron department, thirty-five men are engaged on ash pans, dome casings and other light work.

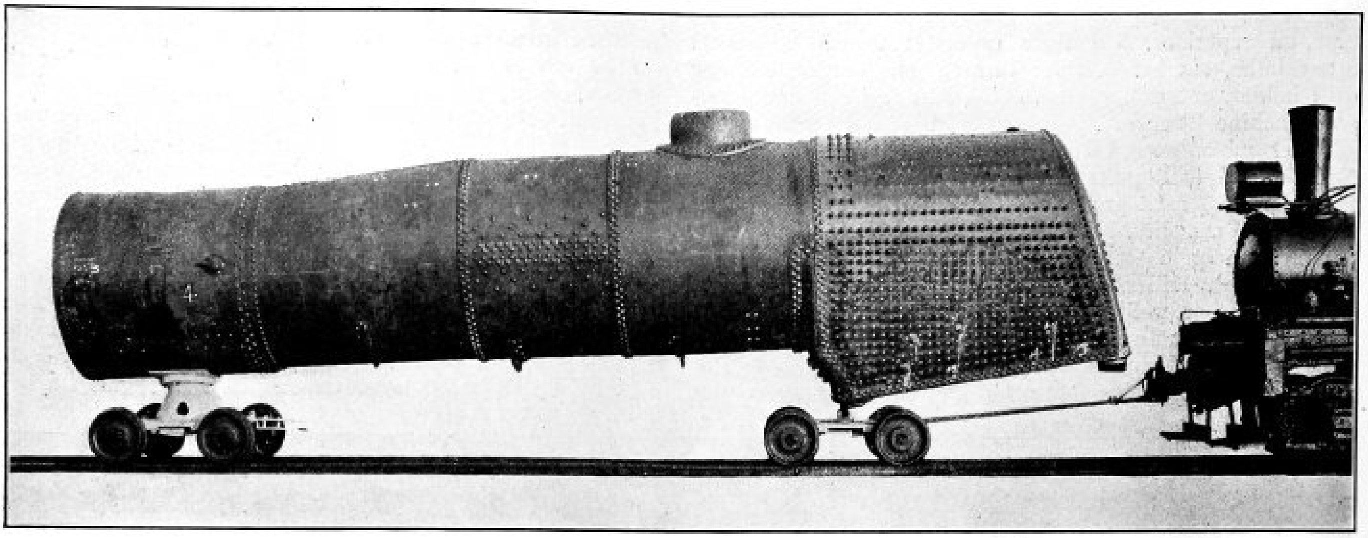


Another special smokebox job

The shop is able to handle under normal production about forty to forty-five boilers a month, although this number can be greatly increased under forced production.

Layout Work

The layingout methods developed at Lima have been particularly successful, and offer features that would seem to be more or less original in locomotive building. At this plant the shop layout department is entirely responsible for the accuracy of boiler drawings when the job is completed. The drawing room gets out the general boiler details, as is customary in all plants. On these drawings are shown the general arrangement of the boiler with openings and vertical and horizontal center lines. The layout department, working from the general boiler plan as a basis, develops the boiler and all its sheets. The work starts with the smokebox ring which is the first to be laid out. Each course follows in order and must check with the smokebox and other courses previously made. The first set of plates developed is used as a template for laying out other boilers on the order. If an error is found on the boiler drawing a check is first made and then the correction sent to the drafting room

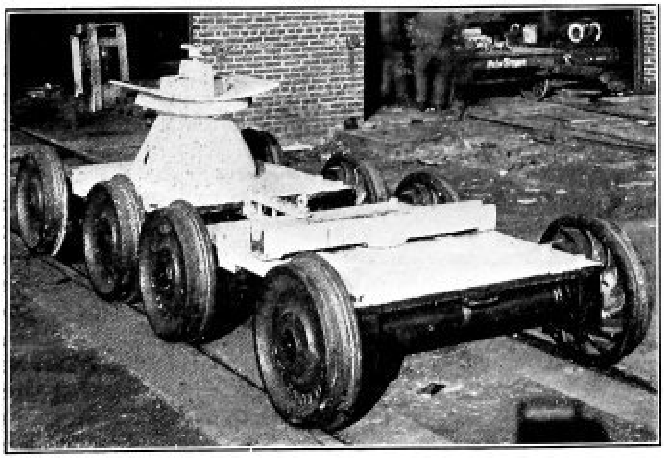


Special trucks for handling boilers between boiler shop and erecting floor

where it is incorporated in the general boiler plans. When the revised drawing is finished, work on the layout floor goes forward.

The layerout spaces all staybolt holes and makes his own diagrams. This is done for both the firebox wrapper and crown sheets. All flanges are laid off for the flange fire. This work is carried on in a subdivision of the shop devoted to plate work. Then the flange sheets go into a special department in the main shop where thin sheet templates are developed for locating all holes in the flanges. Two views of an outside throat sheet, as it is marked up for drilling in this department, are shown on page 63.

The template used is generally of 12-gage metal laid off so that the differences in thickness of metal between it and the boiler sheet are allowed for. All holes are laid out and drilled before the flange sheets are put in place. The accuracy obtained by this method is remarkable and is well demonstrated when the flange sheets are fitted up. Holes in the wrapper sheet and crown sheet check almost perfectly. Holes in back head flanges and wrapper sheet, between courses and between tube sheets and their connections rarely require reaming for bringing them in line. All holes are drilled with a slight allowance for reaming but this allowance is seldom required for lining up the holes. The result of this method of laying out is that the accuracy of the work is absolutely assured with a constant check on the boiler drawings. When the first boiler on an order is completed, as many others can be made from the drawings as are required—all duplicates of and interchangeable with the first. Replacement parts or complete sheets can be made at any time from the corrected drawings with the assurance that they will absolutely fit.



Close up view of boiler trucks

It is the practice of this shop in carrying out firebox welding to "V" both sides of the sheets and weld inside and out.

Another special feature of the boiler work is the use of solid cast steel mud rings to replace the customary built-up rings having cast steel ends and wrought iron sides. With the solid ring, fitting up and welding of the assembled ring is avoided. The only special care required with the cast steel ring is in straightening it after cooling.

For drilling extra wide plates, it was found that the table of the six-head gang radial drill, shown on page 64 was too narrow. In order to adapt the machine for wide work, one of the end heads has been made readily removable and the plate to be drilled is fed in endwise. In the case of the bending rolls too, it was found that some of the single sheet firebox plates were too wide, so the shop rolls were extended 32 inches. The work of lengthening the rolls was carried out in the shop. The original rolls were taper bored and the added section fitted into the taper with a shrunk fit. After this the seam was welded and ground down. Two roller bearings were installed under the joint to take care of any strain that might occur when rolling plates.

Another rather interesting item of shop equipment is a special truck made to carry finished boilers from the test department to the erecting shop. An excellent idea of the work may be gained in an illustration shown on this page.

Boiler Tests

Great care is exercised in carrying out the tests of the finished boilers. First the boiler is given a hydrostatic test with the pressure 25 percent above the working steam pressure. Next the boiler is fired and brought up to the working pressure. It is then blown down and fired up to pressure again. After this it is again blown down and fired a third time. This repeated firing is done so that the expansion and contraction strains occurring at each stage of heating and cooling will show up any leaks that may be present in the boiler. When these leaks develop under the continued working they can be eliminated for good. After the third firing test the water is drawn, appliances fitted and a refiring test made before the boiler goes to the erecting shop.

During the final running test on the boiler, men from the boiler shop are present to take up any leaks that may develop.

(*Continued on page* 88)

Effect of Water in Boilers Causing Scaling*

Researches carried out in England on the causes and prevention of priming, corrosion and scaling

IN the working of a boiler one of the most important points to watch is that of the water supply. This is particularly the case with a locomotive boiler where the concentration is much higher than that found in the majority of steam-generating plants. Even today a capacity of 1,000 gallons of water, weighing 10,000 pounds, is fairly high for a locomotive boiler, while a consumption of 3 tons of coal during a trip is not excessive.

Assuming that 8 pounds of steam are evaporated per pound of coal, this gives $6,720 \times 8 = 53,760$ pounds of steam evaporated during the run, and means that whatever impurity there is in a gallon of water at the beginning of a journey which has not passed off with the steam has increased by 5.376 times at the end of the journey. If we assume that there are in the water as fed into the boiler 10 grains of sodium salts per gallon, these will be increased to $10 \times 5.376 = 53.76$ grains per gallon at the end of the day. If not washed out or blown off and a similar trip be run, 53.76 grains more will be added, making a total of 107.52 grains per gallon.

It will be appreciated that the troubles arising from concentration of impurities with a locomotive boiler are worse than with the generality of watertube boilers, which usually work in conjunction with a plant where condensers are used, from which the condensed water is returned to the boiler. It is interesting to note that recently considerable attention has been given to using water especially condensed for the "makeup" water of these boilers.

A railway company running over any area of country has to deal with water of widely varying composition, and, in connection with this, one line in particular has introduced a system of coloring its water columns, tanks, etc., red where the quality of the water is bad or its price excessive, and the apparatus at other points yellow, so that drivers may fill up whenever possible at points where it is advantageous.

It is not possible to deal fully with the general composition of water used for locomotive boilers, or with the effect of all the varying constituents one meets with, and one may refer those who require detailed information to a little book, recently published, on "Boiler Feed Water," by Percy G. Jackson, F.I.C. (Charles Griffin & Company), one who was for some time connected with the chemical laboratory of one of the railway companies and afterwards for many years chemist to one of the large boiler insurance companies.

The chemical impurities in water may lead to trouble from three causes—scale, priming and corrosion—and it is proposed to deal with these three briefly.

Scale

Scale results from the deposit of the various chemical impurities in the water, and is sometimes intensified by the water being muddy, i.e., by suspended matter in it. Nearly all waters contain a certain amount of calcium bicarbonate. This upon heating is decomposed into calcium carbonate and carbonic acid, the former of which is only slightly soluble in water, with the result that a quantity of it is, upon the water reaching boiling point, deposited in the form of scale. The hardness which results from this is spoken of as "temporary hardness," a term sometimes applied to the calcium and magnesium carbonates contained by water. One of the troubles of this type of hardness is the fact that scale tends to be deposited in any feed pipe the temperature of which reaches boiling point before the water is discharged.

Of the other constituents found in feed water the most common are calcium sulphate, magnesium carbonate, and magnesium sulphate. These are all more soluble than calcium carbonate, but, either in the form in which they exist or into which they become converted, are liable under the conditions in which water is used in a locomotive boiler to form scale. This is where the disadvantage of the "concentration" previously mentioned comes in. The amount of the constituents when the water is fed in may be comparatively small, but as they are not carried off by the steam, the grains per gallon become higher and higher until, finally, the water becomes saturated and crystals are deposited and form scale. In most cases the constituent minerals are more soluble in hot water than in cold, and so it is advantageous to blow off at as high a temperature as possible.

Although, if the hardness of water were due to a single chemical impurity only, one could predict what form the scale would take, this is impossible when there is a number, as is usually the case. Experience, however, will show whether the scale is likely to be hard and dense or soft and muddy. Although the latter is much easier to work out, it is in many cases even worse from a heat-transmitting point of view. This is probably due to the bubbles of steam, which are poor conductors of heat, being trapped in the soft scale or mud.

Priming

Priming is probably more liable to occur in a locomotive boiler than in any other type. In the first place, the amount of steam given off per unit of water surface area is very great and, secondly, priming is more liable to take place when a sudden demand for steam is made than when the supply is regular. It often happens that a locomotive, after running with steam off on a down grade, is faced immediately with a heavy rising grade, with the result that the regulator may be suddenly opened almost to its full extent. This may result in water being carried over to the cylinders.

One of the chief causes of priming arises from the concentration of sodium salts in the water in the boiler, namely, sodium carbonate, sodium sulphate, sodium chloride, and sometimes sodium nitrate. Unfortunately, in many otherwise desirable methods of softening water containing calcium and magnesium compounds, these depend on replacing these salts with those of sodium.

It will be appreciated that the concentration mentioned applies to sodium salts as well as to others. Experience has shown that water in locomotive boilers is liable to prime when it contains from 150 to 350 grains of sodium salts per gallon. It has been stated that these figures are very low, as compared with experience with stationary boilers, but this may be due to the fact that a locomotive boiler is constantly agitated and, as is well known, gives, for this reason, a greater evaporation than a stationary boiler of the same heating surface and grate area. This may, however, also cause it to prime more readily.

Corrosion

Corrosion may arise from many causes, and only a few of these can be mentioned here when dealing with feed water. They are, primarily, of two classes: electrical and chemical. The former has not, probably, been investigated and, certainly, is not understood as it should be. A water, and

*From an article by Sir Henry Fowler, deputy chief mechanical engineer, and S. J. Symes, works manager, Derby, London, Midland & Scottish Railway, appearing in a recent issue of *The Railway Engineer*.

particularly a concentrated water, may form an electrolyte, which will set up electrical or galvanic action between two classes of steel, such as those employed for the rivets and plates of a boiler barrel. This may account for the corrosive effects of certain water, the chemical composition of which seems to preclude the trouble being directly a chemical one. One difficulty, however, is that there are rarely, if ever, signs to show that corrosion is due to the great difference of potential between the copper and the steel.

The most obvious source of chemical corrosion is that which arises through the pollution of the source of the feed water with acids from factories. This is, however, somewhat rare nowadays.

All the magnesium salts in the presence of chlorides and nitrates are liable to set up corrosion, the extent of which will largely depend upon the other constituents of the water. Peaty waters frequently cause pitting, owing to the particles of peat being converted into humic acid. Although not found directly in the water, any animal or vegetable oils will cause corrosion. Many engineers state that the insertion of a lump of tallow into the boiler causes the regulator to work more easily; this may be so, but tallow is very certain to start corrosion. One railway company has entirely dispensed with its use, with the most satisfactory results. After a long drought, the character of the source from which water is drawn may, owing to the absence of surface water, change for the worse.

Accelerated Circulation Features New Marine Boiler

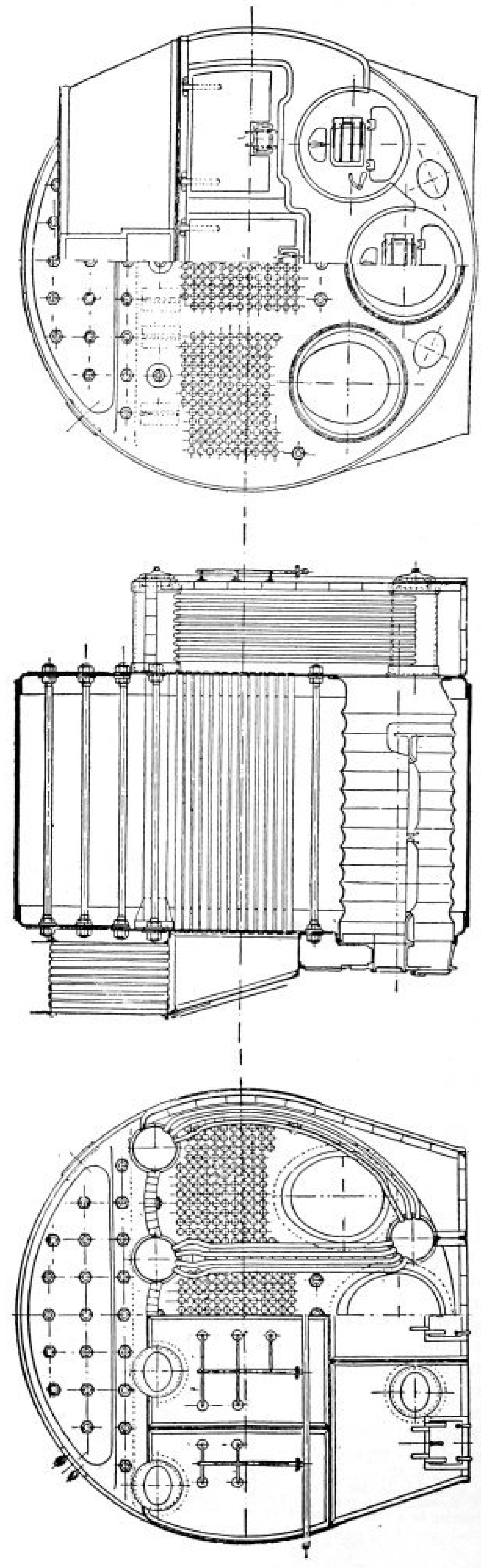
THE Prudhon-Capus marine type boiler, the license for which is controlled by the Chantiers Navals et Chaudronneries du Midi, has been recently brought to a stage of development that has warranted a number of major French steamship lines to adopt it on several new vessels.

Although the Prudhon-Capus boiler has been designed along lines similar to those of the ordinary Scotch marine boiler, certain features have been incorporated for which advantages are claimed over the conventional type. The principal features of the design are brought out in the accompanying drawings.*

In its essential features, the Prudhon-Capus boiler consists of a cylindrical envelope having a front and back end with the smoke tubes, side tubes and furnaces passing through the cylinder. Two groups of collectors of large diameter are installed at the back end of the boiler. These collectors are in free communication with the inner space of the main cylinder, one group being fitted at the lower part of the boiler and the other at the upper part. The normal water level passes directly through the center of each of the upper collectors. The upper and lower groups of collectors are connected by means of tube nests fitted inside a large combustion chamber which is surrounded by walls made of firebrick strongly attached to the exterior of the metal casing.

GROUPS OF TUBES IN COMBUSTION CHAMBER CAUSE RAPID CIRCULATION

It is quite evident that the groups of tubes situated at the lower part of the boiler where the gas temperature is highest constitute a direct heating surface of comparatively high efficiency. Because of this, a rapid circulation of water takes place as soon as the fire is lighted in the furnace and, it is claimed, that the maximum boiler pressure may be reached in a much shorter time than is the case in the ordinary type of boiler. In addition, the large volume of the combustion chamber assures a good mixing of the gases and



Prudhon-Capus boiler having special features promoting water circulation

* Publication of these drawings has been possible through the courtesy of the *Marine Engineer and Naval Architect.*

so enables a forced draft system to be employed economically.

In order to make each combustion chamber independent in this design it is only necessary to insert a division wall of firebrick between the immediate sets of tubes. Ashes which may be carried over from the furnace are collected at the lower part of each combustion chamber where a cleaning door is fitted. Each door is arranged so that the ashes may be removed while the boiler is working. The smoke and watertubes can be cleaned by means of a steam jet in the usual way.

Prudhon-Capus Boiler Highly Efficient

The watertubes installed in the boiler which set up a rapid circulation are credited with producing the high efficiency of the Prudhon-Capus boiler as compared with the customary cylindrical boiler. Even at high speeds there are no visible signs of smoke which indicates efficient combustion at all times. Because the interior combustion chambers have been eliminated in this boiler, the great number of stays ordinarily required in the installation of combustion chambers is eliminated. All parts of the Prudhon-Capus boiler are readily accessible and no part of the boiler is liable to damage from low water.

Manholes are provided at the head of the collectors to insure satisfactory ventilation when the boiler is empty and to make inspection of the tubes and their cleaning easy. Another feature is that the intense circulation of water in the tubes prevents the formation of deposits, while the differences of expansion and contraction which cause wear in certain parts of the usual type boiler are also eliminated.

Advantages Claimed for the Boiler

The most important of the advantages claimed for the new type marine boiler is the elimination of the combustion chambers, as this provides greater facility for repair work. Renewal of the tubes on a ship can be performed in successive stages, thus avoiding considerable delay of a vessel in port. Another special feature of the boiler is the possibility of removing ashes while the boiler is still in service. Ordinarily the accumulation of ash in combustion chamber boilers would have to be removed when the boiler was cold.

An idea of the size of a typical ship installation may be gained from the boilers to be fitted on four new passenger vessels of the Services Contractuels des Messageries Maritimes.

These boilers will be about 17.5 feet in diameter by about 12.5 feet in length, the distance between tube plates being about 8.2 feet. Each of the four furnaces will have an external diameter of about 4.06 feet, and an internal diameter of about 3.74 feet. The total heating surface will be about 3,845 square feet. The total weight of the empty boiler is to be 63.5 tons and that of the water, 28.5 tons. The boilers are to be fitted with Howdens forced draft system and will use oil as fuel.

Where Sellers of Business Appliances on Installments May Lose Out

By Elton J. Buckley

SEVERAL weeks ago I wrote one or two articles about the law of fixtures, meaning the business appliances that everybody in business puts in his place, sometimes attaching them to the real estate, sometimes not. The points discussed were, when such things belong to the tenant, when the tenant can take them away and when the tenant is compelled to leave them on the premises under the clause which is usually in the lease, that any improvements not mere fixtures are to be regarded as the landlord's property and treated as such.

These articles attracted so much interest and aroused so much correspondence that I venture another article on the same subject, based on a case just decided.

Now bear in mind that this subject is important to the following classes of people:—

1.—Landlords of business property. Whether a given appliance put on the premises by the tenant is a movable fixture or an improvement, determines whether the landlord gets it, or loses it when the tenant leaves.

2.—Tenants of business property for a reason exactly opposite to the reason given in No. 1.

3.—Concerns that sell business appliances on installments, for their rights of seizure, if the payments are not made, are often dependent on whether an appliance is attached to the real estate or not.

4.—Buyers of business appliances on installments for the converse reason.

5.—People who hold mortgages on business property, whose mortgages often extend to all after-made improvements which are attached to the real estate.

In the case I referred to a manufacturer of boiler plants sold a plant to a manufacturer of a food product. It was sold on installments, as most such appliances are sold today, and in the contract was that familiar provision that the title should remain in the seller until all the payments were made. In some states there are laws requiring such contracts to be recorded.

Boilers Part of Property

The buyer of this plant, who by the way owned the building in which the plant was to go, had to attach it to the real estate to a certain extent in order to operate it. Now, it seems that there was a mortgage on this building and in this mortgage was a clause that often appears in mortgages, making the lien cover not only the building, but "all machinery, fixtures and any and all other improvements which attached thereto." The owner of the building, who, as I have said, was the buyer of the boilers, defaulted in his payments and subsequently became bankrupt. The holder of the mortgage and the seller of the boiler contended over who had the better right to it. The holder of the mortgage said it belonged to his security because the mortgage by its terms covered all "improvements attached thereto." The seller of the plant said "no, it belongs to me, because I sold under a contract that held title in me until it was paid for." The question therefore was this: what is the boiler plant? Is it merely a movable fixture which the person in possession of the premises can put in temporarily and take with him when he goes, or is it in the nature of a permanent improvement, which attaches to the real estate and becomes a part of it, thus automatically becoming the landlord's property?

In spite of the reservation of title by the seller, in spite of the proper recording of the contract containing the reservation, in spite of the fact that the seller of the plant had done everything he could to prevent the plant from getting away from him before it was paid for, the court held that as the plant was attached to the real estate, title passed to the buyer and the mortgage attached to it. Therefore the seller lost out. This is from the decision:—

> If the contention was entirely between the parties to this contract (the contract under which the plant was bought) it would be governed by the intention of the parties as expressed in the reservation of title; but, being between a prior mortgagee with an after-acquired property clause as to the improvements, the question is: Is the property in controversy, a removable fixture under the common law? The boiler plant could not be recovered without destroying the property as a manufacturing plant. It was therefore at law a fixture.

Boiler Manufacturers Meet at Cleveland

Forty members of the American Boiler Manufacturers' Association attend annual mid-winter meeting

At the annual mid-winter meeting of the American Boiler Manufacturers' Association, held at the Mid-Day Club, Cleveland, February 12, about 40 members were in attendance. The meeting was divided into two sections—that of the entire body to discuss general matters in connection with the industry, and the other a special meeting of the horizontal return tubular boiler branch of the association. E. R. Fish, president of the association, presided over the general session which occupied the morning and the early part of the afternoon.

The activities of the association, so Mr. Fish stated in calling the meeting to order, have become rather more commercial than technical. Just how the association can benefit the industry to the best advantage is a matter that is not subject to fixed rules. Frequent meetings are necessary to discuss problems that are constantly occurring in order to achieve results; for this reason no definite program had been arranged for the meeting so that any and all questions and reports that required discussion could be brought before the association.

H. N. Covell, secretary of the association and chairman of the membership committee, reported that 3 new member companies had been added to the rolls of the association with prospects of two or three more before the annual meeting in June. The president appealed to the members present to make every effort possible in interesting boiler manufacturers who were not already members in the association so that the body might eventually include all of the prominent builders of power boilers.

Mr. Covell then brought up the question of a code of ethics for the association. This matter was discussed at some length by several of the members and George W. Bach, former chairman of the ethics committee, referred to a paper which was read at the annual meeting four year ago which practically constituted the code of ethics requested. In this paper was outlined the basis on which the boiler industry could conduct its business equably and harmoniously. It was decided that the committee on ethics should be continued as a working unit of the organization to keep a check on the business methods of the member companies and keep the subject fresh in their minds. A. G. Pratt suggested that the code of rules on business conduct, drawn up by the United States Chamber of Commerce, offered food for thought and many of its principles could advantageously be adopted by any business organization. The subject will probably be brought up again at the annual meeting in June.

Commercial Committee

The report of the commercial committee was submitted by F. G. Cox. The report took the form of a proposed standard contract. The discussion following the report hinged on the matter of trade acceptances and other matters of contract. It was found that only a few companies resorted to trade acceptances on deferred payments, certain contingencies of business making the use of trade acceptances valuable as they constitute a safeguard against loss. They have been found better than long-time payments and, since they are negotiable paper, have an immediate value for discounting. The psychological effect on the purchaser of boilers too is very apparent in certain cases where trade acceptances have been given. There seemed to be no objection to the use of them in the minds of the members but few found it necessary to include the matter in contracts. The matter is to be continued in the report of the commercial committee at the June meeting.

The subject of doing business in foreign states, brought up at the last annual meeting, opened up a new line of investigation to the members of the association. The subject was quite completely discussed at this meeting and all members seemed to agree that steps are necessary to safeguard against loss when selling and erecting boilers outside the state in which an individual company operates. George W. Bach mentioned the fact that the matter was of special interest at this time because of the recent New York decision which taxes all business conducted in that state. The suggestion was made that each member should consult his own lawyer when necessary to safeguard his business in states where legislation might react against them. At the June meeting, when the subject was brought up for discussion, a very able address was made by a representative of the Corporation Trust Company and, in referring to this, A. G. Pratt stated that this concern was in a position to handle such matters to the best advantage. It is possible to retain the services of this company for a given sum to carry out all legal matters attending the conduct of business in foreign states. E. C. Fisher stated that his company was registered in a number of states where the bulk of sales was carried on and it was his practice to register in other states whenever it was found necessary. The subject is one that requires very careful consideration if a company is to avoid considerable litigation and loss.

The old subject of boiler erection came up for discussion, that phase of it dealing with the engineer in charge being the important item. It was found that though most companies furnished an engineer on a per diem basis rather than a part of the contract, some companies, however, wrote in the services of the construction superintendent as part of the contract and found it satisfactory, although the other method seems better. The experience of one company was that it made little difference whether this service was part of the contract or on a day basis but in cases where it was written in a time limit was fixed, beyond which the services of an engineer were paid for by the day. Another company includes the erectors' salary and expenses in the original charge for a boiler and no attempt is made to charge for the services on a day basis. This scheme works quite successfully for where extra time is required in one case, other cases requiring a shorter time offset this expense. It was suggested that the commercial committee investigate the subject at some length and bring the matter up for later discussion.

The American Society of Mechanical Engineers' Boiler Code Committee has submitted its report on boiler construction and on the care of steam boilers in service. This report was mentioned at the meeting as being an excellent one and proving very helpful to the industry.

Defective Material

E. R. Fish opened a discussion on the subject of defective material which is purchased at times by the manufacturers. Practically every manufacturer at one time or another is confronted with the problem of settlement on defective plates or other material and in very few cases is it possible to obtain any adjustment other than the replacement by the steel mills of new plates. If defective material has already been included in the fabrication of a boiler before the defect is apparent, there is practically no recourse in the matter and the manufacturer is required to stand the loss. The consensus of opinion was that nothing could be done about rectifying the condition.

The Interstate Commerce Commission is holding hearings on freight rates and it was suggested that some member or members of the association be appointed to attend the hearings in order to safeguard the interests of the boiler manufacturing industry in so far as boilers and material entering their construction might be affected.

Starr H. Barnum, chairman of the cost accounting committee, referred to previous reports made on this subject and had no further suggestions to make at this time. Mr. Barnum introduced a representative of the Stevenson Corporation, a firm of cost accountants, who addressed the meeting on this subject, bringing out various interesting points that will undoubtedly be discussed more completely at a later meeting. Mr. Barnum also suggested that copies of the United States Department of Commerce cost accounting report should be distributed to all members who had not already received one.

In the definitions which the committee of the Stokers Association have put out the question of economizers is of considerable interest to the manufacturers' association and they thought it would be well to exclude economizer surface from the boiler heating surface. The stoker committee of the A. B. M. A. will meet with the committee from the Stoker Association within a short time and smooth out any differences that may be found necessary. The joint committee meetings of these two associations have proved very helpful to both associations and many differences have been eliminated with satisfactory results. Another matter to be taken up with the stoker people is the question of guarantee of performance. The boiler manufacturers cannot guarantee boiler performance unless an excess air supply is specified and the exit temperature of gases is known. This information should be given to the stoker manufacturer and they should be responsible in guaranteeing the stoker performance. The question of guarantee is certainly one that requires the attention of the joint committee in order to see that the boiler industry is dealt with fairly.

No formal report was presented by W. A. Drake, chairman of the steel heating boiler committee, the rating for boilers is to be taken up by the committee. E. R. Fish stated that it was the general opinion in the industry to use the fire side of boiler tubes for computing the rating. Other members felt that it was necessary to arrive at some standard in the matter but since the A. S. M. E. Code provides such a standard it should be followed. The Code defines what constitutes heating surface for a boiler and whether this definition is followed in determining the rating or the fire side of the tubes is used, the conclusion is the same. The matter is one which is of special interest to the horizontal return tubular boiler manufacturers and could well be decided by them at a future meeting. The A. S. M. E. Boiler Code Committee report was made by E. C. Fisher, who had compared the 1918 and 1924 Codes at the last annual meeting. He mentioned the fact that the Unfired Pressure Vessel Code had been issued and that the Code on Operation and Care of Boilers would be out during the year.

In discussing sales methods, George W. Bach referred to an article by Elbert H. Gary of the United States Steel Corporation in the January issue of *System*. This article was an excellent one, having as its object the analysis of sales policies. The subject is one in which all members of the association are vitally interested and it was suggested that it be made the subject of an address by some prominent expert in sales methods at the annual meeting in June.

Charles E. Gorton, chairman of the American Uniform Boiler Law Society, outlined what was being done by the society in promulgating the Boiler Code and the success it was meeting in adoption. The legislatures of 9 states were in session at the time of the meeting and in 7 of these bills moving the adoption of the Code were presented. These states were Maine, Connecticut, Arizona, Iowa, Minnesota, Georgia and Florida. Mr. Gorton stated that it was now necessary to spend more time keeping in touch with inspection departments of the various states having adopted the Code to prevent the individual interpretations from destroying uniformity than it required to introduce new legislation.

The question of testing butt straps was brought up in a letter from one of the members of the association but, as this is a Boiler Code question or more specifically one for the American Society for Testing Materials, it could not well be settled by the manufacturers and was referred to Mr. Fisher who will take it up with the Boiler Code.

It has been decided by the association to hold the annual meeting this year at Watkins Glen, N. Y., June 1, 2 and 3.

A tank and steel plate fabricating association is now being formed and the A. B. M. A. has been approached by representatives of this association to hold joint committee meetings to discuss matters of common interest. Although the two associations will be closely allied, it is better to keep their activities entirely distinct except in cases where business in common should make it necessary for joint discussion.

This completed the general session of the association, the remainder of the afternoon and evening being occupied by a special meeting of the horizontal return tubular boiler manufacturers to discuss in detail the design of a standard 18-foot by 72-inch horizontal return tubular boiler. A report of this session will be given in the April issue of The Boiler Maker.

Simplifications of Sheet Steel to Involve Big Sums

SIMPLIFICATION of variety of sheet steel, the third of the eleven principal products of the steel group, foreshadows a saving of more than $2,500,000 annually to the industry, according to an estimate furnished to the Division of Simplified Practice, Department of Commerce, by Walter C. Carroll, vice president of the Inland Steel Company, Chicago, who was a leading figure in the movement to reduce the variety of sheet steel sizes.

In the forthcoming booklet in the Division of Simplified Practice "Elimination of Waste" series, dealing with this simplification, it is pointed out by Mr. Carroll that 35 manufacturing companies having 686 mills are affected. The production involved is 5,000,000 net tons annually.

Sheet steel, it is pointed out, has a widely varied demand, ranging from the automobile industry, which consumes 37 percent, down to the casket and vault industry, in which the demand is less than one percent. The distribution of sheet steel by jobbers is some 13 percent of the production, ranking second only to the automobile industry.

Eighty-five percent of the demand, Mr. Caroll indicates, was for 15 percent of the sizes manufactured before the simplification program was undertaken. In the field of one-pass cold rolled and box annealed steel, 72 percent of the demand was in 43 of 434 numbers made. In blue annealed sheets, 70 percent of the demand was in 52 of 523 numbers made. In galvanized sheets 71 percent was for 110 of 673 items made, while in galvanized roofing there was 97 percent of the demand for 38 of the 142 varieties made. Eighty percent of the demand in painted roofing was for six of the 47 numbers made.

Warehousing of the 1,819 varieties made has been a huge expense for the distributor, it is pointed out; and if the sizes had been reduced by but 50 percent the saving would have been $2,500,000 annually.

Laying Out Locomotive Boilers—III*

Method of finding the outline of a one-piece crown and side sheet

By W. E. Joynes†

LAY-IN the top center line—Fig. 5 and erect a right-angle line to the top center as shown at (1), remembering that the crown, roof and cone layouts must be perfectly squared and that the best method for squaring is by scribing intersecting arcs with the beam compass.

The slope of the crown sheet from front to back is 3¼ inches, dimension C^3, as shown by the diagram. The distance between the developing lines is 74⅞ inches, C. By referring to Table 3 the increase of this top crown length is found to be approximately 1/16 inch and, therefore, the length of the crown along the top center will increase from 74⅞ inches to 74 15/16 inches, C^1. Measure this length as shown at (4). Using (1) and (4) as a center, draw in a light line radial to these points about as shown. Measure the crown width 1-2, 38⅛ inches on the front line and 4-5, 34⅞ inches on the back line, using (1) and (4) at the center line as the measuring point and

*The first installment of this article appeared on page 1, of the January issue, and the second on page 40, of the February.

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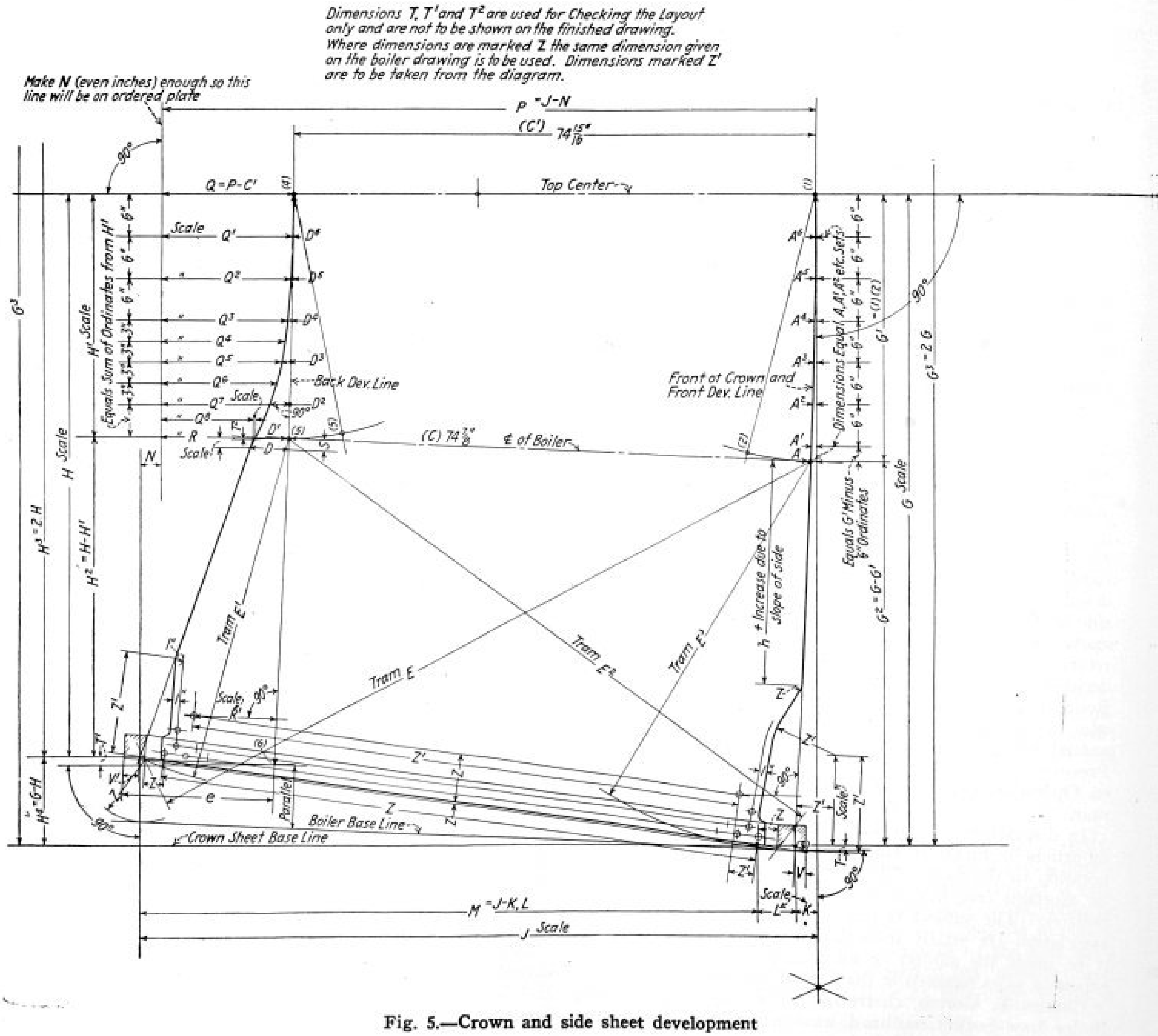


Fig. 5.—Crown and side sheet development

describe arcs as shown at (2) and (5), equal to 1-2 and 4-5 lengths.

The next information needed is the shape of the front edge of the sheet between the top and side center lines. This is obtained as follows: Set the small dividers to a 6-inch space and step-off spaces of this length on the front neutral line of the crown as shown by the very small circles on the diagram, Fig. 4. From these circled points measure vertically to a horizontal line extended from the top neutral point of crown. Dimensions, B, B^1, etc., A, A^1, A^2, etc., are then calculated by proportion by using these measured dimensions as follows:

$$\frac{\dfrac{\text{Horizontal length of crown, } C,\ 74\tfrac{7}{8}\text{ in. (between developing lines)}}{\text{Slope or Vertical Drop of Crown, } C^3,\ 3\tfrac{1}{4}\text{ in. (front to back)}}}{} = \frac{\text{Scaled Vertical Dimensions, } B, B^1, B^2, \text{etc.}}{X = (\text{Sets } A, A^1, A^2, \text{etc.})}$$

$$\frac{C = \text{horizontal length of crown, } 74\tfrac{7}{8}\text{ in. (bet. dev. lines)}}{C^3 = \text{slope of vertical drop of crown } 3\tfrac{1}{4}\text{ in. (front to back)}} = \frac{B, B^1, B^2, \text{etc.} = \text{scaled vertical dimensions}}{X = \text{Sets } A, A^1, A^2, \text{etc.}}$$

or by formula,

$$C : C^3 :: B : X = A$$

C = horizontal length of crown, 74⅞ inches (bet. dev. lines).

C^3 = slope or vertical drop of crown 3¼ inches (front to back).

B, B^1, B^2 = scaled vertical dimensions.

X = sets A, A^1, A^2, etc.

The set, A, at the center line is the next dimension needed to proceed with the layout, and will be used as an example in calculating one of these sets. The first B dimension, which is used in finding the first set, A, does not have to be scaled. This is equal to g plus half the thickness of crown 3/16 inch = 15 11/16 inches for B, see diagram Fig. 3. Fig. 4 will give the same dimension by using C^2, 12 7/16 inches + C^3, 3¼ inches = 15 11/16 inches for B. Then $C : C^3 :: B : X$ and substituting dimensions:

$$74\tfrac{7}{8}\text{ in.} : 3\tfrac{1}{4}\text{ in.} :: 15\ 11/16\text{ in.} : X$$

$$\frac{3\tfrac{1}{4} \times 15\ 11/16}{74\tfrac{7}{8}} = 0.6809\text{ in. or nearly } 11/16\text{ in.}$$

which will be used for set, A.

A practical way to find these sets is to draw a right angle line at the front of crown, extending from the neutral line of the top of crown to the boiler center line, Fig. 3. Project the 6-inch circled spaces Fig. 4 to the front of crown sheet and the right angle line Fig. 3, then scale the distance on these lines between the front of crown and the 90-degree line, which will also give the front sets. The set at the boiler center line should always be scaled as a check when they have been calculated. Draw ordinates 6 inches apart at front of crown, which will correspond with the 6-inch circled spaces at the front neutral line of crown, Fig. 4. Measure set, A, 11/16 inch from vertical line, 1, on to arc, 2, and at right angles to line, 1, using prick punch. As the length of crown does not have any increase at the center line of boiler for projection work this length will be the distance between the developing lines, dimension, C, 74⅞ inches. Measure from the point just made on arc, 2, to a point now to be made on arc, 5. Lay a straight edge or large triangle on these two points and draw in the center line of boiler as shown. Now mark-off the sets, A^1, A^2, etc., on the 6-inch ordinates at the front and connect the spaces between the ordinates with a curve that will take two or more spaces at each marking. This line will be the front of the crown sheet and also the front developing line.

The shape or curve of the back developing line is the same as the front one (for projection work only) from the top center out to a distance equal to the length of the back developing line between the top center and the center line of boiler. Therefore, it is not necessary to find any sets to obtain the shape of the back developing line, but the same method that has been described for the front developing line, can be followed.

As a rule, the difference in length (between developing lines) of the top center and the boiler center line is only 1/16 inch to ⅛ inch, therefore, it is plain that if these lines have the same contour, they are nearly parallel. The best method of transferring the shape of the front developing line to the back of sheet, to form the back developing line, is to have a curve that can be fitted to the front line (a distance equal to the length of back developing line) and then holding the curve at the top center, 1, shift the curve back to 4 and 5 and duplicate the line. If the available curve cannot be adjusted to fit the desired length, it will be seen by referring to Fig. 4 of the diagram, that the front and back crown contour is practically parallel around to the tangent point of the corner radii. The developing lines in Fig. 5 are also parallel for this same distance. Take the length of the plate at top center line, C^1, 74 15/16 inches, with trammels, shift the trammels down—within the parallel-line limit—and draw a short arc. Adjust curve to the front developing line for the parallel length and shift same back to point, 4, and the short arc just made, and draw-in the back developing line for this distance. Fit the curve to the required remaining part of the front line and then complete the back developing line.

To find the outline of the crown sheet at the back, divide the back line of the crown, Fig. 4, into 6-inch spaces with the dividers, as was done for the front line. Project these points (parallel to the center line) to extend between the back edge of sheet and the back developing line, Fig. 3. When there is a tapered corner flange radius in the back flanged sheet, as shown for this boiler, the tangent point of the crown and corner radius and the side line and corner radius is also to be projected to Fig. 3. The distances between the developing line and the back edge of the sheet on these projected lines, Fig. 3, are the sets to give the outline of flat sheet, Fig. 5. Step-off the same 6-inch spaces and the radii tangent points, on the developing line, Fig. 5, and draw in light lines from these points, at right angles to the developing line and toward the back of the sheet as shown. Using hair-spring dividers transfer the sets D, D^1, D^2, etc., Fig. 3, to Fig. 5, making a pin hole in the light right-angle lines. Connect the spaces between these points with a curve, and this curve will be the outline required for the top half of back end of the sheet. This completes the outline of the top half of the sheet or the crown half.

To find the outline of the crown side sheet or bottom half, the firebox ring must be lightly laid in first. This has to be done by tramming and the method of the tram operation is as follows:

The side length, of width dimensions 46⅝ inches back and 55⅝ inches front, Fig. 4, is to be measured from the bottom of the firebox ring up on the developing lines in Fig. 3. If the sides are sloped enough, to increase the length of same, the measured point of these dimensions will be, of course, above the boiler center line. The difference between these dimensions and the boiler dimensions, a and b, should not be used and the points on the developing lines located by measuring the difference from the boiler center line. This will not give correct results, because of the expansion and contraction of the drawing paper. This annoyance is most noticeable in the tramming operations and in determining dimensions by scale, where the drawing must be to scale at the time of scaling or allowance made for any variation caused by expansion or contraction.

The distance affected by expansion or contraction is proportional to the length, and as a rule it is not necessary to consider distances less than 20 or 25 inches. Sometimes the length of the paper will be affected enough to take into consideration the variation in dimensions over 20 inches and at the same time the width of the paper will not be affected enough to consider and vice versa. Continual checking by scaling, when determining a dimension by scale or tram length is necessary.

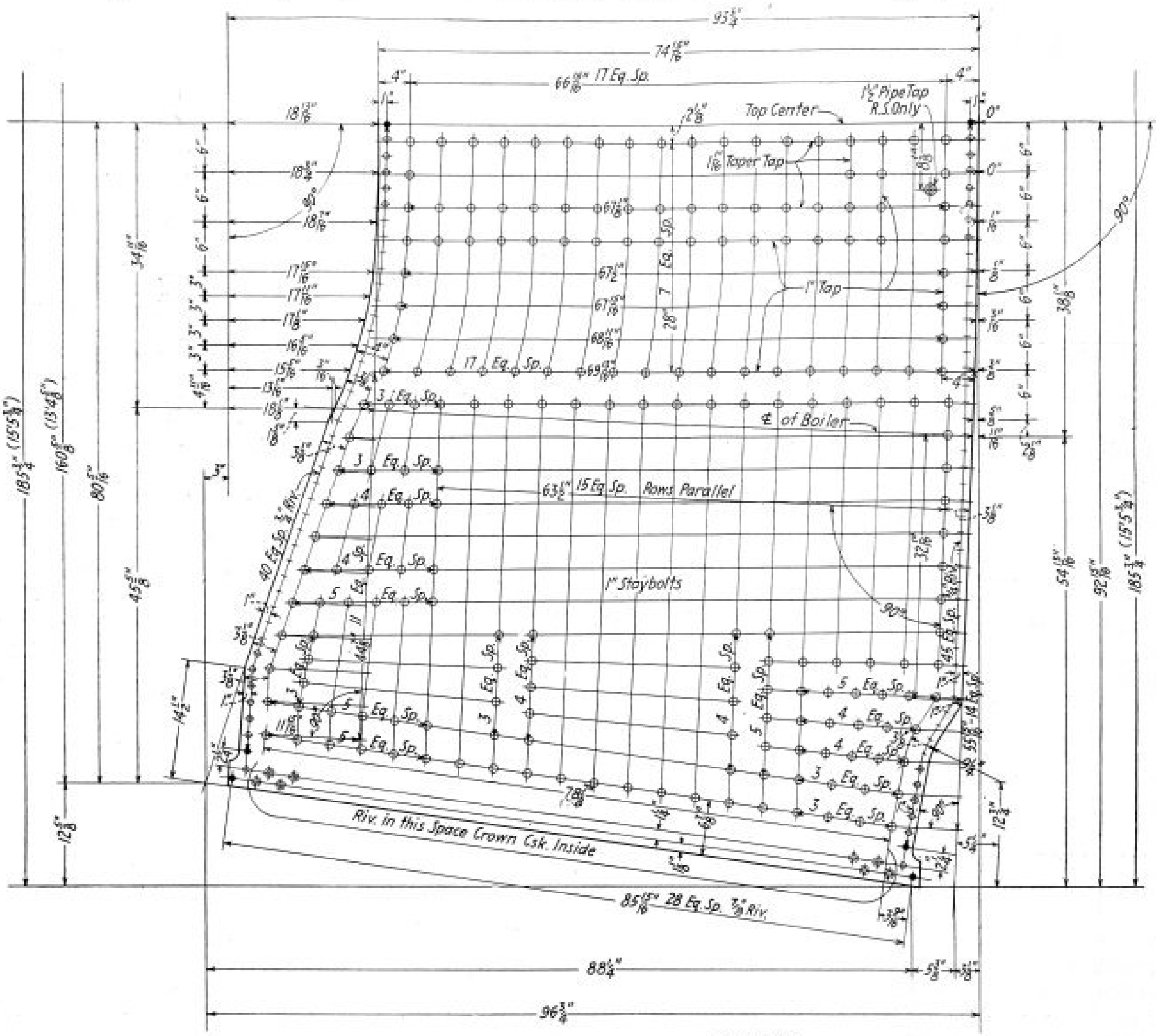


Fig. 6.—Crown and side sheet developed showing staybolt location

In locating the trammel pivot point on the developing lines—as previously explained—for tram swings, E, E^1, E^2, and E^3, it is first necessary to ascertain whether the front developing line, and the front of firebox ring are still to the original scale measurement, from the back of firebox ring, dimensions 96½ inches and 98 inches, respectively. The back developing line as a rule is not appreciably affected, although to check this line too makes for safety.

If the developing line is found to be out of scale 1/16 inch or more, a new developing line—short line at boiler center line and boiler base line—must be made and the tram point located on this new line instead of on the original developing line. Also make on the base line a new prick-punch hole for the front of ring. This will keep the distance between the developing line and the front of the ring in the same original relation to each other.

A sharp chisel-edged point on the trammel pencil is necessary when setting the tram lengths, E, E^1, E^2, and E^3, the passing of the pencil over the prick-punch hole at the intersection point at the bottom of firebox ring, front and back, can be felt. The tram lengths, E, E^1, E^2, and E^3, show the extent of the firebox in its developed or flat form—Fig. 5—since allowance has been made for the increased length caused by the sloped side, by locating the increase on the developing lines as shown for the trammel centering points above the boiler center line, Fig. 3.

It is now evident from Fig. 5, that to locate the firebox ring on the crown sheet development, it is only necessary to transfer, very accurately, the tram length, E, E^1, E^2, and E^3, from Fig. 3 to Fig. 5, as plainly shown by these two figures. With the firebox ring located, that part of the outline of the side at the front, below dimension, h, and at the back, below the corner radius which is at the break in the edge of the sheet, dimension Z^1, is an exact duplicate of the sheet as shown by the boiler drawing and as already worked out on the diagram, also, by letters, Z and Z^1, which indicates that these dimensions are taken direct from the boiler and diagram respectively. It is not practical to make an allowance in the sheet for the slope in the side to the top of the firebox ring corner radius, front or back.

This completes the outline of the right half of the crown and side sheet. The left half is always an exact duplicate of the right half, so far as the outline is concerned.

Now that the outline of the sheet is drawn to scale, it is evident, that the way to determine the front and back and the bottom longitudinal extreme outline dimensions is by scaling this layout and this should be done before the layout is likely to be affected by expansion or contraction.

In determining the outline dimensions proceed in the following order: First, make a check on the layout to see if any error has been made in measurements or tram operations. This is done by referring to Fig. 4 of the diagram. Add the crown width dimensions, 1-2 (= 38⅛ in.), and 2-3 (= 55⅝ in.), total 93¾ inches front; also, 4-5 (= 34⅞ in.), and 5-6 (= 46⅝ in.), total 81½ inches, back. These dimensions are the length of the developing lines on Fig. 5. The effect of the curve of line is so slight in this case, that the decrease sometimes caused by a more decided curve can be neglected here and the front line should measure 93¾ inches from the top center to the boiler base line, 1-3, and the back line 81½ inches, 4-6, to a line projected from the bottom of the firebox ring (back end) over to the developing line and parallel with the boiler base line. If these dimensions check, it is possible to proceed with determining the outline dimensions by scaling.

The intersection of the front firebox ring rivet center line (projected 90 degrees to the bottom of ring) and the bottom of sheet has been found to be a suitable place for locating the crown sheet base line. Scale from the top center to this point of intersection, which will be the extreme half width of crown sheet, dimension, *G*, and base line. The scarfed part ahead of the front rivet is taken care of by the shop.

At the back of sheet the measuring point is taken at the intersection of the bottom of sheet and a projected line of the back edge of sheet, dimension *H*. Dimension *N* should be enough to bring the vertical measuring line on the plate itself. This is done to facilitate laying-out the plate in the shop. The remaining outline dimensions have been symbolized on Fig. 5, in a self-explanatory manner and their derivation should be clear. This completes the development of the crown sheet outline, the remaining work of locating the staybolt holes in the sheet being explained in connection with Fig. 6.

Location of Staybolts

In addition to the outline dimensions, Fig. 6 gives the location of the radial stays and staybolts and also the number of rivets for connecting the crown and side sheet to the flanged sheets. This is the shop drawing and all the information necessary for laying out the sheet in its flat form is given on this drawing.

The locations of staybolts and radial stays on the crown and side sheet are the same as given on the boiler drawing, with respect to the front and back edge of the sheet and to the developing lines. The method of laying out the stays on the crown sheet so they will coincide with the boiler staybolt dimensions after the sheet has been rolled and assembled in the boiler, is as follows: Refer to the diagram, Figs. 3 and 4, and scale the vertical dimensions U and U^1, which are found to be 6½ inches and 7 11/16 inches respectively. The half width of the sheet from the top center to the bottom of the firebox ring, front and back, 1 to 3 and 4 to 6, or the sum of 38⅛ inches and 55⅝ inches, which equals 93¾ inches for the front end and for the back end, 34⅞ in. + 46⅝ in., which equals 81½ inches.

By referring to the boiler cross-section, Fig. 2, it may be noted that the first longitudinal row of radial stays is 2⅛ inches from the vertical boiler center and the seventh row outside of the first row is 28 inches from the first row, front and back. These front and back dimensions for the radial stays usually are the same for projection developments and, therefore, the longitudinal center line of the radial stays will be parallel with the top center line of the boiler. The cross-sectional center line of the first row of radial stays, front and back, from the seam rivet center line, is the same as given on the boiler drawing and the others are divided into the number of equal spaces as given on the boiler.

The staybolt dimensions, 44⅞ inches and 55 15/16 inches shown on the boiler cross-section are calculated from the diagram by using the dimensions as worked out above for widths 1-3 and 4-6, 93¾ inches and 81½ inches respectively. At the front,

93¾ in. —(2⅛ in. + 28 in. + 7 11/16 in.) = 55 15/16 inches.

At the back,

81½ in. —(2⅛ in. + 28 in. + 6½ in.) = 44⅞ inches.

From the above calculations it is seen that these dimensions are taken at the neutral line and on the front and back developing line of the sheet. Therefore, to have the staybolt locations on the developed plate coincide with dimensions of the boiler drawing, they must be measured on the developing lines of the plate development, Fig. 6, the 55 15/16 inches and the 44⅞ inches which locate the first bottom staybolt, front and back, being measured on the developing line. As the first row of staybolt holes, front and back, are not actually on the developing lines, but back of these lines, the staybolt spaces on the front and back developing line must be projected, at a right angle to the developing line to the first staybolt line, before drawing the lines through to connect with the staybolt centers in the broken up spaces and with those that run through from front to back. The 90-degree lines are shown on Fig. 6. The first front and back rows of radial stays and staybolts, also the vertical row of staybolts at the front, which divides off the odd spaces in the lower right hand corner and the last vertical row which divides off the odd spaces at the back of the sheet, should be laid in accurately to scale.

The length of the radial-stay center lines, between the front and back transverse row, is to be determined by scale and shown on the drawing of the crown sheet. The dimensions are also to be used in locating the radial stays on the roof sheet development. The odd staybolt spaces, front and back, are also to be scaled and the dimensions used for locating the staybolts on the roof sheet. For this reason it is essential that the radial stays and staybolt center lines previous mentioned should be laid in accurately to scale.

Sometimes it is necessary to set some of the staybolts in the extreme back row, ahead of the regular staybolt line to clear the backhead and roof seam. This is because these staybolts have a higher position on the roof sheet than on the crown sheet, due to the fact that they are at a right angle to the crown side sheet which tips them up on the outside—see boiler cross section Fig. 2.

A.S.M.E. Spring Meeting Plans Under Way

The technical program of the A. S. M. E. Spring Meeting, which is to be held at Milwaukee, from May 18 to 21, is nearing completion. Technical sessions are scheduled for the mornings, the afternoons will be devoted to excursions and the evenings to entertainments.

A feature of one evening will be a session devoted to matters of engineering interest in Milwaukee at which there will be a valuable study of the "Economic Advantage of Cities Having Diversified Industries," "Mechanical Engineering Problems of Sewage-Disposal Plants," and a "Discussion of the New Riverside Pumping Station at Milwaukee."

The Power sessions will furnish a strong combination of papers. There will be a diversity of topics at the Steam Power sessions; papers will be presented on steam turbines, steampipe insulation, unaflow engines and heat balance.

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

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

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

Below are given interpretations of the Committee in Cases Nos. 461, and 472-476 inclusive, as formulated at the meeting of December 1, 1924, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 461. *Inquiry:* Is it intended that cast iron be not permitted for fittings referred to in Par. P-299 where the pressure exceeds 160 pounds? Is it intended that for all pressures not over 160 pounds extra-heavy fittings should be used if located below the water line? May cast iron fittings described in Table A-5 be used for steam fittings for pressures up to 160 pounds under the provisions of Par. P-299, or was it intended that Table A-6 should be used for pressures over 125 pounds and not exceeding 160 pounds?

Reply: There is a conflict between the second section of Par. P-299 and Par. P-12, and it is the opinion of the Committee that Par. P-12 should govern.

Case No. 472. (In the hands of the Committee.)

Case No. 473. (In the hands of the Committee.)

Case No. 474. *Inquiry:* Is it the intent of the Boiler Code that reports of tests on test specimens of steel castings of Class B grade for percentage of elongation and reduction of area, shall be reported as calculated by the formulas as prescribed in Par. S-55, or shall they be reported as calculations may determine from readings taken from the test specimen, and are these reports then to be checked against by the formulas above cited?

Reply: It is the opinion of the Committee that the percentage of elongation and the reduction of area should be reported as obtained from actual test results. These actual figures should then be checked against the two formulas obtained by using the actual tensile strength obtained from the test and the actual elongation and reduction of area should not be less than that obtained from the formula. In no case should the actual elongation and reduction in area be less than the minimum figure given in Par. S-55.

Case No. 475. *Inquiry:* It is contended that under the conditions that are obtained in hot water heating installations, it is impossible to attain a temperature of the boiler in excess of 250 deg. F., which is the limit specified in Par. H-58 of the Low-Pressure Heating Boiler Section of the Code, and where the relief valve is set at a pressure well within the safe limits of the boiler, the safety of the installation is not jeopardized. Therefore, is it not permissible in an open hot water heating system to omit the requirement of Par. H-58?

Reply: It is the opinion of the Committee that although a hot water heating system may be installed initially as an open system, it may become "closed" by the action of corrosion or other accidental obstruction, and that the requirement of Par. H-58 is essential for safety.

Case No. 476. *Inquiry:* Is the reference in the last sentence of Par. P-230*b* to Par. P-212*b* "for the size of the staybolts, rivets or bolts" correct? Par. P-212*b* does not seem to apply.

Reply: It is the opinion of the Committee that this reference is a typographical error and should refer to Par. P-212*d*.

Cunningham Boiler Bearing Stops the Leaks

A Case of Necessity Suggests the Invention

By J. B. Dillon

When the writer walked into the office of D. G. Cunningham, master mechanic of the Denver & Rio Grande Western, at Salt Lake City, and asked to be shown his boiler bearing, and just how it worked, he felt as if he was treading on forbidden ground, but D. G. jumped up and said: "You bet we will. We are proud to show it because it has saved us many hours of worry, delay in transportation, and the railroad much money." "Whew, isn't that stretching the rubber a little?" "Now there you go, just like the rest of the doubters, but come on and let us show it in position and explain its functions." Arriving at the round house, we stopped before one of the big Mallets and pointing out the innovation, D. G. said: "On all Mallets there are two bearing plates or slide castings. The upper part of these castings is bolted to the boiler with studs tapped into the boiler sheet. We found that these studs gave a great deal of trouble on account of leaking. No matter how carefully the holes were tapped

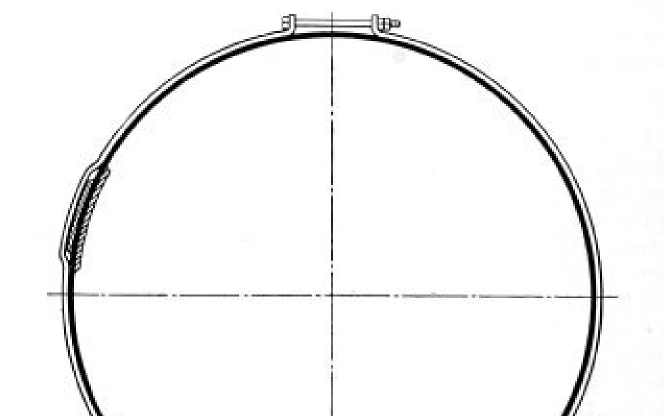


Fig. 1.—Cunningham boiler bearing

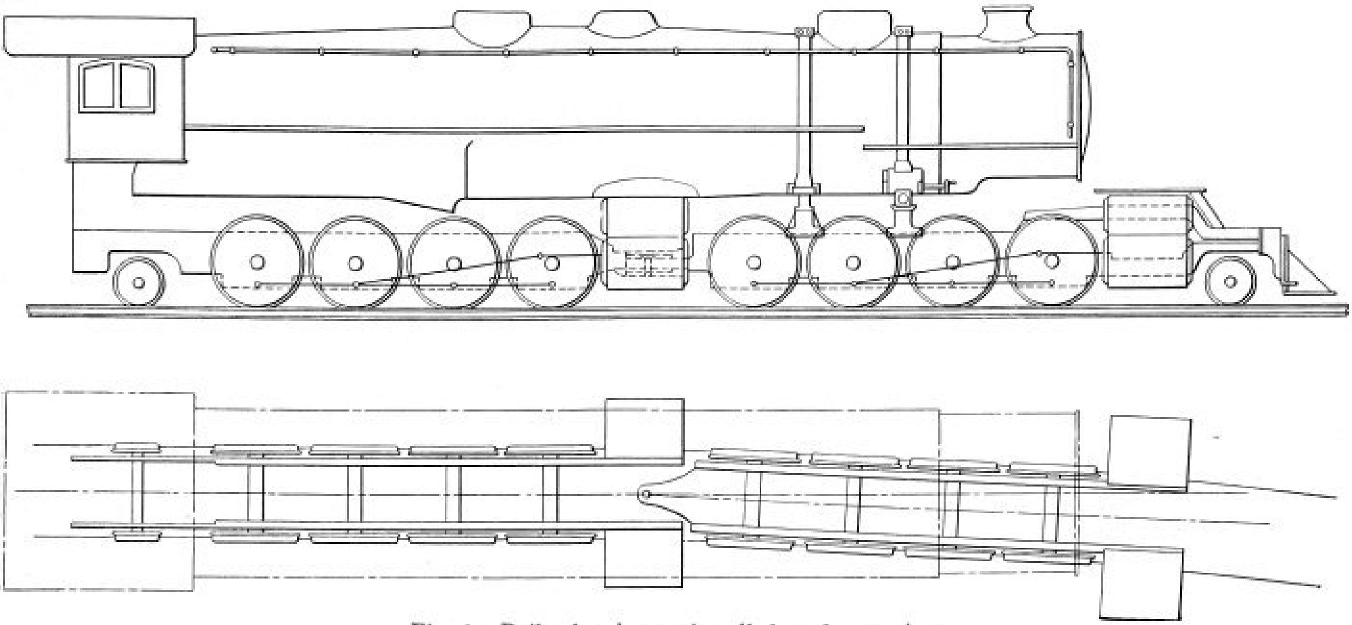


Fig. 2.—Boiler bearing as installed on locomotive

and the studs screwed into the boiler, they would invariably leak. This under the Federal law was a defect, with the result that we had to kill the boiler at the end of every trip and renew several studs. This was not only expensive, but caused serious delay to power being turned."

I started to ask a few questions, but with his long pointer, he continued: "Now you will observe that there are no studs in the boiler, but the riding pads are fastened over the top of the boiler (See Fig. 1 and 2) with two bands that are hinged on the bearing itself and bolted on top of the boiler. You will notice an angle bolted on the smoke arch with a bolt running to the first pad. This runs back to the second riding pad which prevents any motion fore and aft. We have had this device on for some time and there has never been any movement of the boiler."

He was very careful in catechising me to be sure that I was following his explanation and then changing our position, something that we had been frequently doing, he said, "Now let's get an end view. You will now see how it is hinged on to the boiler bearing pad extending over the top of the boiler and fastened by a bolt." "Have you contemplated using it in other ways than on the locomotives?" "Yes, there are many reasons why it would prove its worth on tank cars. Without enumerating them now, Fig. 3 will bring the lesson home."

As Mr. Cunningham said, the thing that suggested the necessity of the bearing was the leakage on the Mallets, and that it has proven its worth, he has no hesitancy in saying that any railroad using Mallet engines can stop the leaks by the device, and as parting courtesy he said: "Don't forget I am ready to answer any and all questions to those who are honestly inclined."

When Mr. Cunningham expressed his eagerness to answer any and all questions relative to the boiler bearing, the first thought was: It looked good, but how long has it been tried out and that question was put. Pointing to one of the Rio Grande's 458 class Mallets, and a 535 class he said:

"On this 458 class it has been tried out for more than four years, without a single failure. The American Locomotive Company at Richmond have been applying it on the 535 class for more than two years, and there has been no failure. In addition to that, the Norfolk and Western are using it on their Mallets and report success. Summing up the events before and after its invention and adoption, we figure that this invention has saved us in delays from one hundred to two hundred engine hours per day, totalling all of the Mallet engines in service on this line."

"How many of each class engines are you using it on over the mountains?"

"There are eighteen of the 458 class and ten of the 535 class."

We discussed the different grades and climatic conditions of the sections the various Mallets of the Rio Grande must meet and there is no place in the United States where a better test under all conditions could possibly be made and as Mr. Cunningham expressed himself: "I have no fear of the outcome, because THERE ARE NO STUDS TO LEAK."

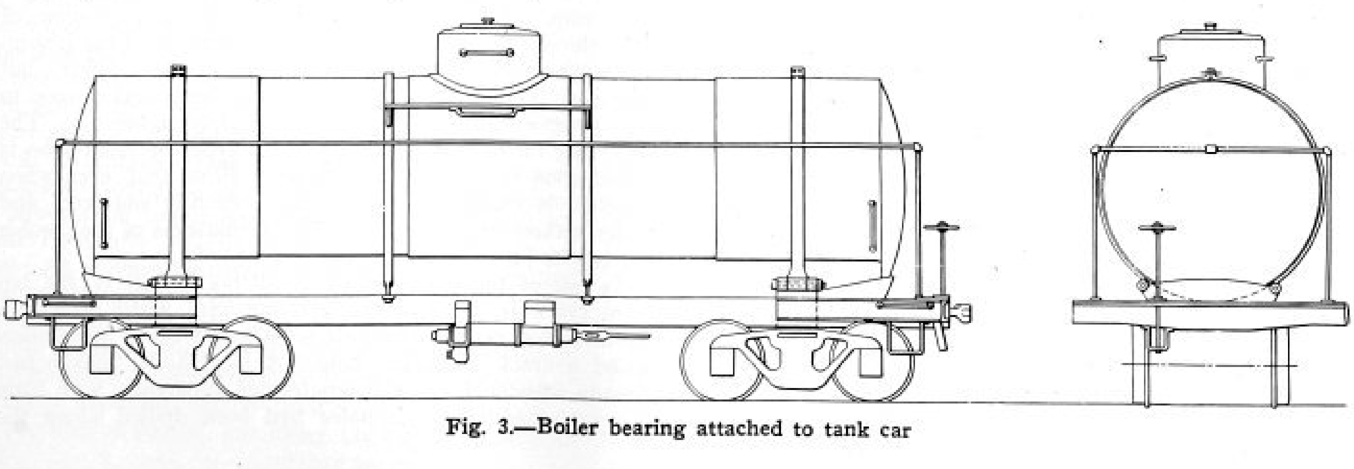


Fig. 3.—Boiler bearing attached to tank car

A Few Remarks on Corrosion and Pitting*

One reader's experience in the field of boiler tube deterioration and his theory as to the cause

E. O. Wright

I HAVE noticed in the different issues of THE BOILER MAKER a great many discussions on the subject of corrosion and pitting in locomotive boilers, which have been very interesting to our readers especially to those who are experiencing the trouble of pitting. The subject of corrosion and pitting in locomotive boilers is so very broad that it is possible only to consider it in a very elementary manner. It has been seen from what has been suggested that the control of pitting is a complex problem, as we seem to know wherein the trouble lies but the application of a remedy is much more difficult than the diagnosis.

Our leading chemists claim that there are two independent causes for pitting; one acid in the water, the other electrical action. They also claim that we do not have as much pitting on the superheater flues as we have on the small flues. Of course we will all agree with them on this but they have failed to give any reason why this is true. I have found in my own experience that we have about fifty percent more pitting on the small flues than we do on the superheater flues. The following will verify my statement:

We applied flues to a superheated engine on December 20, 1921, running directly in our treated water, which were removed on March 24, 1924, on account of pitting or after a period of thirty-eight months in service and a mileage of 83,625 miles. During this time we changed the small flues twice on account of pitting, each time new steel flues were applied. The first set of small flues was removed on February 5, 1922, after a period of thirteen months in service. The second set of small flues was removed on March 12, 1924, with twenty-five months in service. Right here I would like to ask the question why one set of flues gave only thirteen months service and the other set of flues gave twenty-five months service?

We might cite another engine running directly in treated water where pitting did not occur—a switch engine where the flues had to be removed on account of the forty-eight month period. This proves that we have pitting in treated waters in two different cases and another case no pitting was experienced. Right here in my opinion is where the problem should be taken into consideration, as the material in the flues in two cases submitted very readily to the acid in the water while in the other case it resisted the acid.

We are experiencing more pitting in our mixed waters than in the treated waters so I will cite the case of an engine running in mixed waters. We applied new steel flues in a G-5 saturated engine on August 20, 1920. Flues were removed on September 12, 1921, on account of pitting after thirteen months' service. On January 9, 1924, flues were again removed, due to pitting, after a period of twenty-seven months in service. This engine made a mileage of 127,425 miles, with the two sets of small flues. We did not experience any pitting whatever on the boiler shells, but we found that the radial stays were pitting at both front corners of the firebox. The pitting occurred about three-quarters of an inch above the crown sheet and some of the bolts had deteriorated until they were only 5/8 inch in diameter. There were no signs of pitting or corrosion on the crown sheet whatever. This is another case the same as we had in treated waters where one set of flues lasted thirteen months and another twenty-seven months.

*Boiler maker foreman, C. M. & St. P. R. R., Mitchell, S. D.

In the engines that I have mentioned pitting was first visible just back of the front flue sheet and in most cases occurred on the top side of the flues. Most of these flues could be reclaimed at the flue fire.

When I began writing I felt that I would not declare myself on any theory which I believed was causing pitting but I feel that if we all keep our ideas to ourselves whether right or wrong, we would not be progressive. Pitting on flues in locomotive boilers is one of the hardest problems that the railroads have to contend with today, and I can truthfully say that we are experiencing about fifty percent more pitting today on our flues than we did years ago. I believe there is but one cause for pitting and that is acid in the water, for the reason, that flues will pit in a locomotive boiler out of service just as readily as they will when in service providing the engine has been in service before being tied up, as the acid is deposited in spots on the flues and left there like the root of a cancer to continue its deadly work.

In my observation and experience I find that we are not experiencing any more pitting on the shells of our boilers today than we did years ago but we are experiencing a great deal more trouble with our flues. This I believe is due to the fact that years ago there was very little attention paid to our boiler washing, and flues were removed in bad water districts on account of an excessive amount of scale and mud being lodged in the water spaces between the flues and, in good water districts where the incrusting solids in the water would range from 10 to 14 grains per gallon, the body of the flues would usually outlast the life of the beads in the firebox. Today we are washing our boilers thoroughly and have learned from practical experience that one of the biggest items along the lines of engine failures, economy in the consumption of fuel and the cost of running and shop repairs is to keep our boilers clean and free from scale, and by so doing we have brought about more pitting on our flues for we have given the acid in the water a chance to work directly on the body of the flues where heretofore the flues were protected by heavy formation of scale.

The Value of Inspections—

Checking Up on Repairs

FROM time to time we have endeavored to point out the value of inspections by calling attention to some of the serious defects uncovered. The value of the inspector, however, does not lie solely in finding latent defects, but frequently after repairs have been made he is called upon to pass judgment upon the efficacy and safety of the job. The following incidents show some of the types of repairs he is called upon to approve and further indicate that, even when a boiler is found defective, many operating engineers and boiler makers do not appreciate the seriousness of the trouble nor how to properly remedy it.

As one of the most serious of all boiler defects, the lap seam crack is perhaps the best one with which to begin. An inspector, called in because of serious leakage to a boiler, found a crack 28 inches long. A local boiler maker had already attempted to make repairs but apparently with little success. One-half inch holes had been drilled along the crack at intervals of $1\frac{1}{4}$ inches and plugged with rivets. It is remarkable that an explosion did not occur, as the boiler had been under pressure several times since the crack was first discovered. The danger was not realized.

It is interesting, in this connection, to recall a case which illustrates the necessity of a final inspection. A crack had been discovered and marked, and the recommendation made that it be cut out and the plate patched. The crack was evidently invisible to the boiler maker for, although it had been marked, the inspector found that an adjacent portion of the plate had been replaced by the patch, and the crack remained as prominent as ever.

The timely visit of an inspector, who was making his usual rounds undoubtedly prevented a veritable epidemic of explosions in one state not long ago. It was found that a number of horizontal tubular boilers had recently been patched, the patches being simply welded onto the shell, and in a great many cases were right over the fire. Evidently some one had just procured a welding outfit and started out to drum up business and revolutionize boiler repair methods. The prompt suspension of insurance in each case pending replacement with properly riveted patches must certainly have emphasized the inspector's opinion of the work.

On another occasion a well known boiler repair shop replaced a half sheet on a boiler in a thoroughly workmanlike manner. The inspector's examination, however, revealed that instead of boiler plate being used ordinary tank steel had been inadvertently substituted. The brand was plainly visible.

A novel method of repairing tubes in a vertical tubular boiler was discovered a few years ago. A wooden plug would be fitted into the bottom of the tube and the tube filled with concrete. The plug would burn out but the concrete would stay. This method evidently stopped the leaks but is not guaranteed to prevent the tube sheets from blowing out. The inspector found nine such tubes in one boiler. Investigation revealed that all of the tubes were seriously corroded at the water line. A complete new set was recommended.

An interesting case is that of a horizontal tubular boiler which was giving trouble due to leakage at the bottom of both girth seams. A boiler maker from a nearby shop was called in to rectify the trouble. His first attempt at calking was unsuccessful and so he was called back a second and even a third time. Finally the owners decided it was time to call an inspector. Inspection revealed cracks running from rivet hole to rivet hole almost completely around the boiler. The cracks were in the inside sheet and were not visible to the boiler maker from the outside. Evidently the tubes were holding the boiler together. The owner was in a quandary as he could not well afford to shut down the plant, yet all three of the boilers were over one furnace and trouble with one affected all three. The inspector offered a solution. He suggested that the defective boiler be cut off from the line and filled with water and the manhole left open. A wooden flue was constructed around the manhole opening to carry off the vapor, and, by keeping this boiler full, the plant was able to keep going for a couple of weeks, after which the boiler was removed.

When an insured boiler is to be repaired, the inspector usually receives a call and his advice asked before the work is started. Naturally, freak and dangerous repairs are not very commonly found on inspected boilers. Many such are found, however, on boilers not subject to inspection, and they are most frequently brought to our attention through explosions. An interesting case is that of an experience with a patch used to repair a longitudinal seam crack in a vertical tubular boiler. A soft patch was bolted on, but it was decided not to take a chance with the boiler in this condition, so it was relegated to pumping duty at "very light pressure." It eventually exploded, fatally injuring the operator. The line of rupture, of course, was along the crack. Investigation revealed that the crack ran practically the full length of the course. The five bolts in the patch were therefore doing most of the work of holding this section of the boiler together.

What appears to be a better way of repairing a crack of this nature is by means of a riveted patch. One would naturally suppose that, with a visible crack to be repaired by a riveted patch, an acceptable job could be done by almost any mechanic. You can imagine the surprise of the inspector who, upon investigating the explosion of a boiler which incidentally was not insured, found that the immediate cause of failure was a repair job of this type. A lap seam crack had been patched in such a manner that the defective plate was weakened rather than strengthened. The patch had been so applied that the row of rivets along one side of the patch was centered on the crack. Naturally, the boiler failed the next time it was fired up. Two boys were killed and one man probably fatally injured.

Both of the above accidents happened to boilers in which cracking had proceeded to such a stage that serious leakage was actually taking place. The danger should have been realized by any one familiar with boiler construction. Needless to say, an inspector would have recommended suitable repairs and would have followed them through to see that the resulting job was a safe one.

Leakage around a through stay or staybolt receives careful attention from an inspector though operators frequently pay little attention to it. The explosion of a locomotive type boiler in a city on the western coast was found to be due to a lack of understanding of the significance of staybolt leakage. Seven-eighths inch diameter staybolts had been used in the construction of the boiler which had $\frac{1}{4}$ inch firebox and wrapper sheets. Serious corrosion of the wrapper sheet caused considerable leakage around the staybolts. Examination showed the plate very thin around the holes and so it was decided to remedy the trouble by using larger staybolts. The holes were reamed and tapped and $1\frac{1}{8}$-inch diameter staybolts inserted. Corrosion continued, however, and the plate around these larger staybolts was soon as thin as it had been around the smaller ones. Attempts to stop leakage had again been made by calking. The trouble was finally ended by the failure of the boiler, the wrapper sheet having pulled away from the staybolts. One man was injured. Had the advice of a competent inspector been obtained, this explosion would undoubtedly have been avoided.

One of the through stays in the lower part of a Scotch marine boiler had been leaking. The outer nut and washer were removed and new fibrous packing in the form of a grommet was put on the end of the stay. The nut and washer were then replaced. When the boiler was steamed up, the outer end of the through stay, including the nut and washer, was blown out. The stay, being broken off flush with the inside surface of the head, dropped down and left a hole $2\frac{1}{2}$ inches in diameter. This hole was directly in line with the coal bunker, and the jet of steam issuing under 140 pounds pressure fatally scalded the coal passer. The break in this through stay was clearly an old break and, though not discovered while repairing it, would most likely have been revealed by inspection.—*The Locomotive.*

R. I. Fretz has been placed in charge of marketing boiler tubes for the Reading Iron Company, at Reading, Pa. Mr. Fretz has efficiently represented the Bethlehem Steel Company and the Midvale Steel and Ordnance Company for many years. He has been a student of metallurgy and metallography and has been spending quite some time in the Reading Iron Company's plant to secure a working knowledge of its methods and begins his service with a reputation of being a real authority on boiler tubes. His headquarters will be in the general office of the Reading Iron Company, Reading.

Brunler's Experiments on Internal-Combustion Boiler Construction—Flame Burning in Liquid

By G. P. Blackall

IN a most interesting and informative address recently delivered in London, Oscar Brunler outlined the work on the construction of an internal-combustion boiler which he has carried on in continuation of the experiments made by his father on the problem of burning an open flame in liquids. The most important points made by Mr. Brunler in his lecture are summarized hereunder.

All designs of boilers are based on the principle of bringing the flame of the fuel into the closest possible contact with the water in the boiler. This being so, why not burn the flame inside the water? Every kind of liquid fuel burns in liquid so long as the quantity of air or oxygen is large enough to secure complete combustion. During years of experiment liquid hydrocarbons varying in specific gravity between 0.8 and 1.2 have been used, and all of more than 60 different kinds of oil have been burnt without difficulty.

The fuel and the air necessary for the combustion are supplied to the burner under a pressure which barely exceeds the pressure of the steam. Before starting, the water level in the generator must not be above the lower mouth of the burner. The cover of the ignition lamp is removed after heating the fire-clay lining. Then the cover is pulled down again and the flame of the ignition lamp makes its way to the burner. After a few minutes the main burner is hot enough, the main regulating valve is opened, and the flame burns in the generator. Now the connecting valve to the water reservoir is opened and the water in the generator rises up to the middle of the burner. The flame which is burning quietly in the water can be observed through the peep-holes in the generator. By means of the superheater the steam can be superheated to any degree desired. The superheater consists of a small burner similar to the ignition lamp, and its flame burns in the steam reservoir. The size of the flame and consequently the quantity of steam are regulated by means of the regulating valve, and at the same time the ratio of oil and air is kept constant. By turning one wheel the size of the flame can be regulated, and the ratio of fuel and air is not changed. Consequently the combustion cannot be altered through mistakes of the stoker. The temperature in the center of the flame is approximately 1,800 degrees C. This temperature diminishes to the periphery of the flame, so that between the center of the flame and the periphery a rapid fall of temperature takes place. Since a permanent stream of burning gas has to pass this fall of temperature it is evident that also the last traces of carbon monoxide must be converted into carbonic acid. In this way the possibility is ensured of burning the fuel more completely than in the open air. The combustion under pressure brings the molecules of the fuel into better contact with the oxygen, and the most complete combustion is obtained.

At first the flame will give up the greatest part of its heat to the water owing to the radiation and because of its contact with water. Around the flame superheated steam will be produced which will make its way with the nitrogen and carbonic acid to the level of the water and pass over to the steam reservoir. The heating surface is the surface of the flame and the surface of the gas molecules which are passing through the water. It is evident that after a few minutes the required pressure of steam can be obtained. According to Dalton's law, in this boiler, in which steam and gas are present, the pressure of the mixture must equal the sum of the pressures of the gas and the steam.

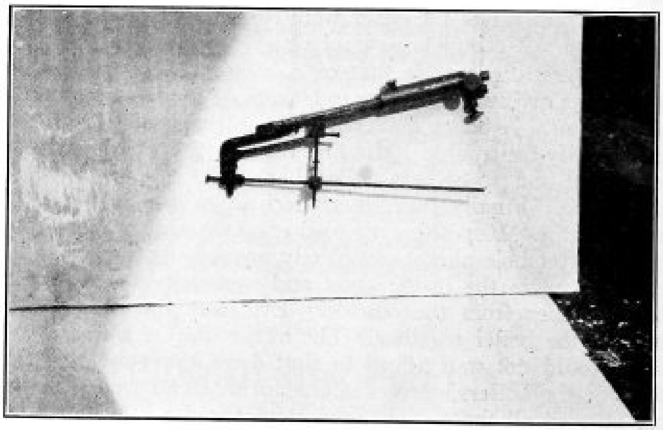
The mixture of gases passing from the steam generator to the steam reservoir contains 60 percent of steam and 40 percent of gases. These are the same gases as in the gas and oil engines, the only difference being that in these engines the amount of steam is much less. The presence of a great quantity of gas in the steam makes the condensing engine impossible; i.e., the steam which is passing off can be condensed, and be pumped into the boiler as feed water, but a vacuum cannot be used because vacuum pumps of a very large size would be required. This fact, however, is not a serious disadvantage. The main idea is to save as much fuel as possible and to obtain the highest efficiency. If this is possible without condensation all the better. Instead of the condenser there is an air compressor, which occupies less space and needs less repairs than the condensation plant. At the same time the steam that passes off can be used for heating purposes.

During the tests which Brunler has carried out with the submerged flame, evaporations have been obtained which surpassed the theoretical ones. Samples of the oil used during the tests were chemically analyzed and burnt in the calorimeter and the exact calorific value of the oil was determined, but for weeks and weeks a higher calorific value, and therefore a higher efficiency than 100 percent was obtained.

Saving Time with an Acetylene Cutting Torch

By David Pearson*

CUTTING circles with a hand acetylene cutting torch is a tedious, crude operation at the best. The operator experiences great difficulty in keeping his hand steady enough to produce an even cut. Fig. 1 shows a simple arrangement whereby these objectionable features are greatly reduced thus effecting a considerable saving in time and labor. The device consists of a radius bar one end of which is fixed to the torch tip. There slides along this bar a pivot bar one end of which fits over and slides along the acetylene pipe of the torch. Suitable adjustments are provided to take care of the various radii.



Attachment for cutting with an acetylene torch

Extension Tip for Torch

The acetylene operator is often confronted with the problem of trying to reach inaccessible places with the cutting torch. An extension tip is used for reaching such places. It is made from a piece of copper tubing and a rod. One end of the tubing is threaded and fitted with a nipple which is screwed in where the cutting tip normally goes. The rod fits inside of the tubing. These extensions have been used to lengths of 10 and 20 feet. The device can be readily used in connection with boiler repair work.

* Welder foreman, Atchison, Topeka & Santa Fe, San Bernardino, Cal.

The Boiler Maker

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

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Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price; United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. Foreign subscriptions may be paid through our London office, 34 Victoria Street, S. W., 1, in £/s/d.

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

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In opening the mid-winter meeting of the American Boiler Manufacturers' Association at the Mid-Day Club, Cleveland, February 12, E. R. Fish, president of the association, among other things brought up the question of how the association could best serve its members and the industry. As he stated, the scope of activities of the association is coming to include many other phases than the technical problems common to the various member companies. The fact that such matters as sales policies, contracts, standard cost accounting systems, legal matters in connection with the conduct of business and other details occupy a great part of the various meetings indicates a healthy growth in the service of the association.

Since modern business itself is founded on service, it is only logical that the tie holding the various units of an industry together—the association—should be service. The question of sales and salesmanship methods as a subject of discussion at this meeting and its extension to the annual meeting as one of the principal topics to be presented, points to the fact that here is a field for development that comes well within the activities of the association.

Although the subject of cost accounting has been before the members of the American Boiler Manufacturers' Association for some years, entirely new phases of it were presented at this meeting and a new line of thought opened for consideration and action. Here again the association collectively can accomplish more by fostering a standard method of cost finding for all its members than can be accomplished individually. The other subjects pertaining to the legal aspects of conducting business in various states in accordance with the laws of those states, of establishing contracts that are more or less standard and in the more technical side, of standardizing types of boilers and material—all these can be made as important a part of the work of the association as the members see fit to carry them and in the process reap actual benefits from their united effort.

During the past two or three years the European boiler industry has carried out a number of experiments with the design and construction of types of boilers that are radical departures from conventional practice. High pressure boilers, electric heaters and others have been developed and used with more or less success. To a certain extent, the same is true in this country in the form of high pressure watertube boilers and in the case of the mercury boiler. In this issue of the magazine are noted two innovations in the field of European practice—the modified Scotch marine Prudhon-Capus boiler and Brunler's internal combustion boiler.

Of the two, the Prudhon-Capus seems to offer the greatest chance for immediate commercialization. In fact it is being used to a considerable extent in the ships of the French merchant fleet at the present time. From the description, it is evident that the construction combines in a balanced way some of the features of the watertube boiler with the stamina of the Scotch marine. This is borne out in actual operation by the greatly augmented water circulation, easier steaming ability and greater capacity. The combustion chambers are eliminated facilitating repair work and the tubes can be renewed in successive stages thus lessening the tie-up in port for boiler repairs.

The second boiler, Brunler's internal combustion type, although still in its early stages of development offers a field for considerable investigation with the possibility of a practical application on a large scale later. The principles on which its operation depend, as noted, are well known and its efficiency is higher than any boiler type yet developed.

These and further developments will be watched with keen interest by boiler constructors in this country and will probably suggest lines of investigation that will bear fruit in special American designs. The results already obtained certainly indicate that there is as great a future in the economic use of steam as a power medium as in any of the other sources of power.

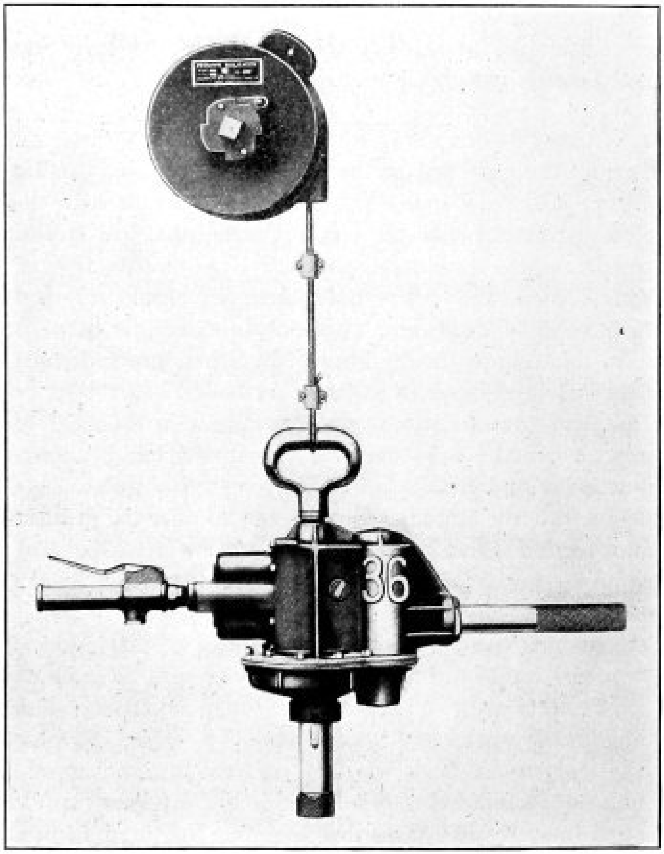
Engineering Specialties for Boiler Making

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

Balancer for Pneumatic or Electric Portable Tools

THE Chicago Pneumatic Tool Company, New York City, has announced the sole distribution rights for the Pedwyn balancer, a self-contained mechanical device offering the only mechanical means available for suspending, balancing or lifting pneumatic or electric portable tools.

The usual method of dealing with the fatigue problem in handling portable tools has been to install an overhead sheave on which a cable or rope is placed with weights fastened to the other end that are intended to counterbalance the weight of the suspended tool. This arrangement of balancing is prohibited by law unless guards are placed around the counterweights.

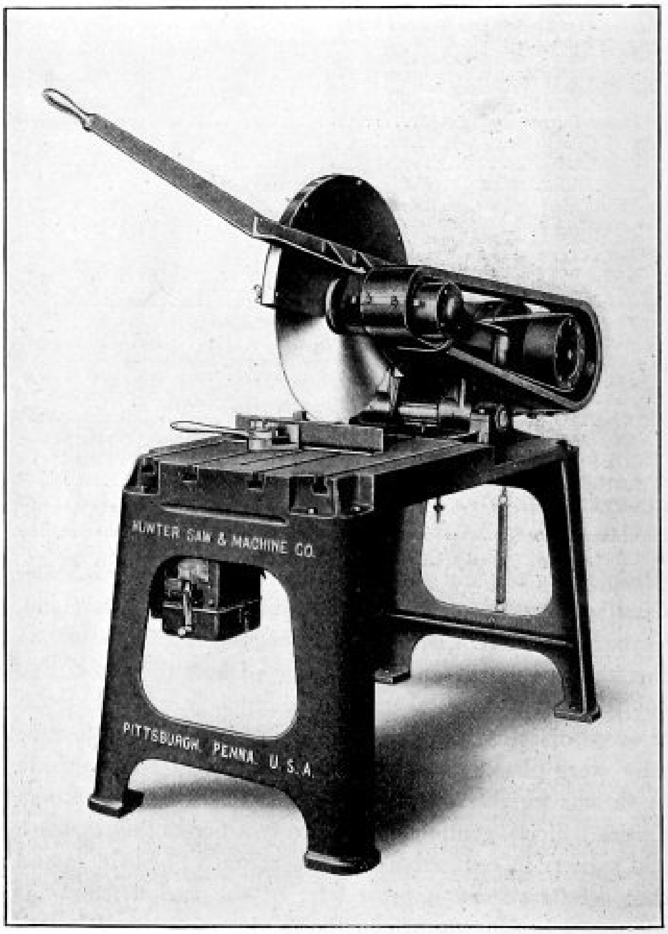


Pedwyn balancer for portable tools

The balancer brought out to replace this method is made in two sizes, the first from 10 to 50 pounds and the second having a capacity of 50 to 100 pounds. Both sizes are adjustable for any intermediate load within the range of their respective capacities. The Pedwyn balancer is classified as a piece of portable equipment and can be moved about to various locations readily. It can also be suspended on a trolley and track for a conveyor and the equipment can be traversed in a longitudinal direction. This method of balancing drills and grinders prevents their falling to the floor which sometimes causes damage to the spindles. The method provides a dependable installation whereby the tools can be suspended conveniently within easy reach of the operators.

High Speed Metal Cut-Off Saw

THE machine illustrated below was designed by the Hunter Saw and Machine Company, Pittsburgh, Pa., to cut cold metal by means of a high rotative speed circular saw, particularly adapted for tubing and metal sections. The motor and saw blade are mounted on opposite ends of a tilting frame, the machine is driven by a belt from the motor and an idler pulley is located in the frame to give a maximum belt contact on the arbor pulley with a minimum tension. The saw arbor and idler pulley are equipped with S. K. F. self-alining ball bearings in oiltight dust-proof housings. The belt and saw blades are fully protected by steel guards to conform with safety specifications. The belt guards can be quickly removed and the belt applied without dismantling other parts of the machine. A pan is attached



Hunter saw for cutting metal cold

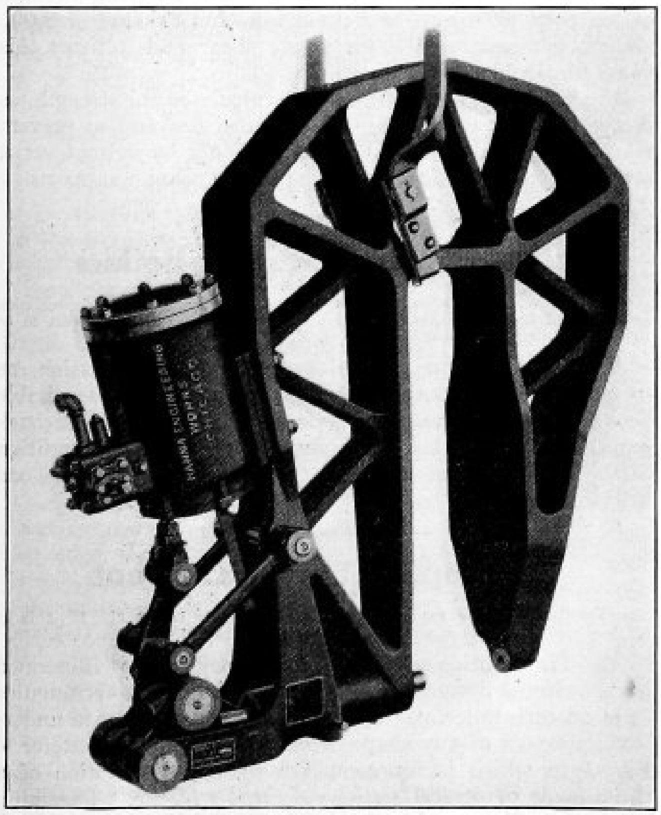
to the under side of the table inclosing the saw at its lowest point to catch cuttings. This pan can be dropped and the cuttings removed.

The motor support is provided with adjusting screws to give the belt the desired tension. The motor end of the tilting frame has a cushioned stop and is connected with a spiral spring to return the frame to the height necessary only to clear the material being cut. The saw is fed down through the work by an offside hand lever attached to the forward end of the tilting frame.

The table is provided with a graduated quadrant stop that can be set to any angle within the sweep of the saw blade used. This stop is held firmly in position on the table by a bolt moving through T slots. The material is clamped by a quick acting eccentric jaw. The machine has a capacity for tubes up to 4 inches in diameter. It is equipped to take care of a saw of 24-inch maximum overall section.

Riveter for Gas Holder Fabrication

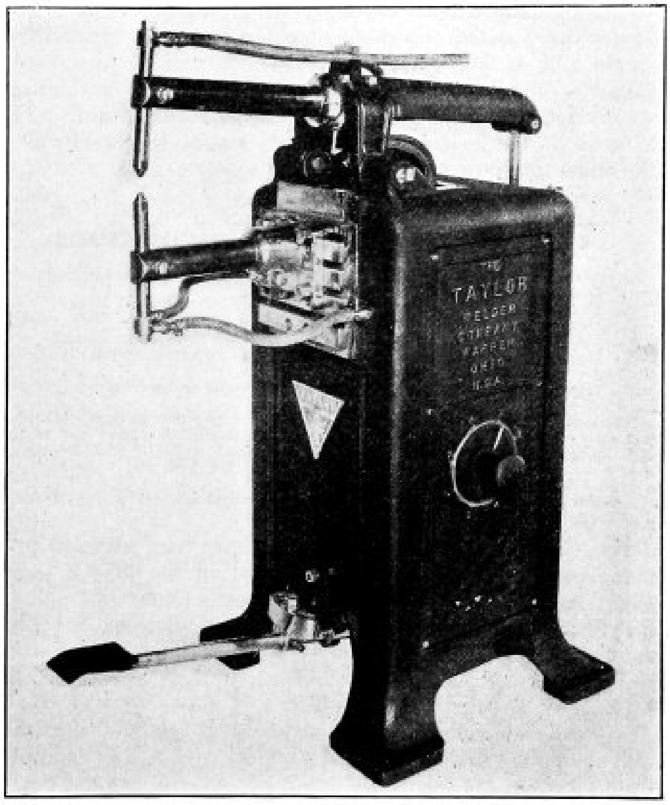
The Hanna Engineering Works, Chicago, Ill., has recently placed on the market a new type of riveting machine developed especially for gas holder cups. The machine has a number of special features particularly designed for this type of work. It has a 42-inch reach and a 12-inch gap with a cylinder diameter of 10½ inches and is capable of exerting 30 tons on the dies at 100 pounds air pressure. The Hanna patented mechanism or motion, which develops a pre-determined pressure uniformly throughout the last half of the piston stroke or the last ½-inch of rivet die travel, is incorporated in this machine. This portion of the die stroke that performs the final or critical setting of the rivet is therefore identical to the die stroke characteristics of a hydraulic riveter. Added to this, the early part of the die stroke, in which very little actual work is done on the rivet, is accomplished on an average leverage of 2 to 1 as compared to 12 to 1 for the uniform pressure of the stroke. Thus the clearance gap between the dies is closed at a relatively small power consumption while the heading of the rivet is performed under known conditions regardless of considerable variation in length of stroke and this without die screw adjustment.



Pneumatic riveter with special frame construction

Water Cooled Spot Welding Machine

One of the type N spot welding machines recently placed on the market by the Taylor Welder Company, Warren, Ohio, is shown in the illustration. This machine is built in three sizes for welding work ranging from No. 30 gage material to two plates 3/16 inch thick. The overhang is from 6 inches to 30 inches. The upper horn is adjustable in and out to permit the use of gooseneck welding points with one of the regular welding points, and both horns can be revolved in either direction to allow welding in corners and otherwise inaccessible places. The lower horn is adjustable up and down and sidewise in either direction.



Taylor spot welder provided with adjustable horns

The smallest machine is equipped with a 10-kilowatt transformer, and the intermediate with a 15-kilowatt transformer. There is an eight-step self-contained regulator for adjusting the current to take care of the lightest work up to the capacity of the machine. The switch is of an automatic and non-automatic type so designed that it cannot close until the electrodes have made proper contact with the work. No adjustments are required for different thicknesses of work or for wear of the electrodes. The switch is changed from an automatic to a non-automatic trip by operating a lever. The automatic trip is desirable for welding work that is buckled and does not fit together properly, as it permits a positive pressure to be applied to the weld after the current has been turned off, and thus prevents the weld from separating while in the molten state. It is desirable to set the switch

(*Continued on page* 88)

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Tank Supports and Calculations

Q.—How is *stress* determined in the following members of a tank support:
1. Diagonals of transverse frames.
2. Diagonal of side panel.
3. Horizontal tie between columns at sides.
4. Horizontal tie between columns at bottom of transverse frame.
5. How is it determined if a gusset plate is required at intersection of diagonals of transverse frames, or not?
6. How is the size of gusset determined if found to be required, as asked in 5?

The reason I desire this information is that the supports gave trouble when put into service in that the diagonal members bulged or dished out of line 3½ inches at point of intersection. This would seem to indicate that a gusset was needed at the point of intersection—but how can I determine if a gusset is necessary in like cases?

I believe the questions asked would be of general interest to your readers, and certainly would be appreciated.—G. H. A.

A.—Some of the data you require have been given in previous issues of THE BOILER MAKER; in the March issue, 1923, is explained several tank support calculations and in the September issue, 1924, is given calculations for bent seam supports.

The stress or pull in the diagonal supports shown in Fig. 1 (a) may be calculated as follows:

Figure each column as u,v,w to carry 1/6th of the total weight of the tank when filled with oil, for in this example,

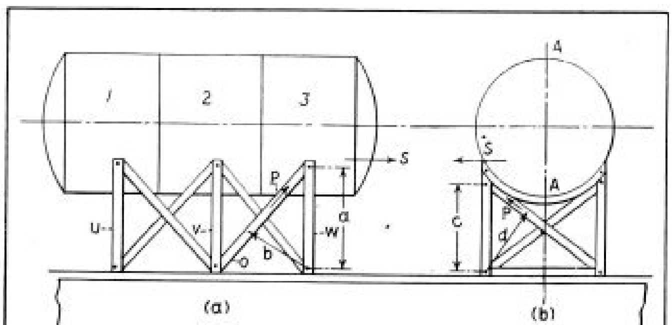


FIG. I

Diagram of stresses on tank supports

the tank is made up of three equal sections supported by 3 columns on each side. Consider the load S in one-half of the section *3* to move in the direction of the arrow. This condition sets up a pulling stress in the diagonal o the magnitude of which may be determined from the stress diagram, Fig. 2.

$$\text{Therefore, } P = \frac{Sa}{b} \qquad (1)$$

in which;

P = pulling stress in diagonal, pounds.
S = load in pounds.
a = vertical distance between opposite ends of diagonals, inches.
b = distance measured as shown in (a) Fig. (1).

$$P = \frac{Sc}{d} \qquad (2)$$

Example: If the load S equals 6,000 pounds, and distance a equals 24 inches, and distance b equals 30 inches, what is the calculated stress in the diagonal o?

Substitute the values given in the formula (1) then

$$P = \frac{6{,}000 \times 24}{30} = 4{,}800 \text{ pounds.}$$

Consider the safe tensile strength of a mild steel bar to equal 6,000 pounds per square inch. The cross sectional area of the required bar would equal $4{,}800 \div 6{,}000 = .8$ square inch. A bar 5/16-inch by 2⅝-inches would meet the requirements.

The calculations for the diagonals, view (b) Fig. 1 are made in the same manner using formula 2 and taking into account the load S produced by the weight in half of the shell for 1/3 the length of the tank. The shearing strength of the bolts must also be figured allowing a value of 5,000 pounds per square inch for single shear and 2 times this value for double shear.

The gussets at the center are not calculated for strength, as they serve only to tie the diagonals together and to prevent vibration. The horizontal tie D need not be figured, as it serves only as a tie for the footing of the column supports.

Depreciation Value of Boilers

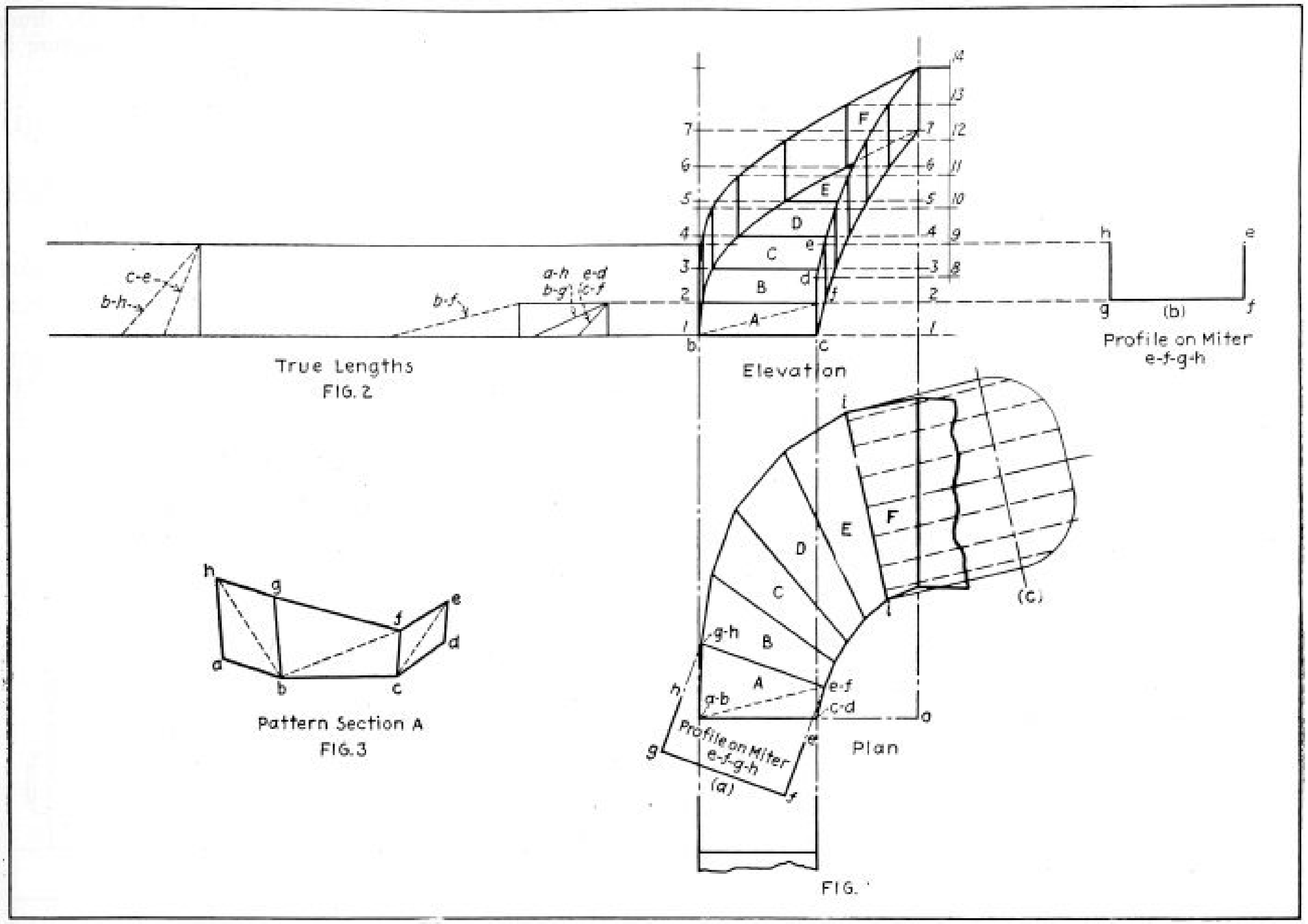
Q.—Will you please obtain for me data for arriving at the depreciation value of second-hand boilers? By this I mean the percentage of cost to be written off after each year of use.—C. R.

A.—This question we will leave open for discussion, as so much can be taken into account for arriving at a suitable percent loss in the value of boilers. The value of a second-hand boiler like other machinery depends on the condition of the materials and what must be done to keep it in good working condition.

Development of Coal Spout

Q.—Will you please explain how a coal spout is laid out? If it is to be in six pieces or more running on the style of an elbow?—F. O. J.

A.—The solution of your problem may be best illustrated by showing a development of a spout having a rectangular form on each miter. If the principles so applied are understood a layout of any shape of chute can be made. Refer to Fig. 1 in which is represented a plan and elevation of a chute made of several sections A, B, C, D, etc. The miter lines are radial terminating in point o, and the outline for each section is measured on the miters between connecting



Plan and elevation of coal chute

sections. The elevation is developed from the plan and from the height given for each section as measured on the miter, thus for section *A* the profile on miter line *e, f, g, h,* is shown at right angles to this miter line, in the plan view. To produce the elevation, transfer the profile (*a*) to the position shown at (*b*). Projectors are drawn from the plan view to intersect those drawn horizontally from the view (*b*) thus locating the points for drawing the outline of the section *A* in the elevation. As the sections are shown foreshortened in both views, the true lengths of the sloping edge lines must be found as shown in Fig. 2. The length of *c-f* and *e-d* is the same, which is found by constructing a right angled triangle using the short edge line *c-f* on the throat of the plan view and a height equal to the vertical distance between the extremities of this line, measured as shown in the elevation. The hypotenuse is the true length. The other true lengths are determined in the same manner, and shown in Fig. 2.

The pattern layout is given in Fig. 3, and as all edge lines are marked to correspond with those in Figs. 1 and 2, the construction should be readily understood.

If the profile on the miter lines is a combination of curved and straight surfaces, as shown in view (*c*), the same method is applied, which involves, however, a greater number of construction lines. These lines are projected from the profile (*c*) to the miter and at right angles to the miter line *i-i*. The profile (*c*) would also be used in the elevation, as explained for (*b*). This method of construction would be applied for all sections showing the shape of the miters in the elevation in relation to their position in the plan. The true lengths of all foreshortened lines are then produced as explained for Fig. 2.

Crown Stays and Stay Troubles

Q.—There is a feature of the locomotive boiler on this road that gives us considerable trouble, and we would like your advice as to how to remedy it. The firebox crown sheet has a T bar attached to it. Driven bolts, taking the place of crown bolts, in the first two rows of holes parallel to the flue sheet, fasten the bar down. They are machined to fit, driven in tight, and have a nut on the top end to tighten the T bar down. The bolts go through ferrules which hold the T bar off the crown sheet. The T bar is fastened to the roof sheet with sling stays. The trouble lies in the bolts and ferrules. It seems that directly around the ferrule, pitting occurs which calls for a patch before the life of the crown sheet is spent. The bolts become leaky and are a constant source of trouble. Would you recommend substituting flexible bolts here? I believe they will work all right. Would plain tapered radial bolts do? I will appreciate any information or discussion on the subject that you can give me.—C. E. S.

A.—On account of the conditions you give and also due to the increased difficulty of cleaning the crown sheet, great weight and cost, and loss of water space taken up by crown bars, the staying of the crown sheet by this means has been generally superseded by the staybolt method.

Radial stays of rigid or flexible types are used in preference to the crown bar method. Such stays to be the most effective should set as nearly as possible at right angles to the sheets they support. Since the crown and roof sheets are usually rolled to a large radius the stays are arranged radial from which the term *radial stays* is derived.

Rigid crown stays are installed in several ways: The *buttonhead* stay is screwed in from the crown sheet until the head fits snug against the sheet, the end that passes through the roof sheet is riveted over. Another method is to set a stay (threaded at both ends) in the roof and crown sheet and riveting; that is, driving a head on both ends. Another method is to apply the stay from the roof sheet side, heading the roof sheet end and placing a copper washer and nut over the crown sheet end of the bolt. For turning these bolts in place, a square head is formed on one end. Where such an end projects into the firebox it should be cut off. This prevents overheating of the bolt heads.

Flexible crown stays, allow the sheets to expand and contract, thus preventing undue strain to arise in the sheets and stays. I would recommend the flexible stay in preference to the solid radial.

Flanging and Dishing Heads

Q.—Could you give me any information in regard to flanging dished heads; that is, on a sectional press a piece at a time?
Would I have to have a bottom block for every different radius?
What position would the head be laying on the press?
If you could forward me a sketch of how it should go I would appreciate it very much and oblige.—W. J. McN.

A.—In flanging and dishing heads on a sectional flanger, flange the head first and then dish the head. The flanging operation may be done as shown in Fig. 1, setting the head

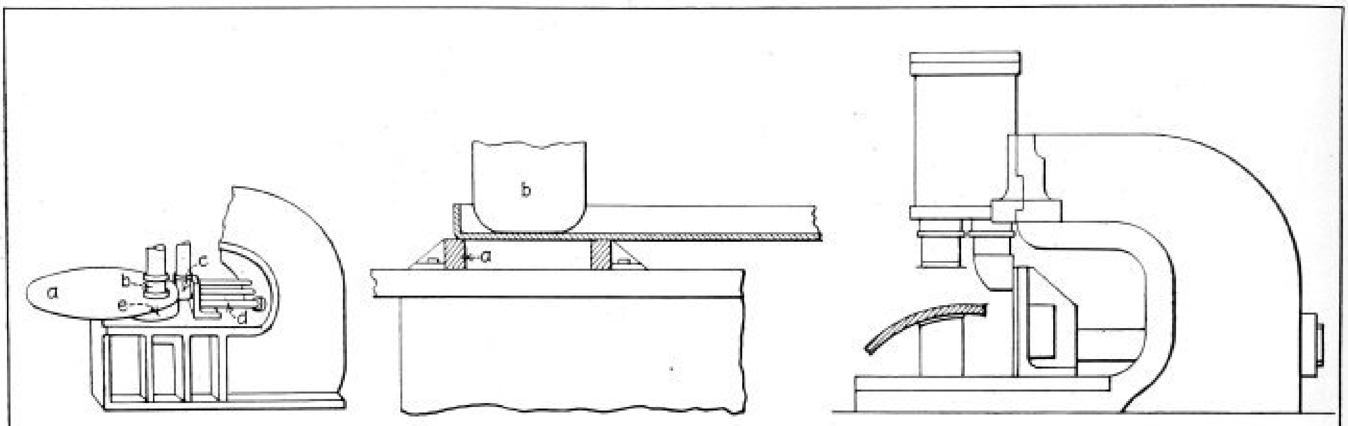


FIG. 1 FIG. 2 200 Ton Press

Various methods of flanging heads

a on the press table and flange block then clamp it down by the ram b. The plunger attachment c is then lowered forming a flange e. After each stroke of the ram c the flange will be uneven; to straighten out the irregularities in the flange, the horizontal ram d is moved in to work out the wrinkles. For dishing the head one set of blocks is sufficient for the small and medium sized heads. A circular ring a and a ram b, as shown in Fig. 2, may be used. The dishing may be done cold, working the plate around from the flange to the center of the head. The most advantageous way to use dishing blocks and form the dish in one operation.

Boiler Calculations

Q.—I am going to trouble you just a bit to ask if you will kindly publish in THE BOILER MAKER the rule for determining the bursting strength of a boiler. I am a practical boiler maker working at the trade but at present am unable to determine the desired information.—L. M. C.

A.—To answer your question completely would require more space than is available in this column. It is necessary that you understand the use of formulas, as applied in calculating strength of materials, and also the principles of boiler design that relate to construction of boilers. The *bursting pressure* is theoretically the pressure at which the boiler will burst, the magnitude of which depends on the weakest part of the boiler, which may be either the firebox sheets, shell, braces or stays, riveted joints, etc.

I would suggest that you obtain a good book on boiler design, construction and strength of materials.

The calculation for determining the bursting pressure of a boiler shell or drum is figured from the strength of the weakest course, which is computed from the thickness of plate, the tensile strength of the plate, the efficiency of the longitudinal joint, or the ligament between the tube holes in the shell or drum, and the inside diameter of the drum or shell. Expressed in a formula, the bursting pressure is found as follows:

$$\text{Bursting pressure} = \frac{Ts \times t \times E}{R} \qquad (1)$$

in which Ts = ultimate tensile strength of plate, pounds per square inch.
t = thickness of plate, in inches.
E = efficiency of longitudinal joints, expressed in percentage.
R = inside radius of drum or shell.

The formula for calculating the maximum allowable working pressure involves the values given in formula (1) and the factor of safety, which is 5 for new boilers; then,

$$\text{Maximum allowable working pressure} = \frac{Ts \times t \times E}{R \times FS} \qquad (2)$$

in which FS = factor of safety.

Hydraulic Riveter Calculations

Q.—Will you please furnish me with the following information: I would like to know what tonnage is obtained on a rivet on a hydraulic riveter at 1,500 pounds gage pressure. I know how to get the tonnage on the riveter from the size of the ram, but don't know the actual tonnage on the rivet itself. Hoping you will furnish me with the formula.—C. M.

A.—The pressure in tonnage required for heading and upsetting rivets by a hydraulic riveter is approximately 100 tons per square inch. Thus for a rivet 1 inch in diameter the required tonnage is $1^2 \times 0.7854 \times 100 = 78.54$ tons.

To find the net pressure exerted by a ram in a hydraulic riveter, when the percentage of friction is not considered, the following formula is used:

$$P = p \times 0.7854 \times d^2 \qquad (1)$$

in which,
P = pressure exerted by the ram.
p = pressure of the water in pounds per square inch.
d = diameter of ram, inches.

To find the pressure per square inch required to produce a given net pressure when the diameter of the ram is known, solve for p in the formula (1)

$$\text{Then, } p = \frac{P}{0.7854 \times d^2} \qquad (2)$$

To determine the diameter of the ram required solve for d in the formula (1)

$$\text{Then, } d = \frac{P}{0.7854 \times p} \qquad (3)$$

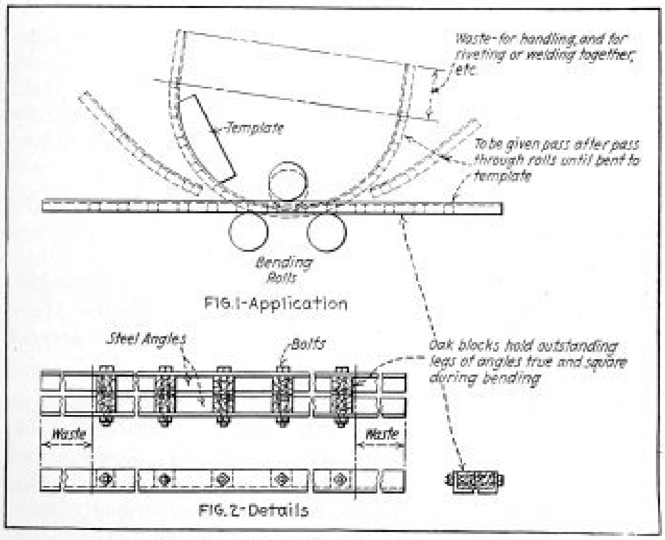
Letters from Practical Boiler Makers

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

A Simple Angle Iron Bending Device

SOMETIME ago a representative of your magazine came through and while here I took him to see a piece of angle iron which we had rolled in a common set of rolls and he asked me to send a sketch to your office. It is too good a thing to keep as it puts the big shop and the little one on the same basis. I saw an article in your paper explaining the way to get the length of angle iron, which we have been working for years and it is all right.

Now, as to bending the angle iron, the sketch will show how it is done. Lay off the holes on both legs, of the angle iron and bolt blocks in between. It works either inside or outside but we leave eight or ten inches on each end to curve the angle iron in the rolls. We roll as high as four-inch angle iron. If we want to roll only one angle we make it in two halves in order to not waste material. The hardwood blocks can be cut on a band saw and will last for a good many runs. The bolts we return for credit or keep for future use. Use bolts the right size for holes. The holes will be a little out of round but this can be corrected by reaming or pinning.



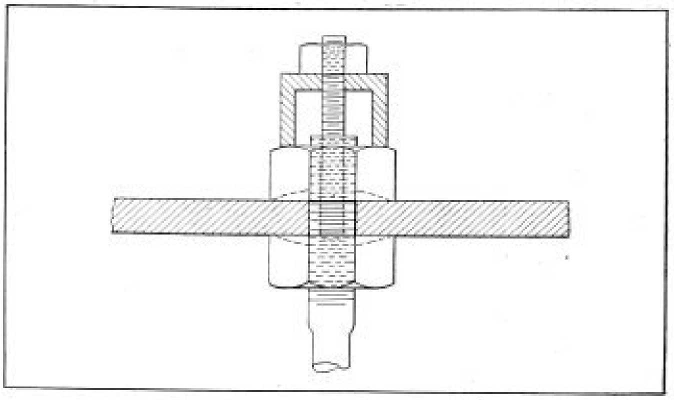
Details of method for bending angle iron

Great Falls, Mont. MIKE WYNN.

Emergency Repairs to a Dry Back Scotch Marine Boiler

AN emergency repair job on a through stay in a Scotch marine dry back boiler may be of interest and benefit to your readers. This boiler supplied power for a large coal loading machine at Lorain, Ohio. We received a hurry-up call for repairs, a bad leak in the combustion chamber being reported.

We found that the leakage came from around the lower stay, which was 3 inches in diameter secured at both ends by nuts, as shown in the accompanying sketch. Due to the corrosion that had set in, we stripped all threads on the stay in taking off the nut. You can imagine that we realized that we were up against it good and proper, as this was the only boiler supplying the unloading machine and every hour's delay cost some hundreds of dollars. We effected repairs in the manner shown, drilled into the stay and applied a one-inch stud, made a heavy dog similar to a handhole dog, and applied same, first packing the stay near the sheet with a good packing, a counterbore on the end of the nut held this in place; tightened up the nut good, then placed a cover of brick and cement over it as protection from the flames. This job gave no trouble for the remaining two months which brought the end of the lake season, when the stay was renewed.



Emergency repair to boiler stay

In reference to Mr. F. Snowden's remark pertaining to repairs of Adamson furnace, I should have made the notation that that also was an emergency repair, to cover the remainder of the season, when both furnaces were removed and Morison furnaces applied.

Lorain, Ohio. JOSEPH SMITH.

Nomenclature of Riveted Seams

ACCORDING to the articles in the last issue of THE BOILER MAKER by Mr. Joynes and Mr. Blanton, it would appear as if it is general practice in the railroad shops to enumerate the total rows of rivets in the seam when speaking of a butt joint. I am wondering if this is a new school of thought or whether a long standing practice in that class of work. However, in either case I consider it a point of considerable interest to all those engaged in the practice or theory of boiler and pressure vessel making because I believe it to be the universal rule to count the rows on each side of the joint. This rule is followed by the A. S. M. E. and every state boiler code that I know of, also every reference book I have seen relating to riveted joints, including Kent's Handbook, Haven and Swett's Design, etc., and most of the steel companies' lists. I also know it to be the standard rule in England.

If then Mr. Blanton and Mr. Joynes are representative of the railroad voice of the trade, when the railroad firm finds it necessary to do business with a general boiler shop and specifies a quadruple riveted butt joint, unless he sends a drawing along with his specification the contractor will be figuring on what to the railway man will be an octuple riveted joint. Inversely, supposing a firm doing railroad work gave a price for making a storage tank with a double seam which was accepted, the customer would be likely to cancel the contract when he found it a single riveted butt. Altogether the system seems likely to cause endless misunderstandings with possibly serious consequences. In my own personal opinion their's does seem the more correct method because when speaking of any joint we naturally mean all and not half of it, so why count only one-half of the rivet rows. However it has become a time-worn custom to do so, and if there is a body of opinion to favor a change it ought to be brought forward before all the interested authorities in order to decide decisively which should be the standard practice, as it is certainly not good policy to have two nomenclatures in the same business even if in different sections.

Chattanooga, Tenn. JAMES WINTHORPE.

Boiler Production at Lima Locomotive Works

(*Continued from page 66*)

After the tests, the flue sheet is sand blasted and the flues welded. The welding is done in the erecting shop but the sheet is sand blasted while the boiler is on its way to the erecting shop.

The entire plant is a very efficiently operated organization, which has developed remarkably in the past year or two. This development is shown in the boiler shop by the fact that a year ago six boilers a week was considered good production while today the shop easily handles nine or ten boilers a week with the same shop organization.

Water Cooled Spot Welding Machine

(*Continued from page 83*)

in the non-trip position in welding wire and clean sheets, and also in operations where greater speed is wanted. The pressure on the electrodes is controlled by means of a hand-wheel.

In addition to the water circulation in the electrodes, the transformer is water cooled. The machine may be furnished with a quick change gear box and either a belt or motor drive. The foot-treadle is adjustable in or out and may also be swiveled to suit the convenience of the operator. The travel of the upper electrode and the foot-treadle can be varied for different thicknesses of work by means of a lever which is located on the front of the machine.

Court of Appeals Awards Right to Arc Welding Apparatus

C. J. HOLSLAG of the Electric Arc Cutting and Welding Company, Newark, N. J., has issued the announcement that the Court of Appeals of the District of Columbia has awarded priority rights to him to manufacture the alternating current transformer type of arc welding apparatus as well as the methods of arc welding with alternating current. The Waters Arc Welding Corporation, New York, has for sometime been selling equipment of this type and the case was carried by this corporation to the Court of Appeals after an adverse decision to their right by the Commissioner of Patents, who had awarded the priority of invention to Mr. Holslag. An extract from the decision of the court follows: "The case turns entirely upon questions of fact. The 3 tribunals of the Patent Office in most elaborate opinions have concurred in awarding priority to Holslag. After careful examination of the evidence and review of the analysis thereof in the opinions of the tribunals below we are convinced that a proper conclusion has been reached. The decision of the Commissioner of Patents is therefore affirmed."

The last four lines of the decision of the United States Patent Office read as follows:

"Priority of invention on all counts in issue is awarded to Claude J. Holslag and the motion for judgment of Charles B. Waters is hereby denied."

BUSINESS NOTES

The Chicago Pneumatic Tool Company announces the opening of a branch office in Mexico at 1ª San Juan De Letran, 15 Mexico, D.F.

The Gibb Welding Machines Company (successors to Gibb Instrument Company) of Bay City, Mich., manufacturers of electric welding equipment, announce the appointment of The Welding Service & Sales Company, Donovan Building, Detroit, Mr. T. M. Butler, manager, as agents in the Detroit territory for their line of arc, spot and seam welding machines.

The Diamond Power Specialty Corporation of Detroit, Mich., manufacturers of Diamond Soot Blowers for water-tube and horizontal return tubular boilers, have appointed the Midwest Machinery Company, 104-106 South Main street, St. Louis, Mo., as their representative for the territory of Missouri, adjacent to St. Louis, south of and including Springfield and Decatur, Ill.

H. A. Anderson has been appointed chief engineer for the Johnston Manufacturing Company of Minneapolis, builders of oil burning heating apparatus for railroads and industrial plants. Mr. Anderson was in the ordnance department, U. S. Army, during the war and has been with the Mahr Manufacturing Company, also of Minneapolis, for several years, the last two as chief engineer.

The Lunkenheimer Company, Cincinnati, Ohio, has sent out the announcement that it will present a complete exhibit of bronze, iron and steel valves; pop safety, blow-off and non-return valves; water columns; water gages and gage cocks; lubricators; oil pumps, hand and mechanically operated; oil and grease cups, whistles, cocks, etc., at the "Informashow" to be held in Milwaukee, Wis., May 25 to 28.

William R. Van Nortwick, who for the past seven years has been district sales manager at New York for the Roto Company, of Hartford, Conn., has severed his connections with that company and has opened offices at 50 Church street, New York, for the sale of material to the same class of buyers. He has covered the combustion field in the Metropolitan territory for the past fifteen years and has a wide acquaintance in the field. In addition to the accounts he is handling he will add one or two more of the highest type power plant appeal.

The Electric Arc Cutting & Welding Company of 152-156 Jellif Avenue, Newark, N. J., has announced the opening of its new branch office at Syracuse, N. Y. This office will be completely equipped to handle all sales and distribution of welding machines and supplies for the entire state, exclusive of the metropolitan district. The new branch office will be under the able supervision of William P. McCarthy, and has been established by the company with a view to meeting the ever-increasing demand coming from every part of the state for such a service.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

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

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

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

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

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

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Second Vice-President—John F. Raps, general boiler inspector, I. C. R. R., Chicago, Ill.

Third Vice-President—W. J. Murphy, general foreman boiler maker, Penn System, Fort Wayne Shops, Allegheny, Pa.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

SELECTED BOILER PATENTS

Compiled by

DWIGHT B. GALT, Patent Attorney,

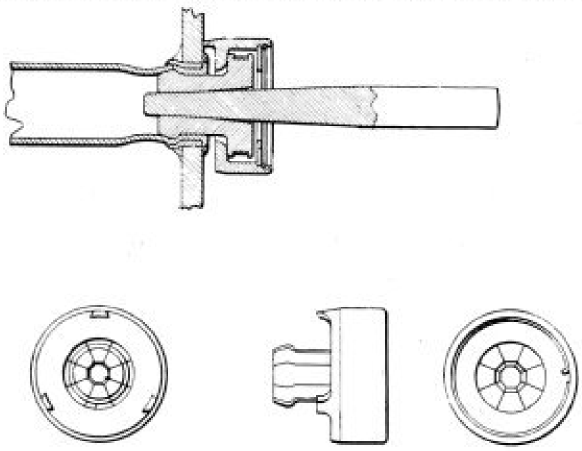
Washington Loan and Trust Building

Washington, D. C.

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

1,521,641.—GRAVES R. MAUPIN, OF MOBERLY, MISSOURI, ASSIGNOR TO THE J. FAESSLER MANUFACTURING COMPANY, OF MOBERLY, MISSOURI, A COPARTNERSHIP. METHOD OF AND APPARATUS FOR REMOVING SCALE AND EXPANDING BOILER FLUES.

Claim v.—The method of removing scale around the tube and inside of the flue sheet of a boiler, which consists in expanding the tube adjacent the flue

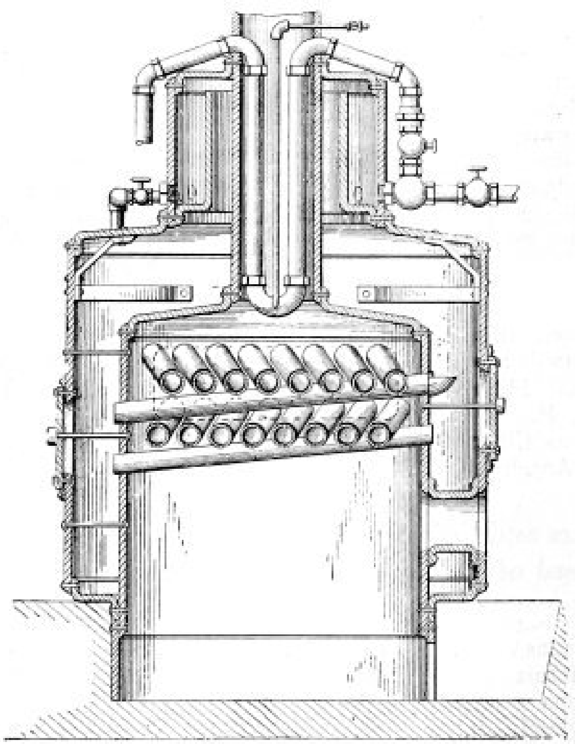


sheet so as to crack the deposited scale, and simultaneously therewith imparting vibration to the flue sheet thereby jarring loose the accumulated scale.

Three Claims.

1,522,288. GEORGE COOK, OF BUFFALO, NEW YORK. BOILER.

Claim 1.—An upright boiler of the water-tube type comprising an outer shell, an inner shell having a fire box therein, a flue connected to the top of the inner shell, a steam dome on the top of the outer shell surrounding

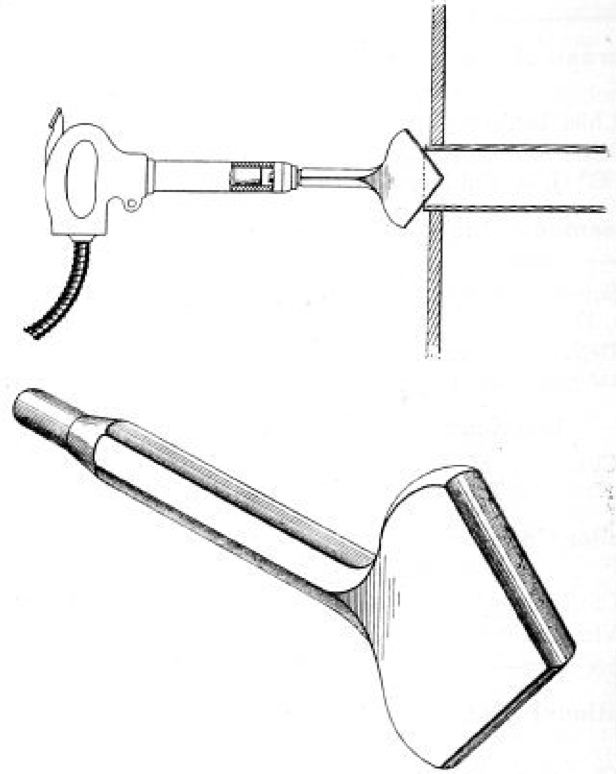


the flue, a baffle coaxially mounted in the steam dome having an integral flange presenting a downwardly bent portion adjacent to the lower edge of said dome, and means to secure said flange and the lower edge of said dome to said outer shell, whereby said integral flange forms the bottom of the steam space between said baffle and said dome.

Two Claims.

1,521,805. PAUL ELLIS, OF AUGUSTA, GEORGIA. SWAGING TOOL.

Claim 1.—A swaging tool comprising a single spear-shaped head having a plurality of edges so arranged at angles to the axis of the tool as to

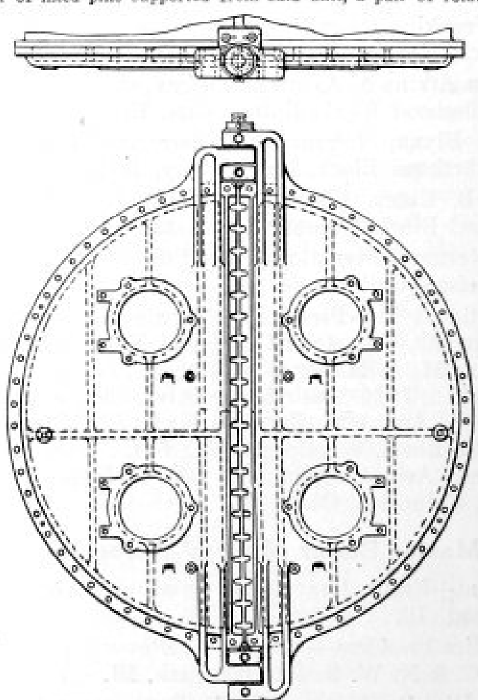


simultaneously contact diametrically opposite parts of a boiler tube end, a rod on which said head is formed, and a shank at the end of the rod upon which a blow is adapted to be delivered to produce impacts upon said boiler tube at said contacted parts.

Two Claims.

1,507,834. JAMES ERNEST JOHNSON, OF BOLTON, ENGLAND. ASSIGNOR TO HICK, HARGREAVES & COMPANY LIMITED, OF BOLTON, ENGLAND. STEAM CONDENSER, FEED-WATER HEATER AND THE LIKE.

Claim 1.—Closure means for condenser, feed heater and the like units comprising a pair of doors hinged adjacent the vertical centre line of the unit, a pair of fixed pins supported from said unit, a pair of rotatable eccen-



tric bush members mounted around each of the fixed pins, a pair of housing members carried by each door and disposed so that each housing member is acted upon by an eccentric bush member when the latter is rotated so that in opening and closing the doors may be displaced with respect to the unit.

Seven Claims.

THE BOILER MAKER

APRIL, 1925

Repairing and Maintaining Boiler Tubes Economically

Advanced methods developed in Austria for handling locomotive boiler tubes and flues

By Bruno Schapira

THE problem of designing boilers for locomotives entails fundamental difficulties of size and weight that are extremely difficult to overcome to the best advantage. The limited space allowable in a boiler and the weights on the wheels of the locomotive are the limiting factors encountered and these must be handled in such a way that high horsepowers can be produced. The only manner in which this object can be achieved is through feeding the grate at forced rates up to 5 or 6 times the normal feeding requirements of stationary boilers.

It is obvious that the escaping flue gases must necessarily contain a considerable quantity of heat which has not in any way been turned to advantage and for this reason represents a more or less great loss of heat value. These losses are in a measure increased through the deposit of scale on the water side of the heating surface as well as through the accumulation of dirt on the fire side. Both these conditions tend to considerably reduce the penetration of heat through the heating surfaces. Dirt accumulations gather primarily around the uneven parts of the inner tube walls and their removal causes considerable trouble. When it is understood that more than 90 percent of the heating surface in the boiler is in the tubes it is self evident that the overall efficiency of the engine depends almost entirely on the good condition of the tubes. Tubes on which accumulations are built up on either the inner or outer surfaces naturally have less heat absorbing capacity than if they were in a clean condition and this deficiency leads to an uneven distribution of heat when the boiler is in service. The remedy is in removing scaled tubes from the tube plate after leakage has occurred. When boilers are subject to this condition it is next to impossible to produce the required volume of steam through increasing the fuel supply.

After a certain length of service, the duration of which depends upon the load placed on the engine, the kind of fuel utilized, the characteristics of the feed water and the maintenance, the tubes must be removed from the boiler and cleaned. Tubes that are faulty have to be fitted with safe

Fig. 1.—Tube cleaning machine in operation

ends or entirely replaced. Providing that this repairing is done in accordance with the working methods hitherto employed (in Europe) a large quantity of valuable tube material is lost, many hours of labor are expended and a thoroughly skilled corps of mechanics is needed. Owing to these circumstances the expedient is adopted of removing groups of tubes for repair and constantly rolling all tubes as they become leaky. It goes without saying that the tube plates suffer through this manipulation without, however, arriving at a satisfactory boiler performance.

Austrian System of Tube Repair

For some years past in locomotive and stationary boiler practice in Austria the Proborsky system of handling tubes has been followed. This method shows decided advantages over systems hitherto generally applied. These advantages manifest themselves in every phase of tube practice from the removal of the tubes to their replacement. In the following paragraphs the principal phases of the method will be described.

(a) *Removing the tubes from the boiler.*

The removal of tubes from the boiler is as a rule accomplished by cutting them out by means of a simple tube cutter in the rear of the tube plate at the smokebox end. The tube is then withdrawn through the back tube sheet.

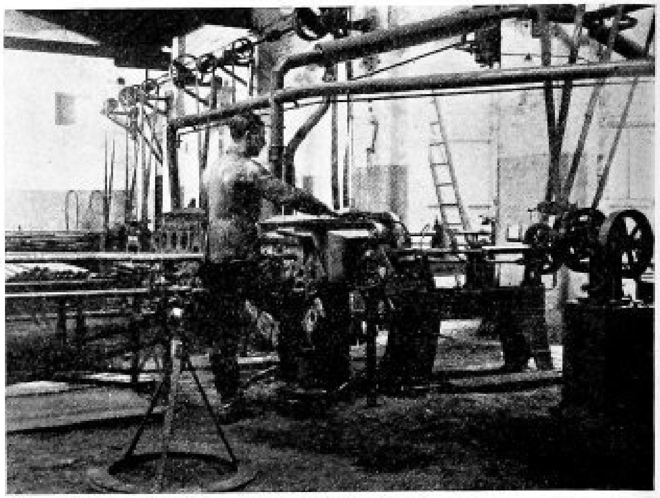


Fig. 4.—Arrangement of welding set

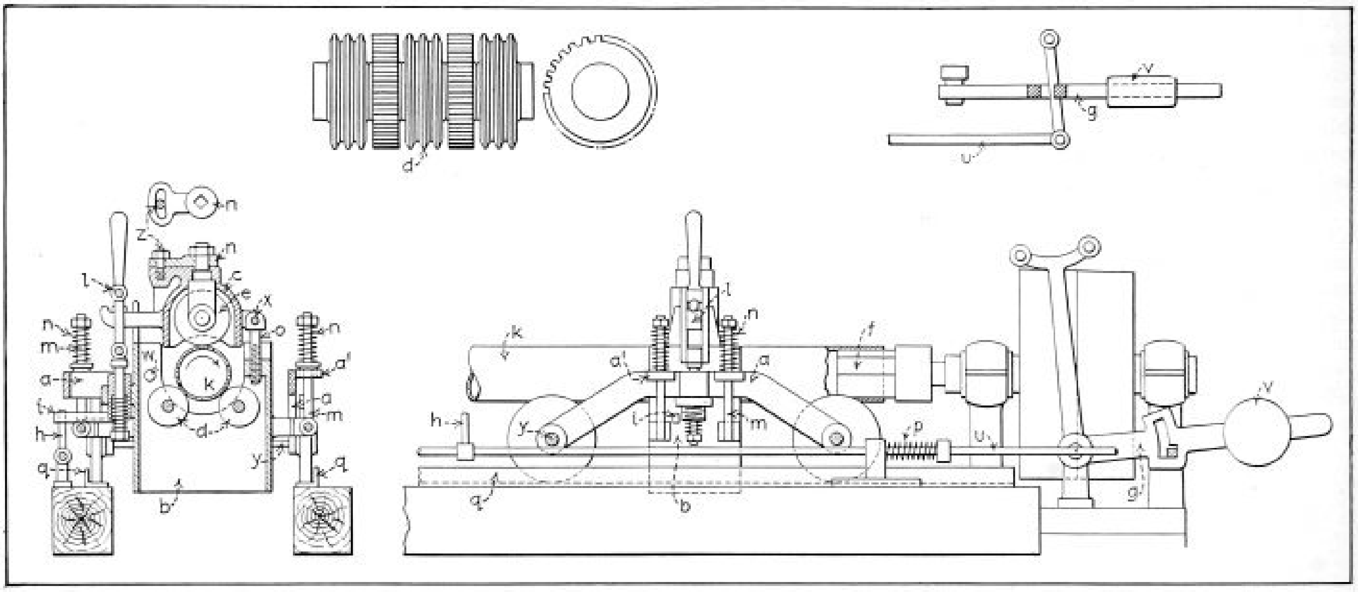


Fig. 2.—Diagram showing working details of tube cleaner

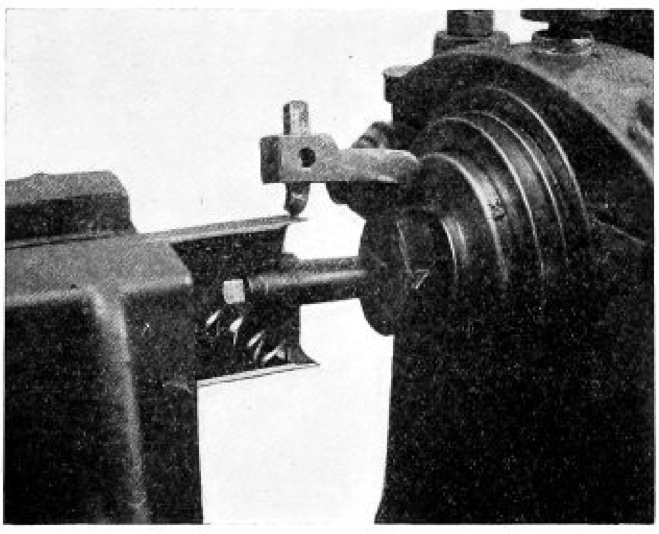


Fig. 3.—Taper being turned on inside of tube

One of the tube holes in the tube plate is then enlarged by means of a tube hole turn out apparatus (also serving to cut a thread in the tube hole) whereupon all the tubes can be removed from the interior of the boiler through this enlarged tube hole at the smokebox side. The tube plate and boiler interior are thus made easy of access and can be cleaned.

(b) *Cleaning the tubes.*

The tubes are subsequently transferred to the tube department and there under constant water pressure cleaned of scale in the machine shown in Fig. 1. This is done without damage to the tube surface. During the cleaning process the tube is kept rotating. Bluntly toothed wheels serve as cleaning tools and are pressed tight against the tube by aid of a spring action. The wheels run in a carriage and permit an all around unimpeded travel of the tube. Machines of this type built for the purpose of ridding boiler tube of scale while at the same time maintaining a rotary movement of the tube between teethed wheels or scrapers are well known in Europe. These wheels or scrapers are generally mounted on a rolling carriage whereby an obliquely adjusted roller produces an automatic continuous progressive travel of the carriage along the tube surface. However as the tubes to be cleaned are usually more or less bent it becomes necessary to impart an equally distributed elastic pressure to the cleaning carriage. This important function is performed by the appliance shown in Fig. 2 and described herewith. The cleaning wheels operate in such a manner that the scale on the surface of the tube is completely crushed and washed away under constant water flow. The water flow is secured by an automatically operating disengagement mechanism.

The process is as follows: The tube to be cleaned is placed in the machine after the cover has been raised and one end is pushed on to the gripping device (f); the other end of the tube rests on a movable stay. Care should be taken to have the carriage advanced to a position which will insure that the cleansing appliances (d) are on a line with the foremost point of the tube. Through the rotating motion the gripping jaws of the device on the driving shaft are forced to operate and pressed against the tube surface in such a manner that the tube is compelled to join in the rotary motion. As soon as the carriage arrives at the other end of the tube the machine becomes disengaged through a stop (h), the cover of the cleaning carriage is then opened, the tube removed and replaced by another.

(c) *Preparations for welding the joint.*

The tube end already cut in the boiler and now cleaned is provided with an internal taper turning, Fig. 3, and the sleeve provided with an exterior taper turning is now driven into the tube. The joint is then ready for welding.

(d) *Welding apparatus.*

The welding of the tubes is accomplished with the aid of a welding set, Fig. 4, consisting of a crude oil welding furnace with a preheating and tube feeding apparatus with, in addition, a roller welding machine.

The tube feed apparatus illustrated in Fig. 5 permits the simultaneous heating of a number of tubes placed in it and allows a steady new supply of tubes to be heated as well as the ready removal of the heated tubes for their treatment in the welding machine.

The feed apparatus hitherto used of a somewhat similar nature has the disadvantage of not keeping the side furnace walls hermetically closed thus allowing the escape of a considerable quantity of furnace heat as well as causing considerable hardship to the men operating the apparatus on account of heat radiation. These drawbacks are overcome in the new tube feed apparatus by constructing the furnace side walls of square sheets (g) which by means of guides (f) are firmly assembled onto one another at the sheet faces (c) of the furnace. This method provides an absolutely tight furnace room. These sheet panels (g) are joined by hinges (o) and furnished with openings (p) allowing the tubes free passage. The sides of the square sheets are equal in length to those of the chain links and their upper line runs horizontal and are closed with the sheet faces of the furnace. The chains are made tense by means of square hubs (k) adjusted on the outside of the furnace, their side lengths corresponding to the length of the above-mentioned chain links. By each quarter turn of these heads (k) the chains advance a couple of tube openings in the direction of the furnace in such a manner that each time a new pair of sheets (g) is presented the foremost pair at the other end of the furnace is released. Prior to each new stroke of the sheets (g) a new pair of sheets must be charged with tubes ready for the welding process. Not until the head tube released from its sheets has been pushed to the welding machine and the discharged pair of sheets has been replaced by the following pair through a step-by-step feed is the stroke completed. During this process the tubes supported on a trestle *B* are conducted by two disks connected by quite similar endless chains. These insure the progressive motion

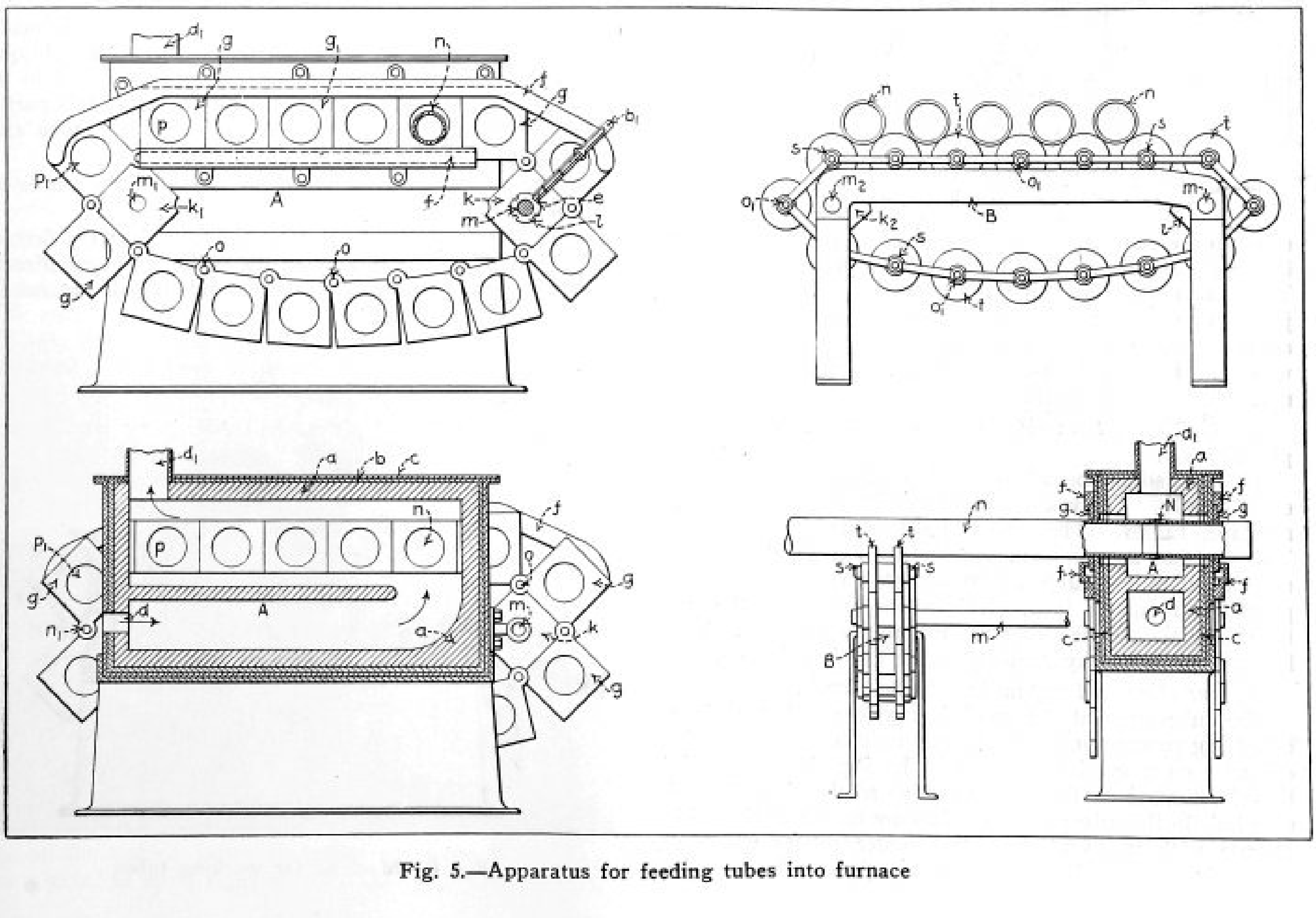


Fig. 5.—Apparatus for feeding tubes into furnace

simultaneously all along the line as each one of the links of the chain moves the tubes parallel in a horizontal direction and perpendicular to the axis of the furnace.

The characteristics of the device for roller welding are as follows: The tubes prepared for welding are in turn shoved on a roller (b), in addition a second displaceable roller (a), Fig. 6, is brought to exert a pressure on the section which is to be welded. Both rollers are impelled by revolving shafts crossing each other. Through the pressure of the rollers against each other a rotation in opposite directions is produced and this rotary movement is again through the force of pressure imparted to the tubes which are to be welded. As the axles of the rollers cross each other the above-mentioned tube pieces are aside from the rotary motion made subject to another one in the direction of their axis. By this means the pressure exerted during the welding is quite uniformly distributed along the entire welding joint of the two tube pieces and more complete welding is secured. To assure the correct position of both tube pieces before beginning the welding, an adjustable stop has been provided. This stop is put out of contact with the tubes by means of a pedal lever which causes the lower

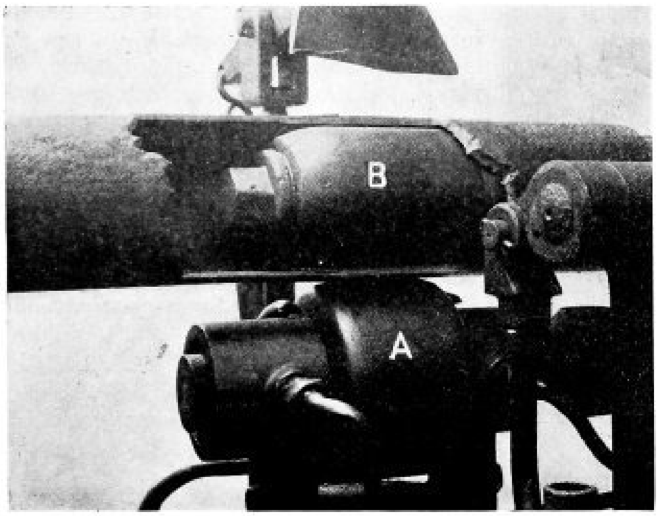


Fig. 6.—Method of roller welding flues

roller to exert a pressure against the upper roller thus affording an unobstructed lengthwise displacement of the tube. The cinders adhering to the outer surface at the welding joint are removed by a hand scraper. Tubes welded by this method were tested at the Vienna University in conformity with the English Lloyd's requirements and declared permissible for use in marine boilers.

(e) *Cutting of the welded tube to length and the hydraulic pressure test.*

After finishing the welding of the tubes these are cut in exact lengths. The work is performed in an ordinary cutting machine, Fig. 7. The tube is fixed while the tool rotates. This tool has an automatic feed. In the hydraulic pressure test the tubes are subjected to an internal pressure of 425 pounds per square inch. The entire length of the tube, including the welded section, is rapidly struck with the hammer while the hydraulic pressure test is going on.

(f) *Inserting and expanding the tube ends.*

The tube ends at the smokebox side are heated in an annealing furnace and subsequently adjusted to the required diameter on a special machine. The fire side tube end is likewise treated on the same machine so that it will fit the tube hole in the tube plate. Devices are on the market which operate with uniformly impelled under rollers which are crossed by upper rollers to perform one part of the operation.

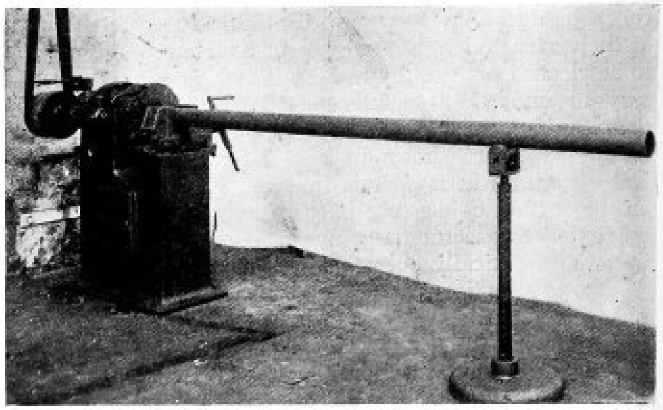


Fig. 7.—Tube cutting machine

However, in order to bring the job to completion several machines are required. With the new machine shown in Fig. 8 all of these operations can be executed. The necessary allowances are obtained by means of adjustable stops. To expand the tubes one end is made red hot placed on the rollers with the rear end on the roller support in such a manner that the mandrel partly enters into the end of the tube to be widened. The tube does not lie parallel with the roller axles but is crossed by these. As soon as the hand lever of the mandrel is pressed down against the inner surface of the tube the latter is carried along undergoing a rotary motion at the same time. Simultaneously the pressure exercised by the mandrel brings about the widening at the tube end. The oblique position of the tube causes it during the operation to run from left to right against the mandrel thereby permitting the tube to be widened for any desired length. By the return movement the expanding produced by the mandrel action brings the tube to a finish with due care as to the exact diameter required.

By the drawing in of the tube end the tube axis is made to lie parallel with the axis of the rollers. The oblique adjustment of one of the rollers causes the tube end to be constantly pressed against the stop. By means of this partly rolling, partly sliding motion the surface of the tube end is smoothed.

(g) *Preparations for the Re-Installation of the Tubes in the Tube Sheet.*

Before the tubes are put back in the tube sheet the firebox tube holes are made round by means of the before-mentioned tube hole turning apparatus, Fig. 9, and threads are cut in

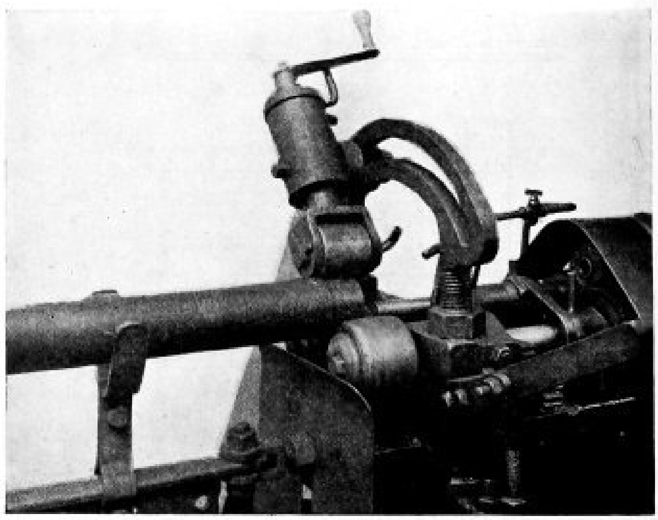


Fig. 8.—Machine for working tubes

the tube holes. By providing these holes with a thread the tightness of the joint is considerably increased, in fact almost doubled as will be seen from the test results referred to below. In case some of the tube holes are too big, a condition apt to occur in tube plates which have been in service for a long period, iron bushings are screwed into these tube holes. It is of great importance to have the rims of the tube holes properly fixed before this bushing is inserted. The facing is likewise done with the above-mentioned turning out apparatus. The bushings are screwed in with the aid of a reamer. By facing the tube hole rims the bushings are made close fitting which insures a compact joint. Calking becomes superfluous. In case of cracks in the tube plate between two tubes the adjacent tube holes from which the cracks originate are likewise provided with iron bushings. The cracks are covered by a copper follower which is pressed against the tube plate by means of the rims of the iron

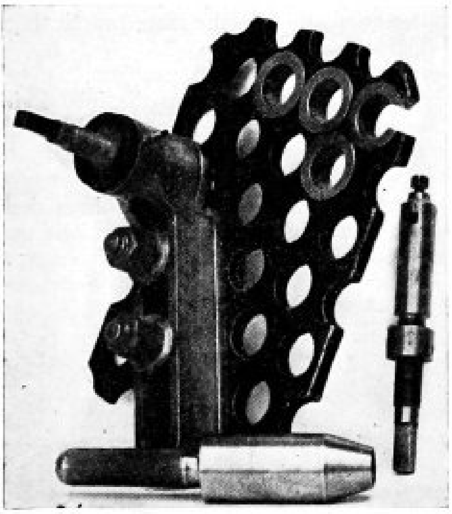


Fig. 9.—Apparatus for turning holes

bushings. This crack repair is performed from the fire side, Fig. 9.

(h) *Welding soft iron sleeves on the fire side of the tube ends.*

Copper sleeves can obviously be replaced by soft iron sleeves which yield a similar compensating action to the copper sleeves and a more pronounced adhesive quality. The smooth soft iron sleeves are welded to the tube ends and rolled into the threaded tube holes, the tube hole is lightly countersunk. The tests made at the University of Vienna concerning the adhesive quality show the following results:

Steel tube normally rolled in steel tube plate	15,800 pounds
Steel tube normally rolled in copper tube plate	8,900 pounds
Copper tube normally rolled in steel tube plate	14,200 pounds
Steel tube with soft iron sleeve in steel tube plate	34,600 pounds
Steel tube with soft iron sleeve in copper tube plate	27,100 pounds

This indicates that the adhesive property in relation to the tube plate doubled through employing the soft iron sleeve. The tube waste is restricted to the soft iron sleeve on the fire side which is cut off. Aside from this, the waste of tubes by the removal operation is limited to 3.15 inches on the smokebox end, 2 inches on the firebox end and to 1.2 inches on the welded joint; altogether not more than 6.35 inches which has to be replaced by a safe end.

Finally it should be mentioned that for the soldering of copper sleeves as necessitated in locomotives with copper fireboxes a special soldering appliance has been constructed which can be operated by unskilled labor.

How Far Can a Trade Association Go in Eliminating Competition Among Its Members?

By Elton J. Buckley

THE following dispatch appeared in hundreds of daily papers a short time ago:

> Washington, March 21.—The Federal Trade Commission soon will begin one of the most extensive investigations ever conducted by that body.
>
> Under authorization of the resolution introduced by Senator McKellar (R., Tenn.) at the close of the session it will go thoroughly into the subject of the "open price associations," which is another name for price-fixing associations. A previous report of the Commission indicated there are about 150 of these, all alleged to be violating Anti-Trust Laws.

Apparently this may touch most of the lines of business now in existence, and I shall therefore discuss the matter in the light of a decision just handed down by the United States Circuit Court of Appeals.

For several years the scope of a trade association's legal rights has been a controverted question. The Federal Trade Commission has always taken a very narrow view of the matter, and has brought several prosecutions expressing this narrow view, most of which have been overruled by the courts. The Department of Commerce has also expressed itself on the subject, its view being much more liberal than the Commission's.

The question at issue is: how far may competitors—members of the same line of business—act through their association along lines which may tend to eliminate competition or even lessen it somewhat among themselves?

One of the few cases to go into it at all thoroughly is the case I refer to. It involved the legality of the activities of an association of a number of jobbers in paper products, the Pacific States Paper Trade Association. The Federal Trade Commission brought a case against this organization on the ground that it was fixing prices at which its members should sell, that it held meetings that were simply schemes to find and adopt plans to restrain competition, and that it had intimidated manufacturers into refusing to sell paper direct to retailers over the jobbers' heads.

The United States Circuit Court of Appeals upheld the Commission's decision in one respect, the last, and reversed on all the others. The view which both bodies took is important in view of the forthcoming attack upon the methods of a large number of trade associations.

Now what this association did in the way of price fixing was this: It published and distributed among its members uniform price lists to be observed in the sale of wholesale paper and paper products, and from the prices thus fixed the members were not at liberty to depart. This price list was used in quoting prices and making sales and was habitually carried and used by salesmen of the members when traveling for the purpose of securing business. But the association did not have any rule or requirement that the price list be observed or carried in quoting prices or making sales and the quoting of lower prices or the making of sales at different prices was not deemed an infraction of any rule or trade regulation of which any jobber or wholesaler could complain.

As to this method of "price fixing" the court had this to say:

(*Continued on page* 98)

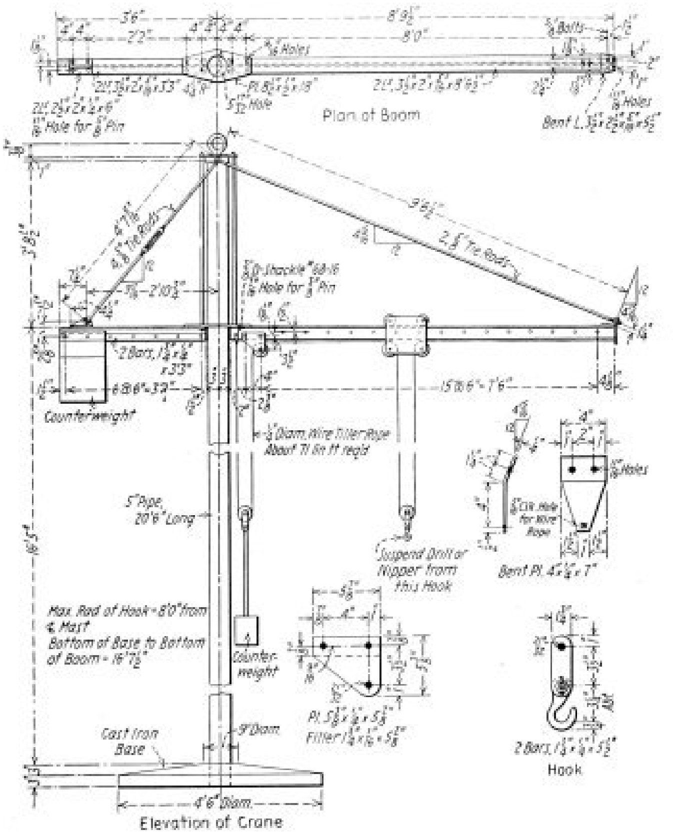
Tooling Up for Production

Ways of developing the efficiency of men, machines and methods in the boiler shop

By C. E. Lester

THE modern foreman is daily confronted with many vexatious problems and the one of reducing costs is not the least of them. In fact a moderately successful foreman must be continually on the lookout for methods of cost reduction. Competition is keen and bids are figured on a close margin of profit, making it necessary for the foreman not to let his wits go wool-gathering and to bestir himself toward ways and means in cost reduction.

To be a "slave driver" and to try to drive the workmen on to a greater, if unwilling, effort does not make an appeal as the logical way to increase production. Rather let the foreman's brain evolve an occasional productive idea. We do jobs in identically the same manner year in and out because we do not take the time to reason out a better and simpler way.



Counterbalanced boiler shop crane

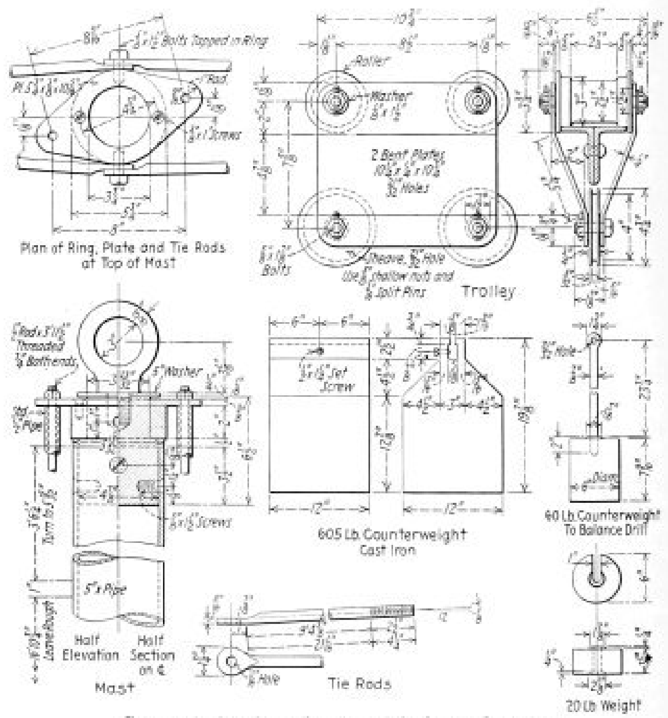
Tooling up seems to be the thing to do to increase production and reduce costs. In many cases, the overworked foreman could, if he had the time to carefully reason out the problem, produce many ideas that would lessen his labors and reduce his costs.

In tooling up, as in all other problems where a successful completion may be anticipated, a general and detailed knowledge of the problem at hand should be the first consideration. In working for the solution of any problem, first of all, one should have what is commonly called in military problems—an estimate of the situation—that is, one should, from information at hand or obtainable, consider the problem from every angle, including the favorable and unfavorable factors that may affect it. From all information at hand, after the estimate is made, comes the decision. In all cases the decision should be the one of the greatest utility—there are many factors governing the decision that may tend to influence action and warp sound judgment. For example, it might be considered easier to recommend the purchase of a new machine rather than to modify an old one, or construct jigs and change practices when the latter might well be the more practical, economical, and more efficient.

The solution of a tooling up problem, as well as any other, is one of execution. Size up the job, decide what is to be done and go after it.

What Tooling Up Means

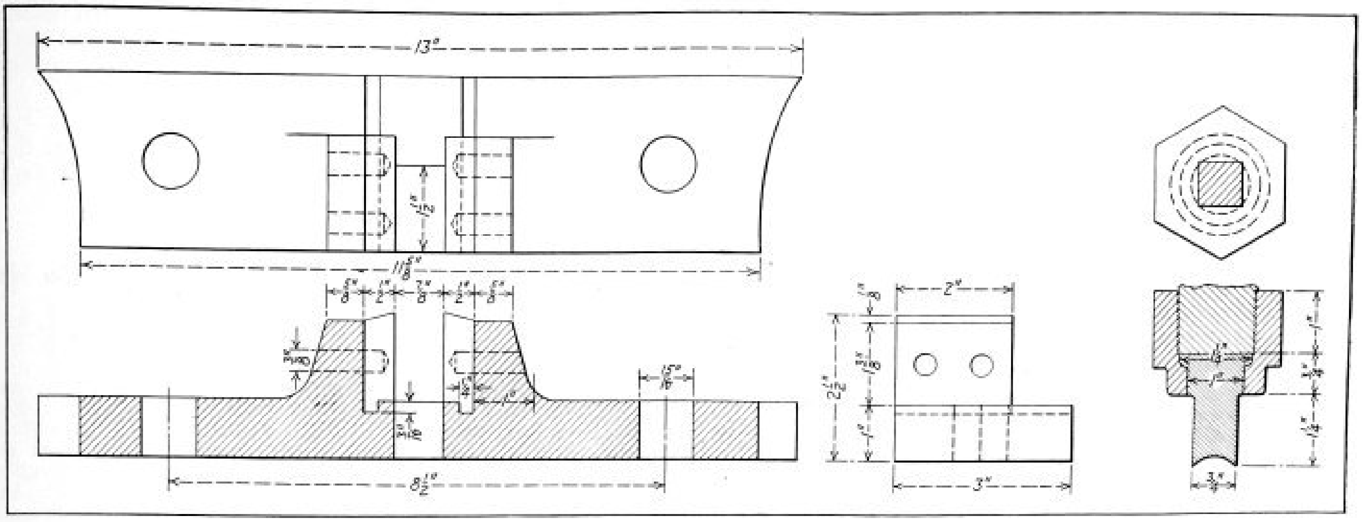
Tooling up a job may mean many things that affect it, not necessarily new tools. Tooling up might mean a new machine, a machine repaired, a machine taken to the job instead of the job to the machine, a machine relocated to assist the orderly sequence of operations, taking a job from one machine and giving it to another; or perhaps, simply a jig—a few bolts and clamps or perchance but a better understanding of his job by the operator. This might well apply in any shop or department.



General details of counterbalanced crane

In the boiler shop tooling up, to me, means many things that are generally lost sight of as production measures. Some that might well be considered as tooling up problems are—congestion and improper location of machine tools; obsolete or worn out machines, in service or occupying valuable space.

Nursing an old machine is a cost breeder. When a workman becomes worn out or obsolete we either discharge him,


Punch and die for squaring staybolts

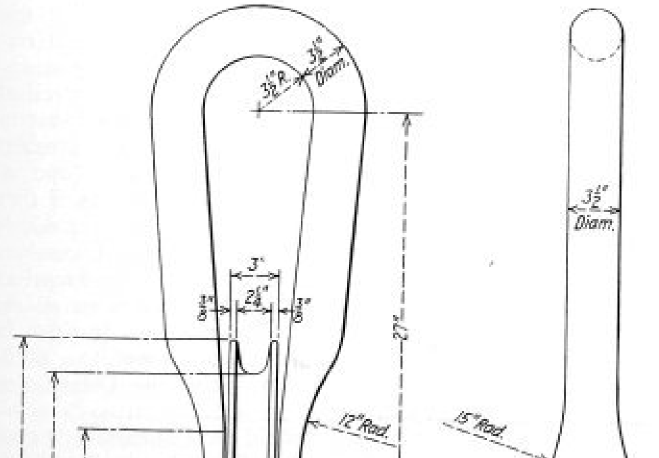
pension him, set him running an elevator or pushing a broom—all these occupations are harmless and generally of little expense to the company, yet a drill press or other machine that has been under almost constant care of the millwrights for years may be nursed and coddled along doing 50 percent production and the foreman and management apparently oblivious to its capacity for repairs and inability to perform a day's work.

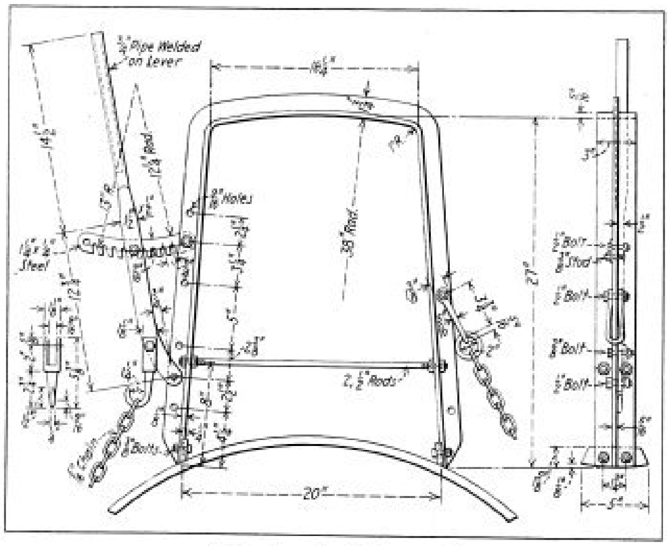
Tooling up may consist of hose, hammers, motors, etc., or there may be enough of these but not in the proper place. The old mechanics with all the tools locked up in their tool cupboards and the new men running the foreman ragged for tools is a tooling up problem. As a matter of fact most shops have thousands of dollars tied up in small tools that should be dug out of their hiding places and put to work.

It is the opinion of the writer that tooling up has more to do with the cost of production than any other one thing and is in many plants given scantiest consideration, for while many jobs may be tooled as many more are neglected more or less permanently.

A job cannot consistently be called tooled up until the manual effort necessary for production is down to an irreducible minimum.

We may control our material, we may route and schedule our parts, we may organize and specialize and plan but if we are not well tooled up we cannot well expect high production.


Sheave block designed to relieve strains on shop cranes


A handy air drill stand

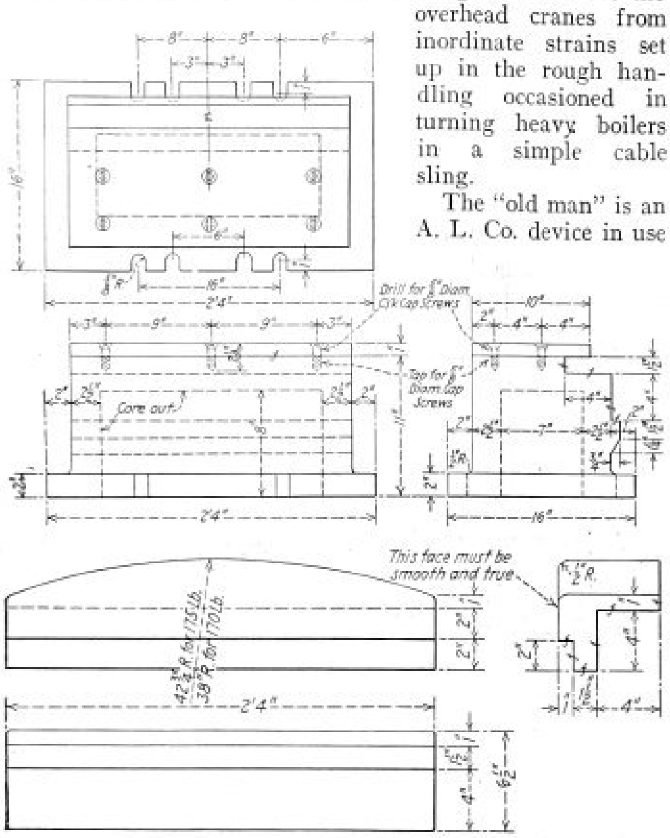
The devices herewith described for tooling up some jobs are all home-made devices, some are my own, others are not; however, they are valuable shop adjuncts and well able to help out production.

The portable jib crane or counterbalance is a valuable device in any shop. It can be used to support air drills, staybolt nippers, dolly bars, rivet busters, etc., and in fact takes the place of a man or overhead crane as well as being mobile in a shop that has crane service.

The punch and die illustrated was designed to lessen the cost of squaring staybolts. The apparatus is used in any power punch very successfully and in the particular case for which these were made the cost was reduced approximately 75 percent as well as a substantial reduction in the cost of making driving sockets. The bolts are not squared but simply sheared off on two sides. The driving sockets instead of being made with an expensive square hole simply have a hole of the proper size drilled in them and later slightly flattened under the hammer to the shape of the bolt or a sort of a rounded end rectangle.

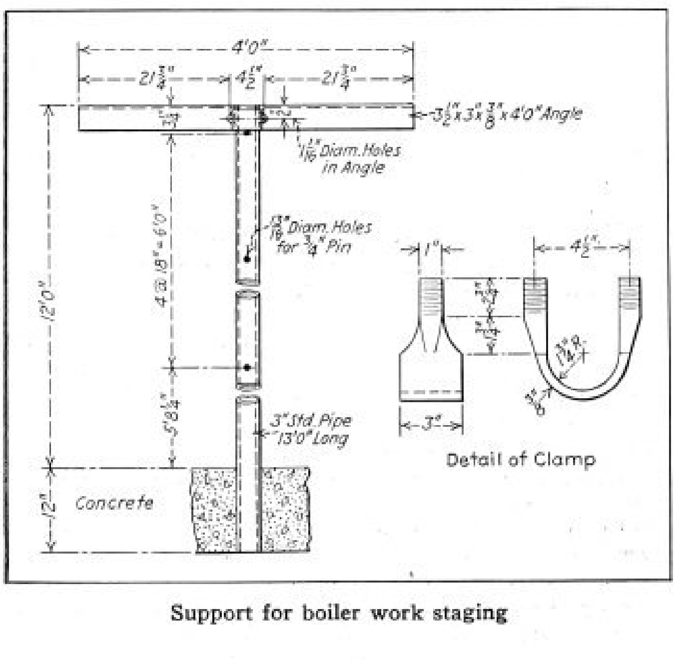
The sheave block and cable were designed to relieve the overhead cranes from inordinate strains set up in the rough handling occasioned in turning heavy boilers in a simple cable sling.

The "old man" is an A. L. Co. device in use for some years in their shops for backing up the air machine drill when driling holes in various locations of the boiler shell.



Adjustable flanging block dies

The flange blocks illustrated have been used by the writer as a very efficient and quickly adjusted device for flanging straight, convex or concave surfaces with a minimum of adjustment. The block is a master block to which a small flange block of any desired shape or size may be fitted very quickly, eliminating extra set ups in the sectional flanger.



Support for boiler work staging

Inasmuch as the inserts weigh but about one hundred pounds and require only such simple patterns as may be made in a carpenter shop at slight cost the foreman can readily procure them without the formality of a plant engineer's order.

The support for staging for boiler work was designed to meet the need for working platforms with a small base that did not interfere with workmen on the floor and that could be adjusted to different heights and various angles.

How Far Can a Trade Association Go in Eliminating Competition?

(Continued from page 95)

The use of a price list of some kind for the information and guidance of salesmen in taking orders and making sales is almost a necessity and it is going very far to say that the mere use, without combination or agreement, of a particular price list which the salesmen are not bound to follow and which differs or may differ from the price lists used by other salesmen in the same locality has such a tendency to fix prices or limit competition as to bring it within the condemnation of the Anti-Trust Act. The principle involved is perhaps more important than the right to use any particular price list, but we do not think that the prohibition is justified by the stipulated facts or by any proper or legal inferences therefrom.

From this the law appears to be that the members of an association can adopt a uniform price list, the distinct purpose of which is to keep the market stable and uniform, and —although it has the result of causing competitors to sell at uniform instead of competitive prices—it is not illegal if there is no actual *agreement* that the members shall follow the fixed prices and no penalty if they do not.

Some day in the probably not distant future some court will have to settle a question which is still more or less unsettled, viz.: when a body of business men adopt a plan which if they use it will as they know restrain competition among themselves, and they do use it and it does restrain competition, is it saved from illegality merely because they have carefully refrained from adopting an iron-clad agreement on the subject and a penalty in the event of a violation? The United States Circuit Court of Appeals seemed to think in the above case that it was so saved.

Now as to the meetings of the association, which the Federal Trade Commission found were also illegal, it appeared that the following subjects were discussed: uniformity of discounts, the establishment of resale prices by manufacturers, the guarantee of prices against decline for specified periods, the question of cutting prices on certain items in order to move them quickly, and resale prices by the members of the association. If these discussions took the form of concerted plans along these lines, it seems to me as if they come close to the line of illegality. The court did not decide this question fully, but merely held that "no doubt discussions at such meetings which tend to monopolize trade or fix prices in interstate commerce come within the prohibition of the statute, but neither the court nor Commission is justified in presuming the unlawful purpose without proof." Technically the court held that on this point the Commission hadn't made its case out.

In one point only the court upheld the Commission's case. It appears that as in many other lines the paper jobbers thought all the trade from manufacturer to retailer ought to go through them. Therefore they resented it when manufacturers sold the retailer direct and operated various schemes to make their resentment effective. The usual means were used—argument, promise to give trade to manufacturers who stood by the jobbers, blacklisting and boycotting manufacturers who refused to stand by. The court held this part of the case proven.

I feel that associations who take an interest in the subjects that this association took an interest in, ought to put their methods under the microscope in view of this decision.

Laying Out Locomotive Boilers—IV*

Spacing of rivets—Outline of one piece roof and side sheet—Locating radial stays and staybolts on roof sheet

By W. E. Joynes†

THE number of rivet spaces should be given and a rivet center line shown for all of the rivets which hold the crown and side sheet to the front and back flange sheet. This is to avoid any error in not having the correct number of rivets, as the crown and side development plate is the only drawing that gives the exact number of these rivets required. It is not necessary to show all of the rivets for riveting the sheet to the firebox ring. These are made check proof by the template which the shop makes from the firebox ring drawing, for marking off the rivets on the sheet. When some of the rivets are used for studs in connection with ash pan and grate supports, then it will be necessary to show all of the rivets in order that the holes which are to be tapped for studs can be indicated on the plate development drawing.

The manner in which this drawing is dimensioned has proved to be one which makes it easy to read, is error-proof and is representative of a one-piece crown and side sheet plate development shop drawing. All dimensions over 100 inches should be given in feet and inches to facilitate laying-out and to check the shop layer-out with his work. It will also be noted that for the radial stays only the tap size is given. The number of threads per inch for the straight tap and the threads and taper of the tapered tap are given on the material and on the detail drawings of the stays. This is all the information required by the layer-out in determining the size of the holes to be drilled in the plate. The size of taper tap, at fire side of sheet, should be indicated on the drawing.

The firebox ring, boiler base line, and all other construction lines not helpful in laying-out the plate have been omitted from the drawing.

Outline of a One-Piece Roof and Side Sheet

The development of a roof and side sheet outline is shown in Fig. 7. The method of finding the outline is similar to the crown and side sheet method of development, and the necessary operations for developing the plate in connection with the diagram layout, Figs. 3 and 4, have been partially explained and shown with reference to the crown and side sheet development instruction, so that repetition will not be necessary, it being required only to point out the location of the front developing line, in relation to the front edge of the sheet, which is clearly shown in Fig. 7. That part of the sheet ahead of the front developing line and above the boiler center line, is measured with a bow-pencil compass. The compass is set to the width of the seam, 4¾ + 1 inch which is the distance between the back edge of seam and the developing line. A short arc is then scribed opposite each circled set point as shown, after which these arcs are connected by a curve, which will be the front edge of the plate. All of the sets at the front of the plate will be the same as those calculated for the developing line sets, A^a, A^b, A^c, etc., with a possible exception of set A^a, at the boiler center line.

If the slope of the boiler center line—Fig. 7—from the front developing line to the back developing line, is sufficient to make the boiler center line an appreciably greater distance from the top center at the front of the plate than at the front developing line the set set, for the front of the plate at the boiler center line will be increased slightly over set A^a. The set should be scaled. This set is invariably the same as calculated for the developing line for projection developments and should always be scaled and compared with the calculated set for the developing line. When the measured distance is found to be less than 1/16 inch greater than the calculated set of the developing line, the calculated set should be used, which will increase the size of plate slightly at this point. All dimensions which determine the outline of any plate should be slightly increased rather than decreased, when there is doubt.

All of the operations for finding the outline of the plate and the method of determining the dimensions have been shown on Fig. 7.

Locating the Radial Stays and Staybolts on the Roof Sheet

The problem of locating the radial stays and staybolts on the roof sheet is quite different from that of locating them on the crown sheet. The reason for this difference is due to the fact that the crown and roof sheets are not parallel in the cross-sectional view and also that the radial stays must be radial to the crown sheet in the cross-section and at a right angle to the crown sheet in the side or longitudinal view.

Radial Stays

To locate the radial stays, proceed in the order of the measurements and calculations as given. Refer to the boiler cross-section—Fig. 2—and take the dimensions locating the distance between the stays which are on the neutral axis of the plate and measure them off on the developing lines in Fig. 8. Connect the measured points by drawing lines through from the front to the back developing lines.

Locate the top radial stay and the last side radial stay on the diagram, Fig. 4. Scale to the nearest ⅛ inch the length of these stays between the neutral lines of the crown and roof sheets. These lengths are 22 inches for the top stay and 8⅛ inches for the side stay. By using the distance between the crown developing lines, dimension C, 74⅞ inches and the drop of the crown from front to back, dimension C^3, 3¼ inches, the position of the stay on the roof sheet at a right angle to the crown sheet can be calculated as follows:

The length between the developing lines, C, is to the drop of the crown C^3, as the length of the stay is to X, or

$$C : C^3 :: \text{length of stay} : X$$

$$74\tfrac{7}{8} : 3\tfrac{1}{4} :: 22 : X$$

$$\frac{3\tfrac{1}{4} \times 22}{74\tfrac{7}{8}} = 0.956 \text{ say } 15/16 \text{ inch, front top stay.}$$

By referring to the boiler drawing, Fig. 1, and figuring from the front of the roof sheet to the front row of radial stays, on the crown, the distance is found to be 7½ inches. This dimension plus the 15/16-inch stay set, just found, equals 8 7/16 inches, which is the distance from the front of the roof sheet to the first top radial stay.

The side stay is located by the same method of calculation except that the drop of the crown is measured radially, between the front and back neutral crown lines, at the point where the last side radial stay is located on Fig. 4 of the

*Previous installments of this article appeared on page 1, January issue; page 40, February, and page 72 of the April issues.

†Boiler Designing Department, American Locomotive Company, Schenectady, N. Y.

diagram. This distance for this boiler is 2⅛ inches and by calculating the dimension using the formula in the previous paragraph, the distance from the front edge of the sheet to the last radial stay is found to be approximately 7 11/16 inches measured at a right angle to the front edge of the sheet. A line connecting this point with the first stay point will be the center line for the front row of radial stays. One or more of the intermediate stays should be figured in order to determine whether all of the figured points are in a straight line. If the point or points are found to be ⅛ inch or more out of line, the stay line should be made curved to the points. The remaining stays are located longitudinally with the same dimensions and number of equal spaces as given for the crown sheet, the only exception occurring when the back row of stays is found to be too near to the roof and backhead seam. When this is the case, the back row must be moved ahead to maintain the minimum distance given on the boiler drawing, from the center line of the seam to the stay line. The seam line is not parallel with the stay line and it will be found necessary to tip only two or three stays in the back row before the normal position of the row will be away from the seam and as located by the dimensions taken from the crown sheet. When the back row, or possibly the two back rows on some boilers are tipped forward to clear the seam

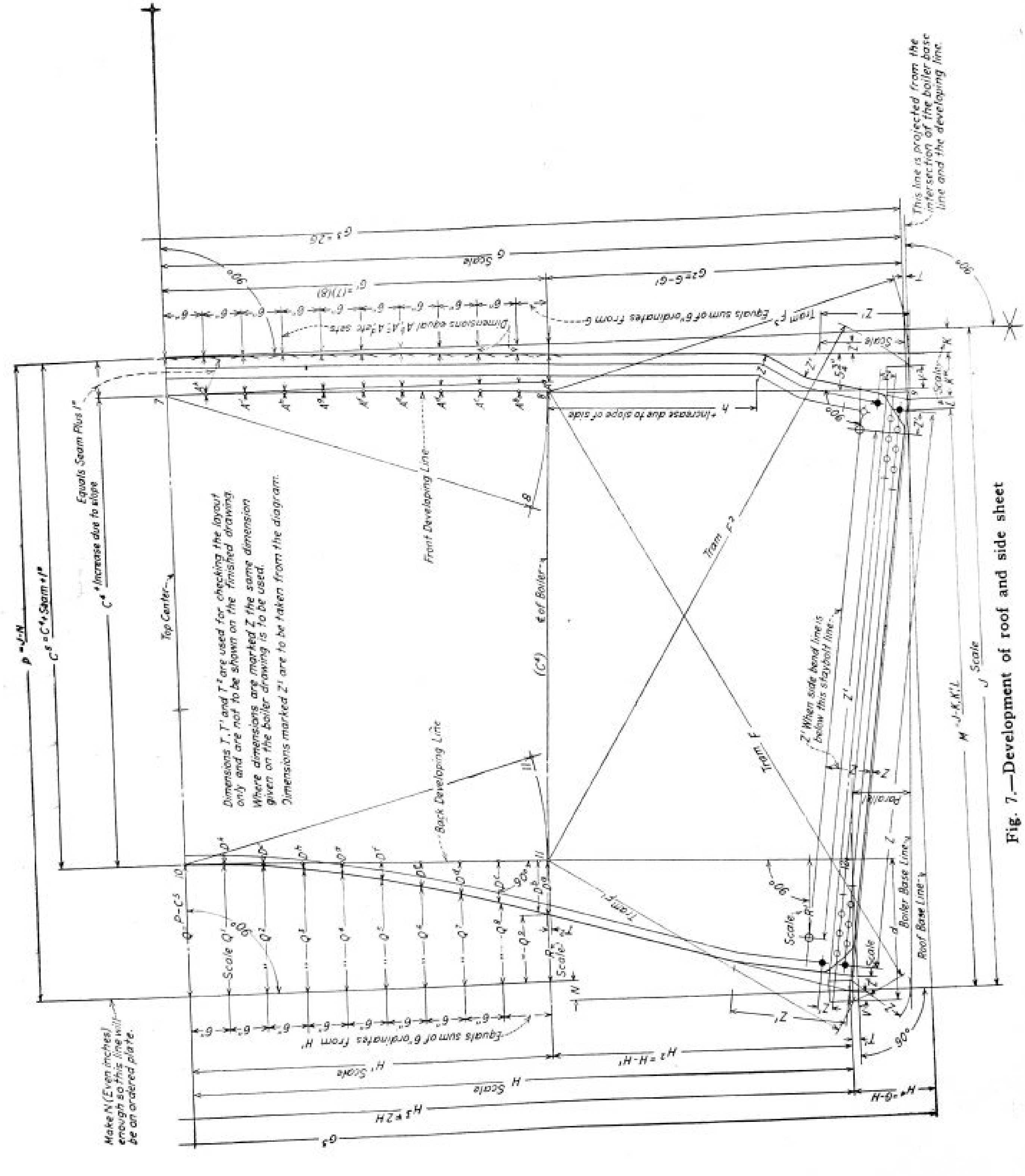


Fig. 7.—Development of roof and side sheet

and not at right angles to the crown sheet, the rows ahead of the forward tipped row will be equally spaced from that point to the same spacing as the crown sheet. The roof sheet which has been used in this problem shows this condition. Sometimes other stays will have to be located off the regular line in both directions to acquire the minimum bridge distance between the stays and a stud, rivet or other holes, such as for cab turret, safety valves, etc.

Re-Enforcing Liners

The rivets for securing the re-enforcing liners to the roof sheet are laid-out at right angles to the top center line of the flat roof sheet. The reason for this is that the edges of the liners are straight and not curved like the roof sheet, therefore, to bring the rivet holes in the roof sheet on the rivet line, as shown for the liner, on the boiler drawing after the liner is rolled to the required shape and placed under the roof sheet for marking off the rivets on the liner, the rivets will have to be at 90 degrees to the top center line of the roof.

The over-all rivet dimension for liners of considerable length, such as the expansion stay liner, is not the same as for the corresponding dimension on the roof sheet. This dimension should be increased for the roof according to the proportion:

$$\frac{\text{liner neutral radius } A}{\text{liner rivet-line length } B} = \frac{\text{roof neutral radius } C}{\text{roof rivet-line length } X} \text{ or}$$

$$A : B :: C : X$$

The nearest 1/8 inch is accurate enough for this dimension.

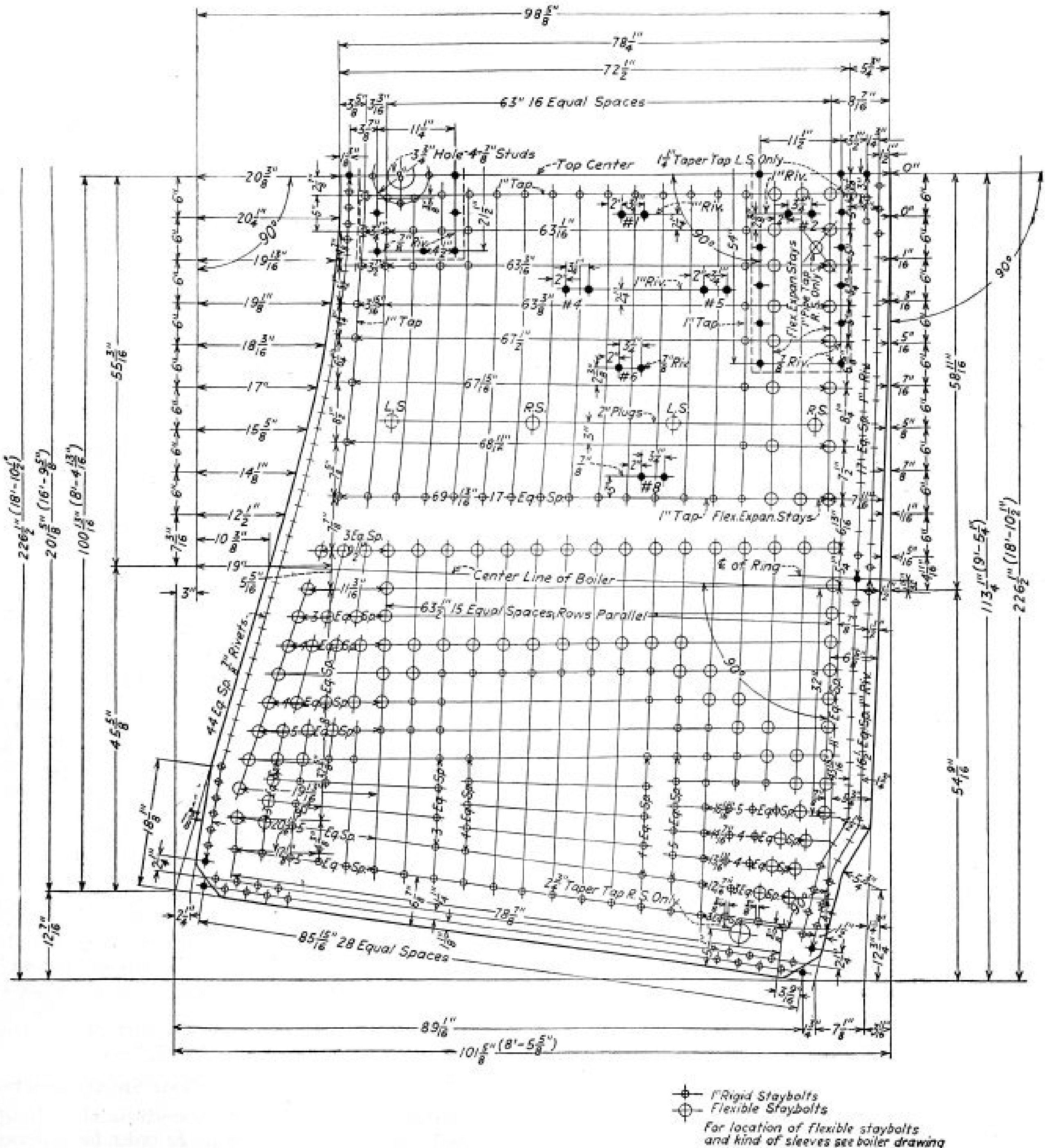


Fig. 8.—Roof and side sheet showing rivet and staybolt layout

When possible, the liners should be so located that it will not be necessary to notch out the liner to clear the radial stays. It will also be found quite difficult in some cases, to obtain sufficient metal between two holes. The preferred minimum bridge distance for such cases is 1¼ inches, but may be less for small holes such as stays, studs and rivets.

Longitudinal Brace Feet

The longitudinal-brace-feet rivets should be located so that the brace pin will be approximately central between the stays and off the longitudinal line of stays a distance sufficient to prevent the stays from striking the foot. This is determined by laying-in the brace feet on the boiler cross-section.

Washout Plugs

The washout plugs are located centrally between the radial stay spaces, as shown on the boiler drawing, and the distance from the longitudinal row of stays as given on the boiler cross-section. When this distance is not the same, front and back, the front dimension is measured at the front row of stays and the back dimension at the back row of stays and the center line for the plugs is drawn through from these points.

Staybolts

The staybolts are not laid-in on the roof side sheet at a longitudinal right angle to the crown side sheet, but are carried straight through in the same relative position from the front of roof and crown side sheets. The location vertically is at right angles to the straight part of the crown side sheet and radially for the curved part of the crown sheet. Therefore, the longitudinal location of the staybolts on the roof sheet are the same as on the crown sheet, except when set off the line to apply washout plugs, blow-off cocks, etc. The vertical locations of all the staybolts are not the same as on the crown sheet because the crown and roof sheets in the cross-section are not parallel to each other, above the bend line. Below the bend line the locations of staybolts are the same for both sheets. The two bottom rows of staybolts are made continuous on both the crown sheet and the roof sheet to simplify the method of dimensioning the staybolts on the roof sheet.

The side bend line of the boiler comes between these rows and by referring to the boiler cross-section, it will be seen that the space between the staybolts on the roof sheet is greater than on the crown sheet. This space, as shown by the boiler cross-section, is not exactly correct because the location has been projected from the longitudinal view of the boiler which is not the true relative location of the staybolts below the bend line though the location is correct from the last radial stay and according to the dimensions, front and back, as given on the boiler cross-section.

To determine the front and back dimension for this bottom space, refer to the diagram—Fig. 3—and take the difference between the distance from bottom of the firebox ring to the staybolt and bend line, which is ⅞ inch for this boiler. Lay-in this staybolt on the diagram cross-section—Fig. 4—⅞ inch below the bend line, front and back as shown. Refer to the crown-and-sides drawing—Fig. 6—and calculate the staybolt space, front and back, which is found to equal 55 15/16 inches ÷ 14, or 4 inches front, and 44⅞ inches ÷ 11, or 4.08 inches back. Lay-in these spaces on the diagram—Fig. 4—from the bottom staybolt, drawing the staybolt line at a right angle (radial if in the bend radius) to the side line then scale to the nearest 1/16 inch the space between the staybolts at the roof-sheet side line.

The staybolt spaces above the first bottom space will have the same spacing as the crown sheet, up to the crown corner radius, at which point they are radial to the corner radius. Those staybolts that come within the crown corner radius, and also the one which comes on the straight part of the sheet just below the tangent point of the crown radius and straight side line should be laid-in on the diagram—Fig. 4. Scale the distance between these stays at the roof neutral line.

Total all the dimensions for the radial-stay spaces and those for the staybolt spaces. These, plus U and U^1, should equal the length of the developing line from the top center to the bottom of the firebox ring, front and back. Measure the spaces on the developing lines.

The front and back row of staybolts are to be projected at 90 degrees from the developing lines and the lines drawn through from these points, as has been explained for the crown. The radial-stay lines should be drawn direct through from the developing lines.

The necessary longitudinal dimensions for locating the staybolts in the odd spaces at the back and lower right hand corner are scaled from the crown-sheet layout, and the dimensions scaled are used for the roof-sheet location. The dimensions are scaled at a right angle to the vertical staybolt line, but to simplify the method of dimensioning, and also because the difference between the straight and the sloped dimension is negligible, they are shown dimensioned along the staybolt line.

It will be noticed that the back line of staybolts on the roof sides is straight as is also the back line on the crown sides, except where the vertical spaces increase or are greater on the roof sides. Then the line is broken. Therefore, it is only necessary to have a dimension at the top and bottom row for the spaces coming within the straight line and as shown by the 11 3/16-inch top, 19 13/16 inch bottom, and 32⅝-inch vertical dimensions for this boiler. All scaled dimensions for radial stays and staybolts should be to the nearest 1/16 inch. Refer to "Features of Boiler Design" for nomenclature of "radial stays" and "staybolts."

Seam Rivets

The roof-to-backhead-seam rivets are spaced on the flat sheet according to the pitch given on the boiler drawing. Scale the distance between the top center and bottom side rivet, using a flexible scale or stepping off with the dividers on a straight line and then scaling. Divide this dimension by the pitch.

The rivet spacing in the top half of the front seam is calculated at the line where shearing occurs, that is, where the underside or water side of the roof sheet and the outside of the ring course come together. The size and pitch of the rivets are given on the boiler drawing and the number of spaces should be divisible by four to come on the three centers of the ring. The number of spaces nearest to the given pitch, i.e., divisible by four should be chosen. For the rivets in the bottom half of the sheet, scale the distance from the ring center to the bottom rivet and divide by the same rivet pitch. Rivets in the bottom half of the roof sheet for narrow firebox boilers, have the same pitch down to the throat seam as the top half of the sheet, and then are scaled from this point to the bottom rivet. Show a center line for all the rivets in these seams. The firebox ring rivets on the roof sheet are spaced the same as those on the crown sheet.

Large circles with the same diameter as the sleeve are shown for the flexible staybolts and expansion stays and small circles of the same diameter as the staybolt for the rigid staybolts. A note on the drawing—Fig. 8—refers to the size and kind of staybolts.

This completes the roof and side sheet shop drawing up to the point of checking.

Checking the Crown and Roof Sheet Drawings

The work of inspecting the correctness of a drawing is termed "checking" the drawing. In order for a drawing to

(*Continued on page* 108)

Repairing Lancashire and Cornish Boilers

Welding and patching methods practised in British shops in connection with boiler work

By "Boilers"

THERE are two methods of repairing defects met with in Lancashire and Cornish boilers, where the defects do not call for renewals, namely welding and patching.

Welding is extensively done but various authorities on boiler work specify patching in preference to welding in certain parts. Generally speaking parts under compression or parts supported by stays may be welded but parts in tension should be patched. In certain cases parts under tension may be welded. Parts subject to bending strains are sometimes welded in preference to patching.

The method of repair depends on the circumstances of the case. The working pressure and the extent of the defects are the principal items by which to decide upon one method or the other. If parts in compression are extensively affected patching will perhaps make the best repair. On the other hand small areas of corrosion of parts subject to tensile stress may be welded, the object being rather to arrest further corrosion than to renew the strength of the part.

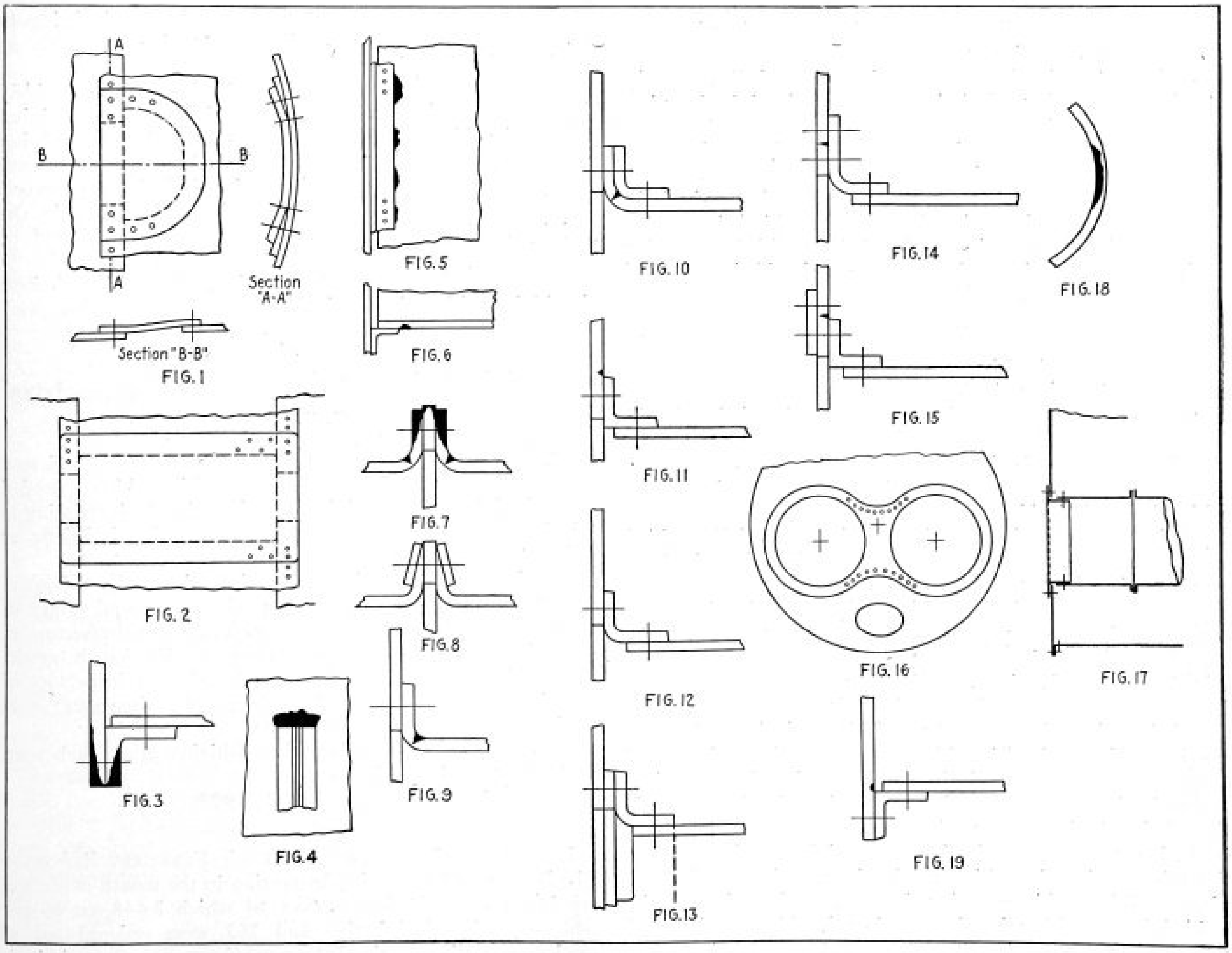
The defects generally met with in boilers of the Lancashire and Cornish type are as follows:

Parts Under Tension—Internal Defects. Pitting and corrosion of shell at bottom and at water level. Grooving adjacent to seams. Lap cracks. Cracks between rivet holes. Wasting of rivet head.

Parts Under Tension—External Defects. Wasting of plates under flue covers and seatings. Corrosion near longitudinal seams and ring seams. Corrosion adjacent to front end plate angle. Wasting near seating blocks and standpipes under composition covering. Bulging of shell plates. Wasting of blow-off elbow.

Parts Under Compression—Internal Defects. Pitting and corrosion of furnace and flue tubes. Corrosion of furnace and flue tube flanges and stiffening rings. Grooving of tube flanges. Grooving of furnace tube flanges to front and back end plates. Wasting of rivets in tube flanges. Lap cracks from rivet holes.

Parts Under Compression—External Defects. Wasting of



Welding and Patching Details for Boiler Repairs furnace tubes at bar level. Smooth wasting of tubes. Wear of first ring from fire iron action. Bulging and deformity of tubes. Wasting of cross tubes.

Stayed Parts—Internal Defects. Grooving of front end plate above furnace tube flange or angle ring. Grooving of flanged end plates. Corrosion of front and back end plates. Corrosion of gusset plates and angles. Grooving of front end plate adjacent to shell angle at bottom and sides.

Stayed Parts—External Defects. Wasting of front end plate and rivets at bottom.

Causes of Defects

The causes of these various defects are generally well known to be due to the action of feed water, air, expansion and contraction, etc. The cause of ovality of furnace tubes is not readily seen. A perfectly circular tube subjected to equal pressure all round its surface gradually becomes oval up to two and three inches. Various theories have been put forward to account for this, the most popular one being that the difference in temperature between the bottom and top parts of furnace tubes causes the ovality. The writer's experience is that it takes place very gradually and may be due to "hogging" of the tube assisted by overheating caused by the heavier scale which is always found on the sides of tubes compared with that found on the crowns.

The principal drawback to boiler repairs by welding lies in the fact that the strength of a weld cannot be guaranteed whereas the strength of the seams of a patch can be readily calculated.

Care should be taken when designing patches that the riveting is equal to that of the boiler seams.

Cover patches should not be applied where the plates are subject to flame or hot gases.

It is not desirable that grooving near shell seams be repaired by welding. It is better to crop the defective plate and fit a patch with well rounded corners as shown in Fig. 1. Fig. 2 shows a patch repair where the shell bottom has been cut away between two ring seams.

Local wasting near the front end plate angle can be built up by welding as shown in Figs. 5 and 6, this being a case of a permissible part in tension being welded. Wasting under seating blocks and flue covers should be repaired by patching, and rivets with wasted heads are better renewed than welded.

Good repairs can be done by welding to laps of tube flanges as shown in Fig. 7. Grooving in these flanges can also be similarly repaired.

After welding laps of tube flanges, the rivet holes should be redrilled and rivets inserted in preference to welding up the rivet heads to the laps.

Fig. 8 shows a repair by patching to furnace tube flanges which is not desirable.

Pitting and corrosion of tubes can be successfully welded as also can the tube flanges to front and back end plates as shown in Fig. 9.

Alternative methods of repair of furnace tube flanges to front and back end plates are shown in Figs. 10, 12, 13 and 16. Fig. 10 is a repair by cover or tippet patch and Fig. 12 is a repair with the defective part cut away. Where both furnace tubes of a Lancashire boiler are grooved above and below the tubes a good repair is made by a figure 8 patch as shown in Fig. 16. The grooved portions and flange are cut away and the patch applied from outside, fitting in the ends of the tubes. This is a far better repair than fitting ½ inch angles above and below the tubes and is in the long run cheaper. Angles are too rigid and do not allow the tubes to breathe which results in grooving of the end plates. Where this grooving is not too deep it may be welded but patching is often preferred. Two methods of patching are shown in Figs. 14 and 15. The former is applied when the tube flange is grooved in addition to the end plate which is sometimes found to be the case. The flange is cut away and an angle having a long side fitted. Grooving of flanged end plates in the root of flange should not be welded as repairs of these parts require careful consideration. Wear of furnace tubes about bar level on the fire side may be built up by welding and corrosion over the bottom back end gusset angles may be welded, see Figs. 4 and 18. Wasting of the front end plate at the bottom is frequently found where ashes are quenched against the boiler front and may be repaired by reinforcing by welding metal, Fig. 3, but where the front end plate at this part is grooved internally it is better to crop out the piece and apply a patch. This grooving is shown in Fig. 19. Where the grooving is not combined with wasting externally it is not necessary to crop out the piece and a cover patch may be applied.

Inspecting Boilers

Most defects which occur in these types of boilers can be detected with reasonable care where good preparation is made for the inspector. The seriousness or otherwise of defects is not readily determined and opinions differ as to amount of wasting and deterioration to allow before advising repair. Fine grooves are more serious than grooves of an open character. Care should be taken when considering defects of boilers with thin plates. Smooth wasting of plates is difficult to detect and should be looked for at seams and flanges. The hammer test is a reliable guide and where any doubt exists as to the remaining thickness test holes should be drilled.

When it becomes necessary to repair a defect it should be carefully considered, the object of the repair being to recondition the part so that it will function as nearly as possible like the original part.

Repairs to boilers by welding will be more extensively done in this country when a systematic scheme of training welders in this work is adopted. The method of welding adopted by operators not skilled in boiler work is to add plenty of metal to the part, increasing its thickness beyond the original thickness and causing increased stress in the vicinity of the weld. A properly finished weld should be no thicker than the original plate.

After extensive repairs by welding or patching, boilers should be subjected to a hydrostatic test of working pressure and a half.

New York Increases Boiler Inspectors' Salaries

THE New York Senate passed, on March 26, and sent to the Governor, the Hackenburg bill, which amended the labor law by adding a new section 18-b, relating to salaries and grades of boiler inspectors, which is briefly as follows:

The inspectors shall be divided into six grades. Inspectors of the first grade shall each receive an annual salary of \$1,680; inspectors of the second grade, \$1,800; inspectors of the third grade, \$1,920; inspectors of the fourth grade, \$2,100; inspectors of the fifth grade, \$2,220; inspectors of the sixth grade, \$2,400. The chief boiler inspector is to receive an annual salary of \$3,500.

Inspectors are to be advanced to a higher grade each year, until the sixth is reached.

The act is to take effect July 1, 1925.

Locomotive Inspection Bureau's February Report—The Bureau of Locomotive Inspection in the month of February inspected 5,732 locomotives, of which 2,648, or 46 per cent, were found defective and 267 were ordered out of service, according to the Interstate Commerce Commission's monthly report to the President.

Autogenous Welding and Cutting as Practised on the Atchison, Topeka an Santa Fe Railway*

By E. E. Chapman† and H. H. Service‡

THE Santa Fe Railway System in its various shops and roundhouses is equipped for handling work by electric, oxy-acetylene and thermit welding processes and instructions are available in the various shops for proper supervision and control of the work so that satisfactory service may be obtained. The various practices for each process have been standardized for the system as the result of extensive investigation work which began on this road about 1908. Even at that time, while autogenous welding was but little understood, it was realized that this type of tool for use in building and repairing might be a wonderful help, but could easily be made a two-edged sword, which if not properly controlled would do so much damage that it would offset the advantage which would accrue from its use.

Welding Folio

With this in view, data on new classes of work were carefully compiled by the supervisor of welding equipment and in compliance with instructions from Mr. Purcell, assistant to the vice president in charge of mechanical matters, these data were issued as a standard pamphlet, designated "Oxy-acetylene and Electric Arc Welding Folio," for the instruction and guidance of those who have direct supervision of welding in the various shops and roundhouses on the system. This welding folio is kept up to date by frequent revisions and as better methods are devised and better welding material and materiel are developed, and tried out with satisfactory results, they are included in the folio.

Boiler Welding

In order that the fundamental principles of this art may not be violated the following general rules are stated for work concerning boilers and pressure containing vessels:

1. Autogenous welding will not be permitted on any part of a locomotive boiler that is wholly in tension under working conditions; this to include arch or water bar tubes.
2. Staybolts or crown stay heads must not be built up or welded to sheet.
3. Holes larger than 1½ inches in diameter when entirely closed by autogenous welding must have the welding properly stayed.
4. In new construction, welded seams in crown sheets will not be used where full size sheets are obtainable. This is not intended to prevent welding crown sheets to other firebox sheets. Side sheet seams shall be not less than 12 inches below highest point of crown.
5. Only operators known to be competent will be assigned to firebox welding.
6. Where autogenous welding is done, the parts to be welded must be thoroughly cleaned and kept clean during the progress of the work.
7. When repairing fireboxes, a number of small adjacent patches shall not be applied, but the defective part of sheet shall be cut out and repaired with one patch.
8. The autogenous welding of defective main reservoirs is not permitted.
9. Welding rods must conform to the specifications.

Autogenous Welding Don'ts

Inasmuch as there are a great many things to be avoided in the use of autogenous welding, due either to rules of the American Railway Association or the Interstate Commerce Commission, a series of prohibited practices have been established and added to as circumstances demand. These constitute a series of *Don'ts* most of which are self-evident while others may be new and consequently overlooked so they are cited here to show the detail of supervision exercised to keep an operator out of trouble and do good work. Our present list follows:

Don't weld cracks in boiler shells.

Don't weld patches in boiler shells.

Don't weld patches in knuckles of backheads and other parts of boilers which are wholly in tension under working conditions.

Don't weld grooves or pitted parts of boiler shell or firebox (remove the defective portion and apply new material).

Don't weld arch tubes.

Don't weld cracks in firebox sheets which are over 12 inches long. Apply a patch.

Don't weld cracks in firebox without removing the staybolts from holes into which the crack extends.

Don't apply excess metal. It is a waste of time, strength and material.

Don't weld staybolts.

Don't weld leaky rivets or staybolts.

Don't weld stay rods for boilers.

Don't weld over cracks in fireboxes unless they are properly chipped out.

Don't proceed to weld any job until it has been properly prepared and the conditions are such that you can produce a good weld.

Don't burn out studs in shells of boilers when the size of studs is less than ⅝ inch in diameter.

Don't weld up solid drain plug holes in air reservoirs. Apply a pipe plug.

Don't weld patches in the unstayed surface of air drums and reservoirs.

Don't weld oil tanks until they have been thoroughly cleaned.

Don't forget to weld on both sides of the seam when it is possible to do so.

Don't weld sharp or worn flanges on tires or wheels.

Don't weld cracks in main rods, side rods, or crossheads.

Don't weld on piston rods.

Don't cut the keyways in piston rods.

Don't weld cracked or worn axles.

Don't weld locomotive drawbars which are cracked.

Don't weld knuckle pins which are worn or cracked

Don't weld on main or crank pins which are worn or cracked.

Don't weld over dirty or greasy metals. Have same thoroughly cleaned.

Don't weld broken frames until the proper allowance for contraction has been provided for.

Don't burn off cast iron castings which can be machined or chipped economically.

Don't burn small holes in plates or castings which should be drilled and can be drilled or punched more economically.

Don't cut plates which can be sheared more economically.

Don't weld arch bars which are cracked or worn

Don't weld tension members on car or coach castings when the tension member is fractured more than 40 percent of the original or total cross section of tension member.

Don't weld cracked or fractured grab irons, equalizers, sill steps, brake staffs or wheels.

Don't weld fractured coupler bodies, knuckles, knuckle pins, locks, lifters and throwers.

Don't weld truck frames, side frames, bolsters, body bolsters, while under cars, when load is on same. Have same taken from under car and weld properly.

Don't start electric welding machines unless you know all the connections are tight and that machine is in good condition.

Don't start welding until the positive or ground wire is firmly secured close to the work which is being performed.

Don't connect ground or positive side of welding circuit to water, steam and air pipe lines.

Don't start welding until you have the proper welding wire.

Don't let your machine or equipment get into a dirty condition. Once cleaned it is easily maintained in such a condition.

Don't start welding or cutting until you have protected yourself and other workmen from the electric arc rays and sparks.

Don't start welding until first having protected your eyes and face with a suitable hood or welding goggles.

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* Abstract of paper read by Mr. Walter Bohnstengel, Assistant Engineer of Tests, Atchison, Topeka & Santa Fe Railway, before the Chicago Section of the American Welding Society at Chicago, March 6, 1925.

† Engineer of Tests, Atchison, Topeka & Santa Fe Railway, Topeka, Kansas.

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Don't leave welding wire or rods on locomotives or tanks or other equipment.

Don't allow welding wire to be used for other purposes than welding.

Don't waste welding material or scatter same over the floor.

Don't forget to brush off all oxide from work after each electrode has been consumed.

Don't leave your job unless you shut off your machine, or disconnect the leads from the work.

Don't allow the negative side of your circuit to remain in contact with the positive side of circuit more than one minute. This may result in heavy damage to the machine.

Don't start welding until the ground wire is firmly secured close to where the welding operation is to be performed.

Don't use leaky equipment. Have same repaired.

Don't use leaky gas hose.

Don't use trimo wrench for tightening connections. Use wrenches assigned for that purpose or a monkey wrench.

Don't use oil on gas hose or connections. It will cause explosions.

Don't allow trucks to run over gas hose. Apply a hose bridge.

Don't allow hose or welding leads to remain scattered around the floor. Keep them neatly coiled.

Don't use gas hose without clamps, but firmly secure hose with clamps at all connections.

Don't throw sparks from cutting blow pipes in the direction toward hose. It is liable to burn your gas hose and cause a fire.

Don't leave your work until all pressure valves are closed.

Don't return gas cylinders as empty when there is sufficient gas remaining in cylinders to perform a job.

Don't let empty cylinders stand around. Return them to store department immediately.

Don't let defective welding equipment accumulate. Have same repaired immediately.

Don't let burner tips become dirty or come in contact with molten metal. It sometimes causes disastrous back fires.

Don't use larger size cutting nozzles or welding heads than is necessary to do the job.

Don't use welding and cutting blowpipes for pinch bars or hammers.

Don't look or hunt for gas leaks with a lighted torch. Use soapy water and a brush or piece of waste.

Don't use oily packing or oxygen valve stems. Use lamp wick and glycerine.

Don't handle oxygen or acetylene cylinders roughly. They have been known to burst on account of rough handling.

Don't store oxygen or acetylene cylinders close to open fire, hot boilers, radiators or hot sun rays. Store in room at a temperature of about 60 degrees Fahrenheit.

Don't heat or warm gas regulators with open fires or red hot irons. Use steam or hot water.

Following this list of precautions and prohibitions are some general instructions to be observed in welding, a few of which will be cited to show their scope.

General Welding Instructions

Carefully fit all patches or seams, allowing not more than one-fourth or less than three-sixteenths inch space at the bottom of the "V" opening. All edges to be welded must be beveled to 45 degrees. All welders, and those preparing seams for welding must be provided with a gage for testing the bevel and opening between the plates. When the opening between the plates closes to less than three-sixteenths inch, welding must be stopped and full opening made by chipping with hammer and chisel. Do not burn the edges of the plates to enlarge the opening.

Keep Work Clean

No piece of work that is to be welded is properly prepared unless it is thoroughly clean and free from all grease, rust, scale, or other foreign substance. The weld must be made on clean bright metal, and that condition must be preserved throughout the welding operation. Proper tools will be furnished to keep work clean, and all are again advised that a reliable weld cannot be made unless the parts being welded are maintained bright and clean throughout the operation.

To Prevent Accidents—Electric Welding

Operators should keep face and hands well protected from the welding rays, and should not attempt to weld without having the eyes protected with suitable hood, which will be furnished for that purpose. All welding operations should be screened from other workmen. Insulation on all lead wires shall be maintained in good condition and must be kept dry.

To Prevent Accidents—Oxy-acetylene Welding

Do not use oil or grease in any way in connection with regulators, because oxygen under high pressure in contact with oil will fuse and destroy the regulators and gages.

Oxygen Regulators

Before attaching regulator to cylinder, open cylinder valve slightly to blow out dirt from the passages. Close valve tightly and quickly.

Attach regulator firmly to cylinder and *fully release* the diaphragm spring by turning regulating screw to the left before opening tank valve. Open tank valve gradually, and while doing so do not face the gages, but stand to one side of the regulator, because the sudden pressure on the gage may break the glass. Oxygen tank valves should be screwed open as far as they will turn.

In adjusting oxygen regulators to obtain working pressure, turn regulating screw to the right, and open oxygen valve on blow-pipe. Then slowly turn the regulating screw to the right until proper pressure shows on the little gage.

Not under any circumstances should oxygen, acetylene, Blau, or Pintsch gas containers be used for any other gases than that for which they are assigned.

Do not try to equalize pressure from oxygen container into any other container or cylinder other than that which has been provided for oxygen only.

Do not use any other vessel or container for storing or equalizing pressure of acetylene gas other than that which has been provided for. The same rules also pertain to Pintsch and Blau gases.

When making connection to any container or cylinder which contains any of the above mentioned gases, it is very important that all connections be free from grease or foreign matter and that they should be thoroughly cleaned. If it is necessary to clean connection with gasoline, same should remain in the open for at least one hour after being wiped dry in order that gasoline remaining on interior connection will have evaporated, so that there will be no danger of explosion or fusion after connection is made.

All gas hose which is used for oxygen and acetylene should be thoroughly inspected once a week for leakage, perforated hose, poor connections, oil soaked, and other defects. If hose is oil soaked, it should not be used for any of the above mentioned gases. All pipe lines and valves should be inspected where permissible, and when found defective, repairs should be made immediately same as gas hose.

All acetylene generator houses or plants should be kept clean and no oily waste or other inflammables allowed to remain around on floor, cupboards, etc.

Oxygen manifold pipes and connections should be kept in proper mechanical repair. If connections become defective they should be returned to Topeka, care of Store Department, with requisition covering the repair and return of same.

If diaphragm washers in acetylene or oxygen regulators become defective, do not use rubber gasket, but return regulator to Topeka with requisition covering repairs.

Any disregard of the above rules may be very hazardous and may possibly cause serious injury or loss of life.

These are followed by safety suggestions and many pages of rules and instructions, numerous sketches and blue prints, so that a man out on the desert or out of way places, away from supervision can read the law for himself.

In order that officials in charge of welding and the welders themselves may know what kind of welding is being done from month to month, it is the practice of Santa Fe Railway to have each welder furnish a test plate monthly to be made in accord with the following instructions:

Secure two pieces of boiler steel 3/8 by 2 1/2 by 9 inches, bevel one end of each to form a 90 degree angle between them, place the two plates in a convenient position for welding with 3/16-inch opening at the bottom of the "V" and make the weld from the top side only, reinforced a maximum of 20 percent over stock size, if welder desires this much reinforcement to produce the best weld he is able to make.

It will be noted that in this test plate the weld is allowed to be reinforced 20 percent over stock size, more than that is milled or ground off, and plate to be welded only from one side, in order that the welder can approximate the conditions of welding a side sheet or its equivalent in a firebox. The welder is instructed not to forward any weld for test unless he is satisfied that it is the best he can make, and representative of the work he does. These welders are then rated according to the percentage strength of their weld which is based on the thickness of the original stock, and a strength of 60,000 pounds per square inch. It is the desire to have welders simulate actual working conditions as nearly as possible, and it is also endeavored by the foreman to have the welder complete his work at the original heat and avoid the plastering over of metal incident to reworking and consequent weakening of the original weld. From the test data thus obtained the foreman has sufficient information at hand to judge the welder's ability to produce good work and it will justify him taking proper steps for keeping the welding up to a high standard by correcting the faults or assigning only the men who are able to make satisfactory welds to the more important welding operations.

Tests have also been made to determine the relative efficiency of welded specimens to the original stock, under vibration or alternate bending but this is a comparative proposition and not one that can be used as a regular control.

An analysis was made of specimens tested for the years 1920 and 1921 to show the average efficiency of welds produced by welders having different years of welding service and the results are shown in Table I.

TABLE I

Years Service as Welder	Welded Specimens Tested			*Efficiency of Weld—Percent.	
	Gas	Electric		Gas	Electric
Less than one	195	147		75.8	90.6
One	93	81		89.2	93.2
Two	177	131		85.8	92.9
Three	78	72		84.4	95.2
Four	47	10		90.6	96.9
Five	27	..		96.7	...
Six	4	6		98.3	101.0
Seven	3	9		74.6	94.9
Eight	16	..		82.4	...
Nine	7	..		89.6	...
Total	647	456	Ave.	86.7	95.0

* These efficiencies are values based on a tensile strength of 52,000 pounds per square inch, the minimum value allowed in specifications for firebox steel.

It is noted that for the six and seven years welding service the value showed a great deal below the average which was due to a poor welder working in these two groups, but the indications are that the longer the service the greater the skill shown by operators. It will also be noted from this tabulation that for strength alone the electric welding shows up better than the oxy-acetylene welding. However, for the year 1923, a check of this relation shows that due to improvement of the kind of metal used for welding with oxy-acetylene the results of the latter are about on a par with the electric welding for strength.

The results obtained in four of our largest shops and in four of the largest roundhouses of the system are shown for the last three months of the year, October, November and December, 1924, in Table II.

TABLE II

Shops	Welded Specimens Number Tested		Specimens* Broken Outside of Weld, Percent		†Efficiency, Percent Specimens Broken in Weld			
					Gas		Electric	
	Gas	Elec.	Gas	Elec.	Min.	Ave.	Min.	Ave.
Topeka	29	46	24	24	77	101	75	96
Albuquerque	63	32	62	53	57	99	75	101
San Bernardino	31	34	45	38	84	104	88	104
Cleburne	16	9	63	33	68	90	83	98
Total	139	121	..	..	..	..	..	..
Minimum	..	..	..	..	57	..	75	..
Average	..	..	50	37	..	98	..	99
Roundhouses.								
Winslow	9	9	56	33	101	108	98	105
Amarillo	8	8	75	75	103	103	78	89
Newton	22	32	46	22	80	99	88	100
Shopton	25	22	52	36	83	98	79	103
Total	64	71	..	..	..	..	..	..
Minimum	..	..	..	..	80	..	78	..
Average	..	..	53	34	..	100	..	101

* This column also includes welds which showed 60,000 pounds per square inch tensile strength.

† Efficiency based on firebox steel, 52,000 pounds per square in minimum tensile strength.

It will be seen from these figures that a butt welded seam with a maximum reinforcement of 20 percent of stock averages well above the 45 or 50 percent efficiency allowed for single riveted seams.

It is believed that for a large railway system like the Santa Fe, too much stress cannot be laid on demanding of welders that they produce the proper strength of welds as shown by their test specimens so that both the management and welders may know when they are doing acceptable work. The test pieces are returned to originating shops and the results discussed with the individual men by the foreman in charge. The system supervisor of welding equipment and service company representatives also go over the results of weld tests with the men and make suggestions for the betterment of the service.

From this it will be seen that our railway management exercises a systematic control over autogenous welding operations, especially as it concerns the welding of boiler and tank steel plates. This, of course, is only one phase of the rather extensive use of these welding methods and the periodic control can easily be exercised, but there is a very extensive amount of work where such control cannot be so applied. Problems, such as best procedure and method of welding locomotive frames, bolsters, couplers, cylinders, where heating and subsequent annealing are required, and many similar questions require careful service observations or comparative tests. The question arrives as to whether it is practical to weld certain kinds of material, whether hot or cold, whether to use cast iron or steel rods or welding material, and with such questions raised many tests have been conducted to increase the list of *"Don'ts"* for anything not prohibited is assumed to be permissible.

It would be presumptuous to attempt to present details of various tests, but it may be of interest to point out the purpose and nature of several tests conducted on our lines and the conclusions that followed. They will be taken up in chronological order so far as possible, so that you may understand the development of the work in its natural order, and see the scope of our tests if not all the details.

In October, 1909, Mr. Purcell, then superintendent of Topeka shops, stated that some freight car truck frames had been welded with the acetylene process and he wished to know the strength, asserting that if they could be made as strong as originally, about $20 per frame could be saved. A hydraulic jack was used to apply a pressure of 25,000 pounds, without producing failure of the welded member and the opinion was expressed that such a method of welding truck frames will prove very satisfactory. The file does not reflect the performance of the weld in service as is so often the inevitable result when material or appliances are put in service on a large railway system and removed at some distant point, where identification is lost.

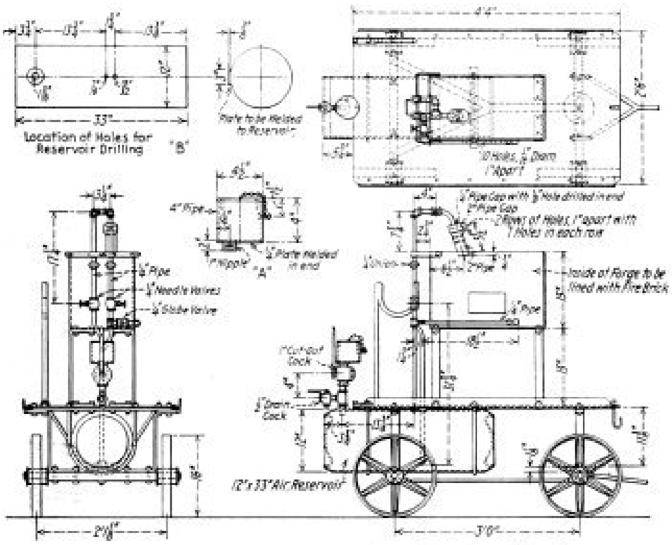
(*To be continued*)

A Portable Forge for Heating Rivets

THE portable rivet heating forge, shown in the drawing, was constructed in the shops of an eastern railroad. It has proved to be useful to the rivet gang engaged in repair work in the field. The forge is supported on two brackets 15 inches above the bed of the wagon. This arrangement provides space for small tools and rivets underneath the forge, as well as additional carrying space in front of the forge for large tools. A hook over which the air hose can be looped while the forge is being moved is secured to the wagon bed between the forge and air inlet cock, as shown in the drawing.

Details of Apparatus

The apparatus consists essentially of a flat topped wagon, a 12-inch by 33-inch air reservior *B*, an oil burner, and a furnace which is constructed of ¼-inch rolled steel and lined with fire brick. Referring to the side view of the forge in the drawing, the air reservoir is filled with fuel oil by means of a cup or funnel, a detailed drawing of which is shown at *A*, the lid is secured by a chain to prevent its being lost. Directly underneath the cup is a 1-inch cut-out cock and a 1-inch by 1-inch by ½-inch tee. This cock must be kept closed at all times, except when refueling. The air hose is attached at the cock on the horizontal branch of the tee. Compressed air from the shop line is admitted to the oil reservoir as desired by opening or closing this cock. The pressure of the air exerted on top of the oil in the reservoir forces the oil up through a ¼-inch pipe, leading from a point near the bottom of the reservoir, to the burner. Air for atomizing the oil is taken from the top of the reservoir by a second ¼-inch pipe which is joined to the fuel oil pipe by a tee which is located about 15 inches above the bed of the wagon.



A portable rivet heating forge designed primarily for use on steel car repairs

With the exception of the wheels, which are of gray iron, pipe fittings and burner, all of the various parts used in the construction of the apparatus are of forged or rolled steel. Two 2-inch by 2-inch by ¼-inch rolled steel angles form the sides of the wagon bed. The oil reservoir hangers are made of ½-inch round bar, bent U-shaped and threaded at the ends. The wagon tongue is forged from ½-inch by 1½-inch flat bar and is 37½ inches long. A hook is provided for holding the wagon tongue up out of the way when the forge is not being moved.

American Welding Society

The annual meeting of the American Welding Society will be held on April 22, 23 and 24 at 29 West Thirty-ninth street, New York. The tentative program for this meeting is as follows:

Wednesday, April 22.

9:00 a.m.—Resistance Welding Committee meeting.
11:00 a.m.—Gas Welding Committee meeting.
2:00 p.m.—Electric Arc Welding Committee meeting.
8:00 p.m.—Educational Committee meeting.

Thursday, April 23.

9:30 a.m.—Business session American Welding Society.
1:45 p.m.—Inspection trip to Bay Way plant, Standard Oil Co.
7:00 p.m.—Annual dinner, Park Avenue Hotel.

Friday, April 24.

9:30 a.m.—Technical session.

Symposium

1.—Methods of inspecting welds.
2.—Testing the skill of operators.
12:00 m.—Luncheon Engineers' Club.
12:45 p.m.—Technical session continued.
2:00 p.m.—American Bureau of Welding.
3:30 p.m.—Board of directors, American Welding Society.

Laying Out Locomotive Boilers

(*Continued from page* 102)

be thoroughly checked, the location of the lines on the diagram and plate development should be verified, also the accuracy of the scaling. All curved lengths must be stepped-off; all trammel work, retrammed; in fact, all lines and holes should be examined closely, and scaled to see if the work is correct.

Several outline dimensions can be checked by calculation and scale, a method which differs from the draftsman's scaling method of determining the dimensions, in that the draftsman's method of establishing the dimensions is affected by expansion and contraction while the former or check method is not thus affected.

To check by calculation proceed as follows: Below the crown sheet base line—Fig. 5—at the front of the sheet will be found dimension T. The line for this dimension intersects the developing line and the boiler base line. Scale dimension T. The length—dimensions taken from the diagram—of the developing line from the top center to the boiler base line minus T, minus the difference between the hypotenuse and the adjacent side of the triangle formed by the developing line, dimension K, and the 90-degree line, should equal dimension G, which the draftsman scales. Dimension, T^1, at the back of the sheet is scaled and used in a similar way to determine dimension H. Dimension T^2, which is shown at the back of the sheet, is drawn parallel to the top center from the intersection of the developing line and center line of boiler, is scaled and subtracted from the length of the developing line, from the top center to the center line of boiler. This should equal dimension H^1, which the draftsman has scaled. Similar dimensions on the roof sheet are determined in the same way. When checking is complete the crown and roof sheet drawings are ready for shop use.

(*To be continued*)

The Welding Service & Sales Company, Donovan building, Detroit, Mich., of which T. M. Butler is manager, has been appointed agent in the Detroit territory for the Gibb Welding Machines Company, Bay City, Mich., for its arc, spot and seam welding machines.

The Boiler Maker

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

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Cable address: Urasigmec, London

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Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price; United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. Foreign subscriptions may be paid through our London office, 34 Victoria Street, S. W., 1, in £/s/d.

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

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CONTENTS

A great many readers of THE BOILER MAKER are interested in one way or another in the trade of welding and cutting. There are many who, although already engaged actively in the work, wish to broaden their training and still others who desire to enter the field but do not know how or where they can obtain the necessary course of training. For the information of these individuals a list of schools and colleges in the United States and Canada giving instructions in welding and cutting is published elsewhere in this issue. Insofar as it has been possible to make it, the list is complete. Any additions or corrections to it will be welcome. The list should also serve to assist such industrial organizations, as require the service of competent men who have received thorough training in the art of welding.

Arrangements are being completed for the 1925 convention of the Master Boiler Makers' Association which will be held as previously announced May 19 to 22 inclusive at the Hotel Sherman, Chicago. As this convention is to be followed by that of the International Railway Fuel Association at the same place a week later, it will be possible for supply members to reserve the same exhibit space for both conventions. The secretary of the Boiler Makers' Supply Men's Association stresses this point in letters to the members of the association so that they will make their reservations at once and plan as complete exhibits as possible. Floor layouts of the exhibit space as well as the charges for extra space and extra badges have also been sent out. A number of companies supplying equipment and material to railroad boiler shops do not belong to the association and to these an invitation has been extended to join the association and exhibit at the convention. The secretary is W. H. Dangel of the Lovejoy Tool Works, Chicago, and applications for membership and reservations for space at the convention can be made through him.

The methods developed in Austria for reclaiming boiler tubes, as outlined in the leading article, offer considerable food for thought to the mechanical departments of American railroads and to the men engaged in the work of safe-ending tubes. While the entire system described could hardly be adopted in this country because of production demands, certain of the equipment could well be adapted to our needs. Specifically, a machine similar in type to the tube carrier described for handling tubes in and out of heating furnaces would fit into the scheme of production with a minimum of fatigue to the operator. This one operation in tube repair as practised here seems to be the weak spot in the entire process—entailing as it does considerable manual labor of handling tubes and in most cases exposure of the operator to the heat of an open furnace. When the operation of bringing tubes to welding heat can be accomplished as speedily and easily as it apparently is in the method described it would seem advisable to improve existing methods here.

One of the earliest exponents of the extensive use of autogenous or fusion welding is the Atchison, Topeka and Santa Fe Railway, its investigations and experimental work with the various processes going back as far as 1908. From that time until the present this company has been indefatigable in the development of welding, always bearing in mind that no practice or application should be made that would in any way retard its advance. The list of suggestions taken from the folio of the welding department of this road as it appears in a paper recently read before the Chicago section of the American Welding Society indicates that little or nothing has been overlooked to insure careful and competent welding as used in the shops of the company. The methods of testing welds and checking the ability of the welding staff, as outlined, form the basis of much of the success experienced with welding by this system. There are few mechanical departments or welders who will not be able to derive some benefit from the study of this paper, a part of which appears in this issue.

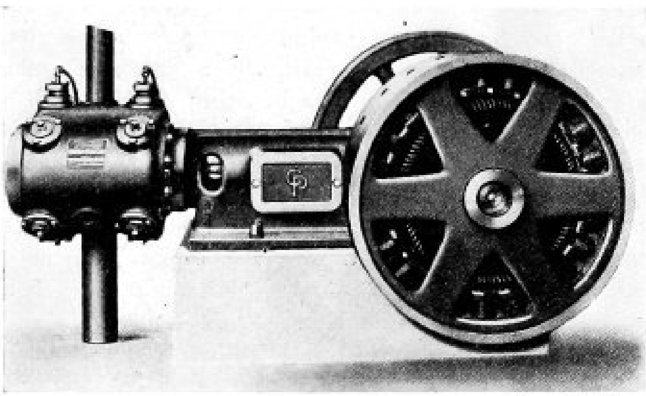
Engineering Specialties for Boiler Making

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

Air Compressor Driven by Direct Connected Fly-wheel Type Synchronous Motors

THE splendid performance results that have attended the application of the direct connected, synchronous motor to air compressors of the larger capacities, have stirred motor manufacturers to unusual activity in developing synchronous motors suitable for driving compressors of smaller size. Such an application is now made by the Chicago Pneumatic Tool Company, Chicago.

In order to overcome the disadvantages of the present general construction there has been designed a line of synchronous motors known as the "Fly-Wheel Type" which are especially adapted to single straight line air compressor operation. This motor is designed with the rotating element outside the stator. The stator is mounted in a cradle support bolted to the compressor frame. This cradle support is bored concentric with the compressor bearing to assure perfect alinement of the stator and a uniform air gap when assembled. The rotor presents the appearance of an ordinary fly-wheel. Its face is crowned for driving an exciter or other auxiliary while on the inner surface of the rim are mounted the poles, adding fly-wheel effect, of which there is an abundance for smooth operation.



Synchronous motor driven compressor

The air gap in this motor is relatively small and the question of maintaining a uniform gap naturally arises. This has been met by designing the stator so that the magnetic pull is upward, relieving the bearings of excessive downward pressure and giving, in effect, a floating rotor. In addition the main bearings of the compressor are fitted with removable die-cast bushings which may be quickly and cheaply replaced at the first sign of wear. With these precautions little trouble may be expected from the air gap source.

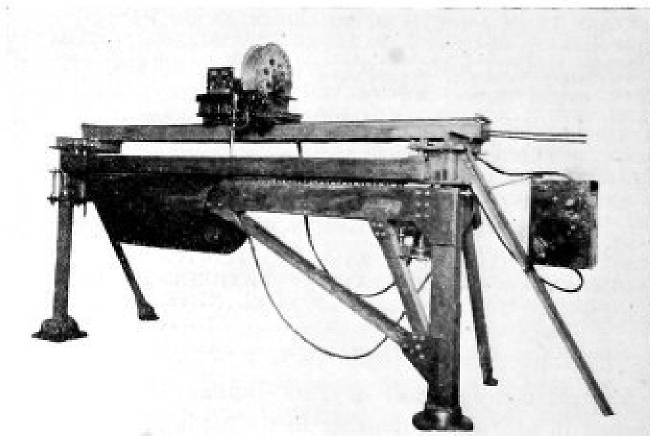
With such construction as that outlined above, the weight and consequently the cost of the motor have been greatly reduced; sufficient fly-wheel effect for steady, smooth operation has been obtained; a uniform, correct air gap has been secured; foundation expense has been reduced; and because of the simplicity of construction and the machined assembly parts, erection costs and repairs are reduced to a minimum. The floor space required to accommodate a machine so equipped is even less than if belted to a line shaft, and at least 30 to 75 percent less than required for short belt motor drive, while the cost of the two types of electric drive are practically the same.

Chicago Pneumatic direct connected compressor units with this type motor are now available in sizes ranging from 139 to 1,000 cubic feet displacement, for 100 pounds discharge pressure up to 125 pounds.

Automatic Arc Welding Apparatus

FOLLOWING several years of development and trial, the General Electric Company, Schenectady, N. Y., is now marketing a line of automatic arc welding equipments. These equipments, sold either as complete units or as separate parts, have been especially designed for quick, efficient and economical welding where quantity production is a factor. Heretofore, it has been the custom to supply the separate parts only.

The new outfit is expected to find its principal application in the construction of such standard products as tanks, boilers, cans, axle housings, and pipe, and also for repairing undercut shafts or axles and building up sharp flanges on car wheels. Its field of greatest usefulness will be in the manufacture of storage vessels where the static load is not greater than 10 pounds per square inch and where the thickness of the metal to be welded is not less than number 16 gage.



Apparatus for automatic arc welding

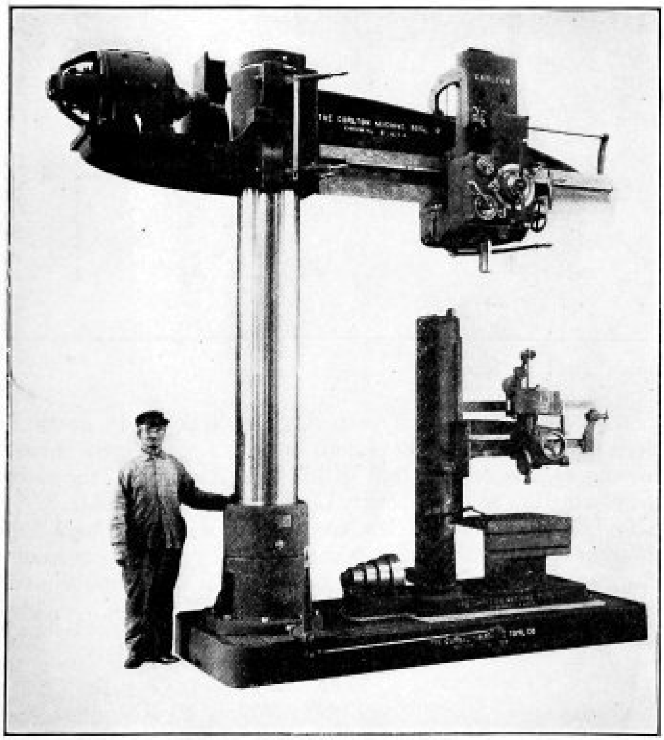
Outstanding among the advantages claimed for these automatic equipments is the resulting increase in speed of production following their installation.

A complete outfit consists of an automatic welding head and control panel, travel carriage and clamping device. Where it is desired in order to meet special circumstances in any plant the travel carriage and other component parts of the equipment may be assembled by the purchaser with his own device for holding the work in place during the welding operation.

Ball Bearing Heavy Duty Radial Drill

A RADIAL drill equipped throughout with ball bearings, constructed on the unit principle, having a concentrated and convenient control and a low-hung drive of the spindle, has been developed by the Carlton Machine Tool Company, Cincinnati, Ohio. Particular attention has been paid to lubricating the machine to increase production by reducing friction, wear, power losses, shutdowns and renewals.

The speed box is composed of several sub units. The driven shaft is provided with four keys running almost its entire length. The six gears which form the cone are made of alloy steel with four keyways multiple broached to fit on the shaft. The large gear on the end is made of cast iron which carries a pawl to drive the ratchet mounted on the shaft so that when the train of gears is disconnected, the pawl drops in the ratchet and keeps the gears in constant motion. The upper shaft, which carries the sliding tumbler gears, is also made from the solid bar. The ratchet teeth on the tumbler engage with a small segment on the front cover and are used only for engaging and disengaging the train of gears. The speed box is entirely closed with long levers extending to the front of the column for the convenience of the operator. The speed box contains a sight oil gage. There are 24 speeds in geometrical progression covering a range from 18½ to 800 revolutions per minute when the speed box pulley is revolving at 500 revolutions per minute. A range of 24 to 1,000 revolutions per minute may be obtained if desired by revolving the speed box pulley at 600 revolutions per minute. These high speeds are made possible by the fact that every bearing, shaft or sleeve is supported by ball bearings. There are 12 feeds mounted in the head, covering a range of .004 to .060 inch per revolution of the spindle.



Carlton 7-foot heavy duty radial drill with the column lengthened to take 8 feet 3 3/16 inches under the spindle

The stump knee has been designed as a complete unit in a housing. The horizontal shaft with bevel gears is mounted with ball bearings at each end. The bevel gear which carries the vertical shaft is mounted on a steel sleeve which is supported on each end with ball bearings. A sight oil gage indicates the amount of oil that these gears should run in.

Details of Drill Head

The head on the arm has two holes bored parallel, one for the weight and one for the spindle. Both the spindle sleeve and the counter-weight have generated teeth their full length and both balance on a pinion gear which is mounted in ball bearings. The head is designed with a low hung drive, with the train of gears underneath the arm which drives the spindle off its largest diameter down close to the work. In order to overcome wearing the head bell-mouthed, the large driving gear is mounted on a large semi-steel sleeve mounted on the head in two large ball bearings. The spindle does not revolve on this sleeve but simply slides up and down in a double keyway and when it reaches its maximum travel of 18 inches it still maintains 7 inches of bearing in the sleeve, which is mounted in large ball bearings 18 inches apart. A pump in the head supplies oil to the gears and bearings.

The only part which connects the transmission to the head is the driving gear in the transmission to the driven gear mounted on the spindle sleeve. The bottom part of the transmission sets in oil in the bottom of the head. This unit contains the reverse for both the gears and their clutches, one for the forward drive and the other for reverse for tapping. The multiple clutch in the unit has seven driving disks in the forward drive and the same number in the reverse.

The outer column of the machine hangs on two ball bearings mounted on the top of the inner column, a large thrust bearing to take the weight and a large radial bearing to take the radial load of the swinging arm, together with roller bearings mounted on the bottom of the column. The clamping mechanism for binding the inner and outer column consists of a pair of eccentric wedges of crescent shape, mounted between the two columns. The column can be locked either by a hand lever or a foot treadle as shown on the front of the base.

Safety Devices

The arm binding levers point toward the operator and are eccentric on the binding end so that the operator pulls down on the lever to bind the arm and pushes up to release it. There is a mechanism in the arm to prevent the operator from trying to raise it while it is clamped. When the arm reaches its maximum travel at the top of the column, it is stopped automatically by a plunger and if it should meet any obstruction while being lowered, it again stops automatically. This is accomplished by a stationary screw and revolving nut. The screw hangs on a friction bearing at the top of the column. The revolving nut is mounted in ball bearings in the arm. The weight of the arm on the screw creates the friction to keep the screw stationary, but when the arm strikes or rests on any obstruction, it releases the weight of the friction and allows the screw to turn with the nut. The power for rotating this nut is received from the rear shaft through a set of hardened tumbler gears.

The variable speed motor is mounted in the arm with an 11-point rheostat directly connected to the head which gives 24 speeds. Variation of speed is obtained by revolving the pilot wheel just above the levers on the head. This attachment is mounted on the head and slides along the spline shaft in the rear.

Questions and Answers for Boiler Makers

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

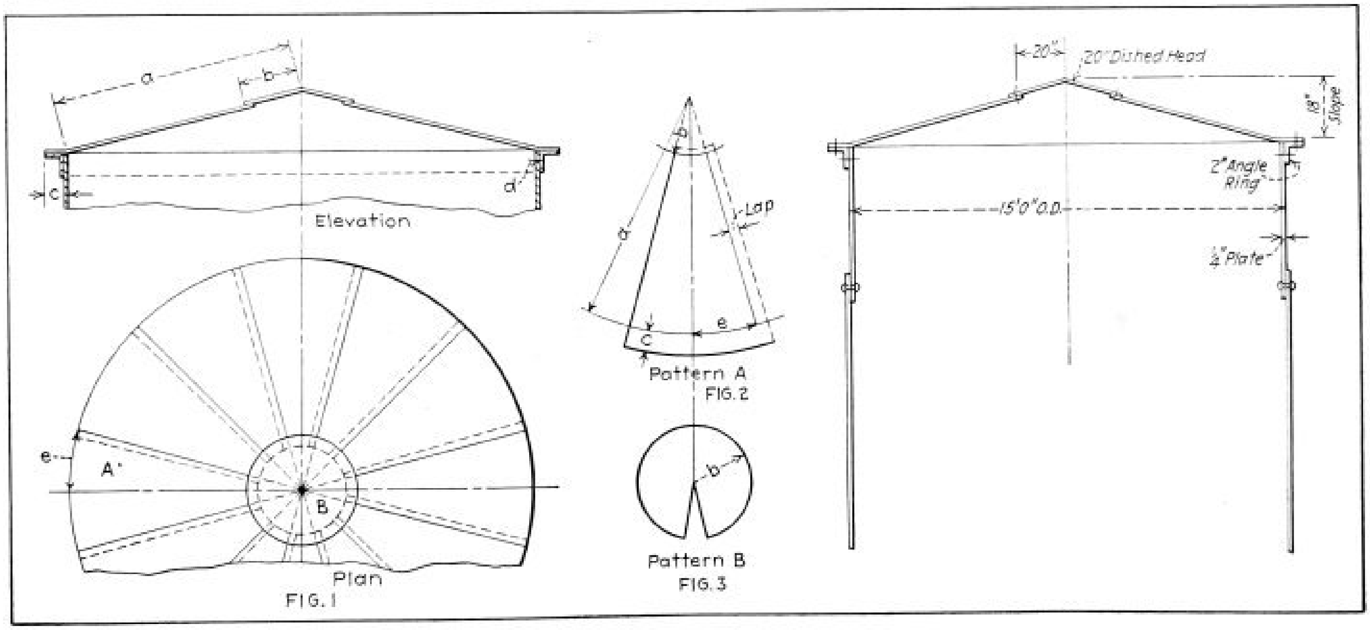
Conducted by C. B. Lindstrom

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

Conical Roof Patterns

Q.—As a subscriber of your magazine I will ask you to show me how to layout a tank roof, as shown in sketch, which is made of 12 equal sheets and of 20-inch dished plate at top-center, all of No. 10 material.—T. R.

A.—Figs. 1, 2 and 3 illustrate the method of laying out the patterns for a conical roof. In the elevation, Fig. 1, are given the lengths *a* and *b* which are used for drawing the stretchout of the patterns, Figs. 2 and 3. The distance *c* is the flange to be allowed for bolting or riveting the cover to the angle *d*. Allowance must be made for the lap along one side of the pattern and for the top where it is fastened to the conical head, *B*. As all lines are marked in the views the construction should be readily understood.



Method of laying out conical roof patterns

Elastic Limit of Material

Q.—I am a boiler maker employed as a layerout and desire to know the meaning of "limit of elasticity" and the method of computing same.—E. L. A.

A.—When a body is subjected to force the material composing it is deformed. When the force does not exceed a certain limit, the material, will on the removal of the force return to its original form. This property of the material is called *elasticity*. When the force exceeds the *elastic limit* of the body, the body does not return to its original form when the force is removed, therefore deformation of the material has taken place which is called *permanent set*. Within the elastic limit, the deformation caused by a force is proportional to the force. This is Hooke's Law on which the strength of materials is based. This law, however, does not apply to stresses beyond the elastic limit of the material, therefore in the design of a structure no part should be proportioned to carry stresses greater than the elastic limit.

If a bar of material is subjected to a pull of 2,000 pounds, and if the "stretch" or "elongation" of the bar, due to this force is $\frac{1}{4}$-inch, then, according to Hooke's Law, if the force is increased the elongation or deformation is increased proportionately; thus if the force is increased to 4,000 pounds, then the stretch increases proportionately or to 2 times that found at 2,000 pounds or $\frac{1}{4} \times 2 = \frac{1}{2}$ inch. From this theory it is evident that within the elastic limit, the ratio of deformation to the intensity of the stress is constant. This ratio is known as the *Modulus of Elasticity*. There are different moduli of elasticity, according to the different kinds of stresses, but for tension and compression the formula used for elasticity is

$$E = \frac{S}{s}$$

in which;

E = modulus of elasticity, pounds per square inch.
S = unit stress, pounds per square inch.
s = unit deformation, in inches.

Modulus of elasticity of the principal materials used in boilers, structures, etc., is as follows:

Material	Modulus of Elasticity pounds per square inch
Cast iron	15,000,000
Wrought iron	27,500,000
Steel	30,000,000

The A.S.M.E. Code specify the minimum elongation in test pieces of different plate thicknesses, based on the following ratio:

$$\frac{1{,}500{,}000}{\text{Unit tensile strength of material pounds per square inch}}$$

Modifications in elongation are given in the Code, for plate thicknesses of ¼-inch and for material over 11/16-inch in thickness.

I would advise you to study the subject of strength of materials.

Spherical Tank

Q.—Would you please show me the best method of developing the patterns for a spherical tank as per sketch?—J. F.

A.—In Figs. 1 to 3 is indicated a simple method for developing the patterns of the segments of a sphere. Draw the plan and elevation, showing the portion of the segments and rivet lines. In the elevation pass the planes *E* to *I* inclusive through the hemispherical section. The planes *F-F* and *H-H* lie between the plane of the seam lines.

The pattern for the top and bottom dished heads is drawn in Fig. 3, using *c-d* of the elevation, Fig. 1, as a radius for the disks. Patterns of the segments are also shown in Fig. 3 in which the arc lengths *1-2*, *2-3*, etc., equal respectively the corresponding arc lengths of the plan, Fig. 2. The lengths *1-1*, *2-2*, *3-3*, etc., equal the arc length *I-G* measured on the semi-circle of the elevation. Allowances for riveted seams must be made for each pattern shown.

Boiler and Stack Proportions

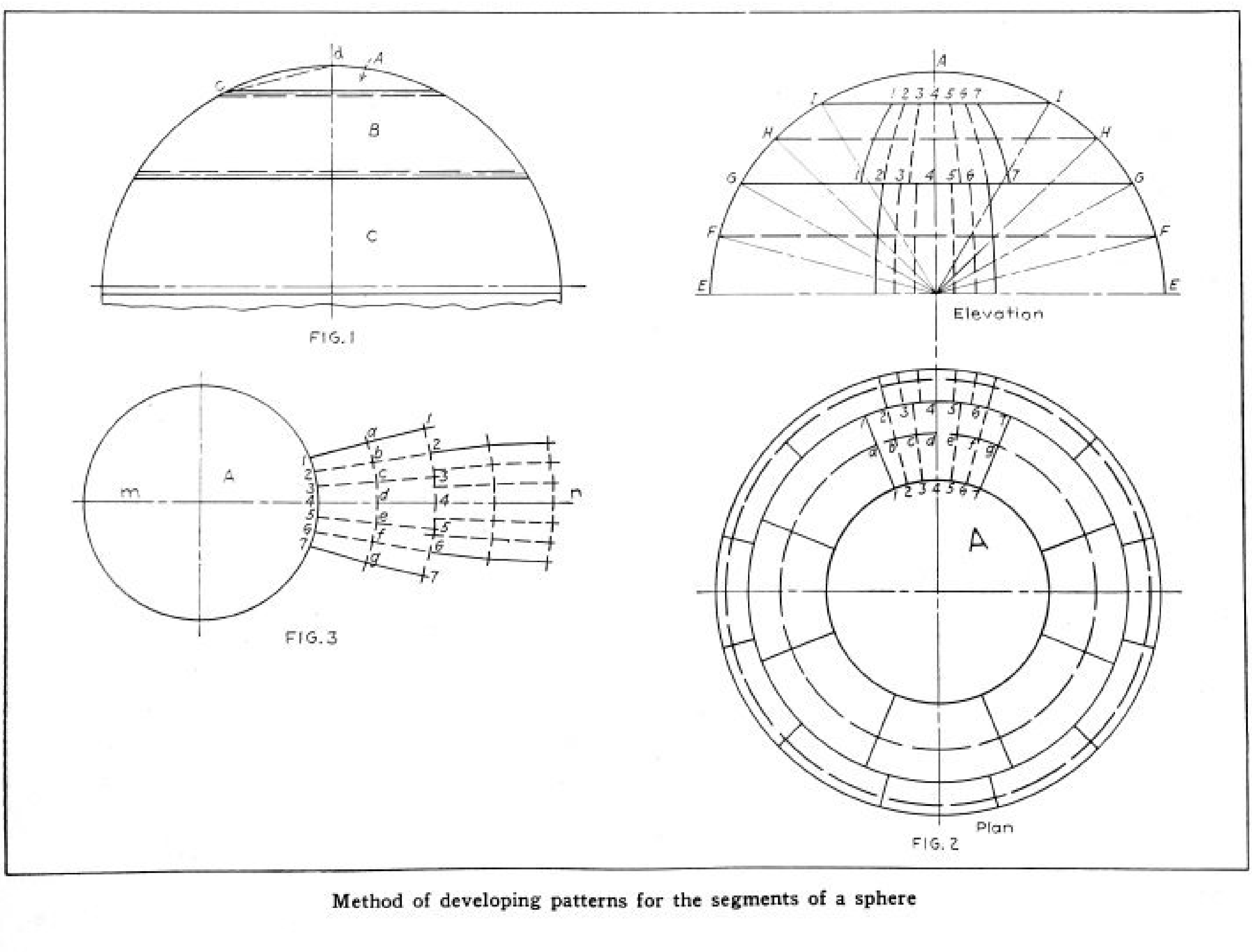
Q.—As a subscriber to your magazine, I would appreciate your answers to the following questions:

1. How is the calefaction surface of a boiler calculated, and which is the factor to find the horsepower, either a stationary boiler or locomotive boiler?
2. What is the relation between the grate surface of a stationary boiler with the diameter of smokestack, and its length?—Feo. G. R.

A.—The calefaction surface of a boiler is the *heating surface* of the boiler plate and tubes directly in contact with the water on one side of the fire and hot gases on the other. The horsepower of a boiler depends on the evaporation. In stationary boilers, of the low pressure type, the evaporation is from 3 to 4 pounds of water, per square foot of heating surface. With boilers of the locomotive type, higher evaporation exists, due to the fact that such boilers are forced to produce the power required. From evaporative tests, the tube evaporation has reached 10 pounds of water per hour per square foot of outside tube heating surface, and 55 pounds per hour per square foot of firebox heating surface.

The heating surfaces of furnaces and firetubes are figured from their internal diameter, for watertubes and external fired heating surfaces by their outside areas.

As explained, the *horsepower of a boiler* is the measure of its capacity for generating steam. It is commercial practice to rate the horsepower of stationary boilers according to the heating surface required for each type. Thus, the



Method of developing patterns for the segments of a sphere

ratio of heating surface to horsepower for boilers operated without forcing is about as follows:

Ratio of Square Feet of Heating Surface per Horsepower	
Horizontal return tubular	12 to 16
Watertube	10 to 12
Vertical	11 to 20
Locomotive (stationary)	10 to 14

This method of rating boilers is indefinite, as boilers with the same heating surface, may, under different conditions, generate steam of different quantities. The standard boiler horsepower is equivalent to the evaporation of 34.5 pounds of water from and at 212 degrees F. per hour.

PROPORTIONS OF CHIMNEYS TO GRATE AREAS

The relation of chimney to grate area depends on the kind and quality of fuel fired. For anthracite based on 12 pounds burned per hour per square foot of grate, the cross-sectional area of the chimney may be figured 1/9 of the grate area; for bituminous coal based on 12 pounds per hour, the chimney area may be figured approximately 1/6 of the grate area.

The height of chimney cannot be figured definitely for all conditions of boiler operation, but it may be determined approximately from the weight of fuel burned per hour per square foot of grate by the formula:

$$H = \frac{(W + 1)^2}{4}$$

in which,

H = height of stack, in feet.
W = weight of fuel, in pounds.

Inspectors, Foremen—Water Level Indicators

Q.—I have been a reader of THE BOILER MAKER for over a year and I see in one column that questions are answered for boiler inspectors, and am asking advice on the following subjects:

(a) What are the best methods of training and developing boiler inspectors and assistant foreman boiler makers?

(b) What are the proper and safe slopes of a crown sheet per foot (on locomotive type of boiler)?

(c) What is the most reliable water registering device on a locomotive boiler, and what benefits, if any, are derived from low water alarms?—J. R. C.

A.—There is no general method followed in the training and development of boiler inspectors and assistant foreman boiler makers.

BOILER INSPECTORS

Boiler inspectors are classified according to the class of boilers they inspect, namely, stationary, marine and locomotive. Each class must fulfill certain requirements before they are eligible to handle boiler inspections. Boiler inspectors should thoroughly understand the principles of boilers construction, strength of materials, boiler rules and formulas, drawings, procedure in the making of internal and external inspections of the boiler, acceptable methods of making repairs, boiler tests which are made hydrostatically for testing the soundness of the boiler parts, safety valve calculations, tests and reports of the inspection.

Assistant boiler maker foreman should be a competent boiler maker, having also the qualifications of a layerout, a good organizer and able to handle the shopmen for securing first class workmanship and production.

HEIGHT OF CROWN SHEET

The difference in the height of crownsheet between the firebox flue sheet and door sheet ranges from 0 to 8 inches,—depending on the type, depth and length of the firebox.

Water gages, cocks, glasses and low water alarms are used on locomotive boilers to indicate the water level. Tests made by a number of railroads showed that by placing the gage cocks on the water column instead of placing them directly on the boiler afforded the safest and most accurate means of indicating the water level. On the water column is also a standard water glass and an additional water glass is placed on the opposite side of the boiler to act as a double check. Low water alarms are also installed, which work automatically by blowing a whistle or by other means of warning that the water has reached the low water level.

Ogee and Staybolts

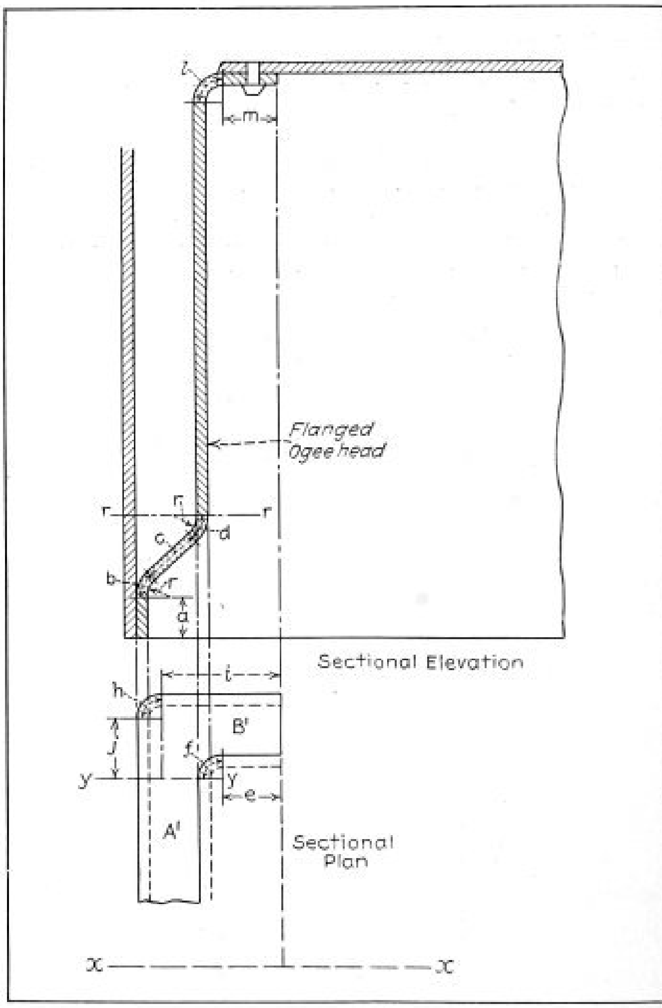
Q.—(1) What is the meaning of the term "O.G." as used in the firebox?

(2) In making the monthly inspection on locomotives will a defective bolt show up under the testing hammer?

(3) Is a staybolt broken from one side to the telltale hole considered a broken bolt?

I have been a reader of THE BOILER MAKER for several years and am taking the privilege of an old friend.—H. D. Z.

A.—(1) The accompanying sketch illustrates an ogee (O.G.) flange. In firebox boilers of the vertical type and also of the smaller locomotive types, this flange is often



Typical Ogee flange

used in place of a mud ring. The term *ogee* is derived from the shape of the compound curve, in which one end is concave and the other convex.

(2) A defective staybolt will usually show up under the hammer test. Such stays when tested with the hammer will produce a dull sound as compared with the sound from a solid stay, and also the reaction or rebound of the hammer from the blow is not effective in the case of broken stays.

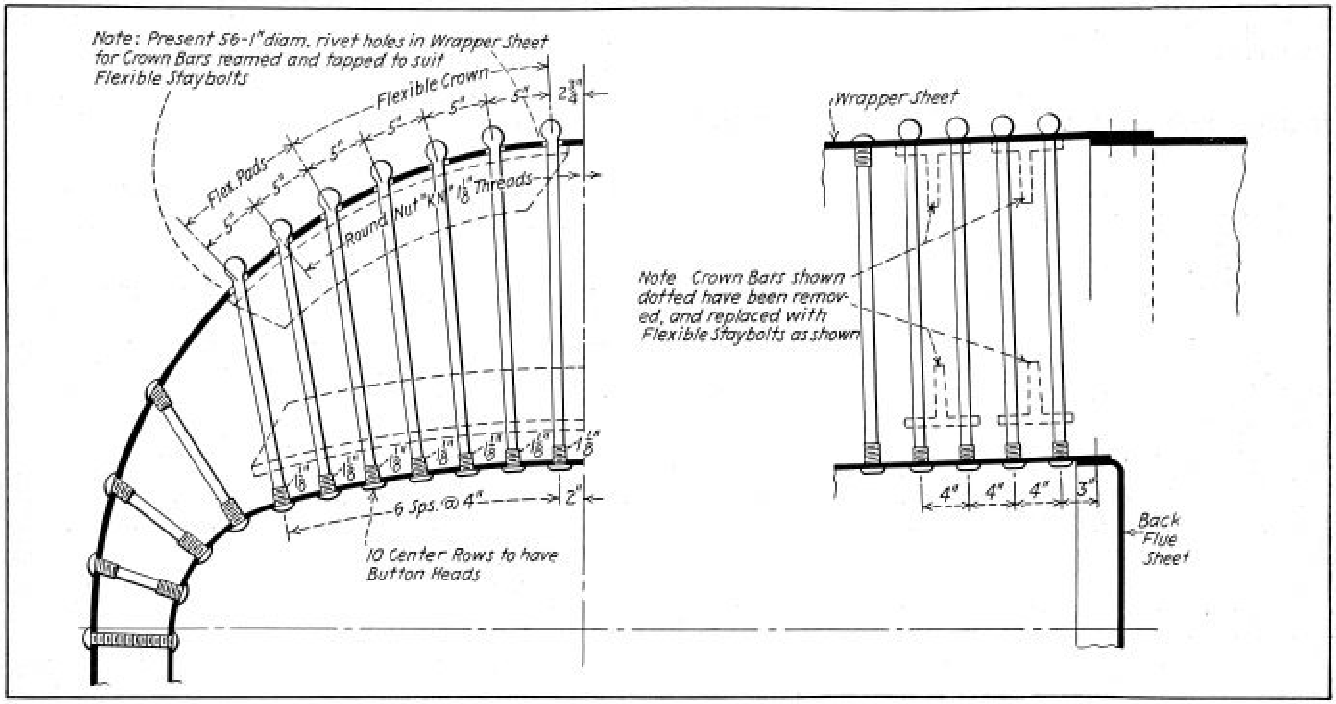
(3) Such a stay does not have its full strength, therefore it is considered as a broken stay.

Letters from Practical Boiler Makers

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

Tee Iron Troubles

In regard to inquiries made by "C. E. S." in the March issue of The Boiler Maker, herewith is a drawing which I wish you would publish for his information. This is the way we overcome tee iron trouble on the Southern Railroad. Apply patch and flexible sleeve; use buttoned flexible bolts 1⅛-inch bolt ends with Tate flexible rivets in the sleeves.



Replacing tee irons with flexible sleeves

Somerset, Ky. Merrill M. Smith.

Removal of Flexible Staybolt Caps

For many years past this writer has been interested in the construction and repair of boilers of all types, especially the locomotive boiler and we have been and still are very much interested in the flexible staybolt, for we think that it is one of the very best of safety appliances that goes into the make up of the locomotive boiler.

In the February issue of The Boiler Maker, page 56, T. P. Tulin, writing on the above subject, says, that one of the most important objects in railway locomotive boiler shops, is the strict and keen inspection required by the Interstate Commerce Commission and supervising officers of the railway relative to flexible stay cap removal for inspection, etc., etc. We quite agree with him, that it *should be both strict and keen,* but from our certain knowledge it is not given that strict and close attention that this wonderful bolt deserves, and that men who are directly responsible for its proper care are most indifferent.

The requirements of the law are very plain, and as far as the general inspection is concerned are lived up to in most cases, but again to our certain knowledge the proper inspection of flexible staybolts is not strictly carried out in all shops and round houses where this class of work is done. We know of cases where the general foreman has ordered the jacket removed on the *outside of cab only,* saying it was unnecessary to take down the pipes on the inside of cab, and let it go at that.

Another case in point was the work of a private concern sent to the shop for general overhauling. This boiler had an entire installation of flexible staybolts, all caps were removed, and were about to be replaced when the writer asked the foreman if the bolts had been tested. "What," he exclaimed, "test flexible staybolts, never heard of such a thing, why flexible staybolts do not break, I have never seen a broken staybolt in all my experience on the New York Central having worked all the way from New York to Chicago." This man had taken it for granted that he had lived up to the law by simply removing the caps, and was quite satisfied that there were no broken bolts, because he could see all the heads, in the bushings, and that none had dropped out when the caps were removed.

There are many others, who not having interested themselves in the flexible staybolts have a very poor conception of its utility. In the removal of caps, many foremen are quite indifferent as to the means used, so that they are removed in quick time, and, as Mr. Tulin says, the work is done in a haphazard way.

We would like to draw the attention of the readers to an article on the removal of caps and the inspection of flexible staybolts by this writer, in The Boiler Maker of April, 1912, in which we gave our experience up to that time, outlining the simplest and easiest way to remove caps, without destroying either caps or bushings, and after 13 years we are satisfied that the lines then written describe what is still good practice. If you will refer to your files of The Boiler Maker for 1918 you will find in the issue for March, page 85, a very interesting letter written by Mr. Arthur Malet, of Denver, Col., on the same subject and illustrated, showing tools for use with pneumatic hammers.

Since the introduction of the piece-work system things have gone from bad to worse, and the removal of caps is now a free-for-all race against time, go as you please, and when helpers are able (and are allowed) to remove caps at the rate of over one hundred an hour it is time to call a halt. All the man wants is to get the work done regardless of the number of caps and bushings destroyed. Flex Ible.

Wilkinsburg, Pa.

Depreciating Values of Second Hand Boilers

THE following information is supplied in answer to the recent question of a reader of The Boiler Maker asking for data for arriving at the depreciation value of second-hand boilers, i.e., the percentage of cost to be written off after each year of use. This topic being left open for general discussion of the readers should prove to be of great interest to everyone whose business is *boilers*.

The first and most important reference to be made on this subject is whether the boiler in question or any other second-hand boiler to be bought is of A. S. M. E. construction or equivalent to the construction as prescribed by the Standard Boiler Rules and Laws governing boiler construction, installation and inspection of the State in which the boiler is to operate. For example, a second-hand boiler not complying with the above may not be permitted to be brought into the State and therefore would be of no value to the purchaser. If the boiler is to be used for operating purposes it is always the best policy, regardless of the type or construction, to request the State Boiler Inspection Bureau or authorized boiler insurance company licensed under the State, for approval to install said boiler. This procedure may serve to save the purchaser a lot of expense before the boiler is moved into the State or within the State, because, in due course of time, the State must be notified or a penalty will be imposed in accordance with the law in default of this ruling.

Definite depreciation of boilers is a subject next to impossible to arrive at due to the wide range of variations in the construction, attention and maintenance of same, since it is well known that no two boilers, even of like construction give precisely the same performance throughout the life of their operation.

Then, if this is the case, a standard rate of depreciation cannot correctly be derived, because depreciation is in a sense directly resultant upon the nature of maintenance by which the performance is obtained. So much depends upon the design, quality of workmanship and conditions of operation that no fixed values can be definitely assigned to depreciation.

Practice shows that the active or useful life of a boiler can be twice as long by careful attention and proper maintenance as another of like design poorly attended or maintained. Periods of approximate usefulness can, however, be readily ascertained by inspection of the condition of all parts of the boiler, giving due consideration to possible crystallization, which condition generally arises around twenty-five years of age, and the possibility of having one or more complete renewals of tubes during this period.

State of Usefulness of Boilers

Therefore, depreciation being the wearing value, intelligent inspection of the boiler can determine *approximately* the state of usefulness that still exists, and an approximate annual charge of depreciation can be arrived at by subtracting the scrap value from the cost new, and by dividing the remainder by the number of years since built plus the approximate number of years remaining before crystallization sets in.

In conclusion, too much cannot be taken for granted when determining the condition of a boiler, and it would seem wise to be cautious and allow for the unforeseen condition which may manifest itself during the period of operation even though thorough attention in maintenance is afforded and effected.

Robert H. Fernald, professor of dynamical engineering, University of Pennsylvania, and George A. Orrok, consulting engineer, New York, in their book on "Engineering of Power Plants" say in part, "For design and comparison purposes it is best to assume a customary fixed percentage of 6 percent for depreciation, and the error from the use of this figure is not likely to be large in the present state of the art."

Jersey City, N. J. T. P. Tulin.

Requirements for Good Welding

HAVING read the article in the February issue of The Boiler Maker, by D. Kooijman, regarding an electric welding job performed on a boiler in Holland, the writer desires to give expression of his opinion in the matter.

In the writer's opinion this was only a makeshift job with nothing to recommend it but short time consumed in performing it. It is clear to an experienced inspector that after the welding had been done around the head where the flange is attached to the shell, there was no means of determining through the ½-inch slots whether or not this welding had been performed properly. It may have stopped the leakage but a tight job is not always a safe one. When the number and extent of the cracks that developed in this head are considered it is evident from a standpoint of safety that this portion of the head should have been renewed.

Permanent Repairs Necessary

If the cracks were caused by the stresses on the head, due to the expansion and contraction, experience in the past has shown that welding is only a temporary job, as the metal in that vicinity has lost its ductility, and other cracks will develop in the near future, so renewing the portion of the head would remove this danger. If cracks were caused by the poor material in the head then the entire head should have been renewed as no amount of welding will make poor material good.

The writer who has had a very good opportunity to observe the results of welding repair jobs on boilers does not condemn welding in its proper place, but is of the opinion that welding a crack in the flange of a head is a very poor practice as observations in the past have shown. As one state in this country which is enforcing a rigid boiler inspection code would not permit a repair like the one explained in previous issue of The Boiler Maker, the writer would advise welders not to make a repair of this nature before getting the approval of the inspector in the district.

Olean, N. Y. Inspector.

OBITUARY

John Luther Nicholson, President of the Locomotive Firebox Company, with headquarters at Chicago, Illinois, died on March 23, 1925 of pneumonia. Mr. Nicholson was born June 25, 1875, in New York City. He came to Chicago at the time the South Side Elevated Railroad started operation and assisted his father who was master mechanic on this road at that time. In October, 1895, he entered the service of the Chicago & North Western Railway as locomotive fireman on the Wisconsin division. He also worked as extra fireman on the Galena division. He was promoted to engineer in July, 1902, and was made assistant road foreman of engines Wisconsin division in 1903, remaining in this position until he left the service of the railroad in April, 1905, when he entered the service of the American Locomotive Equipment Company to handle the sale of the hollow arch for locomotives, of which he was one of the inventors. In 1910 he entered the service of the American Arch Company, successor of the American Locomotive Equipment Company, later going into business for himself to handle locomotive appliances of which he was the inventor. In 1918 he perfected the invention known as the Thermic Syphon, afterwards organizing the Locomotive Firebox Company, to manufacture and sell same, of which he was president at the time of his death.

J. L. Nicholson

BUSINESS NOTES

The Globe Steel Tubes Co., of Milwaukee, Wis., announces the opening of a district sales office in St. Louis, Mo., located at 444 Frisco Building. E. C. Carroll of Milwaukee, has been appointed manager of sales for that district.

William C. Wolfe has been appointed district sales manager, Welded and Weldless Division, of the American Chain Company, with headquarters at Room 690, 208 South La Salle street, Chicago, succeeding George C. Isbester, resigned.

Of particular interest to manufacturers is the announcement of the Marion Machine, Foundry & Supply Company of Marion, Indiana, of the purchase from the Swartwout Company of Cleveland, Ohio, of all the machinery, goodwill and patents covering the Swartwout metal buildings.

The Strong, Carlisle and Hammond Co., of 1392 West Third street, Cleveland, Ohio, has been appointed agents for the sale of Oilgear pumps, variable speed transmissions, hydraulic presses and broaching machines, manufactured by The Oilgear Company, 655 Park street, Milwaukee, Wis.

Lyle Marshall, former manager of the service department of the Industrial Works, Bay City, Michigan, and later connected with the Chicago office of that company, has recently been appointed district sales manager with new offices at 619 Dixie Terminal Building, Cincinnati, Ohio.

James E. Shearer, assistant sales manager of the Industrial Works, Bay City, Michigan, has moved his headquarters from the home office to the Industrial Works' New York office, 50 Church street, that city. George T. Sinks, in charge of the New York district, will remain in that position.

H. B. Warren, Cincinnati sales representative of the Thomson Electric Welding Company, has been made sales manager of the company, with office at Lynn, Mass. R. M. Taylor, assistant general manager of the Thomson Electric Welding Company, has resigned to go with Congoleum-Nairn, Inc.

Coincident with the establishing of a welding service department to handle welding rod problems for customers, the Page Steel & Wire Company, Chicago, announces the appointment of J. J. Flaherty to direct sales of Armco, high carbon and low carbon welding rod wire. Mr. Flaherty, who was formerly in charge of welding for the Boston Elevated Railways, will have headquarters at Bridgeport, Conn.

TRADE PUBLICATIONS

Pinch Bug Riveters.—Bulletin R-202, illustrating and describing Shepard pinch bug riveters, has been issued by the Hanna Engineering Works, Chicago.

Storage Tanks.—A 12-page folder descriptive of cast iron storage tanks for all industries where storage and materials transfer are needed, has been issued by the Conveyors Corporation of America, Chicago.

Welding Electrodes.—The characteristics and applications of three types of welding electrodes, designated as Types A, B and C, are described in a 16-page illustrated booklet, entitled "G. E. Welding Electrodes," which has been issued by the General Electric Company, Bridgeport, Conn. Brief instructions covering the use of each type are also given.

Machinery and Tools.—General catalogue, No. 138, listing a complete line of machinery, tools, cutters, attachments, etc., has been issued by the Brown & Sharpe Manufacturing Company, Providence, R. I. Each piece of equipment is illustrated, and detailed descriptions as well as tabulated specifications and dimensions are given. The catalogue contains over 600 pages and is of a convenient pocket size.

Steel Preservative Paints.—A 24-page, illustrated booklet has been issued by Toch Brothers, New York City, which describes the various forms of steel preservative paints which this company manufactures. The text matter includes a detailed description of each of the various kinds of paints, the purpose for which it is best fitted, and the recommended manner of applying it. This subject-matter is indexed at the back of the booklet with general headings covering types of construction and character of surface. The illustrations show a variety of structures protected by the paints of this company.

Drinking Water Appliances.—Sanitary drinking water appliances manufactured particularly for railroad service by the Henry Giessel Company, Chicago, are described in a fully illustrated, 29-page catalogue, recently issued by this company. The catalogue is in loose leaf form so that new bulletins issued by the company can be readily included from time to time and the catalogue thus kept up to date. Sanitary drinking water coolers, filters, cooling apparatus and auxiliary appliances are described in the catalogue. A full page is devoted to the attractive monogrammed name plate which the company provides with all equipment.

Schools and Colleges in the United States and Canada Giving Instructions in Welding and Cutting

Through the courtesy of *The Acetylene Journal* we are publishing herewith a list of schools and colleges in which instruction in the use of welding and cutting apparatus are given. A great many requests are constantly being received from our readers asking for this information so this list should prove valuable to students interested in the subject as well as to companies or organizations requiring the service of competent welders and cutters. From time to time as additions to the list occur these will be given.

ALABAMA

Oxy-Acetylene School,
University of Alabama, Tuscaloosa.

Tuskegee Institute,
Tuskegee.

CALIFORNIA

Manual Arts High School,
42nd and Vermont Ave., Los Angeles

Trade Extension High School,
115 E. 10th St., Los Angeles.

Y. M. C. A. Trade School,
2834 Whittier Blvd., Los Angeles.

Curtis & Geer,
501 Chestnut St., Oakland.

Polytechnic Evening High School,
400 W. Washington St., Los Angeles.

Heald's Electrical School,
Sutter and Larkin Sts., San Francisco.

Oakland Auto & Trade School,
211 12th St., Oakland.

Pacific Automobile and Engrg. School,
337-341 Golden Gate Ave., San Francisco.

San Pedro High School,
San Pedro.

CANADA

Hemphill Trade Schools,
Calgary, Alberta.

Hemphill Trade Schools,
Edmonton, Alberta.

Montreal Technical School,
Montreal, Quebec.

Hemphill Trade School,
Regina, Sask.

Hemphill Trade School,
Saskatoon, Sask.

Hemphill Trade School,
Winnipeg, Manitoba.

COLORADO

Knights of Columbus Evening School,
1575 Grant St., Denver.

Opportunity School,
13th and Walton Sts., Denver.

IDAHO

Idaho Technical Institute,
Pocatello.

ILLINOIS

Greer College of Automotive Engrg.,
2024 So. Wabash Ave., Chicago.

K. C. Evening School,
26th and Wabash, Chicago.

Lane Technical High School,
Sedgwick and Division Sts., Chicago.

Lewis Institute,
1949 W. Madison St., Chicago.

Joliet Township High School,
Joliet.

Bradley Polytechnic Institute,
Peoria.

INDIANA

Knights of Columbus Ex-service Men's Free Evening School,
Fort Wayne.

Knights of Columbus Evening School,
113 E. Maryland St., Indianapolis.

Y. M. C. A. Night School,
Indianapolis.

Purdue University,
LaFayette.

KANSAS

K. of C. Free Night School for Ex-service Men,
412 Jackson St., Topeka.

Bartlett Wichita Auto School,
119-121 N. Topeka Ave., Wichita.

KENTUCKY

Y. M. C. A. Welding School,
3rd and Broadway, Louisville.

LOUISIANA

Isaac Delgado Central Trades School,
City Park Ave., New Orleans.

MASSACHUSETTS

Northeastern Automotive School,
288 St. Botolph St., Boston.

MICHIGAN

Cass Technical High School,
Detroit.

Michigan State Automobile School,
3729 Woodward Ave., Detroit.

Flint Institute of Technology,
Saginaw and Second Ave., Flint.

MINNESOTA

University of Southern Minnesota,
Austin.

The Wm. Hood Dunwoody Indus. Inst.,
818 Superior Ave., Minneapolis.

Minneapolis Auto and Tractor School,
226 Second St., Minneapolis.

The Motor Institute, Inc.,
2628 University Ave., S. E., Minneapolis.

City of St. Paul Vocational School,
14th and Robert Sts., St. Paul.

Modern Auto and Tractor School,
2512 University Ave., St. Paul.

MISSOURI

Rahe Auto & Electrical School,
11th and Walnut Sts., Kansas City.

David Ranken School of Mech. Trades,
4400 Finney Ave., St. Louis.

Sweeney Auto and Electrical School,
24th and Wyandotte, Kansas City.

NEBRASKA

Lincoln Auto and Tractor School,
2415 "O" St., Lincoln.

Whittier Junior High School,
Lincoln.

Omaha Welding Co. School,
1501 Jackson St., Omaha.

NEW JERSEY

Stevens Institute of Technology,
Hoboken.

Central Evening High School,
Newark.

East Side High School,
Newark.

NEW YORK

Brooklyn Engineering Institute,
1115-21 Bedford Ave., Brooklyn.

Brooklyn Technical High School,
Manhattan Bridge Plaza, Brooklyn.

Pratt Institute,
Brooklyn.

Elm Vocational School,
Buffalo.

Y. M. C. A. Institute,
45 W. Mohawk St., Buffalo.

Institute for Crippled and Disabled Men,
101 E. 23rd St., New York.

Knights of Columbus Evening School,
235 W. 50th St., New York.

Vocational School for Boys,
138th St. and 5th Ave., New York.

West Side Y. M. C. A.
318 W. 57th St., New York.

NORTH DAKOTA

Bishop Auto and Tractor School,
Fargo.

Fargo School of Auto and Gas Engrg.,
1225-1227 Front St., Fargo.

Hanson Auto and Tractor School,
Fargo.

OHIO

Automobile Exchange Co.,
Ohio State Practical Motors School,
117-121 W. Pearl St., Cincinnati.

Automotive Trade School,
Madison Road and Erie Ave., Cincinnati.

Ohio Mechanics Institute,
Central Parkway and Walnut St., Cincinnati.

Rahe Auto and Tractor School,
9th and Walnut Sts., Cincinnati.

Y. M. C. A.,
Cincinnati.

Cleveland Auto School,
Cleveland.

McKinley High School,
Cleveland.

Y. M. C. A. Welding School,
2200 Chester Ave., Cleveland.

Columbus Y. M. C. A. Welding School,
36 S. 3rd St., Columbus.

Loyal Order of Moose,
(Welding Class), Dayton.

Y. M. C. A. Trade School,
26 E. Rayden Ave., Youngstown.

OKLAHOMA

Oklahoma A. and M. College.
Stillwater.

Chas F. Jones & Co., Inc.,
1303 E. Admiral, Tulsa.

Oklahoma School of Mines,
Wilburton.

OREGON

Oregon Institute of Technology,
Sixth and Maine Streets, Portland.

TEXAS

Knights of Columbus School No. 513,
Ft. Worth.

WASHINGTON

State Training School,
Chehalis.

Modern Auto and Tractor School,
Spokane.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.

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

Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.

Vice-Chairman—R. L. Hemingway, San Francisco, Cal.

Statistician—E. W. Farmer, Rhode Island.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

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

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

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

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

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

Master Boiler Makers' Association

President—Frank Gray, tank foreman, C. & A. R. R., Bloomington, Ill.

First Vice-President—Thomas F. Powers, general boiler foreman, C. & N. W. R. R., Oak Park, Ill.

Second Vice-President—John F. Raps, general boiler inspector, I. C. R. R., Chicago, Ill.

Third Vice-President—W. J. Murphy, general foreman boiler maker, Penn System, Fort Wayne Shops, Allegheny, Pa.

Fourth Vice-President—L. M. Stewart, general boiler inspector, Atlantic Coast Lines, Waycross, Ga.

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Secretary—H. D. Vought, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley R. R., 537 Linwood Avenue, Columbus, Ohio.

Executive Board—E. J. Reardon, Locomotive Firebox Company, 632 Marquette Building, Chicago, Ill., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn Avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—J. P. Moses, Jos. T. Ryerson & Son, Chicago, Ill.; Vice-President—F. H. McCabe, McCabe Manufacturing Co., Lawrence, Mass.; Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—E. R. Fish, Heine Boiler Company, St. Louis, Mo.

Vice-President—E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.

Secretary-Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Can.; J. F. Johnston, Johnston Brothers Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works Kewanee, Ill., and A. G. Pratt, The Babcock & Wilcox Company, New York.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

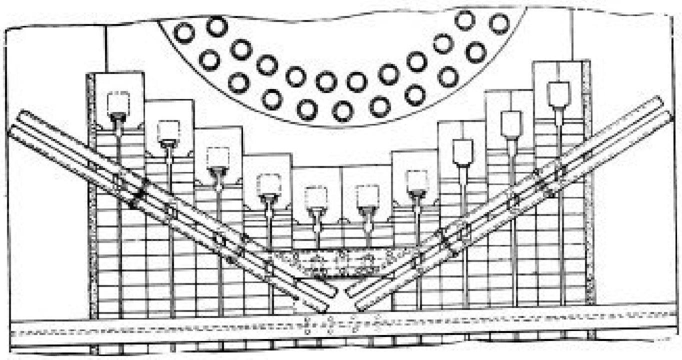
SELECTED BOILER PATENTS

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

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

1,525,986. RAYMOND D. FOLTZ, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO M. H. DETRICK COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS. FURNACE CONSTRUCTION.

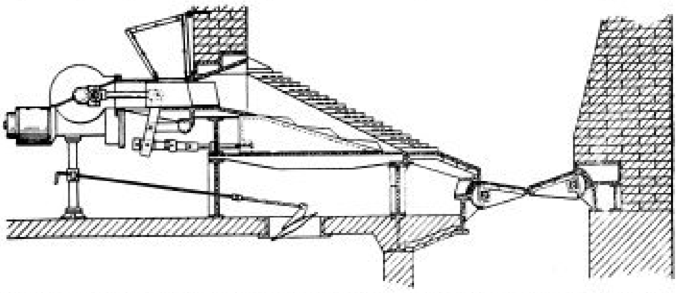
Claim 1.—In furnace construction, the combination with an arch portion, of brackets supported in association therewith, said brackets being provided



with shelf portions and tile retaining lugs, tile supported in horizontal position by the shelf portions and engaging the lugs, and refractories supported on said tile to form in conjunction therewith a wall portion associated with the arch portion. In furnace construction, the combination with an arch portion, of brackets supported in association therewith, said brackets being provided with shelf portions and tile engaging lugs, and slotted tile supported on the shelf portions and engaging said lugs, whereby said tile are retained against shifting off of the shelf portions. Twelve claims.

1,525,472. HARRY M. SWINDLER, OF DAYTON, OHIO. UNDERFEED STOKER.

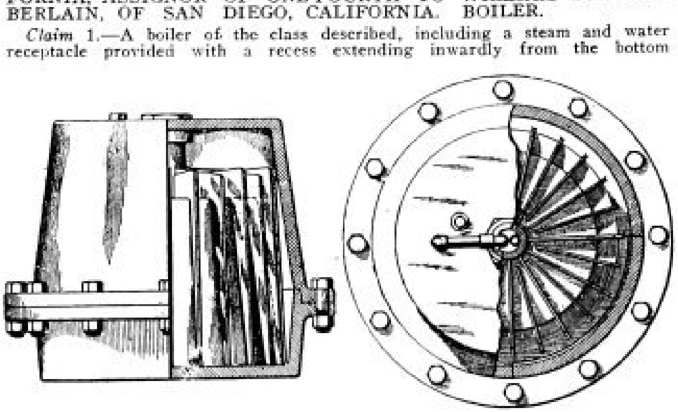
Claim 1.—In an underfeed stoker, the combination with a retort, of two adjacently disposed fuel-feeding rams for feeding fuel thereto, a reciprocable



bottom for said retort divided longitudinally into two adjacently disposed sections, and means to reciprocate said bottom sections in timed relation to said rams. Seven claims.

1,526,489. ANDREW R. BLACKSTONE, OF SAN DIEGO, CALIFORNIA, ASSIGNOR OF ONE-FOURTH TO WILLIAM D. CHAMBERLAIN, OF SAN DIEGO, CALIFORNIA. BOILER.

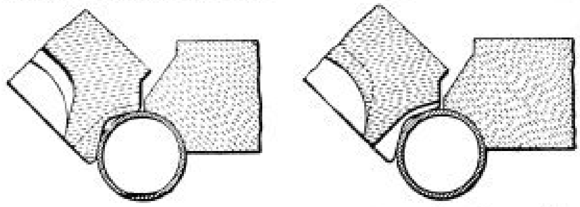
Claim 1.—A boiler of the class described, including a steam and water receptacle provided with a recess extending inwardly from the bottom



thereof, a burner positioned in the recess of said receptacle near the upper end thereof, a superheating coil positioned in said recess contiguous to said burner and connected to the receptacle above the normal water level therein and downwardly inclined heat distributing plates mounted in said recess below said burner. Eight claims.

1,524,272. JOHN P. NEFF, OF EAST ORANGE, NEW JERSEY, ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE. ARCH BRICK.

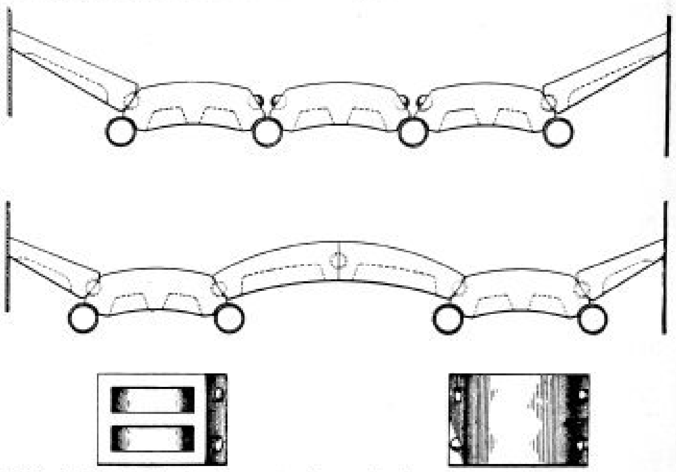
Claim 1.—A side brick for tube supported fire box arches having at its tube-engaging face tube engaging surfaces arranged and disposed to bear



on the tube at circumferentially separated points and making substantially equal angles with the general plane of the brick, and accommodable to tubes of different sizes.
Two Claims.

1,525,959. WILLIAM SCHUTTLER, OF CHICAGO, ILLINOIS, ASSIGNOR TO UNIVERSAL ARCH COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS. LOCOMOTIVE ARCH.

Claim 1.—The combination with the side sheets and tubes of a locomotive, of a baffle wall comprising middle bricks and side bricks, the middle bricks supported on and fitting between the tubes and the side bricks leaning against the side sheet and supported on the end of a middle brick, the co-operating surfaces of the side and middle bricks being provided with co-operating hemispherical recesses and projections, the ends of said middle

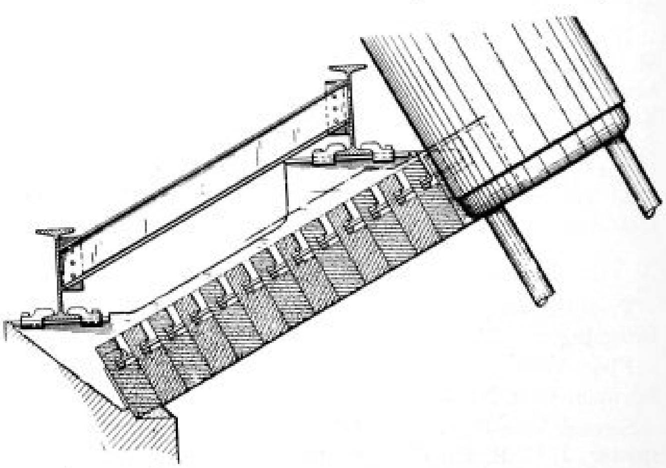


bricks being of duplicate construction, whereby either end may co-operate with a side brick.

2. The combination with the side sheets and tubes of a locomotive, of a baffle wall comprising middle bricks and side bricks, the middle bricks supported on and fitting between the tubes and the side bricks leaning against the side sheet and supported on the end of a middle brick, the co-operating surfaces of the side and middle bricks being provided with co-operating hemispherical recesses and projections, one of said co-operating surfaces being rounded to permit of limited freedom of movement of the side brick to accommodate itself to the side sheet, said middle bricks being of arcuate form and having recesses on their under surfaces to lessen the weight thereof. Two claims.

1,521,839. CHARLES E. SHARP, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR TO LIPTAK FIREBRICK ARCH CO., A CORPORATION OF MINNESOTA. UPPER ARCH FOR BOILERS.

Claim 1.—In a boiler installation, the combination with laterally spaced drums, of an associated arch extended in a plane that transversely inter-



sects the axes of said drums and comprising a plurality of relatively long and short beams, the long beams being extended into diverging spaces between drums, and arch-forming blocks hung from said beams, the blocks on the ends of the long beams filling the diverging spaces between drums.
Four Claims.

THE BOILER MAKER

MAY, 1925

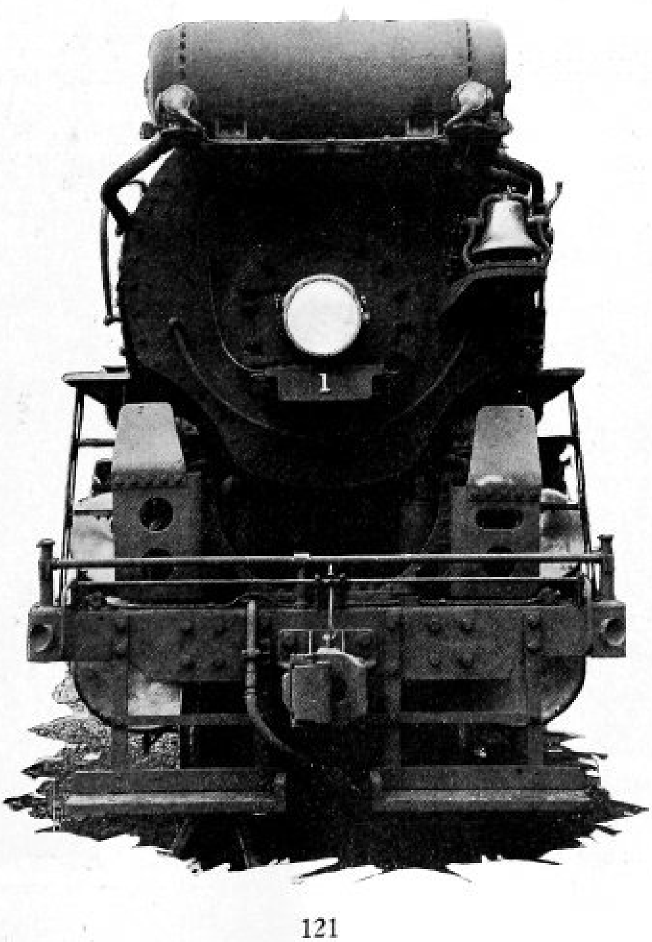
High Power 2-8-4 Type Locomotive

Lima Locomotive Works builds Mikado type locomotive having 7,221 square feet heating surface and 100 square feet grate area

THE Lima Locomotive Works, Inc., late in January, completed a 2-8-4 type freight locomotive with 100 square feet of grate area. This locomotive, which is owned by the builder, was placed in service on the Boston & Albany in February. It weighs 385,000 pounds, of which 248,200 pounds is on the drivers and 101,300 pounds on the four-wheel articulated trailing truck. It carries 240 pounds boiler pressure and, with a maximum cut-off of 60 percent, develops a tractive force of 69,400 pounds. Including the booster, which drives on the rear pair of trailing wheels, the total tractive force is 82,600 pounds.

The Purpose of the Design

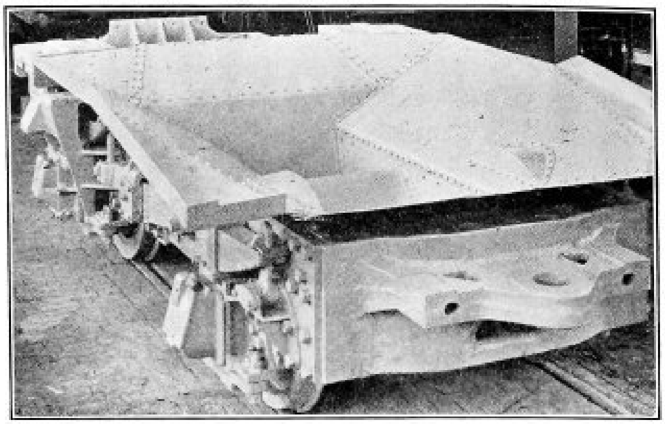
The principal objectives in the design of this locomotive were the development of high horsepower capacity and improved economy in the use of fuel. It may be considered a logical step forward in carrying out the principles on which this builder has been working since the inception of the design of Locomotive 8000 which was built for the Michigan Central in 1922, and of which design over 300 have since been built for various parts of the New York Central System. A comparison of the more important dimensions and proportions of the two locomotives will serve to indicate the methods by which it is expected to obtain the increased horsepower and higher fuel economy. Such a comparison will be found in table I.



It will be seen that the cylinders are the same size on both locomotives. This suggests that an increase in tractive force was not the primary objective, although some increase has been possible because of the smoother torque curve and the resulting lower factor of adhesion which the employment of limited cut-off made possible. The outstanding difference in proportions is in the size of the grate, the new 2-8-4 locomotive having approximately 50 percent more grate area than did the earlier Mikado. It will also be noted that the boiler is somewhat larger in other respects. The total evaporative heating surface has been increased about 12 percent and there is an 18 percent increase in the amount of superheating surface, resulting in an increase of combined evaporative and superheating surface of about 13½ percent. While these figures indicate a considerable increase in capacity for heat absorption, the greatest increase in boiler capacity will undoubtedly result from the ability to release at the grate a large aggregate amount of heat at exceptionally low rates of combustion. This favors both high boiler capacity and high fuel economy.

The other principal factor in this design for the improvement of fuel economy is the employment of the limited maximum cut-off which is accompanied by an increase in boiler pressure primarily to offset the reduction in the ratio of mean effective pressure to initial pressure resulting from the limited cut-off. While the value of the limited cut-off as an economy factor is more apparent within the speed range at which full stroke cut-off locomotives are ordinarily operated, it has also been found that a significant reduction in water rate occurs throughout the entire speed range. For freight service, a very considerable percentage of the locomotive mileage is made in the speed range within which full-stroke locomotives operate at more than 60 percent cut-off.

There is some tendency toward improved thermal efficiency because of the higher boiler pressure. Its principal effect, however, is to increase the tractive force over that of the full-stroke cut-off locomotive at speeds



The front end of the trailer truck, showing the ash pan in place

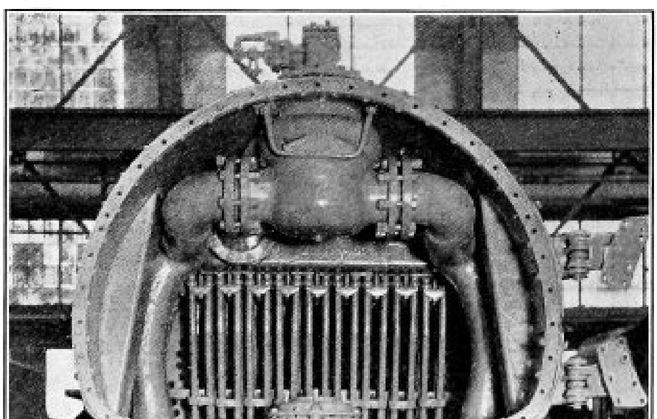
where less than 60 percent cut-off is required. This means correspondingly increased horsepower at these speeds.

Aside from the proportions of the new locomotive, its construction embodies four important innovations in detail design.* These are the cast steel cylinders which have made possible a saving of 4,000 pounds in weight, the articulated four-wheel trailing truck which does not require rear frame

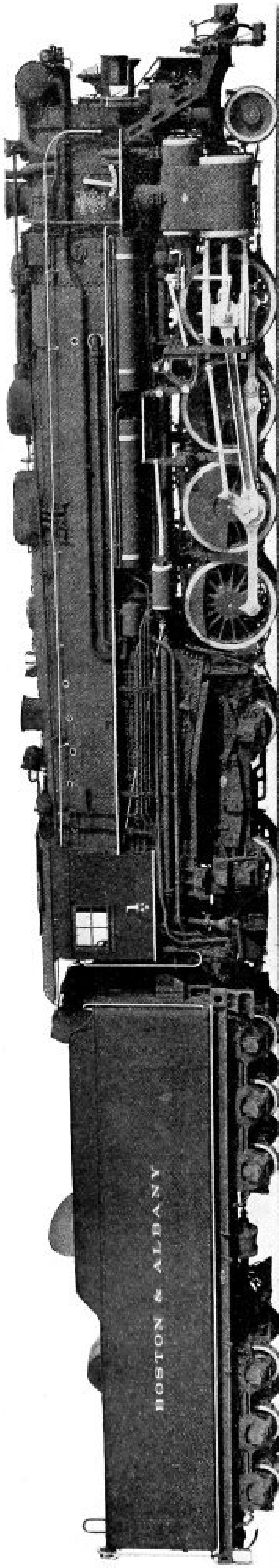
TABLE 1. COMPARISON OF LOCOMOTIVE A-1 AND HIGH POWER 2-8-4 TYPE LOCOMOTIVE AND LOCOMOTIVE 8000

	A-1	8,000
Type	2-8-4	2-8-2
Cylinders, diameter and stroke	28 by 30	28 by 30
Cut-off in full gear	60 percent	Full stroke
Boiler pressure	240 lb.	210 lb.
Weights in working order:		
On drivers	248,200 lb.	248,000 lb.
On front truck	35,500 lb.	29,000 lb.
On trailing truck	101,300 lb.	58,000 lb.
Total engine	385,000 lb.	335,000 lb.
Diameter drivers	63 in.	63 in.
Heating surfaces:		
Firebox, incl. arch tubes	337 sq. ft.	291 sq. ft.
Tubes and flues	4,773 sq. ft.	4,287 sq. ft.
Total evaporative	5,110 sq. ft.	4,578 sq. ft.
Superheating	2,111 sq. ft.	1,780 sq. ft.
Comb. evaporative and superheating	7,221 sq. ft.	6,358 sq. ft.
Grate area	100 sq. ft.	66.4 sq. ft.
Net gas area through tubes and flues	1,536 sq. in.	1,348 sq. in.
Rated tractive force:		
Engine	69,400 lb.	66,700 lb.
Engine and booster	82,600 lb.	77,700 lb.
Factor of adhesion	3.58	3.72

*These details and other features and combinations embodied in this locomotive are covered by patents or patents pending.



Interior of the front end during construction



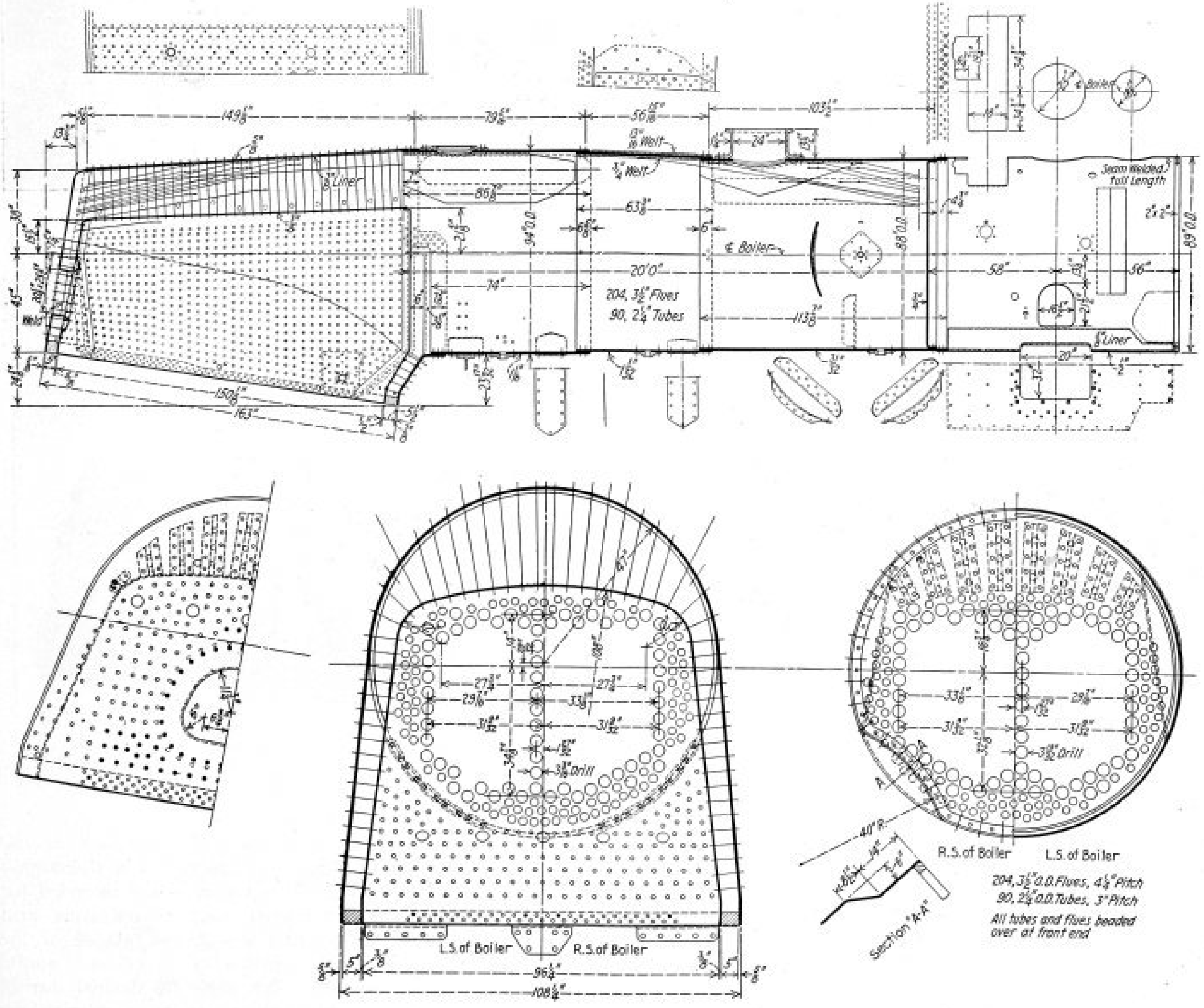
A departure from customary locomotive proportions—A grate area of 100 square feet reduces the rate and improves the efficiency of combustion; a maximum cut-off of 60 percent improves steam economy and increases horsepower output at medium and high speeds extensions and has made possible a marked improvement in ash pan design; the articulated main rod which delivers its load on two outside crank pins instead of on one, and the simple port arrangement by which an unbalanced cut-off has been obtained in the two ends of the cylinders at starting, with a resulting increase in the smoothness of the starting torque curve.

Ash Pan

One of the influences of this truck on the design of the locomotive, which, although incidental, is none the less important, will be seen in the ash pan. The elimination of the rear frame extensions has removed one of the worst restrictions on securing a satisfactory slope of the ash pan side sheets and the space between the trailer axles has permitted the building of hoppers of unusually large capacity. Although the grate is unusually large, the ash pan provides but little less than one cubic foot of capacity per square foot of grate. The ash pan, instead of being attached directly to the mud ring, is built into the trailer truck and when the trailer truck is removed from the locomotive the ash pan is removed with it. The width of the flare required to keep the ash pan under the firebox when the trailer is displaced laterally on curves also provides an unrestricted air opening all around between the ash pan and the mud ring.

In the absence of rear frame extensions from which the cab and a number of items of auxiliary equipment are supported, heavy cast steel cab brackets are attached to the back corners of the mud ring. Heavy lugs are cast below the back and sides of the mud ring at the corners to support these brackets, which also form the top members of the combined furnace bearers and trailer truck lateral motion bearings.

Aside from the size of the firebox, the boiler does not differ materially from the usual type of design. It is slightly larger in diameter and contains a somewhat different tube sheet layout with more heating surface than that of Locomotive 8000. The points of most interest are shown in the photographs. It will be seen that steam is taken from the dome through an outside dry pipe to the Type E superheater header at the rear of the smokebox.



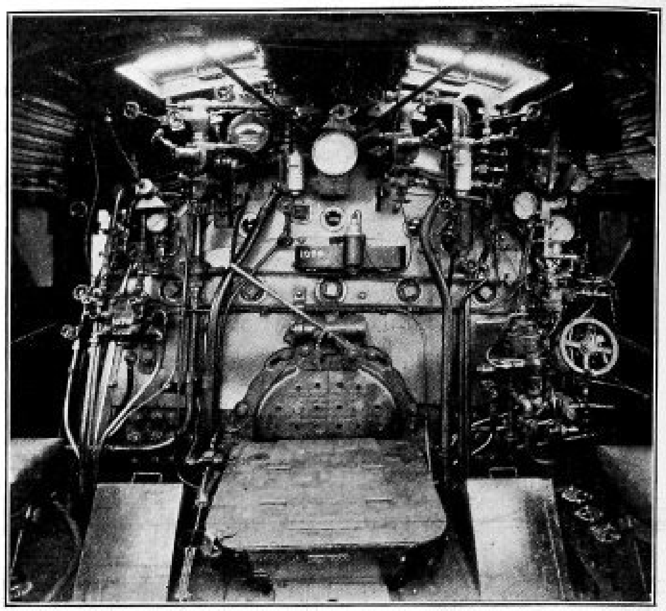
Elevation and cross sections of 2-8-4 locomotive boiler

The throttle is located in the smokebox just ahead of the smoke stack. The single steam connection from the superheater header to the throttle is cast integral with the throttle casing. Branch pipe connections are provided on either side of the throttle casing from which the branch pipes lead down inside the front end, passing outside at points just above the cylinders.

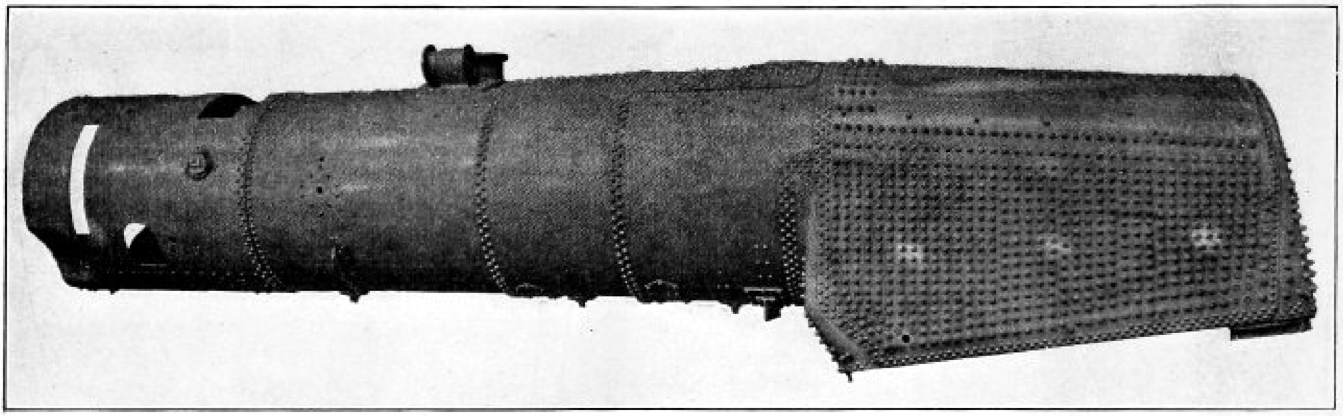
Above the superheater header, an opening in the top of the smokebox permits access to the superheater unit bolts which are placed with the nuts at the top. Unit joints may thus be tightened without the necessity of entering the front end.

There are two turrets from which steam is distributed to the auxiliaries, both located over the top of the boiler just in front of the cab. One of these furnishes saturated steam to the injectors and lubricators. The other draws superheated steam from the throttle pipe connection to the superheater header for use in the air pumps, the feed water pump, the blower, grate shakers, stoker and headlight generator. The whistle, which also uses superheated steam, has its connection welded directly on the steam pipe which feeds the turret. Steam for the booster is taken from the left branch pipe and its exhaust is carried up outside of the smokebox, opening to the atmosphere just in front of the smokebox.

It will be seen from the photographs that two channels of rectangular section are let into the sides of the smokebox. These are provided to take the exhaust steam pipes leading to the feed water heater, which is mounted on brackets in front of the front end, without projecting outside the surface of the smokebox shell. Recesses are also formed in the lower quarters of the front end door ring and in the sheets immediately back of it, to clear the tops of the air compressors, one of which is mounted on a bracket on each side of the front deck casting.



The interior of the cab



The boiler

Cab Arrangement

In arranging the control valves and equipment located in the cab, considerable attention has been given to providing for the convenience and comfort of the engine crew. As far as possible all gages have been brought together in one location where the engineman can see them at a glance. A pneumatic whistle valve has been placed on the side of the cab where the engineman does not have to reach to operate it. The various valve handles have been grouped and labeled, with those most frequently operated placed where they are most readily accessible.

Folding spring cushioned seats, the frames of which are supported on coil springs, are provided on both sides of the cab. Back of the fireman's seat is a locker for clothing.

Tractive Force Fixed by Trial

In designing the locomotive considerable latitude was provided for the selection of the final working boiler pressure and maximum cut-off. This was done in order that the maximum cut-off might finally be determined as the result of trials in actual road service. To this end the locomotive was equipped with a variable exhaust nozzle, the design employed by the Paris, Lyons & Mediterranean having been selected as meeting the requirements of a thoroughly tested and practical device. This nozzle is not intended for manual control by the engineman, but its operating arm is secured to a graduated quadrant on the outside of the front end which permitted adjustments in exhaust nozzle area to be made as frequently as might be desired during the adjustment process without the necessity of entering the front end.

In developing the design of this locomotive, the builders set up the following requirements: That it must be able to handle the same train in drag freight service with 20 percent less coal than is burned by the Locomotive 8000 design; that, in high speed freight service, it must pull the same train at the same speed as Locomotive 8000 with 12 percent less coal, or deliver 10 percent more drawbar pull for the same amount of coal. Experience with the locomotive so far indicates that it will fully meet and probably exceed these requirements. The locomotive is now undergoing tests in service, from which more complete data will later be available.

The principal dimensions and data are shown in the following table:

Type of locomotive	2-8-4
Service	Freight
Cylinders, diameter and stroke	28 in. by 30 in.
Valves, piston type, size	14 in.
Maximum travel	8¼ in.
Outside lap	2 7/16 in.
Exhaust clearance	1/16 in.
Lead in full gear	¼ in.
Cut-off in full gear, percent	60
Weights in working order:	
On drivers	248,200 lb.
On front truck	35,500 lb.
On trailing truck	101,300 lb.
Total engine	385,000 lb.
Tender	275,000 lb.
Wheel bases:	
Driving	16 ft. 6 in.
Rigid	16 ft. 6 in.
Total engine	41 ft. 8 in.
Total engine and tender	82 ft. 6 in.
Journals, diameter and length:	
Driving, main	12 in. by 14 in.
Driving, others	11 in. by 13 in.
Front truck	6½ in. by 12 in.
Trailing truck	6½ in. by 12 in. and 9 in. by 14 in.
Boiler:	
Type	Straight top
Steam pressure	240 lb.
Fuel, kind	Bituminous
Diameter, first ring, outside	88 in.
Firebox, length and width	150¼ in. by 96¼ in.
Height mud ring to crown sheet, back	60½ in.
Height mud ring to crown sheet, front	91¼ in.
Arch tubes, number and diameter	5, 3½ in.
Combustion chamber, length	None
Tubes, number and diameter	90, 2¼ in.
Flues, number and diameter	204, 3½ in.
Length over tube sheets	20 ft.
Tube spacing	¾ in.
Flue spacing	¾ in.
Net gas area through tubes and flues	1,536 sq. in.
Grate area	100 sq. ft.
Heating surfaces:	
Firebox, incl. arch tubes	337 sq. ft.
Tubes	1,055 sq. ft.
Flues	3,718 sq. ft.
Total evaporative	5,110 sq. ft.
Superheating	2,111 sq. ft.
Comb. evaporative and superheating	7,221 sq. ft.
Tender:	
Style	Rectangular
Water capacity	15,000 gal.
Fuel capacity	18 tons
Weight proportions:	
Weight on drivers ÷ total weight engine, percent	64.2
Weight on drivers ÷ tractive force	3.58
Total weight engine ÷ comb. heat. surface	53.3
Boiler proportions:	
Tractive force ÷ comb. heat. surface	9.61
Tractive force × dia. drivers ÷ comb. heat. surface	605
Firebox heat. surface ÷ grate area	3.37
Firebox heat. surface, percent of evap. heat. surface	6.60
Superheat. surface, percent of evap. heat. surface	41.4
Tube length ÷ inside diameter	74.5
Comb. heat. surface ÷ grate area	72.2

Mud-Daubers Hoodwink Inspector

By Inspector J. T. Leary*

WHILE on a visit of inspection a few years ago at a mine, the master mechanic remarked that since the writer's previous visit the boilers had been inspected by another inspector (not connected with the Hartford Company) and repairs had been made as recommended. Questioned as to the nature of the repairs, he explained that they consisted of renewing a number of staybolts in the throat sheet of the locomotive boiler. The repairs, he added, were made under protest as they did not consider the staybolts defective.

"You see it was this way," the master mechanic explained, "the boiler hadn't been fired up since early in the spring. The outside of the boiler was covered with lagging, but some mud-dauber wasps had gotten in and filled up the telltale holes in the throat sheet with mud. The other inspector thought this an indication of fractured staybolts, and so ordered them renewed."

The wasp story did not make a very strong appeal to the writer at the time although he was quite familiar with the habits of the mud wasp. Some time later, however, a visit of inspection was made to another plant, and the story took on a different aspect. A new locomotive type boiler had previously been installed, operated for a few months, and then stored in a shed. It was noted on this visit that the telltale holes of the boiler were closed with mud. Had it not been for the story of the mud-dauber wasps in the first instance, and had the inspector not known the age of the boiler and length of time in service, he, too, would undoubtedly have thought he had discovered several hundred fractured staybolts.

When inspecting boilers, it is not uncommon for the inspector to find various "objects foreign to steam boilers," particularly when the boilers have been idle for some time. On one occasion, for instance, the examination of a locomotive type boiler revealed a bee's nest in each of two tubes. The honeycombs extended about six inches into the tubes, but fortunately (for the inspector) had been deserted. On another occasion a live snake was found coiled comfortably around the safety valve. The report adds, "This defect was forcibly removed."

Other remarkable discoveries are recounted in the following clippings. The first one is offered as a suggestion of the "thrill" that may some day be experienced by an unwary inspector. Regarding the second clipping, our correspondent makes the comment, "This is evidence that they still use wood when lighting fires in locomotives."

FIRE ROUTS OWL FROM DOWNY BED IN BOILER BOX

Sisterville, W. Va., December 29.—Owls have a reputation for being intelligent, but there's a limit to it—they can't see into the future. At least one, a resident of this section, will agree that he, or she, as the case might be, had a hot time of it when John B. Keller, an oil field worker, built a fire in a boiler on location.

Up jumped Old Man (or Lady) Owl, furnishing a scream worthy of an eagle, when Keller set a match to oil-soaked material in the firebox, which the wise bird had chosen for a temporary home. Keller admits he was thrilled. The owl was rescued.—*Pittsburgh Sun.*

SLEEPING MAN TRAPPED IN FIREBOX AS ENGINE IS FIRED UP

Syracuse, N. Y., March 15.—(A. P.)—Horace Harris, a locomotive boiler inspector for the New York Central Railroad, lay down for a nap early today in the firebox of a locomotive he had just inspected.

An hour later the locomotive was ordered out and a fireman kindled a fire in the box, not noticing Harris. The inspector awoke to find himself trapped with a wall of flame between him and the door, nearly six feet away.

The fireman, however, had left the door open and Harris plunged through the flames, falling unconscious on the floor of the cab. He was in a hospital tonight in a serious condition.—*Pittsburgh Gazette Times.*

*Pittsburgh Department, Hartford Steam Boiler Inspection and Insurance Company (The Locomotive).

At a meeting of the board of directors of the Locomotive Firebox Company, Chicago, on May 1, Walter S. Carr, secretary and treasurer, was elected president to succeed John W. Nicholson, founder and president, deceased. Charles Gilbert Hawley was elected secretary.

Causes and Prevention of Pitting in Locomotive Boilers*

By C. H. Koyl†

FOR many years the study of the cause of boiler pitting was handicapped by a confusion of terms between chemists and boilermen, the word cause meaning one thing to the chemist and quite another to the boilerman. The chemists were seeking for the cause of corrosion of iron, meaning by the term corrosion not only pitting and grooving in boilers but the rusting of iron in general. They sought not so much the physical causes which lead up to corrosion as they did the chemical conditions under which it takes place. They had in succession the oxide theory, the acid theory, the electrolytic theory, the biological theory, and others; but in 1922, by a continuous series of eliminations, they were finally able to agree that corrosion takes place only under water, or at least in the presence of moisture, and that its cause, or the chemical condition under which it takes place, is the presence of hydrogen ions in the water.

On the other hand the boilerman, who knows little about hydrogen ions, wants to know whether pitting is due to something in the boiler feed water, and if so, what; or to the kind of metal of which the boiler is made; or to the temperature of the feed water, or to the number and location of the injectors, or what not; always meaning by the word, cause, something under the control of the man who made the boiler, or of the man who runs it.

Accepting the statement on which all leading chemists have agreed, that pitting can take place only in the presence of hydrogen ions in the water, there yet are two distinct methods by which water becomes charged with hydrogen ions —first, by adding acid; second, by electrification. This tallies exactly with our statement of last year, founded on observation, that there are two kinds of pitting in locomotive boilers, one due to acid and the other due to electric action. But, for the boilerman, there are seven or eight conditions of water or metal to be guarded against under these two general headings.

Pitting Caused by Acids

Pitting by sulphuric acid, which in this country can best be observed in the vicinity of the eastern coal mines, is very characteristic in locomotive boilers. It always starts about the firebox, where both iron and water are the hottest. It shows its first effect where the surface of the metal has been weakened by bending, punching or heavy hammering, and gradually works forward, so that in the course of time it may reach the front of the boiler. Therefore, from our point of view, water contaminated by the eastern coal mines is to be avoided as one cause of pitting.

Water from swamps and stagnant ponds, and decomposing sewage, none of which are acid in the cold, will yet pit boilers because they are converted to acids by the heat of the boiler. Therefore, to the boilerman, water from these sources is to be avoided as a second cause of piting.

When the acid in the water is very weak, it has been noticed that the only parts of the boiler affected are those where the smooth surface of the metal has been broken or weakened by rough handling. It may be by scratching a flue as it is worked through the flue sheet; it may be by excessive rolling near the flue end; it may even be by rusting in the open air; but whatever the cause of breaking the hard smooth finish on the steel, it is to be avoided as a third cause of pitting.

Every one knows that the chemical action of acid can be prevented by neutralizing the acid by lime and soda-ash before the water goes to the boiler. On the C. M. & St. P. there is some pitting due to the above causes, but not much. Most of our pitting is on the electric order.

Pitting Caused by Electric Action

Electric pitting in locomotive boilers is also very distinctive in character. It commences at the front end of the boiler where the water comes in, and follows the course of the water toward the firebox though the pitting seldom reaches more than half way back. In its early stages it is found only on the three outer rows of flues, on the front belly plate, and on the front ends of the flues near the flue sheet, but it gradually works toward the firebox.

Also, this kind of pitting is found only in boilers fed with water rich in sodium sulphate or sodium chloride, say 20 grains per gallon as the water goes to the boiler. These alkali salts are chemically neutral to iron at boiler temperatures, but are good electrolytes, that is, they make easy the passage of an electric current through the water; and these circumstances are the starting point for the belief that in this case the hydrogen ions necessary for pitting are the result of electric action.

Furthermore, of late years it has been apparent that electric pitting is of very small amount unless there is oxygen in the water. The reason for this is that in electric pitting the atoms of metallic iron must be dissolved in the water, and since water can hold in solution only an infinitesimal quantity of iron the water would soon become saturated and the pitting cease unless something in the water continuously combined with the iron to take it out of the water and leave room for more iron. This something is oxygen.

Causes and Prevention of Electric Pitting

Therefore, for electric pitting there must exist simultaneously three causes or conditions—electric potential from the iron to the water, alkali electrolyte in the water, and oxygen in the water. If we can eliminate any one of these three conditions we can prevent electric pitting.

For practical purposes we may at once give up hope of getting rid of alkali water, because on the Great Plains between us and the Rocky Mountains there are many thousands of square miles with no other kind of water. It is true that I can show you in print, and signed by a famous man, the proposal to evaporate all this water and then condense it for locomotive use; and it is also true that the chemist of a leading railroad proposed about the same time to freeze all this water and store the ice for locomotive use. Each method would give us nearly pure water, yet either would cost too much. Therefore our efforts for prevention of electric pitting must be limited to the elimination of either electric potential or oxygen.

It is a known fact that between any two pieces of metal under water there is a tendency to form an electric current if they differ in chemical constitution or in physical condition even the smallest amount. Steel is composed of iron and several

*Paper presented before one of the Master Mechanics' staff meetings of the Chicago, Milwaukee & St. Paul.
†Engineer of water service, C. M. & St. P., Chicago.

other elements and under high-speed manufacture cannot possibly be absolutely uniform in texture and in hardness over the surface of even one flue. There are bound to be spots from which small electric currents tend to flow to other nearby spots, and if they do flow, they take atoms of iron with them, and the result is holes or pits in the steel. This kind of action is known as electrolysis, and its cause is inherent in the steel.

Other metals, such as wrought iron and copper, are more uniform in texture than steel, and both have been tested in boilers and found to pit less. But in addition to the greater cost, there are other reasons why neither of these metals has come into general use for boiler sheets or flues.

It has also been found that if an electric battery is carried on the engine, with its positive pole connected to the water and its negative pole to the boiler shell, the water can be kept at a higher electric potential than the metal which eliminates electrolytic currents and pitting is stopped.

But all these more or less expensive or cumbersome remedies have been held in abeyance because it became evident a short time ago that we had not learned all that was to be known about electrolytic pitting. As already stated, this kind of pitting shows principally on the front half of the boiler. But presumably the steel is of the same kind from one end of the boiler to the other, and, if electrolytic pitting were controlled entirely by the quality of the steel, pitting should be uniform throughout the boiler. Also the flues at the hot end of the boiler are held in the flue sheet by copper shims, and if, pitting were due entirely to difference of metal, then steel flues should pit most rapidly in contact with copper; but they do not.

Eliminating Oxygen in the Feedwater

Evidently the presence of alkali water and of the electrolytic difference of potential between hard spots and soft spots on steel, and between steel flues and copper shims are not enough to produce pitting. It is just as evident that the third and necessary factor is in the water when it comes through the boiler check valve, and is used up when the water is half way back to the firebox. The discovery and proof of this third factor is the key to the prevention of electrolytic pitting.

At first it was thought that a difference of electric potential between the boiler metal and water existed when the water entered the boiler, and might be sufficient to last until the water was half way back, and thus explain pitting on the front half of the flues and none on the back half. This electric charge, positive on the metal, negative in the water, does exist when the water has passed the boiler check valve. It is always present while the injector is in operation, but I have never found it of sufficient force or quantity to account for the pitting in the front half of the boiler. The phenomenon will require further study because it certainly has some effect on the pitting, but I am convinced that it is not the controlling factor.

The one remaining active content of the water as it enters the boiler is oxygen, and we have enough proof now to enable us to say that this small amount of oxygen, one part per hundred of the water by volume and only twelve parts per million by weight, is the factor which insures pitting in the front half of the boiler; and that there is seldom electric pitting in the back half of the boiler because there is not enough oxygen to last.

We have been a long time making this discovery because we all thought that electrolytic potential in the presence of alkali sulphate was enough, and it was only when we separated acid from alkali pitting and found the alkali pitting is confined to the front of the boiler, that we were led to study the influence of oxygen in this kind of pitting. The proof is complete when we find that the pressure of an open feedwater heater, which nearly eliminates oxygen, is sufficient practically to stop pitting in stationary boilers. Feedwater heaters for locomotives are new in the world but they are in successful use, and some of them are of the open type so that the oxygen can escape while the water is being heated. On a locomotive equipped with such a heater we have conducted a series of daily tests for two months, and find that on the average, 80 percent of the oxygen is eliminated by this means.

A locomotive feedwater heater saves 10 percent of the fuel and water, and pays for itself in a year or so; and it will not be any added expense to get rid of oxygen and thus prevent nearly all electric pitting. Therefore, I say with confidence that the days of electric pitting in the Northwest are numbered.

National Board of Boiler and Pressure Vessel Inspectors to Meet in Milwaukee

Members of the National Board of Boiler and Pressure Vessel Inspectors will meet this year at the Hotel Pfister, Milwaukee, Wis., in conjunction with the spring meeting of the American Society of Mechanical Engineers. The meeting will be held May 18, 19 and 20.

The program for the various sessions is as follows:

MONDAY, MAY 18

2.00 P.M.

Members of the National Board of Boiler and Pressure Vessel Inspectors and Guests are invited to attend the Boiler Code Public Hearing on suggested rules for Care of Power Boiler.

TUESDAY, MAY 19

9.30 A.M.

Address—Jos. F. Scott, Chairman of the National Board of Boiler and Pressure Vessel Inspectors.

Report of C. O. Myers, Secretary-Treasurer.

Report of E. W. Farmer, Statistician.

Address—C. W. Obert, Secretary Boiler Code Committee. Outlining the close relation between National Board office and the Boiler Code Committee office and the benefits that result to the National Board members.

Address—Chas. E. Gorton, Chairman American Uniform Boiler Law Society.

Address—Fred R. Low, Past President of the American Society of Mechanical Engineers.

Address—E. R. Fish, Vice-President and General Manager of The Heine Boiler Company.

Address—M. A. Edger, Chief Boiler Inspector State of Wisconsin.

TUESDAY

Afternoon

The members of the National Board and Guests are invited to take part in the following excursions (Guests of American Society of Mechanical Engineers):

Allis-Chalmers Manufacturing Company.

Eline's Inc. (Chocolate) Powdered Fuel Plant.

Robert A. Johnston Company, Manufacturers of Candies, Crackers and Cookies.

Kearney & Trecker Company.

WEDNESDAY, MAY 20

9:30 A.M.

Executive session of the National Board.

Approval of specific designs and the consideration of National Board business.

High Pressure Boiler Developments in Germany

The Walther Works, Cologne, develops boiler having 1,600 pounds working pressure—Commercial types in greatest demand

By Captain G. L. Carden

THE Walther Works, located near Cologne, are now building boilers for working pressure of 1,600 pounds. The corresponding water temperature is 600 degrees F. Drums of 31.5 inches internal diameter are employed, the material being Krupp nickel steel, seamless forged. No rivets are used, and the bottom of the drum is forged to the seamless shell. A wall thickness of 2.8 inches is present, and the main tube series is grouped on the drum shell. To avoid supplementary tension in the drum walls under high water temperature, provision is made so as to obviate the shells being touched by fire. The lower drums are uncovered, whereas the upper drums are protected from fire gas action by two fireproof stone walls. While the lower tubes of each fireproof group come in contact with fire only at the lower end, the upper tubes are outside the fire zone.

Circulation tubes are located between the front and back drums. These tubes are outside the fire chamber. The back running tubes are not participating in steam generation, so that the water movement is uninterrupted by ascending steam bubbles. The enclosure of the proper vaporization tubes in a vertical, or upstanding bundle, facilitates full use of heat gas from the grates.

A superheater is located on the boiler, and the gases are conveyed directly hence to a forged iron high pressure condenser, and thence pass into a cast iron low pressure economizer.

The Walther Works have brought out the above high pressure boiler in order to be abreast of all demands. The main output of the plant is in boilers of medium pressures, and for the past fifty years Walther boilers have been in evidence on the continent. A short time ago I witnessed Walther boilers under construction in a French shipyard at St. Nazaire, and learned that the French plant was building the boilers for French power stations.

The usual type of Walther boiler is a four-drum design, but for special purposes three-drum boilers are made. Lately, Walther has taken over the Dr. Otte three-drum boiler, for which the principal advantages claimed are: No fixed connections between separate drums, great elasticity, large heating surface, directly placed over grate, flow of heating gas effected without any sharp curves, good regulation of draft.

No Commercial Demand Yet for High Pressure

Director Peters expresses the view that the economic life in Germany up to now has not favored the introduction of extremely high boiler working pressures, nor does he believe that the time has arrived for the general use of the Works newest design. It is recognized that these high pressure boilers can only be taken by the great power stations, or chemical works, where they will serve largely for experimental purposes. Director Peters bases this opinion after many conferences and discussions with the heads of important power installations, and from them came the reaction that they are not decided partisans of pressures considerably higher than the ones now in use. The natural fear is one of complications, disturbance of work in the prime movers, and tube trouble. From all this Director Peters deduces that while the high pressure boiler is available, the tendency to adopt it is slow in Germany, and that for the immediate future no considerable number of high pressure installations may be looked for in this country. This statement was made to me while the Reparation Commission decision was undecided. With a rejuvenated Germany much, it is believed, may occur to upset preconceived ideas.

Director Peters states that the immediate future program for the Walther Works calls for units of 12,900 to 21,500 square feet of heating surface. Owing to the economic situation following the French occupation of the Ruhr, no orders developed for large boiler aggregations, but the Walthers administration is convinced that as soon as the economic conditions improve, they will be at once employed in building installations in excess of 10,500 square feet heating surface. The figures are placed at 10,500 square feet as indicating what they deem the medium size for German newly planned installations.

During the shut down period entailed by the French occupation of the Ruhr and Rhineland, the Walther Works developed mechanical grate systems designed to handle both turf and low grade fuel. The turf grate was adopted from a design by the Russian engineer Makrieff. Turf is one form of fuel that has resisted all known experiments in Europe looking to economical firing. In the Makarieff design of mechanical feed there is introduced a coal shower firing in combination with an under draft. The procedure adopted has given, it is believed, excellent results, and for the first time, it has been found possible to mechanically fire the wet turf fuel with its high efficiency, and accomplish the firing in satisfactory terms of economy.

With the shutting off of the Ruhr coal from Germany, recourse was had by many German plants to the cheaper grades of fuel, especially the brown coal. Use was also made of dust coal, the mud washings from the mines, and coal sweepings. But none of these fuels, even with changes in existing mechanical grates, gave satisfactory results in burning when thus fired, until Walther brought out a system known as the movable plan grate. In this system there is effected an automatic off-scoring, and simultaneous air pressure entrance underneath the upper port of the grate band. The problem solved by Walther was one of the most difficult in fire technique. The Walther device permits of being thrown back into service for use of high grade fuel whenever the firing of the latter is required.

For the present the Walther Works are of the opinion, as voiced by Directors Peters, that pressures beyond 410 to 440 pounds will not be in much demand in Germany, and they look for building in the immediate future to be largely within those limits. For their boilers designed for these pressures they are using in lieu of a welded chamber, a riveted one, made up of plates cooled from red hot, and cold bent.

Cutting Scrap Material

Although the economical use of welding and cutting gases has been carried to a high degree in the railroad shops of the country, there is one point at which considerable waste occurs. This is in the scrap yard, where the cutting torch is used to reclaim scrap. If gas cutting costs are found to be high in the cost records a study of the cutting operations on scrap material may serve to check the waste in both gas and time.

Laying Out Locomotive Boilers—V*

Practical suggestions to follow in boiler development—Triangulation development of one piece crown and side sheets and three piece roof and sides

By W. E. Joynes†

IN addition to the number of remarks, which the writer found necessary frequently to insert in writing the subject of "Locomotive Boiler Plate Developments," he desires here to add further to these and also to make comment in reference to them as a whole.

I have written the subject as the idea of presentation came to me and have tried to unfold it in the simplest form and in the language of the atmosphere that the work itself creates.

In reference to the stress that has been laid upon the accuracy required to produce this work, it is not my wish to convey any wrong or misleading impression that it requires exceptional ability, or a mathematical genius to do the work. Such is not the case. What I have endeavored to bring out is that the draftsman, or layer out, will find boiler plate development work quite different from most any other kind of layout work. It requires considerable time to become thoroughly acquainted with the general idea of the construction and the details of a locomotive boiler, and the development of the plates is further complicated and made exacting by the large size of the plates, the cylindrical, conical and irregular shapes of the same, which is made necessary because of the severe safety requirements, which mostly determines the design.

The reader must not be misled into believing that if the actual size of a plate is 1/8 or 3/16 inch from being correct, the plate cannot be used. The point is, if the operations leading up to finding the actual size of the plate are not accurately performed, the error in the required size will cumulatively increase, resulting probably in the actual size of the plate being 1/4 inch or more in error. This would make serious trouble in assembling; perhaps it would not be possible to use the plate at all.

It should also be remembered that the error in a 1/8-inch scale layout is increased eight times on the full size plate layout.

The two boilers described here will not present all the problems for all the boilers that the reader is likely to work on. He will find various shapes and sizes of boilers, each one presenting different problems to be worked out. Though, if he learn thoroughly how to develop the plates of these two boilers, he will be capable of working out his own problems for other boilers.

Sometimes one slight mistake in laying out the diagram, or putting an incorrect dimension on it, will cause considerable delay and loss of time all along the line from the diagram to the finished drawing.

The boiler drawing should be read correctly when making the diagram. This is very important.

In looking at a finished drawing of a firebox crown, or roof sheet, the great amount of tedious labor that it takes to produce this work is not realized. There is little or no conception to be gained of how the work is done and the difficulties encountered are not made clear without doing the actual layout work. It has been my endeavor not only to give the information, and the method of doing the work, but to point out all the short cuts, high spots and danger points. Not to record these notes of experience would be a mistake.

It should be kept constantly in mind that due to the large size and weight of boiler plates, the cost represented in the replacement of one spoiled plate is almost prohibitive.

It can be realized that it is comparatively easy to put holes in a plate, but if they are not of the right size, or not in the right location, it is quite another problem to correct the error.

Rivets in the circumferential seams for connecting rings and the back ring to roof seam must have the same number of rivets pitched from the same center, or there will be a plate or plates (depending upon the number of locomotives in the order) to replace. This error cannot be corrected and the plates will be of no value.

In studying the subject of locomotive boiler plate developments, as presented in this work, the student should commence at the beginning of the subject and memorize that part of the instruction relative to carefulness, handling of the drawing instruments, etc.

In conclusion it is hoped that these notes, the remarks in the instructions and the drawings, will fill a long felt need in making clear any past impressions of the seeming secrets held of the work and make it possible for those who are interested to acquire a correct idea of the work by actually doing it.

One Piece Crown and Sides—Three Piece Roof and Sides

(Triangulation Development)

Referring to Figs. 9 and 10, we find a locomotive boiler which looks similar in outline design to the one shown in Figs. 1 and 2; only, a much larger boiler and the firebox is of the combustion chamber type.

However, an examination of the boiler cross section Fig. 10, will show that the front and back, roof radii and the horizontal dimension that locates the front and back, crown corner radii are not equal. This feature causes the crown and roof sheets to cone toward the back end and as a result, these sheets for a boiler of this design cannot be developed by the "projection" method of development which has been explained in connection with the development of the crown and roof sheet for the boiler shown by Figs. 1 and 2.

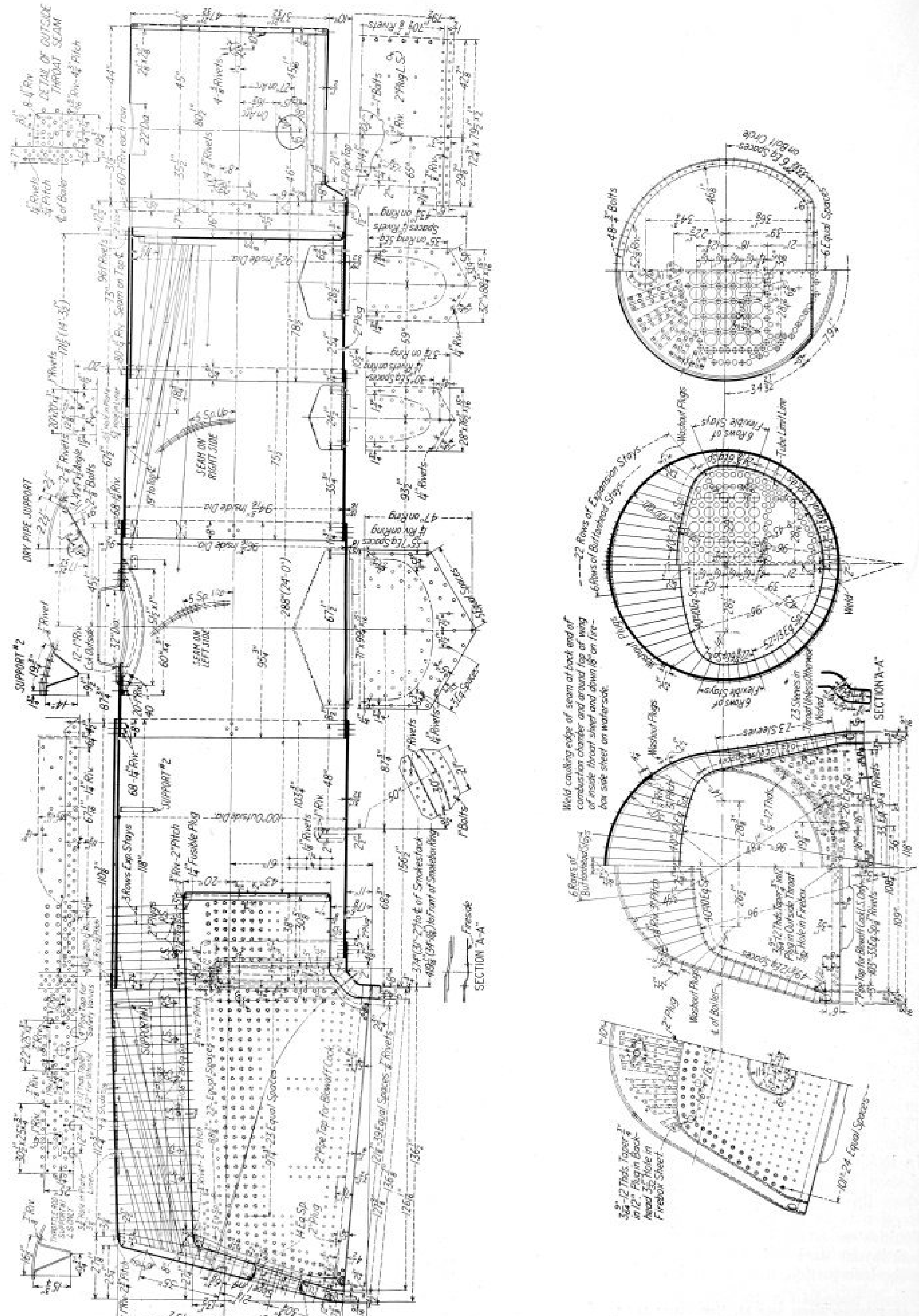
When the front and back section of the firebox end of a boiler is not the same, the method of finding the shape of the developing lines, on the flat crown and roof sheets, is known as the triangulation method of development. This method of development is as follows:

Figs. 11 and 12 show the diagram for the boiler given in Figs. 9 and 10.

The instruction for triangulating the developing lines from the top center to the boiler center line, tramming in the developing lines below the boiler center line and tramming the location of the firebox ring only, will be given for this method of development. Finding the outline of the crown and roof sheet is determined by the same method of operations that has been given for the "projection" method of development.

* Previous installments of this article appeared on page 1, January issue; page 40, February issue; page 72, March issue and page 99, April issue.

† Boiler Designing Department, American Locomotive Company, Schenectady, New York.



Figs. 9 and 10.—Longitudinal and cross sections of combustion chamber boiler

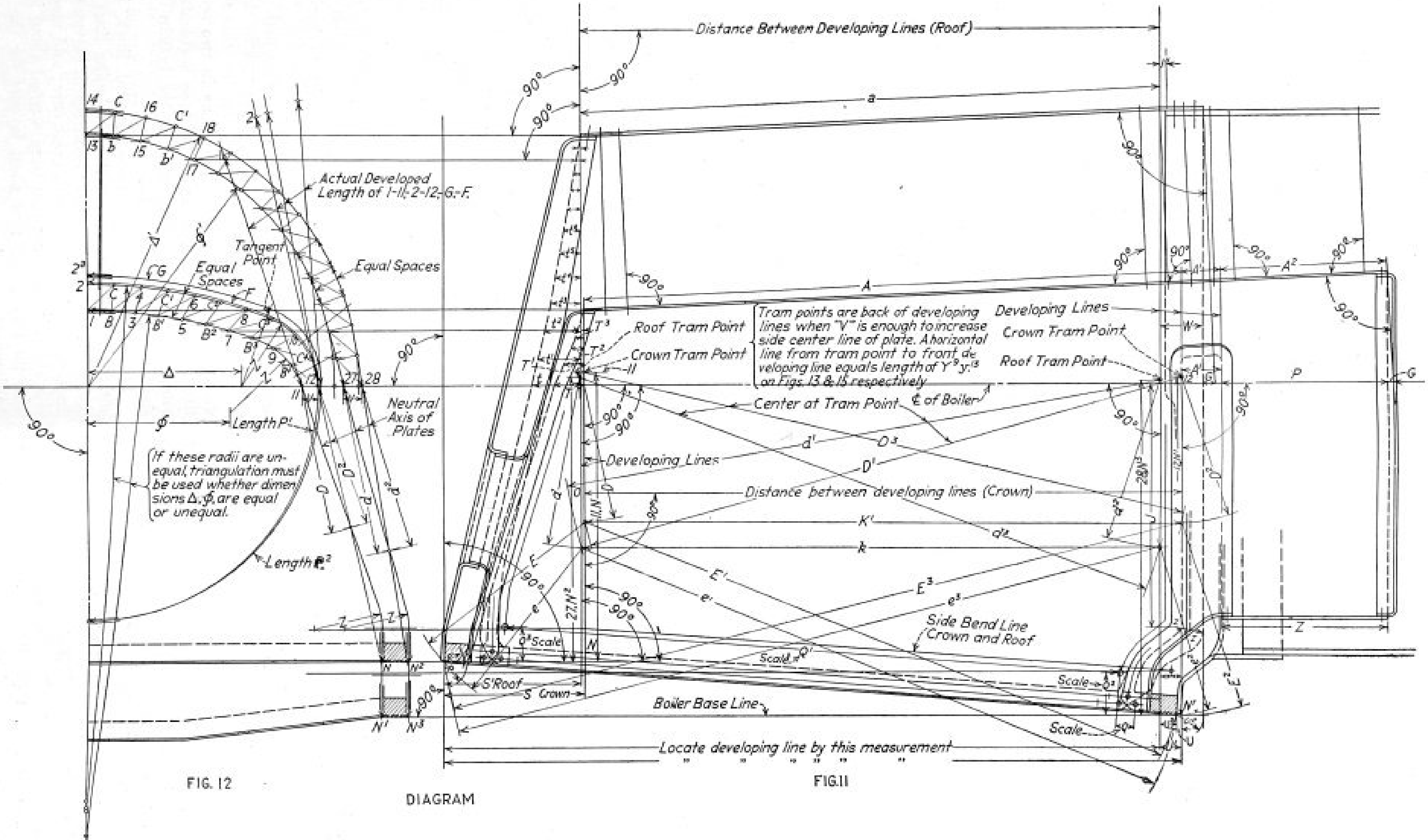
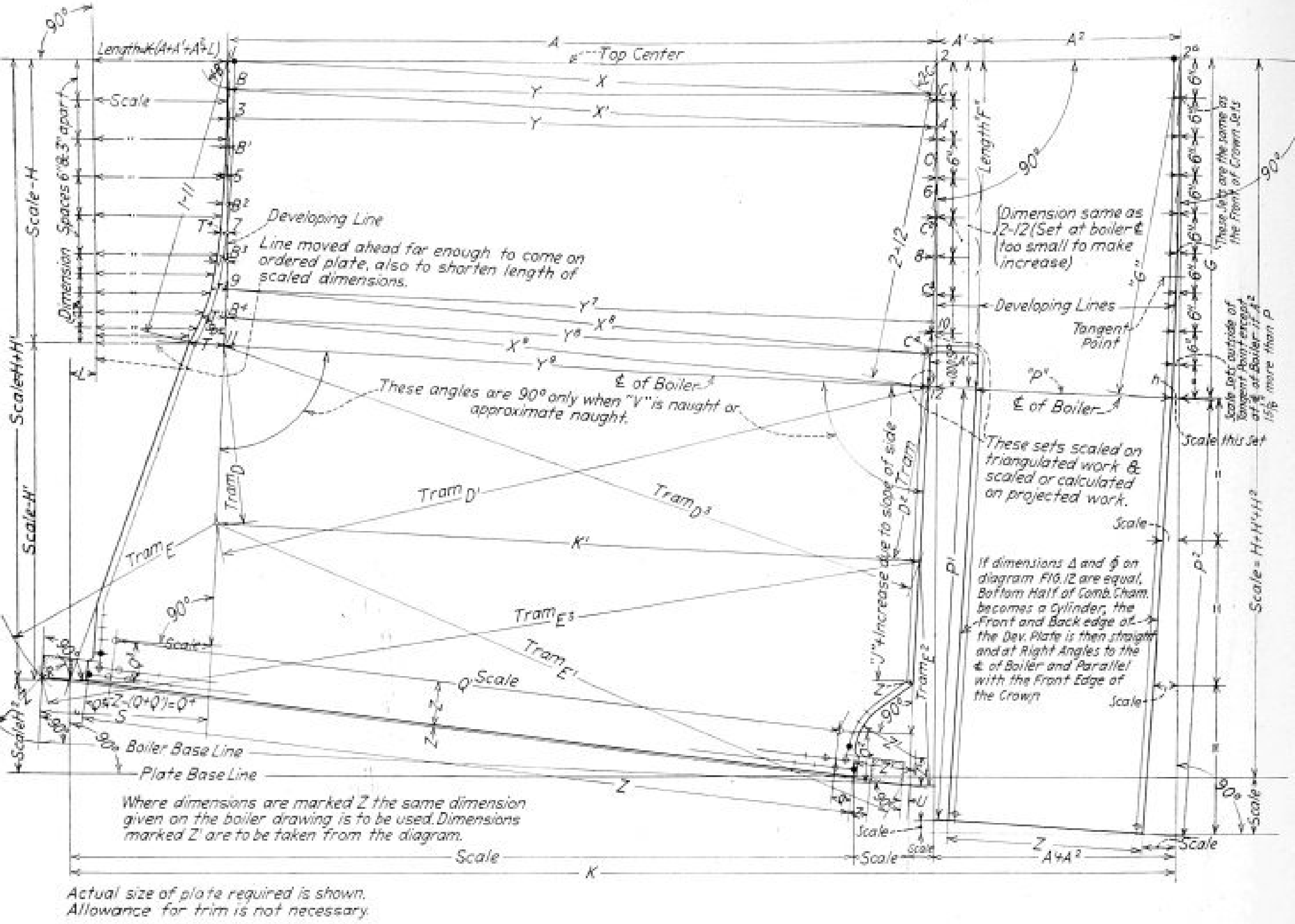


FIG. 12

DIAGRAM

FIG. 11

Figs. 11 and 12.—Development diagram of combustion chamber boiler



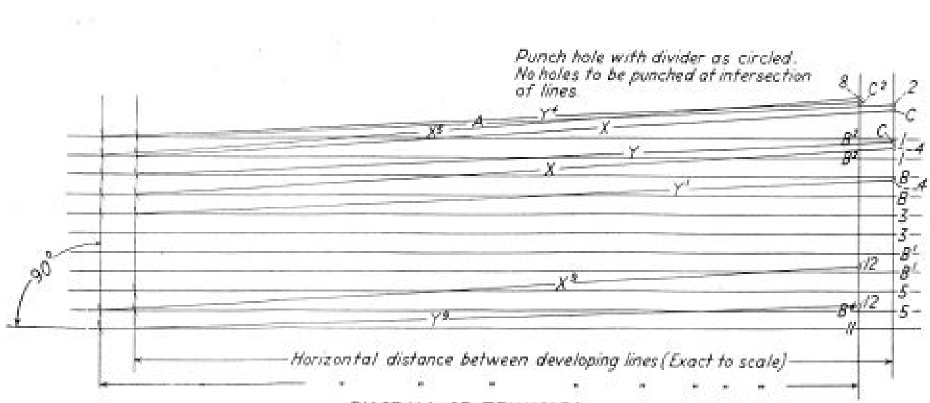


DIAGRAM OF TRIANGLES

Fig. 13.—Development of crown and side sheets

Finding the shape of the front part of the crown sheet, forming the combustion chamber, will be given following the triangulation instruction for triangulating the developing lines of the back part of the sheet.

How to Triangulate the Developing Lines on the Flat Crown and Roof Sheet

On the cross section of the diagram Fig. 12, divide the front and back neutral lines of the crown sheet into the same number of equal spaces, from the top center to the center line of the boiler. Also the neutral lines of the roof sheet are to be divided into the same number of equal spaces. The spaces should not be under four or more than five inches apart. Insert a small prick punch hole for each space and connect the spaces from front to back and diagonally, as shown by the symbols 1-2, 1-*C*, *B*-*C*, *B*-4, etc., for the crown sheet.

At the bottom of the same piece of drawing paper that the plate is laid out on, draw in a series of horizontal lines, about 2½ to 3 inches apart, equal in number to the spaces that the sheet in the cross section of the diagram has been divided into. Lay in two sets of vertical lines, at a perfect right angle to these horizontal lines. See sample of the line arrangement at the bottom of the crown sheet development Fig. 13.

The distance between these vertical lines, is the exact horizontal distance between the developing lines as given on the diagram Fig. 11. This measurement between the vertical lines, should be laid in with great care; and more accurately to scale than any lines that were warned about in connection with the crown and roof sheet layouts for the "projection" development.

Take off the distance between the crown sheet neutral lines

1-2 (use small dividers) from the diagram Fig. 12 and transfer it to the top horizontal and one of the vertical lines. Center one leg of the divider on the intersection of these lines and with the other leg make a small hole (2) exactly in the center of the thickness of the vertical line. With the trammel needle point centered at 2, set the pencil (have a hard chisel pointed pencil) end of the trammel over the intersection of the horizontal and corresponding vertical line. Use the micrometer adjustment and set the pencil *exactly* at the intersection of the lines. Transfer this tram, set to the top center line of the crown sheet layout paper center at 2, and describe a short arc across the center line at 1. This is the first tram operation of the triangulation method of development and it is designated by *A* length on Fig. 13.

Describe arcs for the crown lengths 1-11 and 2-12 as shown on Fig. 13; set a small divider equal to the spaces 1-*B*, *B*-3, 3-B^1, etc. Run the divider over the 1-11 line, until the pitch is exactly equal to the number of spaces that the crown has been divided into, on the diagram Fig. 12. Do not run over the same line with the divider more than twice; make a new light line if necessary to obtain the correct spacing.

Also, set another divider for the front length 2-12 equal to the spaces 2-*C*, *C*-4, 4-C^1, etc.

Take off the diagonal space 1-*C*, from the diagram and mark off on the same vertical line as 1-2, point *C*. Tram off the hypothenuse of this triangle (*C* to the corresponding vertical and horizontal line) and transfer it to point 1, Fig. 13; describe a short arc at the front end as shown at *C*, and designated by the length *X*.

Center the divider that has been set for the front spaces 2-*C*, *C*-4, etc., at 2, Fig. 13; prick a small hole (exactly central) in the short arc made by the trammel for length *X* and as shown circled at *C*.

Refer to the diagram again, take off the short length *B-C*, transfer it to the same vertical line; tram off the hypothenuse, transfer to Fig. 13; center at *C* (front end) and describe an arc at *B*, back end. With the divider that has been set for the back spaces 1-*B*, *B*-3, etc., prick a small hole in the arc as described for the front space.

This completes the triangulating of the first space or section of the front and back developing line.

Continue these operations for the short and long lengths down the same set of vertical lines until the first set is used up and then begin at the top horizontal line with the other set of vertical lines until the center line of the boiler is reached. Do not alternate the short and long tram lengths on the two sets of vertical lines—this will give inaccurate results.

Also take all of the tram lengths from the same side of the paper as reversing the trammels apparently causes an optical illusion which makes it impossible to set the tram length correct.

Be careful to turn the tram in the right direction when transferring above for describing the arc for the developing lines point. Connect the spaces, between the points, with a curve which will form the developing lines.

Two dividers, one for the short lengths 1-2, *B-C*, etc., and one for the diagonal lengths 1-*C*, *B*-4, etc., will facilitate the work of transferring these lengths from the diagram to the horizontal and vertical line arrangement.

When the roof radii are struck from the same point and the side line slopes away from the radius line at the boiler center line as shown on Fig. 12, divide the equal spaces on the neutral radius lines from the top to the side center line. It is obvious that all of the short and diagonal lengths are equal around as far as the radii are parallel which is approximately at the tangent point of the back radius and the side line. Set two pair of trammels, one for the short lengths and one for the diagonal lengths. Triangulate the developing lines with these two settings, down to the last equal space division, which will be at or near the tangent point. From the last equal space point to the boiler center line, re-divide the remaining length (on the sloping side lines, into one or two spaces as may seem best. Reset the trammels for these lengths and complete the tramming of the developing lines to the boiler center line.

Your attention is called again to the measurement between the right angle lines (developing lines) used in connection with the horizontal lines at the bottom of the layout sheet. This measurement and the tram operations should be made with all the accuracy that it is possible for the human hand to accomplish. The slightest inaccuracy will cause large inaccurate results. Some practice with these operations is needed, before results are obtained.

The work of triangulating the developing lines, including the measurement between vertical lines (used in connection with the horizontal lines) should be done in the same morning or afternoon. Letting this work go over the noon hour is not good practice. It should never be left unfinished until the next morning.

Triangulating the work again, with all new lines and points is the only check on triangulation work.

This is triangulation and it consists as you will now realize, with a little study, in tramming off the hypothenuse of the right angle formed by the plate, in sloping from front to back; also tramming of the hypothenuse formed by the diagonal across the divided spaces. The diagonal hypothenuse tram length forms the curve of the front developing line and the sloping plate length the back developing line, on the flat plate.

The roof sheet, cones or any similar object, where one end is smaller than the other, the shape of the developing lines of such objects can be determined by triangulation, though, it may be said, that triangulation on locomotive boilers today is limited to the crown and roof sheets and irregular shaped cones. The shape of a true or right cone and one with a horizontal bottom and a sloping top is determined by calculation and layout.

The location of the firebox ring and the developing lines, below the boiler center line, is obtained by tramming, similar to the tram operations as explained for the projection development, only, the operations are double, when the space between the front and back crown lines or roof lines, at the boiler center line, is more than 2½ inches (see V, Fig. 12).

The tram operations for the crown side sheet are as follows:

Find the length of the front and back side line 11-*N*, 12-N^1 by the method that has been given for the "Projection" diagram Fig. 4.

Measure the lengths 11-*N*, 12-N^1 up from the bottom of the firebox ring near the developing lines Fig. 11. Draw in light lines through these points parallel to the boiler center line.

Check the scale of the front developing line and the front of the firebox ring—from the back of the firebox ring. If these lines have expanded or contracted more than 1/16 inch measure new points.

Take the last tram length Y^9, which is between the points 11-12, at the boiler center line Fig. 13. Transfer this length to the diagram Fig. 11; center the trammels at point 12 which has been made on the front developing line (or new point if it was necessary to make one) by the measurement 12-N^1. Describe a short arc across the light line, at the back end, which was located by the measurement 11-*N*. This point should be slightly in back of the developing line. These two points are the tram centers for the first tram operation.

In the cross section of the diagram Fig. 12, where the front and back side lines cross each other, make a small prick punch hole.

Set the trammels to the distance *D*, transfer to Fig. 11, point 11 and describe a short arc intersecting the back developing line as shown. The distance D^2 is to be transferred to the front developing line. These are the tram points for transferring this part of the developing lines to the plate layout Fig. 13. Tram off the lengths D, D^1 and D^2, D^3, transfer to the plate layout as shown. From these D points on the diagram, transfer the tram lengths E, E^1, E^2, E^3, to the plate layout which will be the location of the firebox ring.

It may be said here, that unless the distance between the side lines, at the boiler center line, of the diagram cross section, measures *more* than 3 inches, the trammed location of the firebox ring will *not* show any difference in location when trammed direct from the tram points above the boiler center line.

The first or double tram method as given above should always be used, but the latter or direct tram operation is a good check, when dimension V is something less than 3 inches.

Measure the developing line dimensions S and U, which locate the bottom half of the front and back developing line. Lay a triangle on the developing line point, at the boiler center line and the S and U points. If the center tram point is found not to be more than 1/8 inch out of line with the above mentioned points—make the developing line straight below the boiler center.

The plate outline, at the back end of the sheet is transferred from the diagram to the plate layout by the same method that has been explained for the projection development. The operations are shown on the diagram and on the plate layout, but the instruction will not be repeated here. See Figs. 3, 4 and 5 and the instruction as given for these plates.

(To be continued)

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

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

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

Below are given interpretations of the Committee in Cases Nos. 472, 473, and 477-486 inclusive, as formulated at the meetings of January 14 and February 20, 1925, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 472. *Inquiry:* What specifications in the Boiler Code are applicable to round and square tubing material when used for the construction of headers for boilers?

Reply: It is the opinion of the Committee that if the material will conform to either of the specifications for boiler tubes or for pipe materials contained in the Material Specifications Section of the Code, the requirements of Par. P-9 will be met, except that in the case of sinuous headers the flattening, crushing, or bending tests need not be made, the work done on the material in forming the sinuous header taking the place of these tests.

CASE NO. 473. *Inquiry:* Is it permissible, under the requirements of the Boiler Code, to acetylene weld the vertical seam of the firebox of a vertical-tubular boiler, using a butt-welded joint with the staybolts passing through the center line of the weld, it being understood that the furnace sheet is staybolted to support the full load thereon?

Reply: It is the opinion of the Committee that if the stress on the furnace sheet due to the steam pressure is fully supported by staybolting, the welding of the vertical seam in the firebox of a vertical-tubular boiler is permissible under Par. P-186 of the Code. The welded seam shall be located between two rows of staybolts.

CASE NO. 477. *Inquiry:* Is the girth joint where the shell is joined to the head of a watertube boiler drum considered, under the terms of Par. P-184d, as a circumferential joint? Also, can this distance be measured from the center of the rivet hole to the calking edge of the plate before calking?

Reply: It is the opinion of the Committee that the rule in Par. P-184d applies to boilers where the stress on the heads is relieved or partly supported by tubes or through stays. It is the further opinion of the Committee that for other constructions the requirements of Par. P-183, which relates to longitudinal joints, should apply to circumferential joints including head joints.

CASE NO. 478. (In the hands of the Committee.)

CASE NO. 479. *Inquiry:* In calculating the staying of heads of welded steel heating boilers, is it permissible to exempt the 3-inch strip adjacent to the shell as prescribed in Par. H-24 of the Low-Pressure Heating Boiler Code?

Reply: Par. H-24 refers specifically to flanged heads. It is the opinion of the Committee that where the heads used in the construction referred to are flanged for their attachment to the shell, the area thereof may be reduced by a 3-inch strip adjoining the flange and a 2-inch strip adjoining the tubes, as indicated in Par. H-24. If the heads are attached by a method which does not involve flanging thereof, the area may be reduced only by a 2-inch strip adjoining the tubes.

CASE NO. 480. *Inquiry:* Does the diameter of the tube sheet specified in Par. P-20 of the Code refer to the diameter measured before flanging the sheet, or the outside diameter after flanging?

Reply: It is the opinion of the Committee that the diameter of the tube sheet referred to in Par. P-20 is the maximum measurement of diameter on the outside of the head after it has been flanged.

CASE NO. 481. (In the hands of the Committee.)

CASE NO. 482. (Annulled.)

CASE NO. 483. *Inquiry:* Will a boiler that has been constructed in accordance with the requirements of the A. S. M. E. Boiler Code, conform fully to the Code requirements if it is provided with a stamping consisting of a brass plate on which the official Code symbol is etched rather than stamped with one of the official Code symbol stamps furnished by the Society?

Reply: It is the opinion of the Committee that such a form of stamping using an etching of the symbol on a non-ferrous plate will not meet the intent of the requirement in Par. P-332 of the Code.

CASE NO. 484. *Inquiry:* Is it permissible to connect a low-water signal or alarm of the whistle type to the water-column or water-gage connections of a boiler?

Reply: It is the opinion of the Committee that Par. P-295 of the Code does not permit the connection or attachment of any form of apparatus to the pipes connecting a water column to a boiler that may under any conditions allow steam to escape therefrom. A low-water alarm cannot be considered as the equivalent of a drain connection, the purpose of which is merely to clear out the pipes.

Case No. 485.—*Inquiry:* Is it permissible to consider the conical flue sheet of a vertical tubeless boiler which connects the furnace sheet with the top head as an extension or continuation of the furnace sheet from the mud ring to the head, so that the staying thereof may be calculated like that of a long circular furnace, reinforced at the girth seams by the riveted joints applied thereto?

Reply: It is the opinion of the Committee that the straight portion of the furnace sheet in the lower portion of such a design of boiler must be calculated under Pars. P-239 or P-240 pertaining to plain circular furnaces, or if it exceeds the limits of Par. P-240 the sheet must be stayed as a flat surface. The conical portion of the heating surface which is a frustum of a cone may be calculated in accordance with the requirements of Par. P-231 or it may be stayed as a flat surface.

Case No. 486. *Inquiry:* Is it permissible, under the requirements of either Par. P-295 or P-321, to so arrange the water connection between a boiler and a water column that there may be a pocket in the pipe which may cause the lodgment of sediment, even though a cross is provided to facilitate cleaning?

Reply: The Rules in the Code do not definitely specify the arrangement of water connection that shall be made between the boiler and the water column, but it is the opinion of the Committee that this water connection should be so made that the water-column blow-down connection can effectually drain all of the water connections between the column and the boiler.

Addenda to Code

As a result of criticisms of the requirements in Section IV of the Code for the calculation of sizes of safety valves for low-pressure heating boilers and claims that they are inapplicable under all conditions of practice in the field, the Boiler Code Committee has carefully reviewed this subject and, after due investigation, has formulated the following proposed revision of these requirements:

Revise pars. H-51 and H-104 to read as follows:

Every safety valve or water-relief valve shall have plainly stamped on the body or cast thereon the letters A.S.M.E. STD., in such a way that the markings cannot be obliterated in service, the manufacturer's name or trademark, and the pressure at which it is set to blow. The seats and disks of safety or water-relief valves shall be non-ferrous material.

Revise first section of pars. H-53 and H-106 to read as follows:

The minimum size of safety or water-relief valve or valves for each boiler shall be governed by the amount of the grate area as given in Table H-6 (or H-10) or H-7 (or H-11).

Revise tables H-6 and H-10 to read as follows:

MINIMUM ALLOWABLE SIZES OF SAFETY VALVES FOR STEAM HEATING BOILERS

Safety Valve			
Diameter, in.	Area, sq. in.	Discharge Capacity, lb. per hr.[1]	Area of Grate, sq. ft.
¼	0.0491	15	1
⅜	0.1104	30	1.5
½	0.1963	60	2
¾	0.4418	130	3
1	0.7854	230	4
1¼	1.2272	360	6.5
1½	1.7671	515	9
2	3.1416	920	14
2½	4.9087	1435	19
3	7.0686	2070	24
3½	9.6211	2810	29
4	12.5660	3675	34
4½	15.9040	4650	39

[1] Capacity of safety valve based on 33⅓ per cent over pressure, valve set to relieve at 15 lb. per sq. in.

Note: The foregoing table is based upon the following formulas:

Where grate area does not exceed 4 sq. ft. } $\text{Diam. of safety valve, in.} = \dfrac{\text{Grate area (sq. ft.)}}{4}$

Where grate area exceeds 4 sq. ft. } $\text{Diam. of safety valve, in.} = \dfrac{\text{Grate area (sq. ft.)}}{10} + 0.6$

If liquid or gaseous fuel is used a grate area shall be assumed equal to that which would be required if coal were used for fuel.

Revise tables H-7 and H-11 to read as follows:

MINIMUM ALLOWABLE SIZES OF WATER RELIEF VALVES FOR WATER-HEATING BOILERS AND FOR WATER-SUPPLY BOILERS

Diameter of Valve, in.	Area of Grate, sq. ft.	Rated Capacity in Gallons per Hour		
		25° Rise	50° Rise	100° Rise
½	1.6	540	270	135
¾	5.6	1440	720	360
1	9.6	2520	1260	630
1¼	15.75	5400	2700	1350
1½	27	10800	5400	2700
2	49.5	21600	10800	5400

Note: The foregoing table is based upon the following formulas:

Where grate area does not exceed 12.5 sq. ft. } $\text{Diam. of safety valve, in.} = \dfrac{\text{Grate area (sq. ft.)}}{16} + 0.4$

Where grate area exceeds 12.5 sq. ft. } $\text{Diam. of safety valve, in.} = \dfrac{\text{Grate area (sq. ft.)}}{45} + 0.9$

An Interesting Sectional Type Boiler

Notes on Foreign Boiler Developments

By G. P. Blackall

The most interesting feature of a unit, consisting of a combined boiler, superheater, economizer, and air heater, constructed by a Swedish engineering concern for use in conjunction with the Stal-Ljungstrom turbine, is the sectional-type boiler. In this boiler the two separate headers are staggered and so kept closer. The distance between the sections can be diminished considerably so that the number of sections and connections for the circulation of water will be increased for a given width of boiler. This arrangement permits the area of the connections between the boiler drum and the sections to be from 40 to 50 percent greater than in a sectional boiler of the ordinary type, provided the tube diameter and floor space are the same in both cases.

Both the air and water heaters are arranged above the boiler, although as a rule it proves less expensive to employ an economizer or air heater of correspondingly large dimensions to absorb all the available heat in the flue gases. The economizer or water-heater tubes at the feed-end and the headers are located horizontally one above the other. Air for combustion is taken from the top of the boiler, so that its heat is utilized. The boiler is made in several sizes and for pressures up to 800 pounds per square inch.

Precautions Necessary in Handling Boiler Stop Valves

The Mercantile Marine Department of the British Board of Trade has recently issued a notice to shipowners, ship-repairers, boiler makers, and engineers, drawing attention to the precautions necessary in handling steam pipes and valves. The notice has been issued as the result of the failure of a boiler stop valve on board a steam trawler, while the vessel was in dock, which resulted in a regrettable fatality.

The boiler stop valve had been opened up for inspection, and after the stuffing box had been repacked and the cover rejointed steam was raised in the boiler. It was then noticed that the steam pipe connecting the boiler and engine stop valve was leaking at the brazing of the flange at the engine stop valve. The pipe was in two lengths and it was arranged to remove the after length for repair. The boiler stop valve was closed and the steam pipe disconnected from the engine stop valve, but as there was a slight leakage of steam from the disconnected end which inconvenienced the men working at the pipe, the boiler stop valve was hardened down with a view to stopping the leakage.

The screw thread of the brass valve spindle was in a serviceable condition, but subsequent events showed that the screw thread in the wrought iron bridge piece in which the valve spindle worked had been seriously wasted by leakage of steam from the gland below and the defective thread stripped while the valve was being hardened down. The consequent rush of steam escaping from the boiler through the disconnected end of the steam pipe unfortunately caused the death of an apprentice engineer, who was assisting in disconnecting the pipe.

"This case," says the Board of Trade notice, "emphasizes the importance of thorough periodical inspections of fittings subjected to steam pressure, and the necessity for great care in handling such fittings when under pressure.

"It is strongly recommended that steam should be blown off a boiler before a steam pipe is disconnected unless there is more than one stop valve in order to stop a leakage of steam, and when closed it should be secured in such a manner that it cannot inadvertently be opened."

Explosions Impossible in New Rapid Steam Generator

After several years of research work Bernhard Becker, a German engineer, claims to have perfected a boiler which he declares will "bring about a bigger revolution in our economic life than almost any other invention." Becker was first granted patents for his device during the war and he pursued his work on it until quite recently, when he brought it to what he considered the final state of perfection.

The invention itself is equally amazing to the layman or the expert. The first boiler has been erected in a small room about 7 feet square. It is in the shape of a small German tile stove about 5 feet high. The boiler itself is considerably smaller and consists of an arrangement of tubes with about 1/200th of the cubic capacity of a normal steam boiler. Thus, while the apparatus only occupies a small portion of a small room, a normal boiler of similar capacity would take up space more than twice that of a room of the same size.

The Becker boiler does not need a chimney or any special boiler house. Further, whereas an ordinary steam boiler of modern design must be preliminarily heated for several hours before it produces enough power to start work and thereby arrives at a pressure of about six to eight atmospheres, Becker's device comes from the cold to at least 15 atmospheres within five minutes. Consequently it is sufficient for this boiler to be started a few minutes before the power is required. The novelty of Becker's invention lies not only in its smallness, but also in the fact that there is no water at all. Steam is produced by spraying water into the tubes and converting same into steam at the moment of entering.

The experimental boiler is heated by oil, but is also to be fitted for burning other fuel. The fuel consumption is not so great as that of an oil motor. Explosions are impossible, inasmuch as there is no water in the boiler, the continued steaming of which is the chief cause of serious explosions. The operation of the boiler and adjustment to a desired pressure is effected automatically. It is to be built to a pressure of 150 atmospheres and over, and will thus offer possibilities the results of which according to leading experts cannot as yet be foreseen.

The inventor has commenced manufacturing the boilers in Nohra, Germany. Boilers up to 30 atmospheres pressure are being produced for stationary installation, the power of which can be adjusted as desired and which will be suitable for factories. A smaller type for steam heating installations is also being produced. Attention is also being paid to the adaption of the invention for locomotion, and it is intended to make agricultural machines which will be economic in operation and generally superior to similar machines at present in service.

Suggested Rules for the Care of Power Boilers

A SET of rules has been prepared by a committee of the American Society of Mechanical Engineers covering the care and maintenance of power boilers. These rules will be presented for discussion of all interested individuals at the forthcoming spring meeting of the Society to be held in Milwaukee, May 18 to 22. It is the request of the committee that these proposed rules be fully and freely considered, so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the council for approval. Discussions should be mailed to C. W. Obert, secretary of the Boiler Code Committee, 29 West 39th Street, New York, in order that they may be considered by the Boiler Code Committee.

This code is designated as Section VII. The preamble and description of sections follow:

Preamble

These rules, used in connection with steam boilers constructed in compliance with Section I of the A. S. M. E. Boiler Construction Code and for operation at a steam pressure exceeding 15 lb. per sq. in. above atmospheric pressure, will lead to safety in the use of steam boilers.

These rules are compiled to assist operators of steam boiler plants in maintaining their plants in as safe condition as possible, the subject of economy receiving only incidental consideration.

The difficulty in formulating a set of rules that may be applied to all sizes and types of plants is recognized; therefore these rules are suggestive only and it may be advisable to depart from them in certain cases.

Description of Sections

I. *Rules for Routine Operation.* These rules are elementary and govern the proper procedure in performing the ordinary duties of operating and maintaining steam boilers.

II. *Rules for Operating and Maintaining Boiler Appliances.* These rules are also elementary in character and are classified to give collectively all rules pertaining to any one boiler appliance, it being impracticable to include some of these rules in Section I.

III. *Rules for Inspection.* These rules apply only to those who are responsible for the operation of boiler plants and must not be considered as applying to the state, municipal, or insurance companies' inspectors. Consideration should be given to the importance of continual inspection as compared with periodical inspection.

IV. *Rules for the Prevention of Direct Causes of Boiler Failures.* These rules are intended as a guide and assistance to those who desire to make a more comprehensive study of the care of steam boilers in service. Their scope, including the entire boiler plant, is wider than that of Sections I and II. These rules are divided into two major subdivisions: Overpressure and Weakening of Structure. The rules on Overpressure deal with conditions which may cause boiler failure by subjecting the boiler to stresses greater than those for which it was designed. The rules on Weakening of

Structure deal with conditions which may cause boiler failure by weakening the boiler structure to such an extent that it cannot withstand the stresses for which it was designed.

V. *Partial Rules for Installation.* These rules are not complete. They treat with some conditions which are not encountered in the Rules for the Construction of Power Boilers.

Appendix—Feedwater Analysis, Treatment and Control. The Appendix contains approved methods of investigating and reporting of analysis, treatment, and control of feedwater with the intent of standardizing methods and forms. It is not intended so much for the operating engineer as for those specializing in the chemistry of feedwater.

The committee is composed of—

F. M. GIBSON, *Chairman*,
E. C. BAILEY,
W. G. DIMAN,
V. M. FROST,
J. R. GILL,
J. W. HAYS,
S. F. JETER,
W. H. LARKIN, JR.,
M. F. NEWMAN,
CYRUS WM. RICE,
J. S. SCHUMAKER,
H. F. SCOTT,
N. STAHL.

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Steam Versus Electricity

By H. J. Blanton

IN spite of the fact that electrically driven locomotives are being rapidly developed for certain specific classes of work, the steam locomotive still predominates.

A number of the champions of the electric locomotive, and they are rarely the men who actually design the locomotive but rather men who have little actual experience on which to base their so-called facts and assumptions, go to great trouble in pointing out the "lack of development in the steam locomotive." According to their ideas, nothing new save a "few incidentals" has been brought out in the past forty years, and in a deprecating manner they state that "the steam locomotive is essentially the same today as it has always been."

Essentially it is—since steam still expands in the cylinders and performs actual work. But what a vast difference in the locomotive itself. Three times the size and at least five times the pulling power of the old time locomotive. The speed factor has increased to the point where the tonnage moved in a given time is greatly multiplied over the performance of an engine of even ten years ago.

And where is the improvement most marked, one may ask. For the most part it is in the boiler and its attachments, although improvements in cylinder and valve motion design also play an important part.

With the advent of the superheater the boiler efficiency took a big jump, only to be increased with the addition of the firebrick arch and arch tubes, the combustion chamber, improved firebox design to burn poor grades of coal, the oil burner, and most recently the feedwater heater.

In the actual construction of the boiler itself improvements in design and workmanship have contributed a great deal to its safety: Along these lines the Boiler Code of the American Society of Mechanical Engineers has laid down laws and rules which make possible a standard safety code for boiler construction. Flexible staybolts have also contributed their part to safety and minimum upkeep. In the way of minimizing upkeep outside steam pipes from the dome to the cylinders is another important step, simplifying the renewal and grinding of joints and so forth.

So that with all these improvements and in addition the power reverse gear, booster, air brakes, automatic stoker, grate shaker and mechanically operated firedoors, the locomotive of today has become a flexible and comparatively safe source of power on wheels approaching and equaling in efficiency the modern steam-electric power plant.

And, "last but not least" it is a prime mover and not dependent upon any other agency for its power.

Program of Master Boiler Makers' Convention

THE official program of the 1925 convention of the Master Boiler Makers' Association to be held May 19 to 22, at the Hotel Sherman, Chicago, is as follows:

FIRST DAY

Tuesday, May 19, 1925

REGISTRATION OF MEMBERS AND GUESTS

8 A. M.

In order to participate in entertainments badges will be required. None will be issued unless your dues are paid and you are properly registered. No deviations from this rule.

BUSINESS SESSION

Convention called to order..................10.00 A.M.

Invocation:
Rev. J. A. McCarthy.

Addresses:
Hon. William E. Dever, Mayor of Chicago.
H. T. Bentley, Gen. S. M. P., C. & N. W. Ry.

Response:
John F. Raps.

Annual Address:
Frank Gray, President of the Association.

Routine Business:
Annual Report of the Secretary, Harry D. Vought.
Annual Report of the Treasurer, W. H. Laughridge.

Miscellaneous Business:
New Business.
Appointment of Special Committees to Serve During Convention.
Resolutions.
Memorials.
Announcements.
Adjournment.

SECOND DAY

Wednesday, May 20, 1925

Convention called to order....................9.00 A.M.

Address:
W. J. Tollerton, G. S. M. P., C. R. I. & P. R. R.

Response:
W. J. Murphy.

Unfinished Business:

Committee Reports:
Report of Committee on Recommended Practices and Standards to 1924 Convention.......... 10.30 A.M. to 12 M.

Announcements.

THIRD DAY

Thursday, May 21, 1925

Convention called to order...................9.00 A.M.

Address:
A. G. Pack, Chief Inspector, I. C. C., Bureau of Locomotive Inspection.

Response:
L. M. Stewart.

Committee Reports:

TOPIC 3: "CRACKED BRIDGES AND CRACKS IN FLANGE KNUCKLES, ETC." L. W. Steeves, Chairman; Henry V. Stevens................10.00 to 10.30 A.M.

TOPIC 6: "TRAINING AND DEVELOPING OF BOILER INSPECTORS AND ASST. FOREMAN BOILER MAKERS: THE PROPER SLOPE OF A CROWN SHEET: MOST RELIABLE WATER REGISTERING DEVICE AND BENEFITS, IF ANY, DERIVED FROM LOW WATER ALARMS." A. F. Stiglmeier, Chairman; J. A. Holder (deceased), Henry J. Raps..................10.30 to 11.00 A.M.

"COMMITTEE ON LAW. RECOMMENDED CHANGES IN CONSTITUTION AND BY-LAWS." Thomas Lewis, Chairman; G. W. Bennett, J. F. Raps ....11.00 to 11.30 A.M.

TOPIC 7: "MOST ECONOMICAL PUMP STATION BOILER AND PREFERABLE STYLE." E. H. Hohenstein, Chairman; T. Tottenhoff............11.30 A.M. to 12 M.

Announcements.

Adjournment.

FOURTH DAY

Friday, May 22, 1925

Convention called to order...................9.00 A.M.

Address:
A. R. Ayers, Asst. G. M., N. Y. C. & St. L. R. R.

Response:
J. W. Kelly.

Report of Executive Board, Mr. E. J. Reardon, Chairman.............10.00 to 10.30 A.M.

TOPIC 4: "RENEWAL OF STAYBOLTS ADJACENT TO THOSE ACTUALLY FOUND BROKEN." C. C. Dean, Chairman; J. P. Malley, F. A. Batchman ....10.30 to 10.45 A.M.

TOPIC 9: "BOILER PITTING AND GROOVING. CAUSES AND PREVENTION." Lewis E. Nicholas, Chairman; Frederick J. Howe..........10.45 to 11.15 A.M.

No report filed by committee on Topic No. 8.

Unfinished Business:
Report of Committee on Resolutions.11.15 to 11.30 A.M.
Report of Committees on Memorials.11.30 to 11.45 A.M.
Report of Committee on Topics for 1926 Convention...............11.45 to 12 M.

Election of Officers................12.00 M. to 2.30 P.M.

The Boiler Maker

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

Edward A. Simmons, *Pres.*
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London, England: 34 Victoria St. Westminster, S. W. 1.

Cable address: Urasigmec, London

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

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

Subscription price; United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. Foreign subscriptions may be paid through our London office, 34 Victoria Street, S. W., 1, in £/s/d.

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

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The convention season is again opening—for readers of The Boiler Maker the three most important meetings of the year are all to be held within the next three weeks. Programs of the Master Boiler Makers' Association convention, of the National Board of Boiler and Pressure Vessel Inspectors and of the American Boiler Manufacturers' Association are published in this issue with general information in connection with each of them. These three association cover practically the entire field of boiler work—the manufacturing organization, practical shop work and the inspection and test of various types of boilers.

The reports of these meetings will appear in the June issue of the magazine for the benefit of all members of the industry who are unable to be present at the meeting of the association in which they are most directly interested. The reports collectively will give a fairly accurate picture of the status of boiler making in this country and the progress made during the past year. In the field of boiler machinery the exhibits and meeting of the Boiler Makers' Supply Men's Association, held in conjunction with the convention of the Master Boiler Makers' Association, will indicate the lines of development of this most important branch of boiler making.

No formal program of the annual meeting of the American Boiler Manufacturers' Association, to be held at Watkins, N. Y., June 1, 2 and 3 was available at the time the magazine went to press. The secretary of the association, however, indicated the high spots of the meeting which are given below. The Glen Springs hotel at Watkins, N. Y., has been selected as the place of meeting. An excellent golf course is available in connection with the hotel facilities for the customary tournament held each year during the progress of the meeting.

Very few other than regular members have been invited to participate in the activities, although David Moffat Myers will deliver an address on "Small Power Plants." Joseph F. Scott, chairman of the National Board of Boiler and Pressure Vessel Inspectors, will outline the progress made by this body during the year. The financial report of the board will be given by C. O. Myers, secretary and treasurer. Charles E. Gorton, chairman of the American Uniform Boiler Law Society, will also address the meeting.

Important discussions will be held on the reports submitted by the committee on commerce covering the subject "Form of Contracts and Insurance" and on that of the cost accounting committee.

The secretary of the association, H. N. Covell, has sent out train schedules and connections to assist members in making reservations for Watkins Glen.

The program arranged for the annual convention of the Master Boiler Makers' Association, to be held at the Hotel Sherman, Chicago, May 19 to 22, as noted elsewhere in this issue, includes addresses by a number of prominent railroad officials in addition to the routine work and committee reports selected for discussion this year. H. T. Bentley, general superintendent of motive power, Chicago & Northwestern Railway; W. J. Tollerton, general superintendent of motive power, Chicago, Rock Island and Pacific Railroad; A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, and A. R. Ayers, assistant general manager of the New York Central and St. Louis Railroad, are scheduled to speak during the progress of the meeting.

In connection with the committee report on "Boiler Pitting and Grooving," members of the association will find the information contained in the article "Causes and Prevention of Pitting in Locomotive Boilers" by C. H. Koyl, published elsewhere in this issue particularly instructive. Mr. Koyl who is engineer of water service of the Chicago, Milwaukee and St. Paul Railway addressed the association at the 1923 convention on this subject. His present paper represents the last word on pitting and grooving.

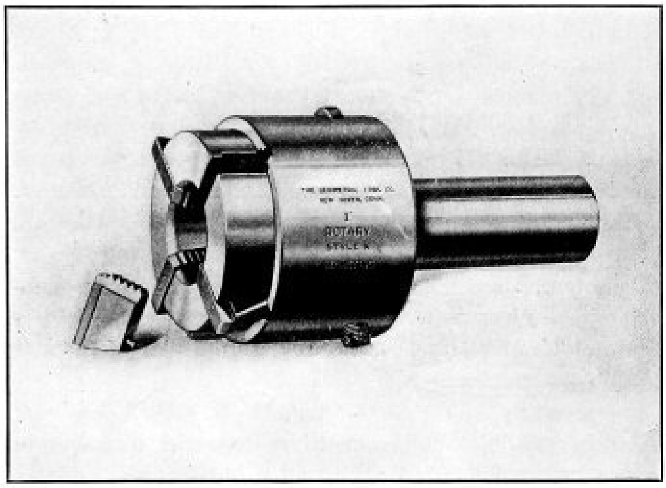
Engineering Specialties for Boiler Making

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

Rotary Self-Opening Die Head

THE rotary self-opening die head shown in the illustration has been designed by the Geometric Tool Company, New Haven, Conn., with particular reference to the various types of multiple spindle automatics and other live spindle machines. Owing to its small diameter, it swings freely in the limited space afforded by many of the modern automatic screw machines.

It is constructed in three units which are completely enclosed, thus keeping out dirt or chips from the mechanism. The opening and closing of the die head is effected by the forward and backward movement. It is designed so that the chasers project beyond the face of the die head, permitting threads to be cut to a shoulder without any adjustment, and also giving maximum chip clearance. All the working parts are ground, including the entire sliding surface of the slots in which the chasers are located.



Geometric Style K rotary self-opening die head

The threading chasers, while in the cutting position, are rigidly supported on all sides and at the top; they are completely boxed in, except in the face, where the teeth are located. The wide slots in which the chasers fit allow them to be large in size, thus providing durability. The chasers can be instantly removed or replaced, for there is no removing of the face plate or screws in order to get the chasers in or out. This construction eliminates the necessity of lining up cam slots before the die head can be locked. Chasers for cutting left and right hand threads are interchangeable.

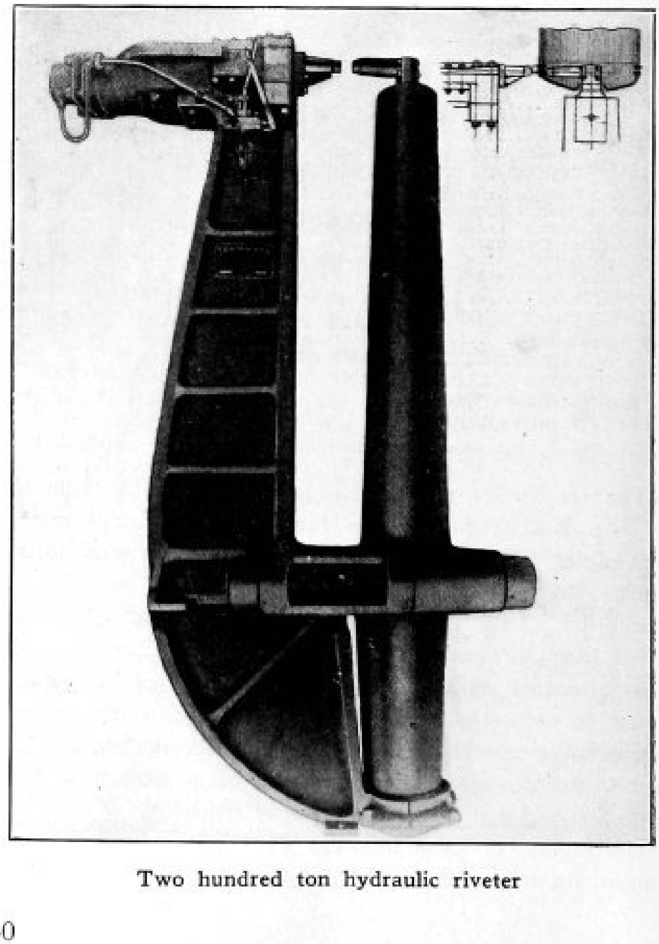
The die head is characterized by its simplicity in operation. When the spindle is advanced, a stop provided on the machine makes contact with the trip on the outside of the tool the moment the desired length of thread has been cut. This opens the die head. When the spindle is returned, the die head is closed by a yoke on the machine which makes contact with the rear of the die head closing sleeve.

This die head is known as Style *K* and is made to take stock sizes of 9/16 inch, 1 inch, 1¼ inch and 1½ inch.

The Largest Hydraulic Riveter Ever Built

A HYDRAULIC riveter having a maximum capacity of 200 tons pressure on the rivet and a minimum pressure of 42 tons has been built by the Southwark Foundry & Machine Company, Philadelphia, for the Casey-Hedges Company, Chattanooga, Tenn. This riveter is probably the largest of the hydraulic type ever built.

Hydraulic cylinders are arranged so that the riveter will give four additional pressures of 65, 112, 135 and 177 tons. These pressures are controlled by means of a 6-power valve arrangement. The riveter stake which carries the 200-ton cylinder is of cast steel. The cylinder itself is securely bolted to the stake casting by means of four 3-inch bolts which are located near the front of the riveter cylinder. All vertical stresses at this point are taken by the bolts. The die stake is a forging of special steel calculated to give the minimum deflection under full load. The diameter of the forged stake at the bottom of the gap is 40 inches. The reach of this riveter is 18 feet 8 inches, measured from the center of the die to the bottom of the gap. The top of the forged steel stake is provided with a special alloy steel horn which will make it possible to drive rivets through a manhole in the boiler head, as shown in the small diagram in the upper

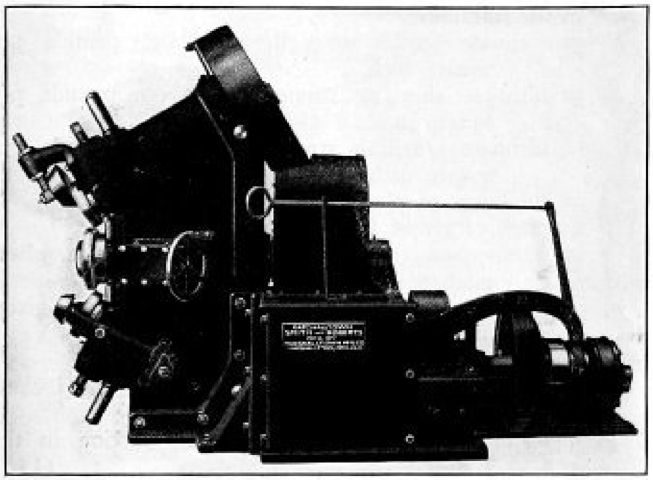


Two hundred ton hydraulic riveter

right hand corner of the accompanying illustration. The stroke of the riveting die is 12 inches. This riveter is especially adapted for the construction of high pressure superheated steam boilers and also for high pressure stills. The raw material entering into the construction of this riveter weighed 230,000 pounds.

Rotary Bevel Shear Designed for Heavy Plates

THE Marshalltown Manufacturing Company, Marshalltown, Iowa, is marketing a double rotary bevel shear which combines the features of the standard bevel shear and the inverted bevel shear. This combination makes it possible to bevel from both sides of a sheet without turning before the sheet passes through the rolls. The machine has a capacity for beveling ¾-inch metal and



Marshalltown double bevel shear

lighter. The depth of throat is 4 inches and the cutters, upper and lower, are 9 inches by 2 inches while the center cutter is 11 inches by 2 inches.

The shear was designed by practical men who have had years of experience in plants where quantities of sheet metal require beveling and where the cost of the work is followed closely. In the handling of these large sheets where it is necessary to turn them, there is always danger of accident. The new type shear eliminates turning the sheets. It is compactly built and weighs 8,500 pounds. It is equipped with a friction clutch gear which enables the operator to start or stop quickly. The machine is arranged for direct motor drive but, if a belt drive is desired, it can be furnished.

Bolt-Pointing and Threading Machine

A MACHINE for automatically pointing and threading bolts that range in size from ¾ inch by 1 inch, to ¾ inch by 6 inches, has been placed on the market by the Economy Engineering Company, Willoughby, Ohio.

The operator fills the hopper located above and to the left of the machine, as illustrated in Fig. 1. A double-blade feeder, which is shown at the bottom of its stroke in Fig. 1, is automatically forced upward through the pile of bolts in the hopper and, on its way, gathers certain bolts the shanks of which fall between the blades. These are then suspended by their heads on the blade edges till, at the top of the stroke, the edges slop downward to coincide with a chute reaching from the hopper to the working section of the machine. The bolts then move down into this chute by gravity and the blade feeder returns to the bottom of its stroke and repeats to keep the chute supplied.

On the side of the chute near the lower end, there is an escapement that, by the operation of two rods which alternately project into the path of the bolts, allows one bolt at a time to slide to the end of the chute where it is picked up by a transfer mechanism and carried to the chuck. This transfer mechanism is located at the lower end of the chute. It consists of a pair of cam-actuated spring fingers, which grip the shank of the bolt and deliver it to the chuck jaws, where the fingers are opened and returned for the next bolt that has been released through the escapement. The chuck jaws are operated by a cam-actuated toggle arrangement, at the left end of the machine. While a bolt is being placed for threading, the turret is locked against rotation.

When the bolt is gripped in the jaws, the turret is released and immediately indexed 120 degrees to come into position with the pointing head which is located, as illustrated in Fig. 1, in the upper center next to the lower end of the chute. This movement also brings the blank that has just been pointed into place for threading in the dies which can be seen in Fig. 1 below the pointing head. The completely threaded bolt is carried around at the same time to the loading station and dropped out as the chuck jaws are opened to take the next bolt from the feeder. The operation is then repeated.

The pointing head and threading die are both fed forward by springs to reduce the possibility of jamming. Cams

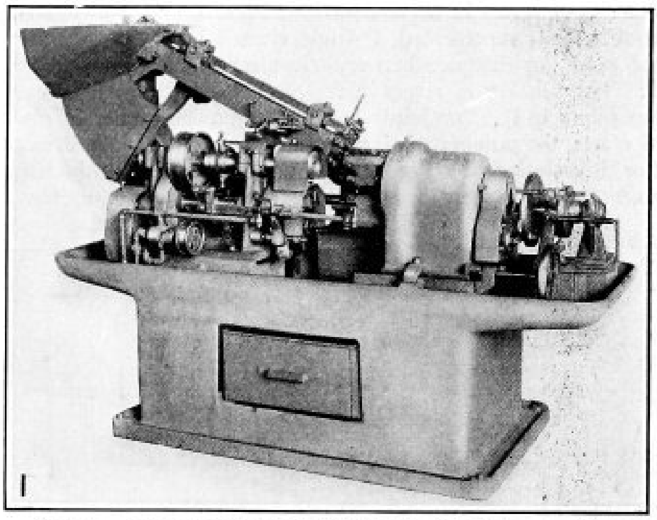


Fig. 1.—Economy bolt-pointing and threading machine

return them from the work. In the case of the threading die, there is a heavy spring for starting the thread that operates only for this part of the operation, when it comes against a stop and a light spring carries the head forward, overcoming only the drag of the moving parts. At the end of the stroke a cam opens the dies and returns the head to the starting point where another cam comes into action to close the dies, and then advances the head to position for the heavy spring to start the dies on the next bolt as it is indexed into position.

Change gears are provided to get the best ratio between speeds and feeds for a given size of work. The cams are arranged so they can be replaced to suit varying lengths and the turret head can be moved back after its clamps are loosened, to accommodate the longer sizes.

A capacity of ¾-inch by 1¼-inches U. S. standard bolts of 660 an hour is said to be attained.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

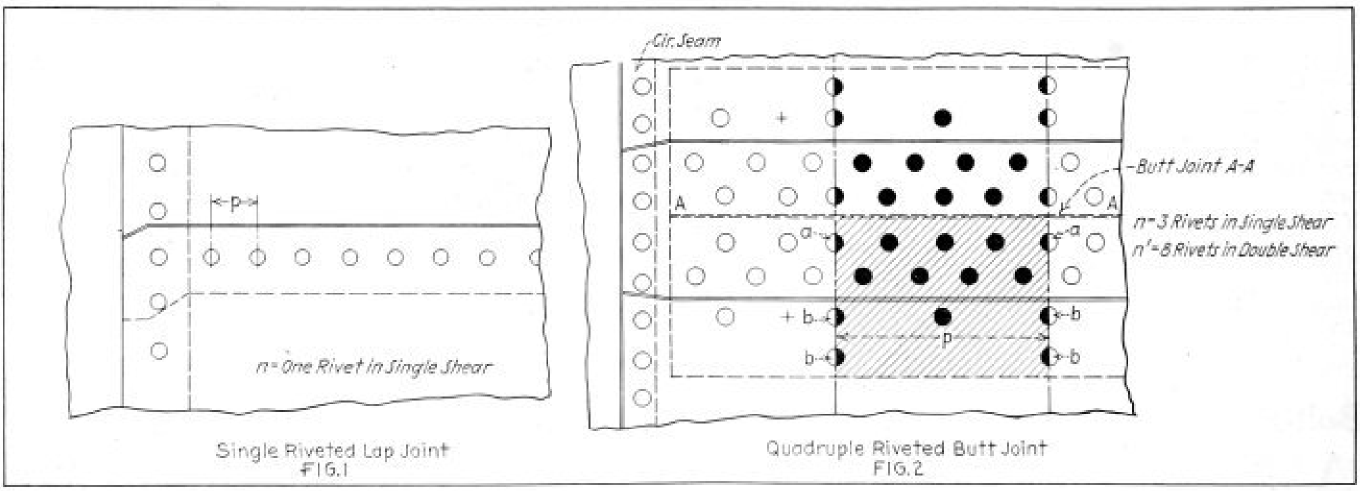
Riveted Head Calculations

Q.—In the December, 1924, issue of THE BOILER MAKER on page 348 there is an example for figuring boiler stresses. Under the formula headed "Tension on Rivets" or

$$\frac{P \times D \times p}{2 \times a \times n} = \frac{200 \times 79.625 \times 9}{2 \times 1.108 \times 9}$$

I would like to know just what constitutes one rivet section and how to find the number of rivet sections or how n is 9 in this example.—F. J.

A.—To illustrate what constitutes a rivet section and the number of rivets in such a section, Figs. 1 and 2 are given. In Fig. 1 is represented a single riveted lap joint in which the *pitch*, or distance between rivet centers, is indicated by P. The number of rivets in the pitch P of all single riveted lap joints is 1. For joints having a greater number of rows of rivets, the number of rivets n increases in the pitch section. For illustration, in Fig. 2, a quadruple riveted joint, the rivet section is considered within the shaded section for a given pitch p. In this case some of the rivets are in double shear and those in the outer row, outside of outside butt strap, are in single shear.



Rivets and rivet sections

The number of rivets in double shear in this type is 8, as there are 7 full rivet sections and 2 half rivet sections a in the pitch p. The number of rivets in single shear is 3, as there is 1 full rivet and 4 half rivet sections b within the pitch p.

The efficiency of such a joint depends on the thickness of plate, pitch of rivets, their size and arrangement. To determine the efficiency of the joint, first ascertain the strength of the solid plate section, then the strength of the unit length p. The ratio the strength of the solid plate section has to the strength of the same unit riveted section is known as the *efficiency of the joint*.

The method applied is as follows, using the symbols given in the formulas.

S_t = ultimate tensile strength of plate, pounds per square inch.

S_s = ultimate shearing strength of rivets, pounds per square inch.

S_c = ultimate crushing strength of plate, pounds per square inch.

t = thickness of plate, inches.

p = pitch of rivets, inches.

n = number of rivets in single shear, for a given pitch p.

n_1 = number of rivets in double shear, for given pitch p.

d = diameter of rivet hole, inches.

a = cross sectional area of rivet after driving, inches.

t_1 = thickness of butt strap, inches.

The tensile strength of the solid plate section in the distance $p = p \times t \times S_t$. (1)

Strength of net plate section between rivets in outer row $= (p - d)\ t \times S_t$. (2)

Resistance of eight rivets in double shear, plus the shearing strength of three rivets in single shear $= (n_1 \times S_s \times a) + (n \times S_s \times a)$. (3)

Resistance of plate between rivet holes in the second row, plus the shearing strength of one rivet in single shear in the outer row $= [(p - 2d)\ t \times S_t] + (1 \times S_s \times a)$. (4)

Strength of plate between rivet holes in the third row, plus the shearing strength of two rivets in single shear in the second row and one rivet in single shear in the outer row =

$[(p - 4d)\ t \times S_t] + (n \times S_s \times a)$. (5)

Strength of net plate section in the second row, plus the crushing strength of the butt strap in front of one rivet in the outer row $= [(p - 2d)\ t \times S_t] + (d \times t_1 \times S_c)$ (6)

The strength of the plate between rivet holes in the third row, plus the crushing strength of butt strap in front of two rivets in the second row and one rivet in the outer row $=$ $[(p - 4d)\ t \times S_t] + (n \times d \times t_1 \times S_c)$ (7)

The strength of plate in front of 8 rivets, plus the crushing strength of the butt straps in front of three rivets $=$ $(n_1 \times d \times t \times S_c) + (n \times d \times t_1 \times S_c)$ (8)

Strength of plate in front of the eight rivets in double shear, plus the shearing strength of three rivets in single shear $= (n_1 \times d \times t \times S_c) + (n \times S_s \times a)$ (9)

The efficiency of this joint is found by dividing the values found from formulas (2) to (9) inclusive by (1), the quotient will be the efficiency.

Working Pressure, Stress in Stays

Q.—I would like to know how to find the working pressure of a locomotive boiler, also the stress on staybolts 1⅛ inches by 10 inches long with 4-inch centers.—J. C. W.

A.—The maximum allowable working pressure on any type of boiler depends on the strength of the weakest section. Therefore, it would be necessary for any given boiler to calculate the strength of each part of the boiler, as for the plate, riveted joints, stays, etc. The stress, or load on stays, 1⅛ inch in diameter, depends on their pitch and the working pressure. If the pressure for illustration is 200 pounds per square inch, the load on each stay, pitched 4-inch centers is $4 \times 4 \times 200 = 3{,}200$ pounds. In this case no deduction in the load is made for the cross-sectional area of the stay. The above calculation is based on stays perpendicular to the side sheets of the firebox. Where the stays are radial, this arrangement must be considered in making the calculations.

How to Figure Heat Units for Driving Moisture Out of Material with Steam Heat

Q.—As one of your subscribers to THE BOILER MAKER I would like to have you give me a rule as to how to figure driving moisture out of material with steam heat.

In other words, if you had a plate about 1 foot square, steam jacketed with a 2-inch space with 80 pounds steam pressure in the space, how long would it take to drive the moisture at 60 percent out of sand? We would figure sand on the plate about 2 inches thick. We would think that if you had a tank about 4 feet wide and 6 feet long with a jacketed bottom having a steam space 2 inches with the same pressure, and water was placed in the tank at a depth of 2 or 3 inches, how fast would the water evaporate from the heat of the steam? We understand about 1 pound of coal would evaporate from 7 to 10 pounds of water, providing the fire was underneath the plate, but not jacketed and the heat was next to the plate, but we are unable to figure evaporation from steam heat at 80 pounds pressure. We would thank you to advise us about this.—H. R.

A.—To determine the number of heat units required to raise the temperature of a body a given number of degrees, multiply the weight of the substance in pounds by the specific heat of the body and by the number of degrees. (The specific heat is the ratio between the quantity of heat required to warm the substance one degree and the quantity of heat required to warm an equal weight of water one degree.)

In this case the sand contains 60 percent moisture, the specific heat of which is 1 and we will assume that the specific heat of the sand equals 0.20.

Example.—Determine the number of heat units (B.t.u.), required to raise 100 pounds of sand containing 60 percent moisture from a temperature of 70 degrees to 212 degrees F.

Solution.—Use the formula:

$$H = S\ W\ (t_1 - t).$$

in which, $H =$ heat units (B.t.u.).

$S =$ specific heat of the material.

$t_1 =$ temperature of the material after the heat is applied.

$t =$ temperature of the material before the heat is applied.

Substitute the values given in the example in the formula then,

$H = [(1 \times .60) + .20]\ 100\ (212 - 70) = 11{,}360$ B.t.u.

One pound of steam gives up 885 B.t.u. (latent heat) in condensing from a gage pressure of 80 pounds per square inch to atmospheric pressure. Therefore, $11{,}360 \div 885 =$ 13 pounds of steam required to raise the temperature of the sand.

The period of time required to drive out the moisture would depend on the thickness of the layer of sand and arrangement of the heating surfaces. This is a matter for experiment.

Wood-Burning Stack and Sand Stove

Q.—Please furnish me with a successful steaming wood-burning stack if you know of any without the casting in the center and also without the cone. I have made the Hunter Bradley stack, balloon stack, diamond stack. They are all good fire-prevention stacks, but the obstruction over the exhaust greatly reduces the steaming of the engine. Also please furnish me with a sketch of a sand stove. How would it do to make a wood-burning straight stack by placing strips of iron on an angle in a round stack? How would they have to be laid out? This is urgent. Let me hear as soon as possible.—J. F. D.

A.—We have been unsuccessful in getting information on the wood-burning stack. The placing of strips in a round stack as you suggest would have a greater tendency to retard the draft than the diamond or other similar stacks.

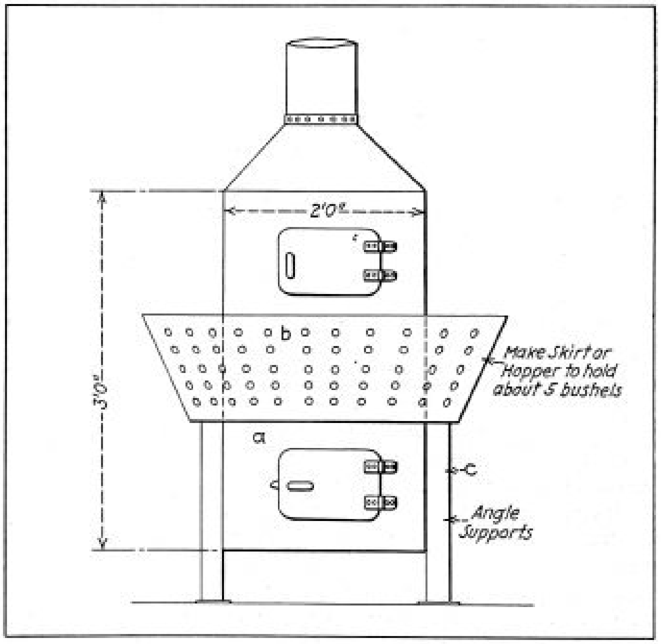


Fig. 1.—Sand stove made from steel plate

SAND STOVE

The sketch, Fig. 1, shows a simple form of sand stove made of steel plate. A grate is placed in the bottom of the shell *a*, and a skirt or hopper *b* surrounds the shell in the manner shown. The legs *c* support the shell and skirt. The amount of sand that the stove will dry depends on the amount of moisture and the intensity of the heat. The fire should be burning before placing the sand in the hopper, otherwise the sand will bake and fail to flow readily through the hopper openings. Only clear sand should be dried as clay or earth would clog the hopper openings and prevent the dry sand from running through the holes.

Data on Strength of Materials

Q.—I should like to have information as to where I could get a book containing the tensile strength of material and shearing strength of rivets and bolts. Also what kind of patch should be applied, also the thickness of the patch and the expansion on locomotive boiler.—G. K.

A.—The Simmons-Boardman Publishing Company will have ready within the near future the latest revision of the book, "Laying Out for Boiler Makers." Therein will be given valuable data on the subject that you inquire about.

If you have the 1920 issues of THE BOILER MAKER, refer to the articles covering the design and construction of horizontal return tubular boilers.

This information is also given in the codes prepared by the American Society for Testing Materials, 29 West 39th street, New York City.

In applying a patch, make the patch either elliptical or of circular form if possible so as to have the seams run diagonally with respect to the axis of the shell. On the firebox of locomotive types, diamond shape patches are also used. The last part of your question is not clear.

Plate Cracks

Q.—I am a subscriber to your magazine and read it every month and surely find it very interesting and instructive. I wish to ask some questions that I suppose are common to all boiler makers, and which I understand fairly well, but which I want a clear and concise answer to:

(1) How would you safely repair a crack in the barrel of a boiler; in firebox sheets; crown sheets; flue sheet; roof sheet and dome?

(2) For what defect would you condemn a barrel of a boiler?

If these questions are too long to answer, perhaps you could refer me to a good handbook which will cover this inquiry.—R. H. U.

A.—The method of patching a boiler should first be approved by the boiler inspector. The method of handling the repair of cracks in shell plate or heads depends on the extent and location of the crack. In the case of a small crack the end of the crack toward the body of the sheet is often drilled out and tapped for a soft plug, which is turned into place and headed. The purpose of drilling is to prevent the crack from extending into the plate. Where a large crack has developed a patch should be applied. If the crack is in a fire sheet remove the damaged plate section and apply the patch so the seams run diagonally to the axis of the boiler. The strength of the patch joint should equal at least that of the longitudinal seam; otherwise if the patch is the weakest part the pressure must be reduced accordingly. Also, bear in mind that a crack may extend into the plate a considerable distance and not be visible from a casual inspection, therefore before repairs are made determine the extent of the crack. Disastrous results have followed from improper repairs of lap seam cracks.

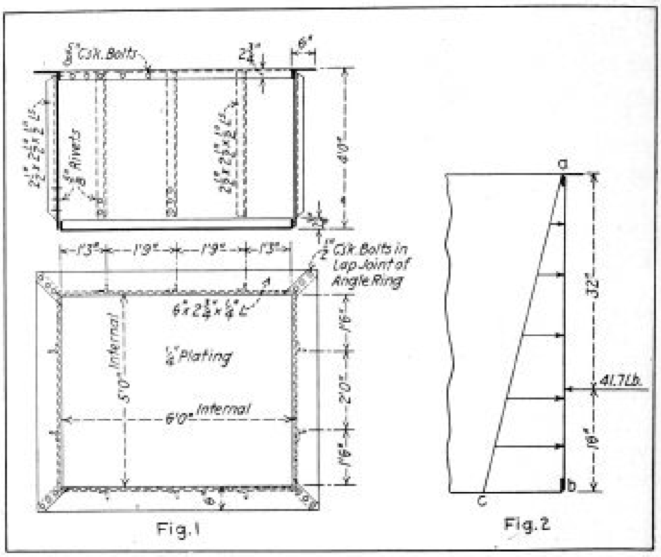
Shells called the *barrel* of boilers, such as in horizontal return tubular types, become defective from overheating. Mud and grease collect at the bottom which prevent the transmission of heat through the plate; as a result a pocket or bag forms in the shell. Wasted plate due to corrosion, plate lamination, bags or pockets, are sufficient cause to condemn the plate.

Stresses in Water Tanks

Q.—Will you please publish for me an answer to the following question: The tank shown in the accompanying sketch is intended for fresh water and the pressure to which it will be subjected is that of its own water weight when full. I like to have calculations worked out to find the stresses (due to its own water head) on the vertical angles and on the angle ring at the top of the tank. It should be observed that the tank is without cover.—T. L.

A.—The formulas given by different authorities for determining the size of reinforcing angles and plate thickness of rectangular or square tanks are approximations only. In their use, all assumptions should be made with a high factor of safety.

The weight of water per cubic foot equals $62\frac{1}{2}$ pounds; or $62\frac{1}{2} \div 1{,}728 = 0.0362$ pound per cubic inch. The pressure at the bottom of the tank per square inch due to the weight of water equals for a tank 48 inches high, $48 \times 0.0362 = 1.738$ pounds. It will be seen from the diagram, Fig. 2, that the center of pressure due to the head or weight of water is along a line $\frac{2}{3}$ of the depth of the tank measured from the top. The *center of pressure* is the line about which the pressure above it balances the pressure below it. This is shown in Fig. 2, where the pressure P



Structural details of tank and pressure diagram

is applied to hold the side against the pressure of the water; the pressure P equals the combined pressures above and below the center line of pressure.

By constructing a diagram laying off a-b equal to the head of water and b-c equal to the pressure at the bottom, the *total pressure* against the side ab would be represented by the shaded portion of the triangle, thus showing that the pressure ranges practically from zero at the top to maximum at the bottom. There are other conditions, however, that produce a load at the top and bottom which will be explained further on.

The *average unit* pressure of all these pressures is used in determining the lateral pressure against the sides of the tank. The average unit pressure for this case equals $\dfrac{1.738 \times 48}{2}$ $= 41.7$ pounds on each 1 inch strip 48 inches long.

Due to the load or weight of water, the pressure at the top and bottom edge of each 1-inch strip may be found by the principle of moments; that is, each force multiplied by its lever arm about a pivot, will form moments that will equal each other when in balance. Assume that the top edge a of a 1 inch strip, Fig. 2, is pivoted, and a force P of 41.7 pounds is applied at a point $\frac{2}{3}$ of the height a-b measured from a, then the force at b equals

$$\frac{41.7 \times 32}{48} = 27.8 \text{ pounds.}$$

The pull at a in pounds per inch length at the top equals

$$\frac{41.7 \times 16}{48} = 13.9 \text{ pounds.}$$

Assume that no braces are used in the tank and that the top edge is reinforced by an angle. Consider the angle fixed at both ends and uniformly loaded. The total load at the top equals the pull in pounds per inch length times the length of the beam between fixed ends, or $13.9 \times 72 = 1{,}000.8$ pounds.

To find the size of angle required, calculations involving the properties of structural sections are applied. For beams the strength is calculated by first finding the bending moment, then the section modulus. The latter is equal to the bending moment in pounds divided by the safe stress of the material, which is usually taken at 16,000 pounds per square inch for tension and compression.

For a load uniformly distributed as already determined, the bending moment may be found from the following formula:

$$\frac{W\ L}{12},$$

in which,

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

Substitute the values given in the formulas, then

$$\frac{1{,}000.8 \times 72}{12} = \frac{6{,}005}{16{,}000} = 0.312$$

In structural handbooks the prospectus of structural shapes are given, for this case an angle $2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{4}$ having a section modulus 0.39 to the inch would support the load.

With the top edge reinforced by angles and the remaining edges secured, the plate thickness can be determined from the following formula:

$$t = 0.62 \sqrt{\frac{W\,L\,l}{f\,(L^2 + l^2)}}$$

in which,

t = thickness of plate, inches.
W = load on plate, in pounds.
L = length of plate, inches.
l = width or height of plate, inches.
f = safe stress, 10,000 pounds per square inch.

In this case,

$W = 72 \times 48 \times 0.869 = 3{,}000$ pounds.

Substitute the values given in the example, to find

$$t = 0.62 \frac{\sqrt{3{,}000 \times 72 \times 48}}{10{,}000\ (72^2 + 48^2)} = 0.231 \text{ inch.}$$

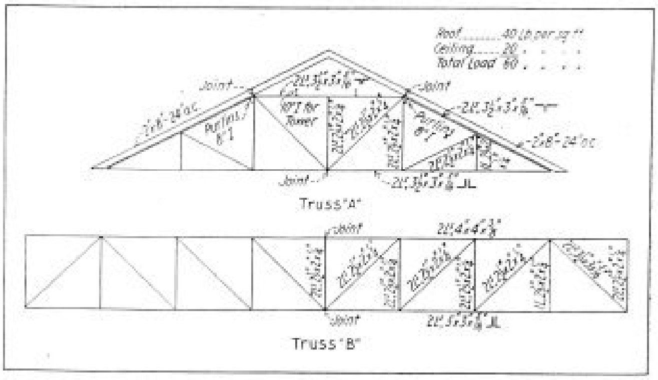
By using braces to carry a part of the load the thickness of plate and size of angle could be less. For this case a plate thickness of ¼ inch would ordinarily be used.

Roof Truss

Q.—I am inclosing sketch of roof trusses of which I would be pleased to have you furnish me details for constructing, size and thickness of plates; also size and number of rivets for each connection.

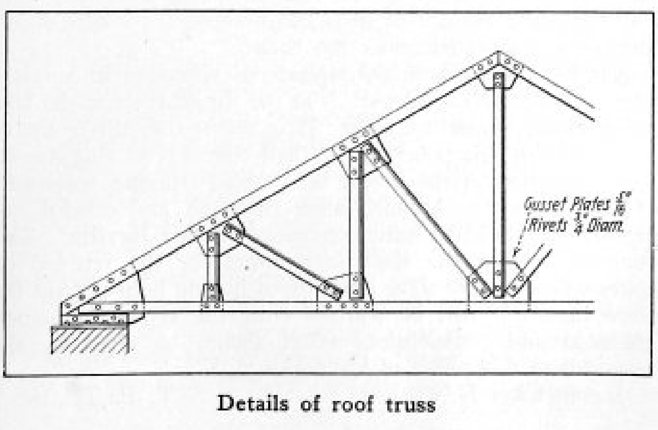
These trusses are to be assembled and riveted in the shop with joints left loose for field riveting as indicated. An early reply will be appreciated.—C. G. T.

A.—The sketch plate, Fig. 2, gives the required diameter of rivets and size of gusset plates. Elaborate calculations



Stress diagram

for this span of 40 feet and less are not necessary; for in the struts and tension members a the stresses are not very great, hence if the calculated sizes of these members were used they would be too small for practical purposes. The spacing of the rivets is governed by practical considerations.



Details of roof truss

Pipe and Boiler Calculations

Q.—Will you please answer these two problems in one of your issues of THE BOILER MAKER:

(1) A drum of 24-inch seamless steel pipe ends are flanged out 3 inches to bolt on a dished head of 9/16-inch 55,000 T. S. steel. What would be the safe working pressure? What size bolts and how many would be used to bolt the heads? Please show how to figure both problems.

(2) Staybolt and flue drilling on a box header water space 12 inches, plates ⅝-inch thick, 55,000 T. S. (pressure 120 pounds now used). What would be a safe working pressure on a job of this kind? What would be the correct size of staybolts? Please show how to figure both problems.—J. J. T.

A.—(1) Refer to page 350 December issue of THE BOILER MAKER,—therein are given the rules and proportions for the shell, rings and bolts for constructions of this kind.

(2) The size of stays required for a given pressure for supporting a flat plate, depends on the thickness of plate and pitch of stays.

The following formula may be used in this case to determine the maximum allowable working pressure.

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

in which,

P = maximum allowable working pressure, pounds per square inch.
C = 120 for stays screwed through plates 7/16-inch thick with ends riveted over.
t = thickness of plate in *sixteenths of an inch.*
p = maximum pitch of stays.

Substitute the values you have given in the formula, then

$$P = \frac{120 \times 10^2}{8^2} = 187 \text{ pounds per square inch.}$$

The pressure on the flat plate section within the pitch of staybolts, when the area of tube holes is not considered, equals in this case

$$187 \times 8^2 = 187 \times 8 \times 8 = 11{,}968 \text{ pounds.}$$

The size of stay required to support this load is found as follows:

Divide the load on the stay in pounds by the allowable stress on the stay in pounds per square inch. The allowable stress on the stay for this case equals 7,500 pounds per square inch, then $11{,}968 \div 7{,}500 = 1.6$ square inches nearly.

The diameter of the stay equals $\sqrt{\dfrac{1.6}{0.7854}} = 1.43$ inches.

Letters from Practical Boiler Makers

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

Piece of Hose Is Safety Device

MANY a workman has suffered serious injuries to his hand when his hammer glanced from the head of a chisel or punch that he was holding. In order to reduce this risk the service supervisor in a large concern in the state of Washington made a safety device from a piece of discarded air hose. He cut a slot about two inches from the end of the hose and into this he inserted the chisel or the punch. He drove two pieces of wood in the end to hold the tool firmly in position. It has been found an easy matter to change the position of the tool so as to work from different angles.

Simple kink eliminates danger from holding-on a chisel

Chicago, Ill. GEORGE F. PAUL.

Why Do Boilers Explode?

NOT long ago the writer got into a discussion on the above subject. The writer took the stand that firetube boiler explosions are more disastrous than watertube boiler explosions because the former hold more water per horsepower. A gentleman of national prominence took issue with me, claiming that I was wrong—that watertube boiler explosions are liable to be more disastrous.

With a view to getting unprejudiced information on the subject I inquired of a large manufacturer who makes both types of boilers—firetube and watertube—without explaining to the manufacturer why the question was asked. He replied as follows:

"Beg to advise that a return tubular boiler will contain more water per horsepower than will a watertube boiler of equal size. For instance, on a 72-inch by 18-foot boiler with seventy 4-inch tubes and rated 150 horsepower, beg to advise that the weight of the contained water would be 22,800 pounds. On a 150 horsepower watertube boiler having seventy-four 4-inch tubes with one 36-inch drum the weight of the contained water would be 13,000 pounds."

In other words this manufacturer's firetube boiler holds nearly twice as much water as does the watertube type. The writer now feels more strongly than ever that his stand is justified.

Newark, N. J. W. F. SCHAPHORST.

Crystallization of Locomotive Boiler Shells

CRYSTALLIZATION, phenomenal as it is in its nature, yet when identified with boiler steel its study is not so remote or incomprehensible that the average boiler inspector or individual concerned with the subject need be without a proper understanding of the principles that apply directly to the practical side of his duties.

Laboratory analyses, metallurgical researches or scientific complexities are unnecessary in this article. In order not to confuse the mind of the reader who is not thoroughly familiar with the principles of higher mathematics, a practical definition and explanation only of the problems of crystallization will be given here. Boiler inspectors especially should be concerned with the subject and acquaint themselves with all the available information on this important phase of their work so that they will be able to detect any agents in a boiler working towards the crystallization of the metal. Crystallization in boiler steel is the action resulting from a condition in which the fibers continually tend to separate the molecular structure of the metal beyond the range of the elastic limit. This distressing effect is brought about in the metal by stresses to which the shell parts of a boiler are subjected which is particularly true in the case of a locomotive boiler. These stresses may be set up while the boiler is in service when it is continually undergoing reactions caused by constantly varying temperatures or by the torturing effect of sudden or continual vibration either of which will ultimately effect the coherent power of the particles making up the metal structure.

On making inspections of boilers, the boiler inspector should give the age of the boiler first consideration in order to determine whether the time of service would bring about any defects from the varying temperatures or vibrations that have occurred when the boiler was being used. It also will indicate in what places the defects are liable to occur. Usually cracks resulting from the breaking down of the molecular structure of the boiler steel are present in the circumferential seams from the rivets to the edge of the seam or in very serious cases these cracks will run circumferentially in the line of rivets. In either case the inspector must know exactly what to look for and must have keen eyesight to find the cracks. When cracks are caused by vibration they will show up most readily at such holes, especially where waist angles are connected under the boiler.

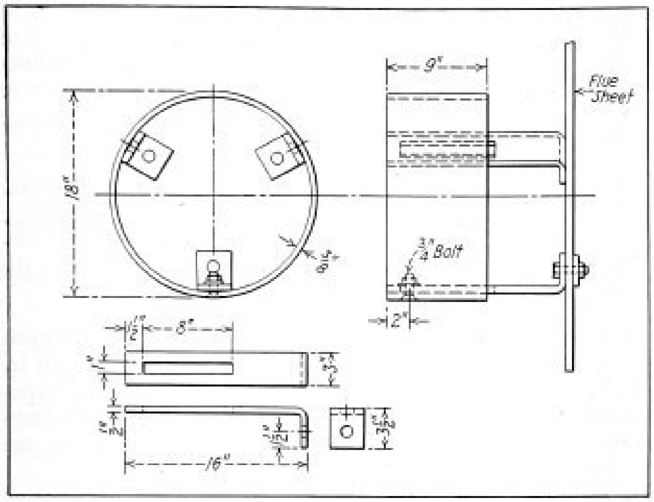
Another point where the stresses of vibration in varying temperatures are most severe is at the throat sheet at the last shell course connecting ring. It is rather difficult to detect any cracks at this point on the shell course rivet ring due to the obstruction of the throat braces and clinging scale and mud beneath it. A much more thorough and careful examination should be made on seams in this locality. Too frequently when the shell is removed for the renewal of courses these cracks show evidence of having been present for some time. It will be realized from the above that much attention and conscientious effort should be given by the inspector to this phase of his duties.

Jersey City, N. J. T. P. TULIN.

Smokebox Drilling

TO eliminate the use of an "old man" when drilling and countersinking holes in the smokebox ring, throat sheet and front flue sheet, a device is now in use at Sayre Shops of the Lehigh Valley Railroad, which not only does away with the "old man," but speeds up the drilling and lets one man do the work formerly done by two. This method was devised by boiler maker Anthony Rouscher.

A piece of 3/8-inch boiler plate is made into a drum, 18 inches in diameter and 9 inches long. Three legs are bolted



New type "old man" for flue sheet drilling

to the inside of the drum and extend out of one end about 5 inches. The projecting ends of the legs have feet in which is drilled a hole for a 3/4-inch bolt.

The drum is held with its axis parallel to the boiler axis and is bolted to the flue sheet near the center by means of bolts passing through the feet and the flue sheet. In this position a firm foundation is provided for all drilling motors used in drilling or countersinking around the smokebox ring, flue sheet or throat sheet. No movement of the drum is required as holes above, below and on all sides may be reached and a firm backing given to the drill motor, thus avoiding the drilling of holes on a slant.

After the drum is in place, one boiler maker can drill an average of 30 1 1/16-inch holes per hour, whereas before its use, a boiler maker and helper could drill but 12 1 1/16-inch holes per hour. The cost per hole has been reduced from 10.2 cents to 2.5 cents; a saving of 7.7 cents per hole.

Riveted Joints

THERE appears to be some difference of opinion on your side of the Atlantic as to how a riveted joint should be designated, especially concerning butt joints. It may interest your readers to know that when talking of riveted joints the following terms are used in this country (England).

Lap jointed and single riveted.
Lap jointed and double riveted.
Lap jointed and treble riveted.

And for butt joints;

Butt jointed and single riveted.
Butt jointed and double riveted.
Butt jointed and treble riveted.
Butt jointed and quadruple riveted.

When it is specified "butt jointed and single riveted" it is understood by all concerned that there is one row of rivets on each side of the butt. "Butt jointed and double riveted" two rows of rivets on each side of the butt. Treble riveted, 3 rows each side of the butt and quadruple riveted, 4 rows of rivets each side of the butt.

Now reverting to James Winthorpe's article in your March issue, he concludes by saying that the total number of rivets in a seam should be specified and not half. Well, that's all right but we will assume that it is understood that quadruple riveted means four rows of rivets in the seam all told; treble riveted, three rows all told; and double riveted two rows all told and single riveted one row all told.

We will now endeavor to imagine a treble riveted butt joint as understood by Mr. Joynes and Mr. Blanton; that is, that the total number of rows of rivets is given. Well there will be one each side of the butt and one in the middle. No, there are two rows on one side and one on the other side. It will be fairly obvious that the seam is impracticable. Again, on the same understanding, we will take a single riveted butt joint. One row of rivets and one row only but where shall we put it?

Now a single riveted butt joint as understood by boiler makers in this country is a common seam and means one row on each side of the butt. Double riveted means two rows on each side of the butt, and treble riveted 3 rows on each side of the butt. However, I should advise all who are called upon to specify a butt joint, to use the following terms:

Exmple: "The longitudinal seams shall be fitted with double butt straps, with two rows of rivets on each side of the butt, making four rows of rivets in all."

Leeds, England. JOHN KIRKLAND.

Repairing Through Stays

IN reference to the letter by Mr. Joseph Smith in your March issue of THE BOILER MAKER, I wish to submit what I consider a quicker and better method of repairing a through stay in a Scotch Marine dry back boiler.

It is as follows:

Cut off the stay end with the burner level with plate. Drill a 1 3/4-inch tapping hole in the stay, and tap out, running in a 1 3/4-inch stud, leaving 2 5/8 inches protruding from the plate. Fit a washer over the stud, say, 6 inches diameter, and 5/8-inch thick. Make up stud with asbestos cord and manganese before putting on the washer. Run a 1 3/4-inch nut on stud tightly.

Yorkshire, Eng. F. SNOWDEN.

Power Show for Chicago

FOR some time a great many manufacturers of power-plant equipment have felt that a Power Show in Chicago, giving engineers in the great Middle West an opportunity annually to see the latest and best of their equipment would be highly desirable. The thought has been that the new show would supplement rather than interfere in any way with the Power Show already established in New York City, by doubling the opportunity to reach the general field. The time of holding would be set for two months later giving the opportunity, if desired, to use the same display.

With the foregoing as a background the Midwestern Engineering Exposition, Inc., has been formed with offices at 53 West Jackson Blvd., Chicago, and announcement has been made of the first annual Mid-West Power Show to be held in the American Exposition Palace, Chicago, on January 26-30, inclusive, 1926. The main floor housing the show, 240 ft. wide by 425 ft. long, is conceded to be an excellent place for such purposes.

During the same week a number of engineering meetings of national and local associations will be held in the city, so that the attendance locally and from the Mid-Western territory should be enhanced by the presence of these engineers, who will have the double privilege of attending their own meetings and taking in the show as well.

BUSINESS NOTES

The Standard Stoker Company, Inc., has removed its New York City office from 5054 Grand Central Terminal to 350 Madison avenue.

A. H. Beale, president of the Lebanon Iron Company, Lebanon, Pa., has resigned to become president of the A. M. Byers Company, Pittsburgh, Pa.

The Whiting Corporation, Harvey, Ill., has opened a sales room at 997 Ellicott Square, Buffalo, N. Y., and has appointed W. R. Hans district manager.

William H. Keller, Inc., has removed its office from 50 Church street, New York, to 50 Dey street, where a complete line of pneumatic tools and repair parts will be carried.

The Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio, has opened a new office at 203 East Fifteenth street, New York, in charge of L. Wechsler, sales representative.

J. C. Davis, of the sales department of the Ohio Injector Company, with headquarters at Wadsworth, Ohio, has been promoted to assistant sales manager, with the same headquarters.

The Globe Steel Tube Company, Milwaukee, Wis., has opened a district sales office at 444 Frisco building, St. Louis, Mo., and has appointed E. C. Carroll manager of sales for that district.

Paul T. Farrell of the purchasing department of the Youngstown Sheet & Tube Company, Youngstown, Ohio, has been promoted to assistant purchasing agent to succeed C. A. Ilgenfritz, resigned to accept a position with another company.

The Harnischfeger Corporation, Milwaukee, Wis., has removed its Pittsburgh, Pa., sales office from the Fidelity building to 612 Farmers Bank Building, Fifth avenue and Wood street. A. J. Dreyer is district manager and M. B. Bradley is sales engineer at this office.

Lyle Marshall, former manager of the service department of the Industrial Works, Bay City, Mich., and later connected with the Chicago office, has been promoted to district sales manager in the newly opened office at 619 Dixie Terminal building, Cincinnati, Ohio. James E. Shearer, assistant sales manager, Bay City, Mich., has been transferred to New York.

The Bird-Archer Company, New York, is now conducting its Canadian business entirely from a general office at 300 McGill building, Montreal, Que. Previously the Canadian business has been conducted from the head offices at New York; the Canadian factory and laboratory will be located at Cobourg, Ont. Hugh C. Harragin is in charge of the administration of the Canadian business with head offices at Montreal.

The Linde Air Products Company, New York, manufacturer and distributor of oxygen for welding and cutting, has opened the following new district sales offices: In the First National Soo Line building, Minneapolis, Minn., C. E. Donegan, district sales manager; Lincoln Life building, Birmingham, Ala., W. A. K. Popp, district sales manager, and in the Exchange National Bank building, Tulsa, Okla., G. D. Grubb, district sales manager. J. W. Foster, senior salesman in the Pittsburgh Linde district, has been appointed district sales manager at Baltimore, Md.

The B. W. Parsons Company, St. Paul, Minn., has removed its offices from 1306 Merchants Bank building to 1010 Builders Exchange building, St. Paul.

TRADE PUBLICATIONS

Punch Riveters.—Bulletin R-203, illustrating and describing Hanna rapid punch riveters, has been issued by the Hanna Engineering Works, Chicago.

Grinding Machines.—A few typical jobs as handled by the Heald railroad internal grinder are shown in the pages of a 20-page pamphlet, Bulletin No. 522, issued by the Heald Machine Company, Worcester, Mass.

Flexible Couplings.—Bulletin No. 35 descriptive of Falk-Bibby flexible couplings has been issued by the Falk Corporation, Milwaukee, Wis. The couplings, designed for every purpose, range in speed from 1/3 to 20,000 horsepower at 100 revolutions per minute.

Vises.—Catalogue No. 57-B listing discontinued Parker vises and illustrating their substitutes, has been issued by the Charles Parker Company, Meriden, Conn. Line drawings illustrate the various parts of Parker vises, and the names used to designate these parts are given.

Pyrometers.—A 56 page descriptive catalogue of indicating portable and recording pyrometers has been issued by the Republic Flow Meters Company, Chicago. The types of equipment, their application and interpretation of readings with useful tables make up the subject matter of the catalogue.

Bridgeport Products.—Tabulated data, giving the weights, sizes and lengths of Bridgeport products, including brass and copper sheet, rod, wire and shapes, tubing, piping and fabricated articles, are contained in a 48-page booklet, No. 16, which has been issued by the Bridgeport Brass Company, Bridgeport, Conn. Price lists, conversion tables, etc., are also included in the booklet.

Turret Lathes.—Practical methods for producing turned parts in lots of five to fifteen pieces by the use of machines with standard adjustable tools, are outlined in a 12-page circular, entitled "Profits from small lot production," which has been issued by the Warner & Swasey Company, Cleveland, Ohio. Illustrations show the main points in set-up, and set-up times from actual jobs are given.

"Forty Years of Progress."—This is the title of a 64-page book issued by the Harnischfeger Corporation, Milwaukee, Wis., in which a concise history of its growth and development since its founding forty years ago, and photographs and descriptions of the entire plant and personnel as it is today are given. Each of the various products in the electric crane, hoist, machine tool and gasoline excavator lines, are also illustrated and described.

Forged Steel Pipe Flanges.—An attractive catalogue of 86 pages, the purpose of which is to place before those who use or specify flanges a complete list of standard forged steel flanges, together with data, descriptions and other information helpful in connection with high pressure piping layouts or pipe fabrications, has been issued by the American Spiral Pipe Works, Chicago. Formulas and data tables embody the new American Engineering standards of 400, 600 and 900 pounds W. S. P., and cover also the existing standards. Full-size cross-sectional drawings show modern practice in the field of increasing pressures and superheat. A section of the catalogue is also devoted to corrugated steel furnaces.

Cutler-Hammer Products.—New loose-leaf bulletins for the month of April, describing electric controlling apparatus manufactured by the Cutler-Hammer Manufacturing Company have been issued.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.

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

Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.

Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.

Vice-Chairman—R. L. Hemingway, San Francisco, Cal.

Statistician—E. W. Farmer, Rhode Island.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

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

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

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

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

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

Master Boiler Makers' Association

President—Frank Gray, tank foreman, C. & A. R. R., Bloomington, Ill.

First Vice-President—Thomas F. Powers, general boiler foreman, C. & N. W. R. R., Oak Park, Ill.

Second Vice-President—John F. Raps, general boiler inspector, I. C. R. R., Chicago, Ill.

Third Vice-President—W. J. Murphy, general foreman boiler maker, Penn System, Fort Wayne Shops, Allegheny, Pa.

Fourth Vice-President—L. M. Stewart, general boiler inspector, Atlantic Coast Lines, Waycross, Ga.

Fifth Vice-President—S. M. Carroll, general master boiler maker, C. & O. R. R., Richmond, Va.

Secretary—H. D. Vought, 26 Cortlandt Street, New York.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley R. R., 537 Linwood Avenue, Columbus, Ohio.

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Boiler Makers' Supply Men's Association

President—J. P. Moses, Jos. T. Ryerson & Son, Chicago, Ill.; Vice-President—F. H. McCabe, McCabe Manufacturing Co., Lawrence, Mass.; Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—E. R. Fish, Heine Boiler Company, St. Louis, Mo.

Vice-President—E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.

Secretary-Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—George W. Bach, Union Iron Works, Erie, Pa.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Can.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill., and A. G. Pratt, The Babcock & Wilcox Company, New York.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

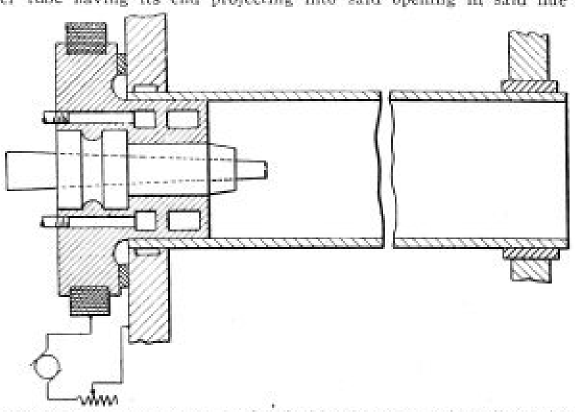
SELECTED BOILER PATENTS

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

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

1,530,266. BOILER-TUBE CONNECTION. FREDERICK T. HUSTON, OF FORT WAYNE, INDIANA.

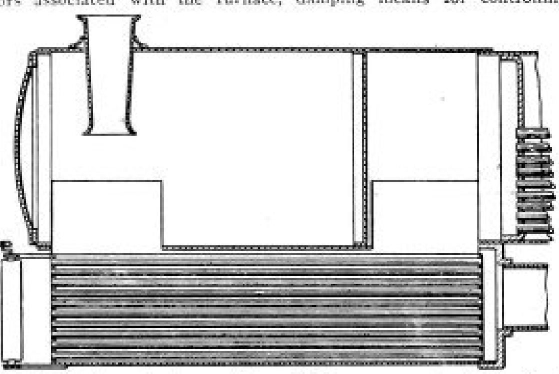
Claim 1.—A boiler comprising a flue sheet having an opening therethrough, a boiler tube having its end projecting into said opening in said flue sheet



and welded to the flue sheet, and a locking part on said boiler tube intermediate the two walls of the flue sheet the material of the flue sheet being removed to form a free space on the other side of said locking part, said locking part adapted to relieve the strain on the welded connection between the boiler tube and the flue sheet. Five claims.

1,531,707. CONTROLLING THE AIR SUPPLY IN LOCOMOTIVE FURNACES PROVIDED WITH PREHEATERS. FREDRIK LJUNGSTROM, OF LIDINGO-BREVIK, SWEDEN, ASSIGNOR TO AKTIEBOLAGET LJUNGSTROMS ANGTURBIN, OF STOCKHOLM, SWEDEN, A CORPORATION.

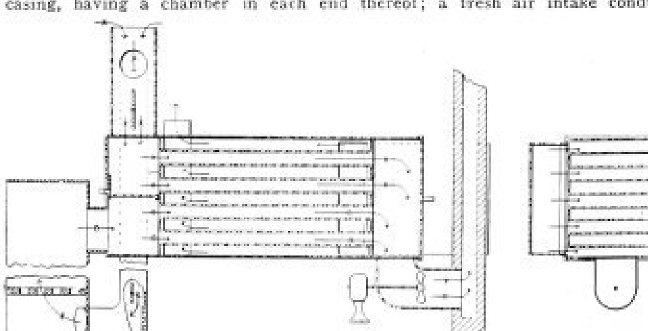
Claim 1.—In combination, an air preheater for locomotive furnaces, movable doors associated with the furnace, damping means for controlling the



supply of air to the preheater and door locking means actuated by the damping means and preventing opening of the doors while the damping means is in open position, said locking means further acting to prevent the opening of the damping means while the doors are in open position. Three claims.

1,530,809. HEAT-RECOVERING AIR-CONTROL DEVICE FOR FURNACES. OLIVER S. BOWMAN, OF COLORADO SPRINGS, COLORADO.

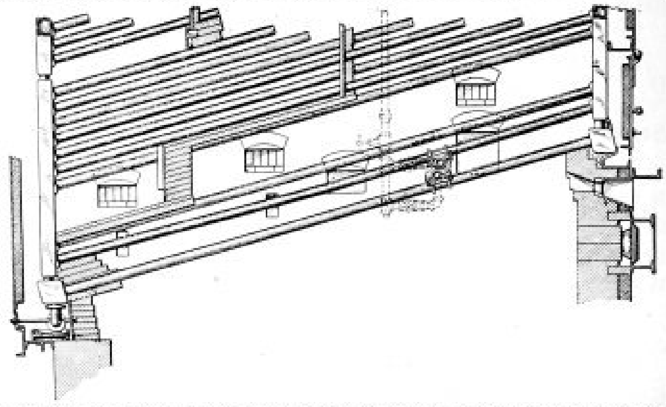
Claim 1.—In a device of the class described including in combination, a casing, having a chamber in each end thereof; a fresh air intake conduit



connected to said casing; a pipe connected to said housing; a plurality of channels disposed within said casing, each alternate channel in open communication with said fresh air intake conduit and said pipe, and the remainder with said chambers, and a foul air conduit in open communication with said casing; for the purposes set forth. Fourteen claims.

1,528,215. PROTECTION FOR WATER-TUBE-CLEANING ELEMENTS. HOWARD J. KERR, OF ELIZABETH, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

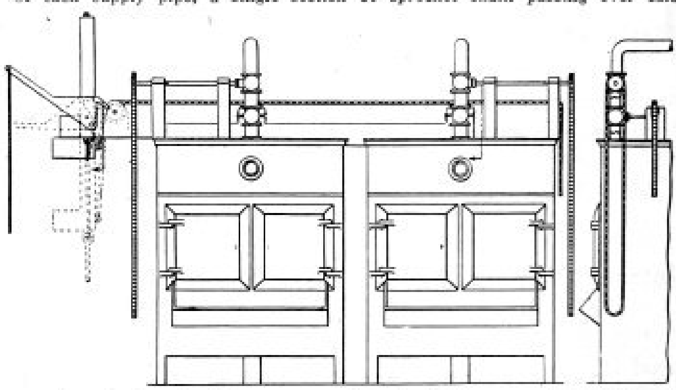
Claim 1.—In a water tube boiler, a blower element extending across a row of water tubes in the path of gases flowing across the tubes, and a metallic cover and support for said element comprising a plurality of metal blocks, each having a tubular opening surrounding the blower element and said blocks being arranged end to end to form a continuous tubular opening



extending the length of the element and each block having an extended surface adapted to fit against a water tube, and means on each block to connect it to one water tube only and to draw its extended surface into contact with the water tube, said blower element having lateral jet elements extending from the sides thereof through ducts formed in said blocks. Four claims.

1,522,589. MIKE MISKULIN, OF ZEIGLER, ILLINOIS. BOILER.

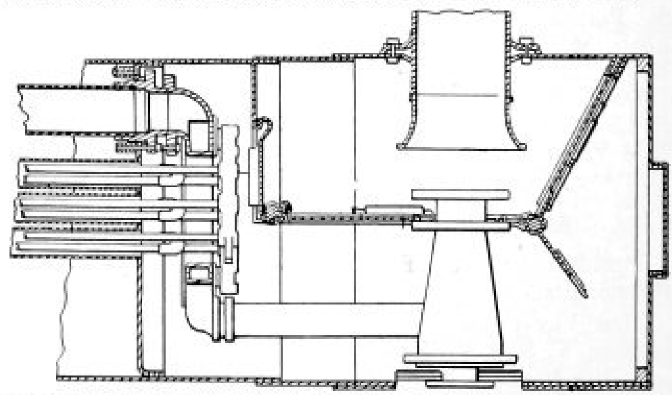
Claim 1.—In steam boilers of the type described, a steam supply pipe associated with each boiler, a steam service pipe in communication with the supply pipes, a valve in each supply pipe, sprocket wheels connected to the valve of each supply pipe, a single section of sprocket chain passing over said



sprocket wheels, a bracket arm secured to the boilers, a weighted slide rod mounted in the outer end of the bracket arm to which weighted slide rod the sprocket chain is connected, co-operating means carried by the bracket associated with the sliding rod for holding the same in an elevated inoperative position, said means including a lever pivoted to said bracket, a finger extension carried by said lever, and a latch piece having a cord connection with the bracket with the cord positioned beneath the sliding rod and the latch piece disposed above said bracket for engagement by the lever finger. Three Claims.

1,531,332. LOCOMOTIVE DRAFT CHAMBER. GEORGE SAMUEL BOYLER, OF TORONTO, ONTARIO, CANADA.

Claim 1.—In a draft chamber for locomotives, the combination with a locomotive body provided with a dead plate forming the rear wall of the smoke chamber, of a floor plate forming the floor of the draft chamber, an



interlocking connection between the rearward end of said floor plate and the rear wall dead plate, spark arresting screens forming the forward wall of the draft chamber, an interlocking connection between the lower end of the screens and the forward end of the floor plate of the draft chamber, and wedging means for forcing the lower end of the spark arrester and floor plate and their interlocking connections forward so as to force them into tight contact. Nine claims.

The Boiler Maker

JUNE, 1925

Constructing Welded Steel Smokestacks

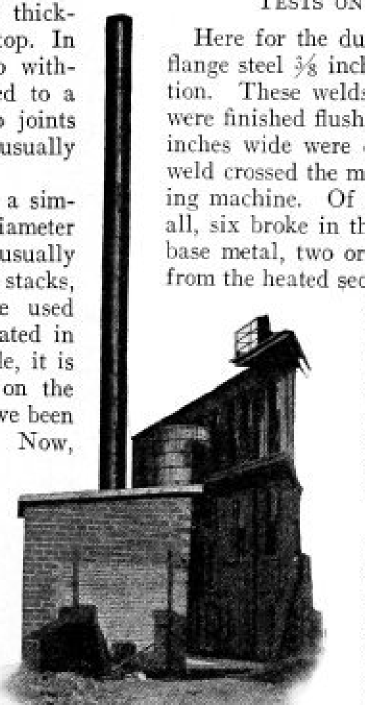
Comparison of riveted and welded stacks—Practical suggestions for carrying out welding operations

By T. C. Fetherston

WHERE they can be used, steel smokestacks are usually preferred to those built of other materials because of their comparatively low initial cost and the ease with which they can be erected. In general there are two types of these steel stacks: those that are self-supporting and those that are guyed.

The former type is usually built only in sizes over 5 feet in diameter and 125 feet high. The plates vary in thickness, being heaviest at the base and lightest at the top. In order to make the structure sufficiently strong to withstand wind pressure, the base is flared and bolted to a heavy concrete foundation, and double-riveted lap joints are used throughout. Self-supporting stacks are usually built up in place, sheet by sheet.

Guyed stacks are smaller in size, ranging from a simple smoke pipe up to a stack about 4 feet in diameter and as much as 100 feet high. These stacks are usually made of lighter plate than are the self-supporting stacks, and generally plates of the same thickness are used throughout. A guyed stack can be entirely fabricated in the shop. If too long for transportation as a whole, it is shipped in two or three sections and assembled on the ground before erection. Single-riveted lap joints have been used in their construction for a number of years. Now, however, quite a number of stacks are being fabricated by welding. These have already proved entirely satisfactory. A brief review of the characteristics of the two stacks makes the reasons for this success apparent.



The single riveted lap joint, with rivet spacing close enough to secure tightness, is seldom more than 40 percent efficient in strength as compared to that of the original plate. On the other hand the average oxwelded butt joint, properly made, runs to above 80 percent in efficiency, or is as strong as most quadruple riveted joints. When desired, even this high figure can be exceeded, and a joint stronger than first quality flange steel made.

This statement may sound like an exaggeration to people who are accustomed to think of oxy-acetylene welding as a means of securing tightness, giving it little or no consideration where strength is involved. However, the utility of a good oxy-acetylene welded joint from the standpoint of strength, has been amply proved, both in experiment and in actual service. The latter can very readily be illustrated by calling attention to the vast amount of welded equipment and the great number of metal parts that have been repaired by welding which have stood up under severe service over long periods of time. The former has probably nowhere been brought out to better advantage than at the annual meeting of the American Society for Steel Treating held in Boston last year.

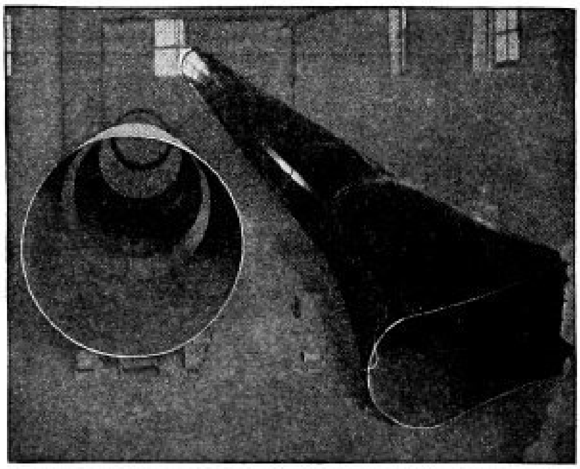
Tests on Typical Welded Specimens

Here for the duration of a week, welds in first quality flange steel ⅜ inch thick were made and tested to destruction. These welds were of the double vee butt type and were finished flush with the base metal. Test coupons two inches wide were cut from the welded pieces so that the weld crossed the middle, and these pulled in an Olsen testing machine. Of the total number of welds, about 80 in all, six broke in the weld and the remainder broke in the base metal, two or three inches from the weld—far away from the heated section. The principal feature involved in this test, however, was not the small number that broke in the weld, but the fact that the poorest of these breaks in the weld took place when the piece was stressed beyond 52,000 pounds per square inch, equal to the tensile strength of several of the samples which broke in the original plate.

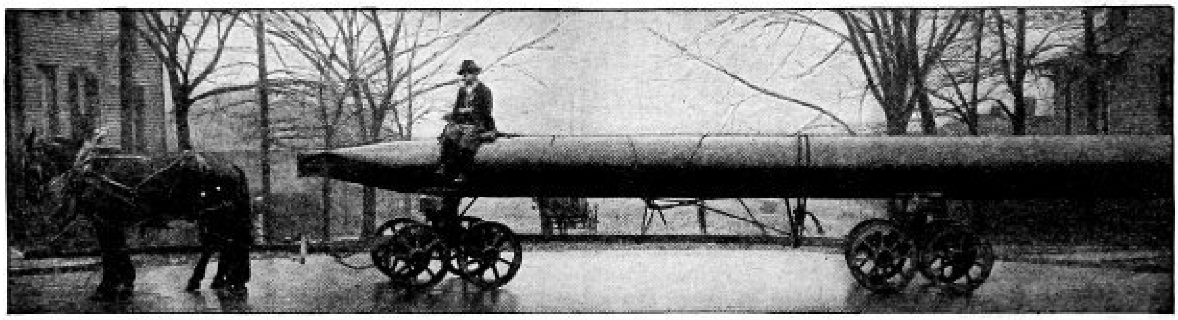
The results of this test demonstrated in a convincing manner, the fact that under the proper conditions and using proper welding rod, welds can be made that are as strong as first quality flange steel, even without reinforcing. With this point established, it is very easy to understand that a weld could hardly be worthy of the name if it is only as good as a single riveted joint. In fact it is no trick at all to make a weld under ordinary shop conditions with Norway iron rod that will be as strong as a triple riveted seam.

Quality of Weld Depends on Skill of Operator

In order to assure the maximum of success in welding on heavy sheet or plate, there are several important factors to be given consideration. One of these, of course, is to be sure that the operators are properly instructed and properly supervised. A man with the best intentions in the world cannot make a good weld if he does not know how; just as a man who knows nothing about riveting cannot without instruction, make a riveted joint that will be up to standards. On the other hand, regardless of the work that many men are called upon to do, unless they are properly supervised and unless the management insists that their work be up to the highest quality they are capable of producing,



Stack section lined up and welded



Stack in transit ready for erection

the work will often be slighted—that is only human and happens in every shop.

Another point is to select sheet or plate of good welding quality, tough and free from laminations or non-metallic inclusions, evenly rolled and tempered. Then the operators must be equipped with good apparatus and furnished with a high quality of welding rod. It is no more necessary that these features be considered in welding than in doing any other kind of metal work. With inferior tools, no mechanic or workman can be expected to produce a first class article. This caution, however, is necessary when welding is considered because many early failures in applications of the welding process were due to the use of inadequate apparatus, home-made flux and welding rod of inferior quality. Ordinary merchant rods, wire, or strips cut from sheet should never be used as welding rod.

In welding smokestacks, also, an important consideration is the fact that the plate must be properly prepared for welding and must be set up so that welds of the best quality can be made. These features will be mentioned in detail later.

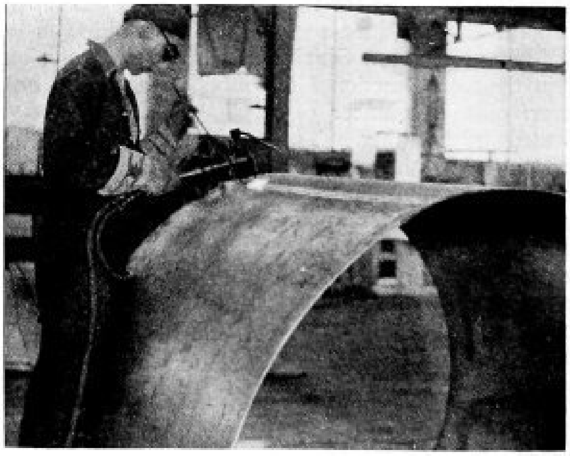
Corrosion Lessened in Welded Stacks

In addition to strength and tightness, another feature of the welded joint makes it particularly adaptable to use in fabricating smokestacks. Under normal conditions, corrosion in the joint is the most important factor affecting the life of a stack. Smoke from coal or oil almost always contains sulphurous gases. These combine with moisture in the air to form sulphuric acid which rapidly corrodes steel. Even though a riveted stack is well painted, acidulated water will collect on the edges of the lapped plates and seep into the joints.

A welded stack has no joints, cracks or depressions to retain moisture, hence corrosion is avoided and its life is much longer than that of a riveted one. The initial cost, too, of a welded stack compares favorably with that of one built by riveting.

Welded smokestacks have been built and installed in practically every kind and type of plant. Many chemical plants, cement plants, steel mills and foundries have had excellent success with welded stacks. In every instance so far reported, welded stacks have outlasted riveted stacks. It is difficult at this time to give the ultimate life, because even though some of them have been in use for several years, these have not yet begun to show any indication that they will soon have to be replaced. Under normal conditions, there is no doubt that the welded stack will give longer service than the riveted one.

Where irregularities in size or shape of the stack are encountered, welding offers several important advantages over riveting as a method for making the joints. There are practically no restrictions at all for welded joints. As long as the metal edges can be brought together and held in the proper relative positions for welding, a tight, strong joint can be made.



Method of welding stack section

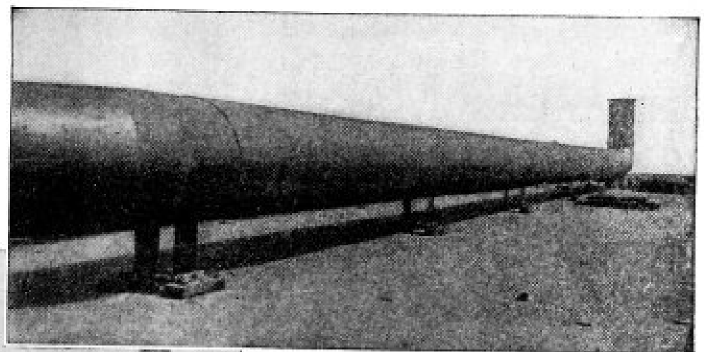
An all-welded stack involving several special features was recently erected on a western bank building. The intake for the ventilation system had been located too close to the short smokestack originally erected, and better distribution of smoke was necessary. To accomplish this, a horizontal steel tube 36 inches in diameter was run from a damper box, built at the base of the existing stack, across the roof to the other side of the building, a distance of 116 feet. There it ended in a vertical length about 14 feet high.

The damper box is about 3 feet 6 inches, and has a 5-foot by 5-foot 6 inch umbrella flange at the bottom which keeps out rain and still allows expansion and contraction. A damper within the box permits the use of either the old or the new stack, as dictated by atmospheric conditions.

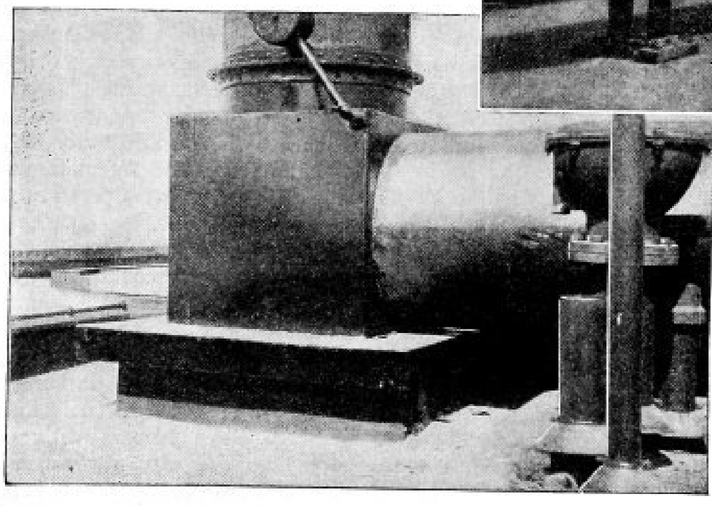
The horizontal flue, made of 3/16-inch plate, was shop-fabricated in three sections and hoisted to the roof and assembled by welding. It contains two 30-degree bends, to avoid skylights, and one 90-degree bend to make the turn to vertical at its far end. Eight steel plate saddles are oxwelded as supports. The total cost of fabricating, erecting and painting was about $1,200.

Steel stacks on tugs and river boats have to stand much more abuse than those on land. They are subjected to the same acid action and wind pressure as a land stack. In addition, they must weather the vibrations due to the engines, the

Steel stacks on tugs and river boats have to stand much more abuse than those on land. They are subjected to the same acid action and wind pressure as a land stack. In addition, they must weather the vibrations due to the engines, the shocks of bumping against tows, and the boat's pitching and tossing motion. Maximum life of riveted stacks in such service is 2 years. Some welded steel stacks put into tugs 3 years ago were recently examined and found to be in excellent condition, apparently good for several years more.



Damper box and horizontal flue



Arrangement of damper box

Shop Details of Stack Fabrication

All oxwelded stacks are made in about the same way. The procedure is very little different from that employed in building gasoline storage tanks or other types of round tanks where the size of the tank itself and the thickness of the material is about the same as involved in the fabrication of stacks. In preparing the plate for welding, it must first be sheared square and true because only by providing for this beforehand, will it be possible to produce a finished stack that will be regular and straight. (This caution, however, applies just as well to fabrication by other methods.) If the material is over ⅛-inch thick, the edges should be beveled. The single vee butt joint is practically always used. Beveling can be done by machine or with the cutting blowpipe. If the latter is used, the edges should be carefully cleaned with a cold chisel to remove any slag and scale that may be present after the cut is completed. The oxy-acetylene blowpipe is very convenient for this work and dispenses with the need of an edge planer.

Forming is usually done by passing the plate through bending rolls. Care should be taken to see that the entire section is properly curved as the tendency is for the sheet to come from the rolls practically flat at the two ends. This brings the weld outside of what would be the normal circumference of the stack—a fault which is emphasized by the heat of welding. If anything, the edges to be welded should be just a little inside the circle required for the finished stack.

The longitudinal seams are first set up and welded. Usually, the edges at one end of the seam are tack welded and clamps are used at the other end to space the sheet apart about ¼ inch for each foot in length of the weld. It may take several clamps along the joint to hold the edges in these relative positions. These can be taken out as welding proceeds or can be moved along the joint.

Welding should be carried on to completion as rapidly as is consistent with good workmanship so as to minimize the amount of heat thrown into the plate and thus prevent distortion.

Welding these longitudinal seams will produce a series of short cylinders which are assembled into the completed stack by welding the circumferential joints. The sections are usually lined up on cradles. For small stacks, these cradles can be nothing more than a length of large channel or an H-beam. Sometimes, they are made of two lines of I-beams laid end to end and secured to the floor. In other instances, old rails are used, properly lined up and properly secured. Care must be used in setting up these guides as upon their accuracy will depend the accuracy of the finished stack. Frequently, cradles are fitted with rollers so that the sections can be rotated during welding of the circumferential joints. In lining up the cylindrical sections, the longitudinal welds should be staggered. This again is good practice regardless of the joining method.

When assembling for the circumferential weld, a space of about 3/16 inch should be allowed between two sections. This, however, as in the spacing on the longitudinal seams, is subject to some variation depending upon the thickness of the sheet, the size of the blowpipe tip used and the speed of the operator. A speedy operator will require less spacing between the sheets than a man who is slower.

This space should be maintained with H-clamps or double L-clamps. Sometimes these are left in position until the weld progresses almost to them. In other instances, they are used simply to hold sections in place for tack welding. The latter is probably the better practice.

For tack welding cylindrical sections together, two welders should work at points 180 degrees apart on the circum-

(*Continued on page* 170)


Frank Gray
Retiring President


T. F. Powers
President


J. F. Raps
First Vice-President

Master Boiler Makers' Association Meeting at Chicago

Sixteenth Annual Meeting of the Master Boiler Makers' Association proves to be one of the most successful in its history

THE sixteenth annual meeting of the Master Boiler Makers' Association opened Tuesday morning, May 19, at the Hotel Sherman, Chicago, with about 700 members, guests and supply men in attendance. President Frank Gray was in the Chair at the opening session. After the invocation by the Rev. J. A. McCarthy, H. T. Bentley, general superintendent of motive power, Chicago & North Western Railway, addressed the meeting. An abstract of his remarks follows:

Abstract of Mr. Bentley's Address

IT is again a great pleasure for me to be able to address you in convention assembled, and I sincerely hope that much good will come of this meeting, not only to the railroads you work for, but also to yourselves.

When addressing a body of railway men such as we have here, it hardly seems as if the name of your organization really brings out the fact that a majority of your members are railroad employes, and therefore it would seem to be more in keeping with the aims and objects of your association if it could be called the "Railway Master Boiler Makers Association"; such action should not, however, prevent boiler makers in other industries from becoming members, if they desired, and your by-laws did not prevent them doing so. This is a subject that has been brought to my attention on several occasions, and I thought I would speak about it for such action as you might find advisable and desirable.

Since our last meeting twelve months have passed, and we therefore should, in that time, have gained experience that will better fit us for the positions we hold, and make us stand out and be available for promotion when vacancies occur or better positions are put on.

At a recent meeting of the Western Railway Club we listened to a splendid paper by A. G. Pack of the Interstate Commerce Commission, Bureau of Locomotive Inspection; it was without question one of the best talks the members of that club had ever listened to and no doubt some of you were present and heard it. One of the outstanding things Mr. Pack said was to the effect that the boiler was the heart of the locomotive and, therefore, unless the boiler was maintained in proper condition, the locomotive as a whole could not give first class service and economical results, and as you are interested in boiler maintenance, the words of Mr. Pack should be taken home with you and every move made ought to be in the direction of efficiently maintaining the heart of the locomotive, so it can properly perform its function of furnishing steam to the engine.

While on the subject, I would like to draw your attention to the splendid efforts made and results obtained in reducing the amount of fuel used per car mile or per 1,000 gross ton miles during the past few years.

You men can help materially in the direction of fuel economy as you know that a boiler with flues, side and crown sheets covered with scale, and flues stopped up, will burn more fuel than one that is clean. The proper rattling of arch tubes helps in that direction and also saves trouble and possible accident due to their failure when not kept clean; it is therefore essential that you see that everything is done to have boilers properly washed out and all heating surfaces kept as free from scale as possible and tubes and flues cleaned out regularly and properly and all air leakages around front end, steam pipes, and other places, kept tight where it would interfere with the proper steaming of the locomotive boiler.

With the difficulty experienced in some places of getting boys to start in as apprentices to the boiler making trade, it has been necessary in a number of cases to make boiler makers through the helper apprentice route. In small towns where there is a railroad population, boys can sometimes be secured as apprentices. Whichever way boiler makers are made, special efforts should be exerted so that the beginner will have ample opportunity to properly learn the trade and the foremen are the ones who should see to it that this is done. It is a reflection on the foremen when a man has served his apprenticeship if he cannot be used successfully on any kind of work that he is called upon to do.

While going through various shops, it is gratifying to see the improvements that have been made to increase the output and improve the quality of the work performed. In some cases improved tools have been to some extent responsible, but in most cases foremen have discovered that when financial conditions will not permit of the purchase of new tools, they must look around and see what improvements can be made in their methods of doing work, and it is a great satisfaction to find what strides have been made in that direction. It is very desirable and necessary to get new and improved tools, but until that is possible we must not lay down in our efforts to get better results.

With the high cost of material, great care should be exercised in using it to the best advantage.

The reclamation of usable material is a good thing if not carried to the extent that we are spending more on reclamation than the new material would cost and when finished it is not as satisfactory and would not last as long as it would have done if new material had been used.

With the large amount of competition from motor bus and motor truck companies by which freight and passengers are handled over roads that have been paid out of the taxpayers' pockets, the railroads furnishing the largest amount of money for this purpose, every effort must be made to overcome such unfair competition and see to it that those common carriers are treated as such and be governed by the same restrictions that the railroads have to contend with.

It is stated that in 1924, 12,500 additional buses and automobiles for bus use were built and placed in service, and it is estimated that two and one half billion passengers were carried in old and new buses in that year, taking business from the railways and using roads that the railroads, through taxation, have helped to build. The freight and passenger automobiles should be required to contribute their fair proportion of taxes for building and maintaining the roads they use at a great profit to themselves and a corresponding loss to the railroads we work for.

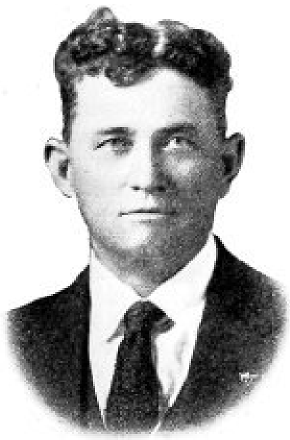
We have made great progress during the last few years in the question of water purification and treatment and the results obtained show that expenditures in that direction are fully justified.

The question of preventing flue leakages during the past few years appears to have been brought under fairly good control due to improved water, better methods of handling flues in shops and roundhouses, etc., and to show what can be accomplished by going after it I will cite the case of the C. & N. W. Railway which in 1911 had 787 flue failures or over two a day, and only made 58,633 miles per flue failure. In 1924 we had a total of 47 failures, or about four per month, and made an average of 1,062,910 miles per failure.

Our old enemies, pitting and corrosion, are still with us and apparently to a greater extent than ever before. A considerable amount of research work has been done on this subject, but so far we do not appear to have reached a point where we can say definitely what causes this trouble, neither can we make use of any remedy that can positively be stated will overcome this money wasting condition. The leadizing, or coating with lead of boiler flues, looks as if it might result in some good and tests are being conducted to see what will happen and hope that they may prove satisfactory, and if so, some similar action might be possible to lead coat the inside of boilers having the same idea in mind, although it might be a rather more difficult proposition than lead coating of flues.

Following Mr. Bentley's address the president delivered his annual talk. An outline of his remarks is given in the following paragraphs.

W. J. Murphy
Second Vice-President



L. M. Stewart
Third Vice-President

S. M. Carroll
Fourth Vice-President

Abstract of President Gray's Address

IT is a great pleasure to greet you this morning at this, the opening session of our 16th annual convention. Looking into your faces, it is most gratifying to note the presence of a number whom I have known personally for a long period of years as well as many younger men whom I have not known quite so intimately and upon whom must eventually devolve the responsibility of taking up and carrying on the important work of the association, along the lines of progression and constructive purpose.

It is my recollection that it was my privilege and pleasure to take part in the first meeting held to discuss and determine whether it would be advantageous to our employers and beneficial to the members of our craft to organize an association of foremen boiler makers whose objects should be the mutual benefit and advancement of its members upon a broad basis. Fortunately for all concerned, affirmative action was taken, for that was the first step taken in the formation and development of this progressive association that has been so highly beneficial to every man who from time to time enrolled as a member: previous to this organization very few were personally known to each other and comparatively no familiar knowledge of their activities and what they were doing, or how it was being done.

Recommended practices or standards should be adopted but no standard should be made a governing source of method and practice until its merit has been demonstrated by proper trial and experience. This applies with equal force to appliances and processes.

This association covering such a vast territory and boilers using every conceivable kind of water, and maintained often with the utmost difficulty, that standard ways and methods would not operate the same in all localities.

The idea of recommended practices appeals to me as calculated to prove the most satisfactory. Every member should be furnished with a loose-leaf binder or other suitable cover and all recommended practices when adopted by the association should be printed in such form as would fit this loose-leaf binder so members could put them in year after year and keep them in their desks for daily reference.

When the Federal Boiler Inspection Law was first proposed, many of us received it questionably, not without reason, foremen boiler makers having been trained in the hard school of experience, and naturally sensitive as to their work and that their way of doing it was not considered good enough. But after a fair trial and cooperating with the Federal Inspectors, it is my belief that every foreman boiler maker is 100 percent for it.

May what is said and done at this convention have a far-reaching influence on the design, construction and maintenance of the steam boiler.

The remainder of this session was devoted to reports of the secretary and the treasurer and to routine business. Letters were received from A. G. Pack, chief inspector of the Bureau of Locomotive Inspection and A. R. Ayers, assistant general manager of the New York, Chicago & St. Louis Railway, expressing regret at their inability to be present at the convention. At this point Mr. Bentley was proposed as an honorary member of the association. Action on the motion was taken up later by the executive committee and Mr. Bentley's name has been placed on the rolls of the association. This action was taken in recognition of the work that Mr. Bentley has done for the association for a long period of years and for his active support of the railway executives.

F. A. Lucas proposed that some action be taken on the matter of having the master boiler makers' names entered in the *Official Railway Guide* as well as the *Pocket List of Railroad Officials.* This representation in the official rolls of the railroads is something that must be presented by the superintendents of motive power or the master mechanics and a committee has been appointed to take the matter up with these officials.

Wednesday Session

The Wednesday morning session was opened by President Frank Gray at 9:30 o'clock. W. J. Tollerton, general superintendent of motive power of the Chicago, Rock Island & Pacific Railroad, was the first speaker of the day.

Abstract of Mr. Tollerton's Address

I believe that I will take for my subject, this morning, one that you are more or less familiar with, that is, economy. I imagine most of you hear of that all the time. As far as we are concerned, we talk economy all day, and dream of it at night. But the railroads of today, and especially the railroads of the West, are confronted more and more with the need of economy in operation. As the maintenance of equipment expense, next to the transportation, is the greatest that the railroads have to deal with, therefore, when economies are called upon on the railroads, they look to the Motive Power Department to furnish the economies. Unfortunately, we are called upon to produce service, and when the gross earnings begin to fall, we are the first department called upon to satisfy it.

The railroads, today, are having their gross revenue constantly curtailed by the growth of the automobile, truck, both freight and passenger. The annual growth in freight revenues has not scarcely kept pace with the annual loss in passenger revenues. The result is that the railroads to operate efficiently must constantly study the expense problem to endeavor to get their expenses down within their earnings.

The railroad industry, while one of the largest business concerns in the country today, is one of the most controlled businesses. Their earnings are controlled by a Government body and their expenses are controlled by another Government body, while they are compelled, if you please, to go into the open market in competition with any other concern in the purchase of material.

One of the great expenses confronting the railroads today, in transportation costs, is the fuel bills. Transportation costs, on the railroads today, are running between thirty-five and forty cents out of each dollar, while 25 percent or 30 percent of the transportation cost is represented in fuel. The locomotive boiler has a most direct bearing on whether you will be economical in fuel or extravagant in fuel.

In recent years there have been several well developed and tried devices for using fuel economically. The superheater has been so well tried that it is scarcely necessary to discuss it any more. Other devices have come into use in the past few years that have been thoroughly tried out and acknowledged, both as a fuel saver and improving boiler operations. One is the locomotive syphon; also, the feedwater heater is coming into more and greater use. All of these devices will bring about the saving of coal.

It has been estimated on our railroad that if we can save one pound of coal per 1,000 gross ton miles, per annum, we will save $40,000.

I notice one of the papers that you will have is on the electrical welding of flues in the back tube sheet. This is a practice that we have been following for a number of years. You can, by properly welding all flues in the back tube sheet, let an engine go from shopping to shopping, making from 55,000 to 90,000 miles, without having a boiler maker in the firebox.

I believe, today, that the locomotive shops are the most woefully inefficient in suitable and up-to-date machine tools of any big manufacturing plant in the country. A boiler shop is no exception. There are modern tools being brought out every year that will improve and cheapen production. It is the duty of you men to see that your shops are equipped to the best of your financial ability with machine tools that will properly and economically handle your work.

Growing difficulties of the railroads are constant. I believe that you have seen where there are certain reductions being made in forces. Other roads are compelled to close their shops. It goes without saying, gentlemen, that you can not maintain equipment with your shops closed. It never has been done and it never will be done. Therefore, it is our duty to try to maintain our equipment with as little expense from the dollar coming over the counter as possible from freight and passenger revenue.

The average railroad spends, in the maintenance of equipment, about twenty-five cents out of each dollar taken in in freight and passenger revenue. It isn't too much. A locomotive boiler, improperly maintained is the most extravagant thing that can be put on the locomotive, today, because your fuel cost is the highest cost that goes in to making up the expense of transportation. The fuel goes through the locomotive boiler. If it is not, first, properly designed, and, secondly, properly maintained, what do you have? You have a fuel-burner instead of a power-generating unit.

In your experience, you know where losses occur, and therein lies your responsibility for keeping watch, through proper inspection, to see that flues and grates are clean, all leaks stopped, or anything that would hinder in anyway getting the maximum efficiency out of the boiler as it makes its trip over the road. You well know how far a boiler failure on the road may reach, by the delays, increased consumption of fuel over what would have been necessary if the boiler functioned properly in its important duty of supplying steam at the proper pressure in the cylinders for useful work, which is finally found in the gross ton miles.

Following Mr. Tollerton, representatives of the Chambers of Commerce of Buffalo and Cleveland outlined the advantages offered by these cities for the 1926 convention.

Acetylene and Electrical Welding of Firebox Sheets

YOUR committee decided that in view of the fact that the report of Committee on Recommended Practices and Standards* on Proposed Code of Rules to govern autogenous welding on steam pressure boilers, which was read before the convention last year, and covered by motion, this report be voted on by sections to be accepted or rejected by the 1925 convention.

This report is so complete and covers all classes of welding as well as the welding of flues in back tube sheets, that it is not necessary for any additional report and there should be all the discussion that time will allow to pass on this report.

Your committee recommends that copies of the 1924 report be distributed to all the members so they can read and study same, in order that they can vote on the paragraphs or sections, as read, intelligently.

On February 9, 1925, the A. R. A. voted on certain rules and regulations covering autogenous welding and we, as boilermakers, should do the same, giving careful consideration to this subject, and for the best results. This subject has been discussed at our conventions for years and we feel that from our knowledge and personal observation we are capable of voting on a set of rules to govern autogenous welding on steam pressure boilers without fear of criticism from the mechanical world.

This report was prepared by a committee composed of L. M. Stewart, G. F. I., Atlantic Coast Line, Waycross, Ga., chairman; John J. Keogh, David J. Hartford.

Next in the order of business was the reading of Topic No. 1 above by L. M. Stewart of the Atlantic Coast Line. In the course of his remarks Mr. Stewart stated that in view of the fact that the report of the committee on recommended practices and standards on rules to govern autogenous welding on boilers is so complete, the committee feels that no additional report was necessary on the subject. It was moved by the meeting that the report on standards be discussed paragraph by paragraph. Before entering the discussion, however, J. A. Doarnberger of the Norfolk & Western Railroad outlined a series of tests made on welded specimens, the gist of which follows:

J. A. DOARNBERGER (Norfolk & Western Railway): I consider this one of the most important subjects that has ever come before the Master Boiler Makers' Association. In reading over this report, the Committee has to be congratulated on the work that they have done. We do not want to go back to the old days of the punch and riveted hole. We know well enough from past experience that patch bolts under 240 pounds are things of the past. We know that autogenous and electric welding has been the means of making it possible to keep our power going that would not be possible otherwise. A great many of us know that the American Railway Association has this subject up. They have been voting on it all over the country. I know, in a general way, what that vote has been.

G. B. Usherwood
Fifth Vice-President

W. H. Laughridge
Treasurer

H. D. Vought
Secretary

A. F. Stiglmeier
Chairman of Board

Mr. Pack has repeatedly warned us, in his addresses throughout the country, that if more carefulness was not exercised in the application of autogenous welding in fireboxes, he would be compelled to ask the Interstate Commerce Commission to grant him the privilege of making more drastic measures. I visited a certain place, a few weeks ago, and am not surprised at Mr. Pack's statement. I saw some of the most horrible welding that I have ever seen in my life. It would make one shiver to see how this thing has been abused, and sooner or later, we will be defeated in all that we have been doing along this line.

I worked patiently with Mr. Pack and with a Committee of the A. R. A. I have some welded test specimens with me. The Committee on this has made some very good tests. We have made laboratory tests, and we have proven beyond a doubt that electric welding in fireboxes is far superior to the old riveted and patch bolt systems. It would be a pleasure for me to show you some of those specimens here this morning, as I believe they would be of benefit to all of us, and before this report is adopted, I have a recommendation or a resolution to offer in regard to this.

The first is known as the scallop weld having four 1 inch rivets and 4 inch pitch. We tried this weld by throwing the line of force through the section of the plate, to see whether or not we could tear that weld through on a firebox, but instead of that, when the pull came on, it was elongated one-eighth of an inch at 90,000 pounds. The ultimate strength was 96,500 pounds. Instead of that breaking at the weld it tore through the hole, touched along the electric welding edge, followed up to the next hole and let the electric welding remain intact at a load something in the neighborhood of 96,500 pounds.

*Report appeared on page 257 of the September, 1924, issue of THE BOILER MAKER.

We tried another one, making it longer. In this case the specimen elongated one-fourth of an inch. The load on that plate was 124,600 pounds, and before it started at the edge of the weld, it broke through the weld, took a downward course and let the lap remain intact.

We went on a little bit farther than that for a straight pull. We took two plates. We connected them together by reinforced plates with four 1-inch rivets. We pulled those sheets and in this pull the yield point went to 95,220 pounds, ultimate elongation was 5/16 in 6 inches. It did not break through the weld at all. It broke through the line of holes again.

On the next one we took a straight weld, right straight through the section of the plate, and that weld never broke through the hole. On the straight weld, not on the scallop weld, the yield point was 95,200 pounds and the elongation was 5/16 in 6 inches and it broke through the line of holes.

We wanted to go a little farther and we left the holes out. We took the scallop weld. It never went through, not in the direction of the weld.

On the next one we took a straight weld. Instead of following that, it broke through the line of rivet holes and let the weld remain intact. The yield point of that was 95,000 pounds, and the elongation was 3/16 in 6 inches.

Now, as I say, we have made these tests, and we must continue, in order to carry on the electric welding in fireboxes, which we know is quite an improvement. We do not want to go backward and have the Interstate Commerce Commission stop the advancement of this wonderful progress.

We have had boilers with welded fireboxes in service on the Norfolk and Western since 1909, and they have proven entirely satisfactory in service.

Professor Kinsey of the Stevens Institute then outlined the attitude of the American Society of Mechanical Engineers towards welding in general.

PROFESSOR KINSEY (Stevens Institute): I have just come from the meeting of the A. S. M. E. in Milwaukee. I am a member of the American Society of Welding Engineers, with headquarters in New York City, and I have written quite a lot about autogenous welding. Therefore, maybe, I could speak with a little authority.

I do not think that you need to worry about the future of autogenous welding, or shall we drop that word because it came over from France, and use the word, *fusion* welding?

The Boiler Code Committee of the American Society of Mechanical Engineers has worked with the Committee of the American Society of Welding Engineers (of which Committee I was Chairman for several years), and they have adopted a Code which will cost you $1 if you want to get it. I bought one yesterday, myself. They allow an efficiency of about 50 percent, that is gotten from a formula, which is based on the tensile strength of the steel you use, and it figures about 50 percent or 52 percent of the strength of the weld. We all know that we can make welds much stronger than that, but that is where the old forge weld had to start, 50 percent efficiency, and the safest way is to take the new method of making the weld. They have the old forge weld efficiency value up to 65 percent, and they have told us, those who are active on that Committee (and I am very close to the members of that Committee) that we need not worry; that they expect to give us greater value, and all they want is to wait a little while longer to be sure that we have our welders under control.

Now, that won't need to take long, and I feel pretty sure in saying that within a few months, the efficiency value of the fusion welding done by electricity and oxy-acetylene, and very likely where we use the fusion weld by the thermit process, that efficiency will be increased. That does not apply to boilers and it takes in, therefore, all kinds of tanks and it will take in piping, because that is a pressure vessel.

I just wanted to get over to you a feeling that while I am not directly a member of your organization, yes, I am, too, because I am my company's representative, I want you to know that you do not need to be nervous about the fusion weld. If you can keep on doing the work, training your welders and insisting on quality work, you need not have any fear whatever of the future of welding.

H. H. SERVICE (Santa Fe): I believe you have all heard me get up here before and make remarks in regard to the checking of the efficiency of your welders.

This year, we have totaled the entire records of all of the welders on our lines as to their efficiency. Now, this record includes men with one week's experience and men with seven or eight years' experience.

We took four of the largest shops on the system, all of the test plates, and they furnish one a month; and four of the largest roundhouses where most of this autogenous welding was being performed. We have a minimum of 57 percent efficiency, calculated on 52,000 pounds, tensile strength, firebox steel.

Then, we have an average, of 98 percent efficiency. That is for oxy-acetylene welding. For the electric welding, we have minimum, 75 percent, and the average, 99 percent. That is for the large shops.

Now, for the roundhouses, where they have variety and different classes of work, the minimum for the oxy-acetylene welding was 80 percent, and the average was 100 percent. When we say 100 percent, in some instances it is based on 52,000 pounds per square inch and some of the steel will break at 60,000 pounds. Of course, that brings your average to the one hundred mark.

With the electric arc welding process, 78 percent, for the minimum, the average is 101 percent. That 101 percent, of course, is taken up by the same method as I previously explained, steel breaking at 60,000 or 62,000 pounds and based on the 52,000 pounds, firebox steel.

All these welds are reinforced 20 percent, just as you would ask your welders to make your welds in the fireboxes.

T. W. LOWE (Canadian Pacific): I would like to ask several of these gentlemen just one question. In referring to the tensile strength, or the failing point of the weld, did that refer to the sectional area in square inches of the weld or what?

H. H. SERVICE (Santa Fe): That is based on the sectional area of the steel.

T. W. LOWE (Canadian Pacific): I would like to know if the sectional area is of deposited metal?

H. H. SERVICE (Santa Fe): No, asking for 20 percent additional.

T. W. LOWE (Canadian Pacific): The reason I asked that question was because I asked the Locomotive Boiler Works to make a little investigation for me, and they returned to me a letter, which I have with me, in which they said that the weld that they had tested for me showed 58,000 pounds tensile strength, and that weld only welded from one side of the plate. I want to give you that for your information, gentlemen, because our Committee has not included what we are universally using on the Canadian Pacific, and which is standard. I do think that when we are speaking of the weld, we should speak of the sectional area of the deposited metal.

H. H. SERVICE (Santa Fe): I wish to withdraw my remarks about the sectional area. I misunderstood you. That was based on the sectional area of the weld.

LEONARD C. RUBER: When I received a letter several years ago from our former president, Mr. Lewis, that I had been appointed Chairman of this Welding Committee, I was amazed, because I felt the responsibility that was thrust upon my shoulders.

I asked myself the question: "Am I capable to head a Committee of such vast importance to the United States?" After serious thought, I concluded that some one had to do it. Someone had to make the start. I immediately got in touch with the rest of the Committee, and you can rest assured that the rest of the Committee felt the same as I did, they felt that great responsibility. After going over this subject for one year, we did not feel as though we had given it enough thought and enough time. Therefore, we asked for an extension of time, which was granted to us. Now, we prepared this subject, and I think that it would be doing an injustice to the Committee that prepared this subject for us to adopt it without having first gone over it very carefully as an Association. As I said at our last meeting, we did not consider our own individual practices, because we, as a manufacturing company, cannot to a certain extent, have a standard practice. We have to accept and build according to the practices as outlined in the specifications and prints that we received from the various railroads. Therefore, I want to cast from the mind of any one who has such a thought that we were trying to put into that report our standard. We gathered the information for a standard from every possible source.

Well, gentlemen, I think with a subject of this kind, an important one, one that is going to be put before the world, you have to ask yourselves a very important question, "Have we something that we are not ashamed of? Have we something that we are not afraid to put before any association or any group of intelligent men and say to them, 'Here, we present this to you as a standard of autogenous welding'?"

T. F. Powers: I would like to make a recommendation on this paper, so as to see if we can not cover some ground on it, and, that is, that the recommendations covering the use of autogenous welding in steam boilers be read section by section and voted on, and any amendments offered to any particular section will be brought up at that time and voted on, either accepted or rejected. I make that as a motion.

The discussion of welding continued and each section of the proposed Code was read, revised and in some cases referred back to the committee for further action. This report appeared in complete form on page 257 of the September, 1924, issue of The Boiler Maker. It seems unnecessary to repeat this report at this time but when final action has been taken and the report accepted as a standard by the association in its revised form it will be published again in the magazine. The discussion on this subject occupied the remainder of the Wednesday session.

Thursday Morning Session

The meeting convened at 9:10 o'clock with the president in the chair. After considerable routine business was settled the discussion of special topics was opened by the reading of Topic No. 3 by L. W. Steeves, general boiler foreman, Baltimore & Ohio Railroad.

J. A. Doarnberger as a member of the topic committee reported that the subject of "Cracked Bridges" had been included in the schedule because of an epidemic of trouble of this nature on combustion chamber boilers on his and other roads. He outlined the experience of the Norfolk and Western in trying to overcome the difficulty, by welding and patching and other means, but the results have not been as satisfactory as they might be. Finally a bar reinforcement was used around the knuckle to strengthen the sheet where the movement was greatest. This method of support has proven fairly successful up to the present time, but a further time test is necessary to indicate whether or not it provides the correct solution.

This report on "Cracked Bridges" will appear in a later issue together with the discussion. The subject of "Flue Sheets" was next taken up by the convention.

Flue Sheets—Combustion Chamber Type Boilers

The chairman is unwilling to submit a report as he has not been able to understand what was wanted. The following individual report was prepared and submitted by Mr. Lowe and under the circumstances is printed with Mr. Patrick's consent.—Secretary.

(a) Direction, range and extent of movement of crown sheet with relation to related parts, and how can conditions be best controlled or provided for.

The western lines of the Canadian Pacific Railway have operated boilers of this design during the past five years both in good and bad water and have not observed that the movement of the crown sheet is any different from what obtains with the firebox which is minus the combustion chamber. The same class of defect such as cracks running laterally in the top root of the back tube sheet flange are no more common with this design than the ordinary firebox. The cracks extending outward from the tube holes are more numerous than with the ordinary firebox. They extend from the water side of almost every tube hole throughout the circumference of the tube sheet, whereas the ordinary firebox exposed this defect over the top tube holes only.

To control the first of these conditions we should have a two inch radius for the flange throughout its circumference and thus secure greater immunity from lateral cracking. The provision required for the second condition is a greater depth of flange which will increase the strength of the plate section between the outer edge of the tube holes as well as permit more freedom for the body of the sheet to expand and contract.

(b) Design of connections between flue sheet, crown and side sheets.

Until such time as restrictions are removed from the universal use of welding methods, I consider we should connect the top flange of the flue sheet with rivets until the crown sheet is submerged 18 inches with water and use a lap welding method to unite the remaining flange to the combustion chamber.

(c) Bracing of flue sheets.

The only bracing to the firebox flue sheet now is that afforded from the superheater and ordinary flues. The deeper flange prescribed in Section "A" of this paper is suggested with a view of almost encircling the tube sheet with a method of staying independent of the crown sheet or combustion chamber plate. This stay is suggested to secure the deep flange of the tube sheet and shell of the boiler together as far as it extends. Openings would be provided to allow free water circulation and the stay would be arranged so as to not interfere with keeping the bottom of the boiler clean under the tubes. Several other tube sheet stays are desirable which should be secured to the shell of the boiler and extend forward of the combustion chamber instead of under it. This suggested staying is with a view of preventing the defect now common to tubes which crack and groove immediately inside the front tube sheet.

(d) Crown bolts, the design and arrangement of which have influence upon the flue sheet.

The first four rows of crown bolts next the tube sheet should be of such design as will give the tube sheet freedom to expand upwards, thus preventing the permanent set downwards of the top tube sheet flange which ordinarily obtains when rigid stays are employed at this location.

(e) Development of any form of distress in flue sheet connection with crown sheet.

1. "In what form?"

No serious defects have occurred during five years operation except the small cracks extending outward from the tube holes and the lateral cracking in the top root of the flange.

2. "How cared for?"

The former have not developed sufficiently to necessitate repairs and the latter being a roundhouse development were taken care of temporarily with the electric welding method. The cracks are usually V'd, welded internally and externally, as well as reinforced internally. This class of repair proves entirely satisfactory to operate the engine until it is shopped for machinery and renewal sheet.

3. "Effect of length and staying of combustion chamber as well as the relation of the combustion chamber to the barrel sheets upon the flue sheets."

There is about two feet difference in the length between passenger and freight combustion chamber engines. The passenger engines are about 32 inches long from the front of the mud ring to the tube sheet and the freight engines about 57 inches. The tubes on the long combustion chambers fail by grooving and cracking immediately inside the front tube sheet about twice as early as those on the short chambers. Pitting is more severe on superheater flues and ordinary flues with the long chambers than with the short ones. The short combustion chamber has flues about two feet shorter than the long chambers.

The staying of the long or short combustion chamber boilers to the barrel sheets are alike and the flue sheets do not appear to suffer due to the method employed. About half of the entire combustion chamber has flexible staybolts which divide equally from the top center of the boiler and the bottom half are equipped with tell tale rigid staybolts.

The life of the flexible bolts in the combustion chamber has not been determined because none has been removed due to breakage in about five years time, whereas the rigid telltale staybolts surrounding the bottom half of the chamber and side walls became so troublesome due to frequent breakage after four years service, it was considered profitable to renew all of them within four years service. These rigid bolts are now renewed at the nearest shopping date to four years.

The advantages of this procedure are economy in application, relief to the roundhouse, quicker dispatch and greater security. The long combustion chamber boiler and long flues develop pitting in the front tube sheet immediately above the flues and at the front of the crown sheet which never attacked boilers of other design in the district where these engines were assigned heretofore. The district referred to has the same source of water supplies now as during the past 30 years and analysis does not indicate that it should be under suspicion.

It is my opinion that the combustion chamber boiler has so many advantages to favor it compared to the boiler without it, that these defects are of minor importance, particularly when we expect to overcome the defects by mechanical methods assisted with means whereby the water and foreign matter at the front of the boiler will be kept in free circulation the same as other parts of the boiler, rather than having the front tube sheet act as a breakwater to hold all the impurities against it and thus create sluggish condition at that location.

This report was prepared by a committee composed of Charles P. Patrick, Macon, Ga., chairman; T. W. Lowe, George B. Usherwood.

Discussion

MR. PATRICK: Mr. Chairman, I did not compile a report for the reason that I did not understand the question that was asked. I should have resigned from the committee at the time of my appointment. Therefore, I accept Mr. Lowe's report, if the convention will.

T. W. LOWE (Canadian Pacific): Since I had that report forwarded, I have made some experiments, and there is a slight change in the method of flanging the back tube sheets for combustion chamber boilers, to overcome or assist in overcoming the cracking that you speak of, transversely, and, again, to prevent the cracking which now develops in forms such as my friends here expressed, and even surrounding all the tube holes, and while we have no data yet as regards the result we may expect from this application, I thought it would interest you.

This method of flanging a tube sheet, back tube sheets, or any other kind of tube sheets, for any class of boiler can be performed only by the assistance of a machine which we recently bought from the McCabe people.

I want to say that this tube sheet is flanged entirely cold. The first flange is the large part of it, the second operation is the shoving in of the portion to give you that nice radius, just like a two-inch flue around that tube sheet flange, and while we have three engines which have been in service now about four months, you can readily understand that it is far too early for me to tell you what the results are going to be.

GEORGE AUSTIN (Santa Fe): I would say that we made some very complete tests, that is, had apparatus and flanges and indicators of various kinds all over the boiler. We know just how it moves, that is, on the outside, but we do not know just yet what conflicts between the outside movement and the movement of your firebox sheets, or other parts which we were not able to clearly determine.

It has been indicated that there is an outward movement of the side of the wagon top or outside wrapper sheet. We concluded that was on account of the upper flow of the accumulative expansion, as it went up. That was one feature.

That upward flow of expansion is met by a downward tendency of the radius passing this upward movement. In other words, the sheet inside the wrapper sheet tries to pass the outside wrapper sheet and it has bolts and it has to shove the outside wrapper sheet to do it. The upper part of your wagon top sags down or is pulled down from it. It pulls the top down and pushes the crown sheet. Some of those things I said we are not quite clear about.

It is not only that, but we also concluded that there is an expansion, a cumulative expansion, if you please, from the center of your crown sheet, each side, and it is also traveling toward this short radius. As it hits this short radius, there is a wave that precedes it, and this wave passes and may come back again. We have indicators there that showed that one part of the point indicated this way, which was run to the right; another part of it comes to the left, indicating that there must have been some sort of wave like movement that caused that indicator to vibrate in that way.

Now, it is those things that I speak of that we are combating today, and this is my opinion, whether it be in cooling or firing up or heating up, when your locomotive is working its hardest and that firebox sheet is taking all the work that it is capable of taking, there is more strain and more movement there than at any other time, and that is one of the strong arguments for good clean boilers.

T. F. POWERS: I would like to ask Mr. Austin, as a result of all tests conducted, if he has done anything to remedy the cause of this.

GEORGE AUSTIN: We had a lot of locomotives built. The tests would not change those engines. Now, we have to wait, and, perhaps, in the next locomotives we build we will have some improvements. One thing seemed to be pretty clearly suggested, that on account of this wave movement that I spoke of, you have to put in a bolt upon that radius that is going to be a little bit stiffer than what we have been putting in there. In other words, you make your bolt so much weaker in the sheet that the sheet will bend it backward readily, so you have to make your bolt a little larger to bend the sheet a little. The bolt has to bend around this way and the other way, and there is no question about the wave in my mind, although I cannot prove it.

MR. HARDAMANN (M. K. & T.): Has there been an investigation as to the difference between the flange knuckle and the flue sheet being flanged cold and flanged hot? I think it would be well to embody that in the report, mention the fact whether there is any difference in the life between a flue sheet that has been flanged cold and one that has been flanged hot.

T. F. POWERS: We find that the knuckle of a hot flanged sheet cracks just as quick as when they are cold flanged.

J. P. POWERS (Northwestern): There is one point that has not been touched on in this paper. We have a lot of knuckle cracking. In fact, our flue sheets do not last much longer than our flues. We have to renew our flue sheets about every eighteen months. We find that the primary cause of this is due to pitting, and that is what starts your cracks. We do not find any clean cracks in a knuckle, all due to pitting or corrosion. The point I had in mind is that if we could control that pitting by plating the knuckle, after the flue sheet is flanged, we may stop something.

H. J. WANDBERG (C. M. & St. P.): There has been a great deal said about the cracking of flanges, the expansion and contraction. I have been in this game for a great many years. They had it when I first started and still have it and will continue to have it as long as we have internally fired boilers.

There is one thing that we can do, I have done it, you can increase the radius of your flue sheets and control your troubles in the crown sheet. Reduce your radius on the flue sheet flange and you will confine your troubles principally to the flue sheet. As far as getting away from the expansion, that is beyond us, we can not do it, because both ends are bound. The next thing for us to do is to see where we could take care of it cheaper. We on the Chicago, Milwaukee & St. Paul know that the flue sheet is the cheaper part to take care of. We have eliminated a great deal of it by moving our flues away from the flange as far as possible, making the sheet more rigid, using an inch and a half of radius for the flange, yet that does not overcome the trouble.

There has been so much said about the top of the flue sheet. We have it on the bottom as well as on the top, on our Mallets and heavy United States engines, but not as much, however. One of the best things to overcome it is what I mentioned, keep your flue holes away from the flange, say two and one-half to three inches, leaving a medium radius on your flange, but above all, educate your boiler makers so that when they go into a red hot firebox to not use a hammer. The next thing I found that would help considerably is to keep your boilers clean. I thank you, gentlemen.

C. A. SELEY (Locomotive Fire Box Company): Talking about the grain in steel, we all know who have been at the rolling mills at all that they start in and roll a plate, this way and that way and this way and that way, until they get it to the width desired. Then they start in and roll the thing backward and forward until they get the whole length of the sheet. That may induce a grain. Personally, I do not believe it.

My days extend back to the old iron days when there was a grain in iron, iron plates were put in locomotive boilers, but after they went to steel that was largely done away with. I believe that test pieces taken across the sheet do show slight differences. I know there is a sense in which that is regarded in boiler application as modifying stress or increasing it. I think, however, the foundation of the whole matter is this: You take a locomotive boiler, it is one of the most difficult pieces of machinery built, notwithstanding all of the uses and you have a cold medium at the bottom, ordinarily, compared with the rest of it, while your temperature at the top is high, consequently, you have an expansion like this, that goes up. You cannot say that expansion always goes this way in relative measure. You start with a cold foundation and the top of your boiler is hot, consequently, you are spreading it out in that direction.

There has been some little talk here about additional strengthening. A great many times in mechanical matters we make it too heavy. They break because they are too heavy, too large. I remember in my days when most all radial stays were inch and one-eighth and six-tenths body. They are not that way now and the big advantage is due to that change.

I think that the foundation of the whole matter is to go back to a control of the temperatures in your structure.

Now, as you come to the larger engines and the engines that Mr. Doarnberger knows about so well, 240 pounds, look at the difference in actual distance from that mud ring to the top of that boiler over which those temperatures act. There is the thing that this committee should look into, not only a reduction of the ties and bonds which tie that thing up in such a way that where it has to go is concentrated. You bring all those stresses to bear on one point instead of distributing them.

Mr. Wandberg spoke about putting those flues farther away, giving that corner a chance. That is the proper method to do it. We know more about what a flue does nowadays than what we used to, and we want to give more freedom.

Professor Voss in some of his papers made the statement that when tying the boiler up if we would not tie it so tight and allow more freedom, we would have more life. If we will study the effect of temperature, go back outside of your material, I do not care what you put into a flue sheet, I think the thing that works out in knuckle failure is the result of stresses brought about by variation of temperatures. Consequently, if you will go back to those temperature stresses and reduce that range, circulation of water, or whatever it may be, you are going to have the improvement that you are looking for.

Topic No. 5 was read by L. M. Stewart followed by a discussion of the paper from the floor.

Method of Applying Arch Tubes

(a) Best method of cleaning arch tubes

OWING to this subject being presented many times heretofore, we feel that but few new views can be advanced in the application. The following method should be followed as closely as possible that there may be a standard application: Drill a guide hole in sheet or punch hole, then drill proper size hole for tube 1/32 inch larger than tube. Have tube bent by cold bending machine if shops are equipped; otherwise have them bent by heating. In most cases tubes are kept in stock bent and ready for application, 1 inch larger than required. When boiler is ready for tubes, place tube in holes, mark tube for proper length, remove cut off at top end the extra material with cutting machine or hack saw. We do not recommend cutting the tubes off with oxy-acetylene, without chipping off the slag accumulation after burning, it has been found that the slag after burning was beaded over making part of the bead. The tubes then should be properly placed in holes, held with clamps, so they will not slip. Also use gage to see that they are held straight for proper set for arch brick. Then roll and bead. Each railway should have a standard beading tool or belling tool. The practice of beading or belling tubes is only a matter of opinion. We feel that they are a safe method. We recommend the tubes to extend past the sheet ¼ inch for beading, and ⅜ inch for belling.

The use of copper ferrules where tube holes become large is good practice, but the thickness of copper should have a limit. We recommend that the radius of arch tubes be given careful consideration, as we feel that better cleaning can be done as well as taking care of the expansion and contraction. They should enter the sheets at right angle, where possible.

We recommend the use of air or water turbine cleaners to clean the tubes. There are many makes of different kinds on the market.

This report was prepared by a committee composed of S. M. Carroll, Foreman B. M., Huntington, W. Va., C. & O. Railway, chairman; A. C. Dittrich, Stewart A. Fagan.

Discussion

L. M. Stewart (Atlantic Coast Lines): In our practice we use quarter-inch arch pipe, and we are now belling them. In my opinion, it is one of the greatest mistakes in the world to put copper ferrules in an arch pipe. The belling of the tubes should be long radius bends in order to take care of the cleaning.

W. M. Wilson (Rock Island): For the information of the members, I might say that the Rock Island's practice is to bell the arch tube and bead the arch tube within sixteenths of an inch, as far as we can judge. That is in order to give it a little freedom and prevent breaking off the beading, and I will say that that practice seems to be working out all right. We have no trouble with the beads breaking off.

W. H. Laughridge (Hocking Valley): We used to have a great deal of trouble with arch pipes crawling, when they were put in the ordinary way, and it did not make any difference whether you beaded or belled them, they would crawl. In this last year, we have been using a home-made process, putting a shoulder on both sides, just the same as expanding the flue.

I agree with Mr. Stewart in regard to using ferrules if you can avoid it, but you can not throw flue sheets away every time the holes get worn a little, and before we used this tool on the shoulder, we couldn't hold those ferrules in there, they would crawl, but since we have expanded them, throwing the shoulders on each side, we have eliminated the crawling of ferrules. We have been using them for a year on three and one-half inch tubes.

E. W. Young (C. M. & St. P. R. R.): We have a form of arch tube certificate that runs along something like this: "This is to certify that I have applied middle, right or all arch tubes, and the same are properly rolled and beaded." The boiler maker doing the work signs his name and underneath the inspector's or foreman's, simply, "This is to certify that I have examined the above work and found same to be correct," and I tell you gentlemen that has gone a long ways to prevent accidents on our railroad.

W. M. Wilson (Rock Island): Another point in connection with the arch tubes that I believe we ought to bring out a little more fully, as we have a great number of members here, and that is the practice of using the copper ferrule. If a copper ferrule is not necessary, it is just simply a waste of money both for material and labor to apply it. On the Rock Island, we feel that it is economy to apply the copper ferrule. We feel that we get a tighter arch tube in the sheet. It isn't necessary to roll the arch tube nearly as severe and hard in order to get the arch tube tight; also, in the roundhouse practice when the arch tube will show indication of leakage, it is simply a matter to re-roll the arch tube to tighten, but without the copper ferrule, it is a little hard job to get that arch tube tight.

C. Bowen (New Haven): Our practice is to put in arch tubes and throw them out to about forty-five degrees. Of course, in new sheets we apply new ferrules, but after the holes become large, we apply copper ferrules.

We made a little test down there on four different tubes, that is, on nine inch plate, both three inches and three and one-half inches. These were three and one-half inches that I am going to refer to, and we put necessary plates in, one we rolled, just merely rolled in the plates, another one, opened it out, one-eighth of an inch, and the other one we opened forty-five degrees, and the other one we beaded. Of course, we beaded the tube, beaded on the floor and could make a nice job of it. Got a little better advantage than what we could through the water space. On the first tube, that was just merely rolled, it went 26,000 pounds before we pulled it out the plate. Next one went one-eighth of an inch, I believe it pulled out of the plate at 27,500 pounds; then, the third one which we had pulled out went 56,000 pounds, and the one that was beaded we did not pull it out of the plate, but bursted the tube at 56,000 pounds.

Topic No. 6 "Training and Development of Boiler Inspectors and Assistant Foreman Boiler Makers" was read by the chairman, A. F. Stiglmeier. This complete report and the discussion held from the floor, will appear in a later issue of the magazine. At this point the meeting was adjourned to convene again later in the day.

Thursday Afternoon Session

The meeting was reopened at 1:35 and the subject "What is the Most Economical and Desirable Pump Station Boiler?" was the first subject discussed. This report follows:

What Is the Most Economical and Desirable Pump Station Boiler and What Style Is Preferable

THE style of boiler desirable for pump station depends upon the size of the plant and the amount of water to be furnished. Our recommendations for large plants are water tube type or return tubular boiler; medium size plants, the "Economic" or large vertical boiler, and for smaller plants, small size vertical boiler.

All vertical boilers should be of the submerged type as they are preferable over the dry type on account of a lower maintenance cost.

This report was prepared by a committee composed of E. H. Hohenstein, G. B. I., Rock Island Lines, chairman; T. Tottenhoff.

Topic No. 4, "The Renewal of Staybolts" was next read by secretary Vought. The reading of the report was followed by a complete discussion which will appear in a later issue.

Topic No. 9 was next in order of the day on the subject of "Boiler Corrosion, Pitting and Grooving." This report was read by F. J. Howe, one of the members of the committee and will also be published later with a full discussion.

The next subject under discussion was the revision of by-laws for the association which were adopted in the form recommended by the subcommittee of the executive board.

Friday Morning Session

The Friday morning session opened at 9:25 o'clock. After a discussion of certain routine business, W. H. Laughridge of the Hocking Valley Railroad, proposed that a committee be appointed to define and name the various parts of the boiler so that future confusion might be avoided in making up the reports on the subject of locomotive boilers. A committee of this nature is being appointed to report on the matter at a later meeting. A vote was taken on the place in which the next convention should be held and it was decided that Buffalo would be given the convention for 1926.

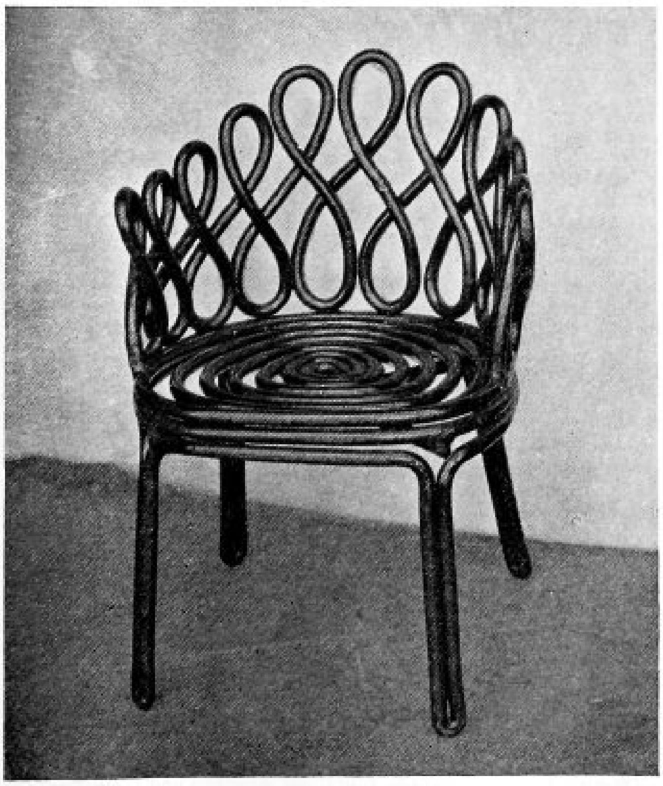
The remainder of the closing session of the convention was devoted to the election of officers, a complete list of which follows:

President, Thomas F. Powers, assistant general foreman, boiler department, Chicago & Northwestern; first vice-president, J. F. Raps, general boiler inspector, Illinois Central; second vice-president, W. J. Murphy, general foreman boiler maker, Pennsylvania; third vice-president, L. M. Stewart, general boiler inspector, Atlantic Coast Line; fourth vice-president, S. M. Carroll, general master boiler maker, Chesapeake & Ohio; fifth vice-president, George B. Usherwood, supervisor of boilers, New York Central; secretary, Harry D. Vought; treasurer, W. H. Laughridge, general foreman boiler maker, Hocking Valley; executive board, one year, E. J. Reardon, Locomotive Firebox Company; H. J. Raps, general boiler foreman, Illinois Central; L. E. Nicholas, general boiler foreman, Chicago, Indianapolis & Louisville; two years, C. H. Browning, foreman boiler maker, Grand Trunk; L. R. Porter, foreman boiler maker, Soo Line; A. F. Stiglmeier, general boiler shop foreman, New York Central; three years, I. W. Clark, general foreman boiler maker, Nashville, Chattanooga & St. Louis; F. T. Litz, general boiler foreman, Chicago, Milwaukee & St. Paul; C. J. Longacre, foreman boiler maker, Pennsylvania; A. F. Stiglmeier was elected chairman of the board and H. J. Raps, secretary.

Chair Presented to President of Supply Men's Association

DURING the progress of the Master Boiler Makers' Association convention a chair, made entirely of Lewis special staybolt iron, was presented to J. P. Moses, president of the Boiler Makers' Supply Men's Association.

The design was developed by C. J. Nieman of Joseph T. Ryerson & Sons, Inc. It was made of 7/8-inch round solid staybolt iron bent cold and welded at various places where the different parts join each other. The chair weighs about 175 pounds.



Chair made of Lewis special staybolt iron

Registration of Members

Aiken, C. H., The Bourne-Fuller Co., 2177 Maplewood Road, Cleveland Heights, O.
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Amrein, John, F. B. M., N. Y., N. H. & H. R. R., 154 Center St., West Haven, Conn.
Anderson, J. A., G. F. B. M., Industrial Wks., 216 N. Madison Ave., Bay City, Mich.
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Becker, W. C., B. F., I. C. R. R., 612 Veronica Pl., St. Louis, Mo.
Beland, Arthur J., G. F. B. M., Chicago Junction R. R., 7346 Kenwood Ave., Chicago, Ill.
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Biklen, F. L., F., C. B. & Q., 1033 Ash St., Burlington, Vt.
Bower, Wm. G., F. B. M., C. & N. W., 4206 Washington Blvd., Chicago, Ill.
Browning, C. H., G. F. B. M., Grand Trunk Ry., 53 Cherry St., Battle Creek, Mich.
Bures, Rudolph S., B. M. F., C. M. & St. P. R. R., 1248 Manard Ave., Chicago, Ill.
Burroughs, W. D., B. F., C. I. & L., Bloomington, Ill.
Burke, Lawrence, B. F., C. & N. R. R., 5523 So. California Ave., Chicago, Ill.
Burnett, David, F. B. M., N. Y., N. H. & H. R. R., 7 Alma St., Natesbury, Conn.
Butler, Chas. C., Asst. Gen. B. Insp., C. R. I. & P. P. R., Box 74, Horton, Kans.
Calmback, G. M., Sup. Welder, Air Reduction Sales, 115 Plum St., St. Louis, Mo.
Callahan, J. L., G. B. I., Bird-Archer Co., 122 Michigan Ave., Chicago, Ill.
Campbell, John C., Ulster Iron Works, 719 Peoples Gas Building, Chicago, Ill.
Carbis, N. J., Shop, Eng., Locomotive Firebox Co., Box 1917, Station E., Cleveland, O.
Carroll, S. M., G. M. B. M., C. & O. R. R., 2919 Merrill Ave., Huntington, Vt.
Cavedo, A. L., B. F., C. & O., 2213 W. Grace St., Richmond, Va.
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Chastain, J. H., B. M. F., M. C. & St. L., 299 So. Blvd., Atlanta, Ga.
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Clark, R. W., G. F., M. C. & St. L., 720 17th Ave., So., Nashville, Tenn.
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Laughridge, Wm. H., G. F. B. M., Hocking Valley, 537 Linwood Ave., Columbus, O.
Law, Geo., G. F. B. Shop, Central Steel Co., Massillon, O.
Lewis, J. H., G. B. F., A. T. & S. F. R. R., 613 W. Silver St., Albuquerque, N. M.
Libera, Jos. R., B. M. F., C. & N. W. R. R., 1023 Jenifer St., Madison, Wis.
Linerode, Frank, B. F., Erie R. R., 538½ Washington St., Huntington, Ind.
Litz, F. T., G. B. F., C. M. & St. P., 21½ 37th St., Milwaukee, Wis.
Lonergan, Jno., B. F., C. & N. W., 4045 Park Ave., Chicago, Ill.
Longacre, Chas. J., F. B. M., P. R. R., 664 Monroe Ave., Elizabeth, N. J.
Loveland, D. A., G. B. F., L. V. R. R., 206 So. Main St., Athens, Pa.
Lowe, Thos. W., G. B. I., C. P. R. R., 760 Westminster Ave., Winnepeg, Man., Canada.
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Lucas, A. N., Oxweld R. R. Service, Dist. Mgr., 333 Ry. Exchange Bldg., Chicago, Ill.
Lucas, W. H., Chief Boiler Insp., M. C. R. R., Park View Apts., Metcalfe St., Thomas, Ont., Canada.
Lux, Peter, F. B. M., C. & N. W., 1458 S. 7th Ave., Maywood, Ill.
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Madden, Charles, B. F., C. B. & Q., 335 S. Sycamore St., Centralia, Ill.
Mahar, Thomas, Trav. Eng., American Arch Co., 2 Line Place, White Plains, N. Y.
Mahon, Joseph, Foreman, N. Y., N. H. & H., 936 Winchester Ave., Hampden, Conn.
Mansfield, J. J., G. B. I., Cent. R. R. of N. J., 74 Pearsall Ave., Jersey City, N. J.
Marivan, James J., G. B. F., Soo Line, 525 Wisconsin Ave., North Fond du Lac, Wis.
Marsalis, Harry L., Welding Supv., I. C. R. R., 317 N. Cherry St., McComb, Miss.
Martin, R. E., Asst. B. F., Box 640, McComb, Miss.
Martin, N. W., F. B. M., M. & St. L., 52 Ash, Minneapolis, Minn.
Mayer, F. A. G., M. B. M., Southern R. R., 1300 Penn Ave., Washington, D. C.
Mays, W. W., B. F., C. & O. Ry., Selma, Va.
McCarthy, Jas. A., B. F., E. J. & E. Ry., 405 Chase Ave., Joliet, Ill.
McCune, T. E., F. B. M., Rock Island Lines, 432 W. 72nd St., Chicago, Ill.

(Continued on page 181)

Supply Men Elect Officers

At the annual business meeting of the Boiler Makers' Supply Men's Association, held during the convention the following officers were elected for the coming year:

President, F. H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.; vice president, J. W. Kelly, National Tube Company, Pittsburgh, Pa.; treasurer, S. F. Sullivan, Ewald Iron Company, Chicago, Ill.; secretary, W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

Executive Committee (one year)—L. W. Schnitzer, Ingersoll-Rand Company, Chicago, Ill.; (two years)—J. L. Rowe, Chicago Pneumatic Tool Company, New York; (three years)—J. C. Kuhns, The Burden Iron Company, Troy, New York; F. M. Roby, The Talmage Manufacturing Company, Cleveland, Ohio; Harry Loeb, Lukens Steel Company, Philadelphia, Pa.

List of Exhibitors and Supply Men at Master Boiler Makers' Convention

The following members of the Boiler Makers' Supply Men's Association were represented at the Master Boiler Makers' convention and held exhibits of equipment and supplies which proved of great interest to the members:

Air Reduction Sales Company, New York.—Represented by R. T. Peabody, G. E. Phelps, George Calmback, Fred Granaman, R. F. Helmcamp, Joseph Kenefec and G. Van Alstyne. The exhibit included Airco oxygen, Airco acetylene, Airco Davis-Bournonville welding and cutting apparatus. Specimens of firebox steel showing cuts with Airco oxygen (99.5 percent pure oxygen used on some and 99 percent on others); also samples of butt and lap welded joints in locomotive firebox steel.

American Arch Company, New York.—Represented by Thos. Mahor, E. T. Mulcahy, George Wagstaff, R. J. Himmelreght, J. T. Anthony, A. W. Clokey, A. M. Sucese, W. W. Neale, William Haag and John P. Neff.

American Bolt Corporation (Boss Nut Division), Chicago, Ill.—Represented by J. W. Fogg.

American Locomotive Company, New York.—Represented by G. P. Robinson, Arthur Haller, C. O. Rogers, George Weiler, E. W. Rogers, George Wilson, Robert Brown. The exhibit included staybolts, flexible staybolts, rigid staybolts, welded flexible staybolts.

American Railway Appliances Company, New York.—Represented by Lloyd D. Brown and J. Wallace Henry. The exhibit included a model installation of the Superior locomotive flue blower.

Baldwin Locomotive Works, Philadelphia, Pa.—Represented by C. H. Gaskill, W. H. Evans, F. A. Neely, Leonard Ruber and R. J. Schlacks.

Bethlehem Steel Company, Bethlehem, Pa.—Represented by George H. Raab. The exhibit included Bethlehem special staybolt iron and charcoal iron boiler tubes.

The Bird-Archer Company, New York.—Represented by C. J. McGurn, J. J. Clifford, J. L. Callahan, T. A. Peacock, H. C. Harragin and L. F. Wilson. The exhibit included boiler chemicals and blow-off cocks.

THE BOILER MAKER, New York.—Represented by George Slate, H. M. Brewer and L. S. Blodgett.

W. L. Brubaker & Bros. Company, New York.—Represented by Fred M. Bettes and W. Searls Rose. The exhibit included taps, dies and reamers.

The Burden Iron Company, Troy, N. Y.—Represented by John C. Kuhns. The exhibit included samples of solid and drilled staybolt iron, engine bolt iron and Burden iron rivets.

A. M. Castle & Company, Chicago, Ill.—Represented by George R. Boyce, Leonard J. Quetsch.

The Central Steel Company, Massillon, Ohio.—Represented by I. H. Jones, P. M. Snyder, A. S. Taylor, George Law. The exhibit included samples of Agathon alloy steels, staybolts, nickel steel boiler tubes and Agathon alloy engine bolt steel.

Champion Rivet Company, Cleveland, O.—Represented by David J. Champion. The exhibit included descriptive booklets.

Chicago Engineer Supply Company, Chicago, Ill.—Represented by W. M. Burns and R. G. Rennacker. The exhibit included

Cesco tube cleaners for locomotive arch tubes and stationary boilers.

Chicago Eye Shield Company, Chicago, Ill.—Represented by Robert Malcom. The exhibit included welding helmets, welding glass (Essentialite) goggles.

Chicago Pneumatic Tool Company, Chicago, Ill.—Represented by J. L. Rowe, H. R. Deubel, G. Grant Porter, J. V. Conway and F. H. Liggett. The exhibit included sectional views corner motor, type 91; sectional exhibit No 36 staybolt tapping machine.

The Cleveland Pneumatic Tool Company, Cleveland, O.—Represented by H. S. Covey, C. J. Albrecht, B. H. Tripp. The exhibit included a complete line of pocket-in-head riveters, ball bearing air drills, ball bearing air grinders, Cleco pressure-seated air valves, Bowes air hose couplings for locomotive and car shops.

Dearborn Chemical Company, Chicago, Ill.—Represented by J. D. Purcell, James Roddy, Nelson Dunn, O. H. Rehmeyer, Isaac Bowen, L. P. Bowen, Chas. M. Hoffman and R. F. Carr. The exhibit included feed water treatment; NO-OX-ID anti-rust treatment.

Detroit Seamless Steel Tubes Company, Detroit, Mich.—Represented by L. R. Phillips.

Ewald Iron Company, Louisville, Ky.—Represented by S. F. Sullivan. The exhibit included staybolt iron, hollow drilled bolts, threaded solid and drilled bolts.

J. Faessler Manufacturing Company, Moberly, Mo.—Represented by Austin Ruse, J. W. Faessler and G. R. Maupin.

Falls Hollow Staybolt Company, Cuyahoga Falls, O.—Represented by C. M. Walsh, M. M. McCallister and G. H. Mansfield. The exhibit included tested and threaded samples of hollow and solid staybolt iron.

Firth-Sterling Steel Company, McKeesport, Pa.—E. T. Jackman, Charles E. Hughes and Carl O. Ericke. The exhibit included bar stock, Firth-Sterling special tool steel; exhibit of forged tools made from bar steel.

Flannery Bolt Company, Pittsburgh, Pa.—Represented by J. R. Flannery, E. S. Fitzsimmons, G. R. Greenslade, W. M. Wilson, G. E. Howard, J. H. Murrain and J. H. Cooper. The exhibit included standard designs of flexible staybolt assemblages and demonstrations of the Flannery method of testing the staybolts in a boiler.

Forster Paint & Manufacturing Company, Winona, Minn.—Represented by C. T. Caswell.

Garratt-Callahan Company, Chicago, Ill.—Represented by A. H. Baker, J. G. Barclay, W. F. Caspers, H. M. Gray and A. H. Hawkinson. The exhibit included "Magic" boiler preservative.

Gary Screw & Bolt Company, Chicago, Ill.—Represented by P. Robinson, G. J. Garvey and R. W. Dierker.

Globe Steel Tubes Company, Milwaukee, Wis.—Represented by F. J. O'Brien, T. F. Clifford and J. S. Bradshaw. The exhibit included Seamless Steel Tubes.

Housley Flue Connection Corporation, Indianapolis, Ind.—Represented by R. B. Housley. The exhibit included Housley safety washout plugs.

Huron Manufacturing Company, Detroit, Mich.—Represented by H. N. Reynolds, E. H. Willard, M. T. Willard and J. M. Barrowdale. The exhibit included boiler washout plugs and arch tube plugs.

Independent Pneumatic Tool Company, Chicago, Ill.—Represented by A. Anderson, Irving T. Cruice, W. A. Nugent, Henri E. Nelson and O. Dallman. The exhibit included a complete line of Thor tools, chipping and calking hammers, riveting hammers, air drills and reamers, electric drills and reamers, cut-out models and accessories.

Ingersoll-Rand Company, New York.—Represented by T. E. Forbes, Wm. F. Mitchell, D. G. Reeder, G. C. Williams and L. W. Schnitzer. The exhibit included riveting hammers, chipping hammers, drills, grinders, rivet sets and accessories with demonstration models of the tools.

Wm. H. Keller, Inc., Grand Haven, Mich.—Represented by Daniel Woodhead and J. D. Crowley. The exhibit included pneumatic tools and a complete line of super hammers.

King Pneumatic Tool Company, Chicago, Ill.—Represented by John M. Butler and J. C. Buckels. The exhibit included pneumatic tools, the new King arch tube cleaner, new King automatic two-man rivet buster.

Lagonda Manufacturing Company, Springfield, O.—Represented by H. A. Pastre, C. F. Harms, E. L. Davis and F. C. Angle. The exhibit included Liberty and Lagonda arch tube cleaners and Liberty surface cleaner

Liberty Manufacturing Company, Pittsburgh, Pa.—Represented by H. A. Pastre and E. L. Davis. The exhibit included Liberty and Lagonda arch tube cleaners.

Locomotive Firebox Company, Chicago, Ill.—Represented by A. A. Taylor, E. J. Reardon, C. M. Rogers, B. E. Larson, Thomas Klein, E. Frank Smith, C. A. Seley and Walter S. Carr. The exhibit included working model of boiler equipped with Nicholson thermic syphons.

Lovejoy Tool Works, Chicago, Ill.—Represented by W. H. Dangel. The exhibit included Mack rivet sets and clips, Mack re-cupping tools, improved "use-em-up" sleeves, Lacerda dolly-bars, flue-setting pins, flue-opening pins, sleeve drivers, Dixon roller expanders, railroad flue cutters, square sockets, belling tools, staybolt chuck, roller expanders and spring expanders.

Lukens Steel Company, Coatesville, Pa.—Represented by Harry Loeb. The exhibit included literature, photographs, etc.

McCabe Manufacturing Company, Lawrence, Mass.—Represented by Fred H. McCabe and Edward McCabe. The exhibits included model flanger and flue sheets.

National Tube Company, Pittsburgh, Pa.—Represented by George N. Riley, J. W. Kelly and P. J. Conrath. The exhibit included superheater tubes and hot rolled seamless tubes.

Oak Grove Handle Company, Cameron, Wis.—Represented by J. C. Templeton and E. M. Scheflow. The exhibit included flanging mauls and ironwood fillers; maul, sledge and hammer handles.

Otis Steel Company, Cleveland, Ohio. Represented by George Sevey.

The Oxweld Railroad Service Company, Chicago, Ill.—Represented by H. V. Gigandet, J. W. O'Neil, W. A. Hogan, W. A. Champieux, H. W. Schulze, A. N. Lucas, C. S. Wright, O. D. Hayes, F. H. Frye, Scott Daffer, J. A. Smith, R. R. Kester, O. F. Ladtkow, G. V. Rainey, R. Webster and Frank C. Hasse.

Parkesburg Iron Company, Parkesburg, Pa.—Represented by W. H. S. Bateman, L. P. Mercer, J. F. Wiese and Robert W. Porteous. The exhibit included sections of genuine knobbled hammered charcoal iron, superheater tube sections, swelled, swaged and flanged; also ring tests, body flues showing various A. R. A. (Mechanical) and A. S. M. E. tests; arch tube sections; book for distribution on recommended practice for the application and maintenance of charcoal iron boiler tubes, arch tubes and superheater tubes.

Penn Iron & Steel Company, Creighton, Pa.—Represented by Joseph T. Ryerson & Son, Inc.

Pittsburgh Steel Products Company, Pittsburgh, Pa.—Represented by J. D. Brandon and C. H. Van Allen. The exhibit included samples of tubing.

Pratt & Whitney Company, Chicago, Ill.—Represented by F. A. Armstrong. The exhibit included straight and spiral staybolt taps, boiler taps, new spindle staybolt tap and washout taps.

The Premier Staybolt Company, Pittsburgh, Pa.—Represented by J. C. C. Holding, J. F. McGann and W. F. Heacock. The exhibit included locomotive boiler staybolts.

The Prime Manufacturing Company, Milwaukee, Wis.—Represented by D. A. Lucas, C. A. Dunn and Arthur Dunn. The exhibit included washout plugs and washout nozzle.

Rome Iron Mills, Inc., Rome, N. Y.—Represented by B. A. Clements and C. C. Osterhout. The exhibit included physical tests, Rome superior staybolt iron, Rome perfection engine bolt iron.

Joseph T. Ryerson & Son, Inc., Chicago, Ill.—Represented by J. P. Moses, L. D. Hiner, E. S. Pike, H. F. Gilg, A. W. Willcuts, A. M. Mueller, C. J. Nieman and G. L. Shinkle. The exhibit included Lewis engine bolt iron, Lewis special staybolt iron and Lewis special drilled hollow staybolts.

Scully Steel & Iron Company, Chicago, Ill.—Represented by J. W. Patterson, C. E. Lingenfelter and H. M. Drew. The exhibit included tools for tube expanding work, roller expanders, sectional expanders, beading tools, staybolt headers, flaring tools, hose couplings; also the Campbell nibbling machine.

The Superheater Company, New York.—Represented by J. E. Mourne.

The Talmage Manufacturing Company, Cleveland, Ohio.—Represented by F. M. Roby and H. B. Thurston. The exhibit included Cleveland low water alarm, Talmage ash pan and Talmage blow-off valve.

Thomson Electric Welding Company, Lynn, Mass.—Represented by F. H. Leslie and Harry L. Burrhus. The exhibit included miscellaneous samples of electrically welded safe ends on different size boiler flues and tubes including welds on superheater units and superheater tubes.

Torchweld Equipment Company, Chicago, Ill.—Represented by W. A. Slack, R. P. Smith and J. M. Jenson. The exhibit included Torchweld dependable gas welding and cutting apparatus and supplies.

Tyler Tube & Pipe Company, Washington, Pa.—Represented by A. M. Castle & Company, Chicago. The exhibit included test pieces of charcoal iron tubes; pieces showing quality of iron and bloom.

Ulster Iron Works, Dover, N. J.—Represented by H. A. Gray, John C. Campbell, Norman C. Thulin, E. W. Kavanagh, John H. Cragie and C. F. Barton. The exhibit included Ulster special drilled hollow staybolts, Ulster special staybolt iron and Ulster engine bolt iron.

United Alloy Steel Corporation, Massillon, Ohio.—Represented by A. L. Roberts, L. F. Johnson and J. C. Brennan. The exhibit included Toncan guessing contest and a display of Toncan tubes and staybolts.

Van Dorn Iron Works, Cleveland, Ohio.—Represented by J. A. Boyden. The exhibit included a new staybolt riveting tool.

Laying Out Locomotive Boilers—VI*

Combustion chamber development — Radial stays and staybolts—Roof sheet development

By W. E. Joynes†

THE development of the front extension of the crown sheet, which forms the top half of the combustion chamber, is given in the following instruction, and is clearly shown in Fig. 13.

Set a bow pencil compass equal to the dimension A^1, which is the cut out in the crown sheet to receive the inside throat sheet. Start at point 2 of the plate layout Fig. 13, describe a short arc opposite the circled triangulation points (circled points used as the arc centers) of the crown developing line, to the boiler center line. Connect the spaces between these points with a curve, forming a line as shown; the length of this line equals the stepped off length of line F, from the diagram Fig. 12.

Set the trammels equal to the lengths, A^1 plus A^2, from the diagram Fig. 11. Start at point 2 of the plate layout, describe a short arc opposite the triangulation circled points, out to the tangent point of the front of the combustion chamber and the corner radii. Scale the tangent point from the diagram Fig. 12. From the tangent point to the boiler center line, the front of the combustion chamber will *not* be parallel with the crown developing line. This is due to the space between the front of the crown and the front of the combustion chamber, at the boiler center line, being smaller than the same space at the vertical center line of the boiler $2\text{-}2^a$, Fig. 12 of the diagram. Unless the length of crown dimension A^2 is considerably longer than shown on Fig 13 the difference in the length A^2 at the top center and P at the boiler center line will not amount to 1/16 inch. Therefore, it is a simple operation to fair in a curve from the tangent point of the crown and corner radii to the boiler center line, which will complete the shape of the front of the combustion chamber, from the top center to the boiler center line. Draw in the boiler center line through the combustion chamber, which will be found not to be exactly in line with the boiler center line of the crown sheet.

Triangulation is the practical method for developing the bottom half of the combustion chamber. Divide the front and back neutral lines of the bottom half into the same

*Previous installments of this article appeared on page 1, January issue; page 40, February issue; page 72, March issue, page 99, April issue, and page 129, May issue.

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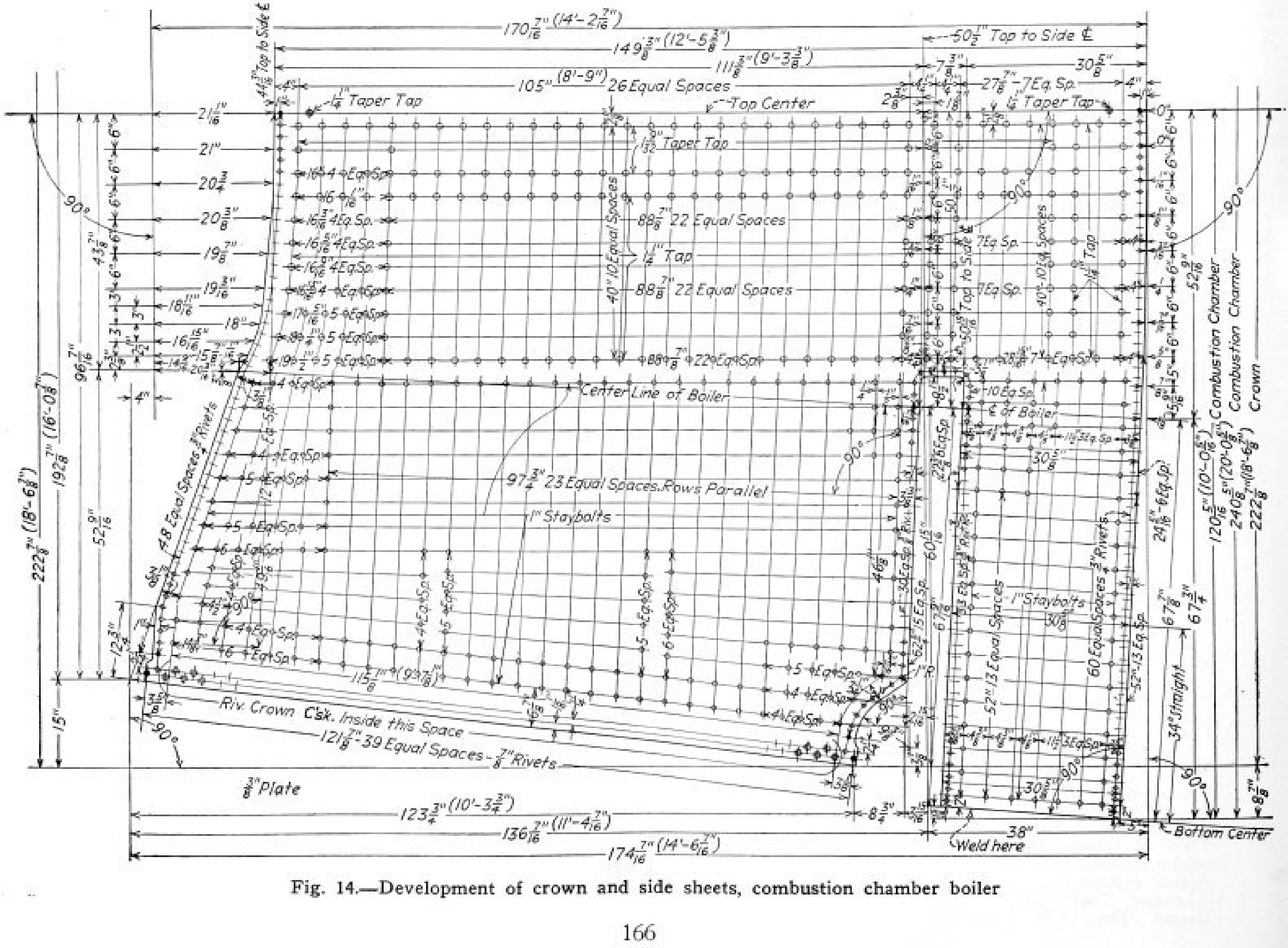


Fig. 14.—Development of crown and side sheets, combustion chamber boiler

number of equal spaces (similar as shown for the top half) from the boiler center line to the bottom of the chamber at the vertical center line.

Using the longitudinal length of the plate or distance between developing lines for the "diagram of triangles" perform the triangulation operations as instructed for the crown sheet development.

Calculate the front and back neutral length of plate, dimensions P^1 and P^2.

A quarter ($\frac{1}{4}$) size scale layout will be found more practical in the triangulation development for the bottom half of the combustion chamber.

The back edge of the combustion chamber sheet, below the boiler center line, is not parallel with the front edge of the crown sheet for a triangulation development.

The bottom half of the combustion chamber becomes cylindrical for a "projection" development instead of cone shape as for a "triangulation" development. Therefore, the front and back edge of the sheet is straight and parallel with the front edge of the crown sheet and at right angles to the boiler center line. A cylindrical combustion chamber bottom is seldom or never used, due to the backhead contour being mostly always reduced below half the diameter of the back boiler ring course.

The sets for the front developing line of the crown and the front edge of the combustion chamber sheet are equal out to the tangent point of the crown and corner radii and are to be scaled for triangulation developments.

Set G (crown and roof Fig. 11) will be approximately $\frac{1}{8}$ to $\frac{1}{2}$ inch more for the crown sheet and $\frac{1}{2}$ to 1 inch more for the roof sheet (at h Figs. 13 and 15) for triangulation work than for projection work.

This completes the development of the crown and combustion chamber sheet.

Fig. 14 is the shop drawing for the crown-sides and combustion chamber sheet development as shown in Fig. 13. The dimensions for this sheet are clearly shown and they are determined in a similar manner to the instruction as given for the "projection" development crown sheet Figs. 5 and 6, and as noted on the crown and combustion chamber development Fig. 13.

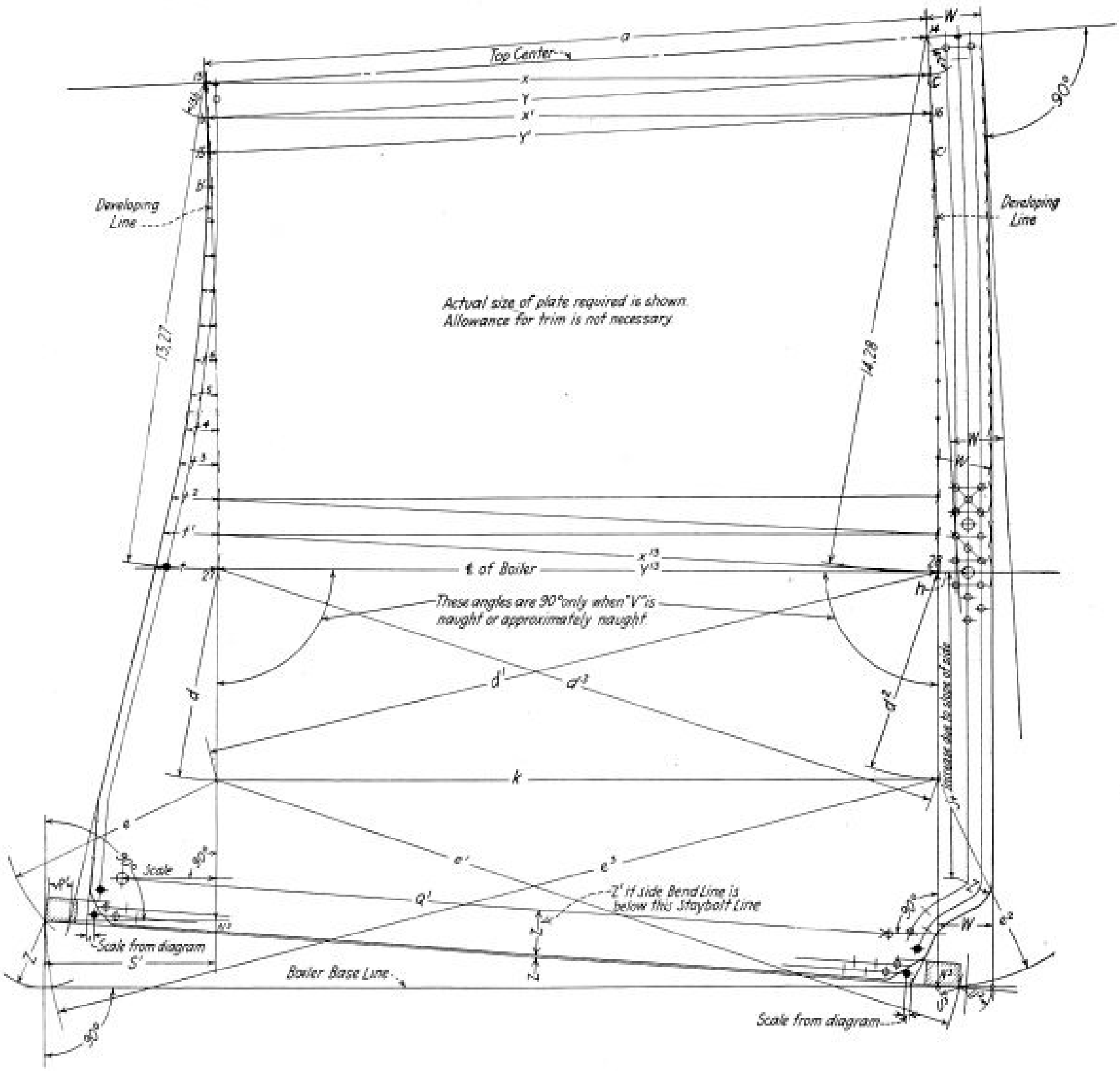


Fig. 15.—Roof and side sheet development

Radial Stays and Staybolts—Crown

The radial stays are spaced off on the back developing line and the front of the combustion chamber, then drawn direct through from front to back. The staybolts in the crown side sheet are spaced off on the developing lines and projected 90 degrees to the developing lines, onto the front and back staybolt line as explained for the projection development, Fig. 6.

The staybolts for the combustion chamber are spaced off on the front and back edge of the sheet and the lines are drawn direct, across the sheet, from these points.

Roof Sheet Development

The roof sheet development is similar to the crown sheet development, the operations are clearly shown on Fig. 15 and there should be need of no further instruction other than has been given above, in connection with the crown sheet development.

Fig. 16 is the shop drawing for the roof sheet development as shown in Fig. 15. This drawing shows that the sheet will be in three (3) pieces instead of one (1) piece when assembled.

It was stated at the beginning of this subject that the three-(3) piece crown sheet was obsolete. The 3-piece roof sheet is also practically out of date, with a few exceptions, which will be mentioned below. It was not the writer's intention to present either a 3-piece crown or roof sheet in this treatise, but as the boiler that has been selected for the "triangulation" developments has a three-piece roof sheet a few remarks will be written in this connection.

A 1-piece roof or crown sheet is preferred. It eliminates the side seams, simplifies both the drawing room and shop work and makes a neater looking boiler.

The 3-piece roof is used when the size of the 1-piece sheet exceeds the manufactured size of the plate required. Also, 3-piece roof sheets are used when the steam and water space between the crown and roof sheets (at the top of crown) is great enough to cause the required thickness (at the top of roof) to be much greater than is required for the thickness of the sheet, at the sides.

It will be realized that to reduce the thickness of the side sheets, as shown in Figs. 10 and 16 from the required thickness of the roof 13/16 inch to 9/16 inch, the required thickness of the sides has advantages in weight and cost of material.

As a rule the 3-piece roof sheets are used only on large combustion chamber boilers where the required steam space, above the crown, is calculated at the front of the combustion chamber, thereby making the space greater above the crown, at the roof sheet, due to the slope of the crown.

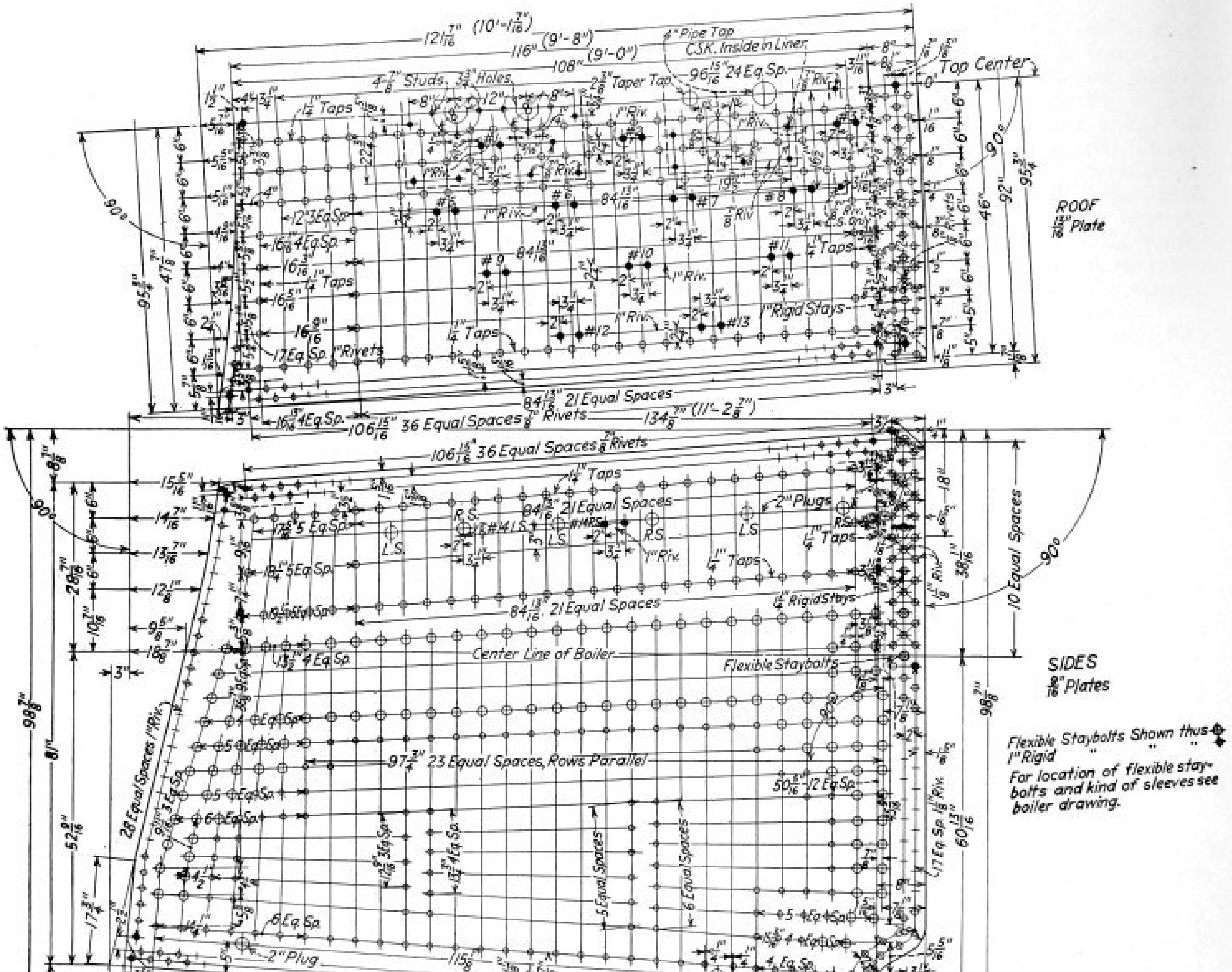
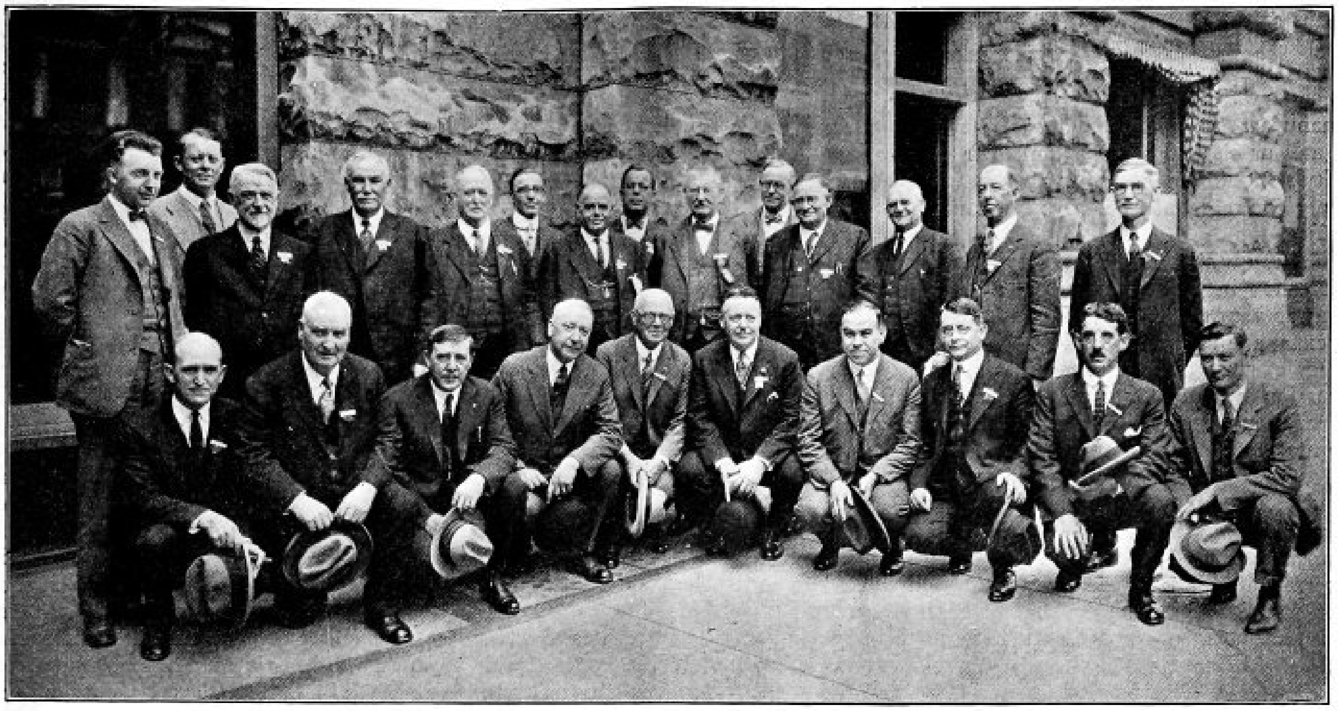


Fig. 16.—Shop drawing for roof sheet development

(*Continued on page* 170)



Members and Guests of National Board

Front Row—Left to Right. Mr. J. D. Newcomb, Jr., State of Arkansas; Mr. Geo. Wilcox, State of Minnesota; Mr. C. O. Myers, State of Ohio; Mr. D. M. Medcalf, Province of Ontario; Mr. Fred R. Low, Editor of *Power*; Mr. Chas. E. Gorton, Chairman American Uniform Boiler Law Society; Mr. Jos. F. Scott, State of New Jersey; Mr. Jas. E. Speed, City of Erie, Pa.; Mr. John Forgeng, City of Scranton, Pa.; Mr. L. M. Barringer, City of Seattle, Wash.

Back Row—Left to Right: Mr. A. L. Daniels, City of Parkersburg, W. Va.; Mr. L. C. Peal, City of Nashville, Tenn.; Mr. Huston, Lukens Steel Co.; Mr. Wm. P. Eales, State of Pennsylvania; Mr. E. W. Fitt, City of Omaha, Nebr.; Mr. Wm. H. Furman, State of New York; Mr. H. E. McBryde, City of Tulsa, Okla.; Mr. L. R. Land, State of Oklahoma; Mr. Wm. Ranton, Fidelity & Casualty Co.; Mr. H. H. Mills, City of Detroit, Mich.; Mr. E. W. Farmer, State of Rhode Island; Mr. John M. Lukens, City of Philadelphia, Pa.; Mr. C. D. Thomas, State of Oregon; Mr. Chas. J. Manney, State of Ohio.

Boiler Inspectors Hold Meeting in Milwaukee

National Board of Boiler and Pressure Vessel Inspectors meet in conjunction with A. S. M. E. spring meeting

By C. O. Myers*

THE National Board of Boiler and Pressure Vessel Inspectors held a very successful meeting at Milwaukee, May 18, 19 and 20, in conjunction with the spring meeting of the American Society of Mechanical Engineers. This meeting was called at this time with two objects in view—first: To bring about a closer relation between the Chief Inspectors and the members of the Boiler Code Committee. Second: To save expenses, as arrangements were made by the American Society for all those attending this meeting to receive half-fare return rate. This enabled us to keep the expenses of this convention within our means.

The meeting was very well attended, there being twenty states and cities represented. There were a number of insurance company representatives, boiler manufacturers and others interested in this movement present who took an active part in the proceedings of the meeting.

We had with us D. M. Medcalf, Chief Inspector of the Province of Ontario, Canada, who advised us that he had completed arrangements with the Minister of Labor, so that boilers bearing the National Board stamp would be accepted in the Province of Ontario. He also advised us that it would be necessary to fill out the data on such boilers upon forms furnished by his department, as this is a requirement of the Laws which now prevail in the Province of Ontario.

The work of the National Board has been progressing slowly and we are very well satisfied with the results we are obtaining. However, it might seem to some of those interested in the work of the National Board that some things should have been cleared up before this time and it might be well for me to state that our policy has been to concentrate our efforts on the more important points necessary to bring about a complete uniformity and interchangeability of steam boilers.

We have been devoting all of our time and attention to clearing up the question of stamping and shop inspection of new boilers, as we feel that this is one of the questions causing the most confusion and we are very much pleased with the progress which has been made along this line.

When calling this meeting we had two questions in mind to have cleared up before the Board adjourned, which were—first: Individual registration of boiler manufacturers when they are stamping their boilers National Board, and, second: The individual commissioning of inspectors for shop inspection. These questions were thoroughly discussed in open meeting and some very interesting information was obtained.

The first question was definitely decided that no state or

* Secretary-treasurer of the National Board.

city would require manufacturers of boilers to register with their state or city when they are registered at the office of the secretary and treasurer of the National Board. However, manufacturers of boilers are required to register in any of the states or cities, if they stamp their boilers with such state or city's stampings, but when the National Board stamp is used only one registration is necessary and that is at the secretary's office.

The question of individually commissioning inspectors for shop inspections drew out a very lengthy discussion and it was very evident that some work must be done within the next year in clearing up the various ideas and misunderstandings of some of the States on this matter. However, the discussion turned into a direct question being asked each and every representative present, the question being, "Will representatives here present accept the National Board commissioned inspector for shop inspections without issuing an individual State commission to such inspectors?" We asked for a yes or no answer on this question, and we had all affirmative replies excepting one, whose State Law could not permit at this time the acceptance of an inspector unless he holds a commission from that State; however, this State will issue a commission on the strength of an inspector holding a National Board commission. This will not create any undue hardship as it will not be necessary for the inspector to take more than one written examination.

The discussion on these two points emphasized the fact that it is necessary for us to progress slowly and clear up any misunderstandings that may exist. If we try to progress too rapidly we are in danger of creating some feeling with the authorities which would react on the general movement.

The Boiler Code Committee has made a provision in the Code for the stamping of boilers which has been causing considerable confusion, as some of the manufacturers of boilers understand that the stamping, as set forth in this Code, is acceptable in all of the states or cities adopting said Code.

The Boiler Code Committee has made an earnest effort to secure a form of stamping acceptable to all the States at the last revision, but the stamping as outlined in this Code could not be accepted by the States, as there is no provision for State Standard numbers or National Board numbers, which are necessary for the proper registration and filing of data reports.

This question of stamping was thoroughly discussed at this meeting and it was finally decided that the following recommendation be forwarded to the secretary of the Boiler Code Committee:

> "We recommend to the A. S. M. E. Boiler Code Committee that the stamping provisions required in the Code relative to that part which refers to the registering of boilers be eliminated, and that this matter be left entirely to the National Board of Boiler and Pressure Inspectors."

It is the general opinion of the chief inspectors that the Boiler Code Committee should provide in the Code for only such stamping as is necessary to designate a boiler to be a Code Boiler, leaving the other part of the stamping, which is for registration purposes, up to the National Board. This means that the Code should only provide that a boiler be stamped with the A. S. M. E. symbol.

We are pleased to report at this time that we have registered 85 boiler manufacturers, who are authorized to use the National Board stamp and 391 boiler inspectors commissioned as National Board inspectors. These boiler manufacturers and inspectors are located in all parts of the United States and during the past year 13,145 data reports have been received and filed in the office of the secretary and treasurer of the National Board.

With reference to the financial condition of the National Board, I am pleased to state that it is in a very good condition and to advise that our receipts for the past year were sufficient to bear the expense of the meeting and we sincerely trust that this work will continue to the extent that we can continue having annual meetings of this kind which have proven to be very beneficial in the movement towards securing uniformity and interchangeability of steam boilers.

Constructing Welded Steel Stacks

(*Continued from page* 153)

ference of the stack. Tack welds should be made first on the quarter points, then at points midway between the previous ones. For material 3/16 or ¼-inch thick, tack welds should be about 9 inches apart.

Welded steel stacks are readily erected by means of a "gin pole" (a guyed mast with a block and tackle at the top); or, for a short stack, an "A" frame can be used. As a matter of fact, any support several feet higher than the center of the stack and strong enough to carry the load is suitable. No special attention need be given handling of the stack because it is welded. In fact, welded stacks can be hoisted into place in their final condition where it would be impracticable to do this with a riveted stack. This again is an illustration of the strength and dependability of the well-made welded joint.

Steel guy-cables are permanently secured to the stack while it is lying on the ground. Then the end of the wire rope from the block at the hoisting support is passed around the stack at a point several feet above the center and firmly secured. As the stack is hoisted, the guy ropes are gradually payed out. When it is finally up-ended, the steel guys are used to pull it into position. Then it is bolted to its foundation and the guys permanently secured to ground anchors. Occasionally during transportation, assembly and erection, a stack is dented. This is quite serious if it happens to be a riveted stack, for, in order to straighten it, rivets often have to be removed and redriven. The dented section of a welded stack, however, can be heated with the welding blowpipe and easily hammered back into shape. The blowpipe can be so handled on some dents that even hammering will be unnecessary.

Laying Out the Locomotive Boiler

(*Continued from page* 168)

The roof and side sheet is laid out as shown on the development drawing Fig. 15. The radial stays and staybolts are laid in on this sheet, similar to the method as given for the "projection" roof sheet Fig. 8.

After the radial stays and staybolts have been laid out, locate the seam between the radial stay space as shown on the boiler sections. Dimension the drawing as shown and separate the top (roof) and side sheet when tracing.

The radial stays and staybolts, between the seam rivets, at the front end of the sheets, should be carefully laid in. These stays have to be arranged to clear the cab turret dry pipe, longitudinal brace rods that run through to the ring course ahead of the roof, etc.

To have the seam rivets equally spaced and the stays central between the rivets simplifies the layout. This is not always possible for the reasons mentioned above, and also for reason of the stay being thrown too much out of line, thereby making a bad thread angle for the crown sheet end of the stay. Therefore, it is sometimes necessary to break up the rivet spacing to meet the stay requirements.

The stays can sometimes be shifted closer to the rivets (if the bridge between the stay and rivet does not become less than 1 inch) without breaking up the rivet spaces.

(*To be continued*)

Boiler Manufacturers Discuss Business and Technical Problems at Thirty-Seventh Annual Convention

Members of American Boiler Manufacturers' Association meet at Watkins, N. Y.—George W. Bach Elected President and A. R. Goldie vice president for the coming year

BUSINESS methods and technical progress in the boiler making industry were discussed for three days by the members and guests of the American Boiler Manufacturers' Association at the thirty-seventh annual convention of the association held at the Glen Springs Hotel, Watkins, N. Y., on June 1, 2 and 3. About 50 members and associates of the association attended the meetings which were held in the morning of each day, the afternoons being given over to golf and social activities. At the final session George W. Bach of the Union Iron Works, Erie, Pa., was elected president and A. R. Goldie of the Babcock & Wilcox, Goldie-McCulloch Company, Galt, Ontario, Canada, vice-president of the association for the coming year. H. N. Covell of the Lidgerwood Manufacturing Company, Brooklyn, N. Y., was re-elected secretary and treasurer.

E. R. Fish of the Heine Boiler Company, St. Louis, Mo., president of the association, presided at the meetings. At the opening of the convention on Monday morning, President Fish read his annual address, an abstract of which follows:

Abstract of President's Address

President Fish in his annual address discussed briefly some of the acute problems which the boiler manufacturing industry faces today in the hope that the discussion might help to crystallize some ideas that might ultimately benefit the trade. In his opinion the boiler building capacity of the country is considerably in excess of the demand, for which the only possible remedy is either an increase in demand or a decrease in capacity. The demand, however, must depend entirely upon the actual steam making needs of the country. Furthermore, with the constantly growing tendency to use central station power by small and medium sized industries, the demand is further curtailed, in spite of the fact that, from a combined engineering and commercial point of view, the power user could make his own power just as cheaply, if not cheaper, than by buying it. The fact that a great variety of manufacturing lines are running without profit, if not at a loss, contributes greatly to the lack of a market. That this condition will change is inevitable, but even when manufacturing generally is on a more normal basis there will, for some time to come, be a surplus of capacity. The result of this combined lack of demand and excess of capacity is, of course, intense competition.

As to how the situation may be rectified, the obvious answer is for some shops to close up or go into a different kind of work, which is not an easy thing to do and the question always is, "who shall it be?" Only in the last extremity may it be expected that any shop will voluntarily shut down. One way out of the difficulty suggested lies in a consolidation of some sort by which there may be a centralization of general administrative activities resulting in a considerable decrease in overhead and increase in efficiency of operation, coupled with a shutting down of the less efficiently equipped or managed or less strategetically located shops, thus making it possible to operate the others more nearly at a normal rate and at a maximum efficiency.

Our commercial practices, he pointed out, are without any generally accepted or observed trade customs. Without transgressing any state or Federal laws it is entirely possible and practicable to agree on uniform practices in many of these respects with great benefit to the industry. This applies to such matters as "terms of payment," "the amount of work to be included in a contract," "extent of free services," "guarantees of performance," "selling methods," etc.

As to the problems of construction and operation, the constantly increasing demand for increased pressures and larger units is rendering obsolete much of the old equipment and the installation of new and expensive tools of all sorts. Old methods in vogue with thin plates are being supplanted by methods partaking more of machine shop practice. This condition adds force to the argument for the consolidation of some of the smaller shops which cannot afford to install expensive equipment for use only part of the time. To supply the extremely large sizes and high pressures, which are becoming more and more common, entirely different designs and methods of construction must be resorted to; it is not sufficient merely to magnify and expand old methods.

Of the problems concerned with the operation of boilers, that of so-called caustic embrittlement is becoming more prominent. In this, boiler manufacturers are secondarily concerned because, while there may be no reasonable doubt about the material and workmanship having been substantially perfect when the boiler left the shop, the tendency of the purchaser, when anything develops after the boiler has been put in service, is to take the manufacturer to task. Mr. Fish stated that there have been a number of cases of cracked shell plates which cannot be attributed to defective material or workmanship and he expressed the opinion that many of the so-called "fire cracks" and "lap seam cracks" are due to manifestations of this kind and in all probability many explosions may have been due to the weakening of plates because of this peculiar chemical action of which nothing has been known up to a short time ago and about which comparatively little is known even now. It is a subject in which the trade generally should have an interest and to which it should contribute what it can to the solution of the problem.

He also expressed the belief that it is impossible to make any considerable progress in the way of organized and concerted action with only the occasional meetings which the association has and suggested the advantages of the services of a competent and adequately paid secretariat, an end that might be attained by combining the boiler manufacturers' association with other associations of similar activities which would provide the necessary revenue for maintaining an active secretarial organization.

Report of Secretary and Treasurer

H. N. Covell, secretary and treasurer, reported a gain of two members since the semi-annual meeting in February, making the total 70 active, 27 associate and 2 honorary members. The treasury showed a favorable balance and Mr. Covell thanked the members for their cooperation, urging them individually to make further efforts to increase the membership of the association.

A. S. M. E. Boiler Code

Owing to the recent death of E. C. Fisher of Wickes Boiler Company, Saginaw, Mich., who was chairman of the committee to act with the A. S. M. E. Code Committee, S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., reported briefly for the committee, stating that a number of complaints had been received lately regarding the manufacturers' data sheet. The chief complaint was that the sheet was difficult to make out and that it required too much material. Mr. Jeter suggested that the manufacturers write their views of the matter to the Code Committee and also that the association should take an organized stand in the matter. The shop inspectors say that they are qualified and licensed to see that the Code rules are lived up to and that it is only necessary for them to state on the data sheet that all the materials have met the requirements. Mr. Jeter also called attention to the Unfired Pressure Vessel Code that has recently been issued and also to the Code for the Care of Boilers in Service which is coming out shortly. The provisions in the latter Code are not compulsory but are given as recommendations for the guidance of boiler users.

DISCUSSION

M. F. Broderick of the Broderick Boiler Company, Muncie, Ind., declared that the new data sheet placed a severe handicap upon the manufacturer. When turning out three to four boilers per day it requires the services of two to three extra men in the shop to get out the data. He believed that the customer pays no attention to it and does not receive any benefit from it.

J. H. Broderick added that three or four months' data sheets are in their shop but have not been sent out.

Mr. Jeter stated that if the boilers go into states where the boiler inspection department is fully organized, the sheets will have to be sent out.

George W. Bach of the Union Iron Works, Erie, Pa., concurred in the opinion that the sheets required too much data, especially with regard to the physical and chemical characteristics of the material.

Stoker Committee Report

A. G. Pratt of the Babcock & Wilcox Company, New York, told the convention that the Stoker Committee had no report to make as no suggestions had been received from the boiler manufacturers. The Stoker Manufacturers' Association is working on the exit temperatures on which to base guarantees. After the stoker manufacturers have agreed on a figure for this it can be discussed by the boiler manufacturers.

Caustic Embrittlement

C. W. Obert, secretary of the A. S. M. E. Boiler Code Committee and chairman of a committee of three appointed at the last meeting of the Boiler Manufacturers' Association to report on the subject of caustic embrittlement of boiler steel, read a carefully prepared report which will be published in full in a later issue of THE BOILER MAKER covering the results of investigations made in this country and abroad regarding the causes and effects of caustic embrittlement.

DISCUSSION

A. G. Pratt stated that caustic embrittlement was the water-treating man's trouble. He stated that the Babcock & Wilcox Company's position is that mere treatment of the water does not cause the trouble but over-treating. He referred to the fact that when the use of a boiler compound high in caustic was abandoned in the Navy no further cases of caustic embrittlement occurred in boilers on naval vessels.

President Fish read a letter from Professor McIntosh of the Carnegie Institute of Technology suggesting that they were in a position to undertake further investigation of this subject and would be willing to do so if the Boiler Manufacturers' Association wished to support such work.

Mr. Pratt suggested that the small sum of money asked for this work would not go very far as his company has already spent over $50,000 in the last ten years investigating the matter and does not know the answer yet.

D. J. Champion of the Champion Rivet Company, Cleveland, O., stated that the boiler manufacturers' responsibility in the matter ended when he had produced a boiler as mechanically perfect as possible although he suggested that it might be well to agree on a uniform specification for the water used in the boiler.

S. F. Jeter said that the extensive experience of the Hartford Steam Boiler Inspection and Insurance Company shows that not every crack in a boiler can be attributed to caustic embrittlement—many cracks are due to something else for many pressure vessels in the paper-making industry use strong caustic solutions without cracking the plates.

M. H. Broderick believed that the steel makers should settle this matter with the boiler users.

W. C. Connelly of the Connelly Boiler Company, Cleveland, O., suggested that such organizations as the Iron and Steel Institute, the National Electric Light and Power Association and the insurance companies should have a hand in the matter.

W. H. S. Bateman, Philadelphia representative of the Champion Rivet Company and Lukens Steel Company, commended the authors of the paper for the work that they had done and stated the belief that the steel manufacturers should take the matter up.

After some further discussion of the matter, upon a motion of Starr H. Barnum of the Bigelow Company, New Haven, Conn., it was voted that the association defer action in this matter.

Cost Accounting

S. H. Barnum, of the Bigelow Company, New Haven, Conn., presented the Report of the Cost Committee, which will be published in a later issue.

Trade Acceptances

The report of the commercial committee on trade acceptances was read by F. G. Cox, chairman, as follows:

Replies to a questionnaire sent out to the members showed that Trade Acceptances are little used by the association. Replies from 20 members show that 8 have used Trade Acceptances. The 12 who do not use them give a variety of reasons which indicate, in some cases, unfamiliarity with the advantages to be obtained from their use. One member does go so far as to state that to take Trade Acceptances would be to start a bad habit, a second states that he prefers to accept notes and a third says he will accept Trade Acceptances, if requested by a purchaser. All of these replies indicate a lack of information on the subject.

Those members who make a habit of using Trade Acceptances are unanimous in the statement that they have no difficulty in getting customers to give Trade Acceptances. Only two members make any mention of Trade Acceptances in their terms of payment as printed in their proposals. Eleven indicate that they are willing to secure Trade Acceptances when possible. Only two members use forms especially printed for their own use, the other six use commercial forms obtained from stationers, banks, etc.

The committee made the following conclusions and recommendations:

1. That those who use Trade Acceptances are very well pleased with the results obtained.

2. That while certain members will not care to ask certain customers to give Trade Acceptances there are doubtless some of the members who do not know Trade Acceptances. We recommend everyone to become more familiar with the uses and advantages of using Trade Acceptances.

3. That members using Trade Acceptances have forms printed for their own use, bearing their own name. Specially printed forms will make a more favorable impression upon the purchaser than the use of commercial forms.

After giving the committee report on this subject, Mr. Cox read a paper by C. R. D. Meier of the Heine Boiler Company which will be published in full in a later issue of THE BOILER MAKER.

MONDAY EVENING SESSION

On Monday evening the return tubular section of the association met to consider the adoption of various construction details of a standard 72-inch by 18-foot boiler, the preliminary design of which had been approved at the midwinter meeting in Cleveland. J. A. McKeown of the John O'Brien Boiler Works, St. Louis, Mo., was appointed chairman of the meeting and G. W. Bach secretary. It was the purpose of the meeting to adopt the minimum size and numbers of some 15 details in this particular size boiler based on returns from a questionnaire hitherto sent to the members so that a complete standard design for this size boiler could be adopted.

Upon a motion of Mr. Bach it was voted to standardize all appurtenances for this size boiler including details of suspension, clean-out doors, etc.

At this session W. A. Drake of the Brownell Company, Dayton, Ohio, read a committee report on the Promotion of the Sale of Return Tubular Boilers, which will be published in a later issue.

TUESDAY MORNING SESSION

At the opening of the Tuesday morning session Joseph F. Scott, chairman of the License and Steam Boiler Inspection Bureau for the state of New Jersey and chairman of the National Board of Boiler and Pressure Vessel Inspectors, read a paper on the "Advantages of Uniformity in the National Board" which will be published in a later issue.

Mr. Scott's address was followed by a report by C. O. Myers, secretary-treasurer of the National Board of Boiler and Pressure Vessel Inspectors, covering the recent convention of the National Board in Milwaukee, a report of which is published elsewhere in this issue.

American Uniform Boiler Law Society

Charles E. Gorton, chairman of the American Uniform Boiler Law Society, stated that since the last meeting the State of Washington, the District of Columbia and Panama Canal Zone had adopted the A. S. M. E. Boiler Code. A boiler inspection bill had been introduced in Montana but it was defeated by unsatisfactory financial and labor conditions in the state. In Maine a similar bill had been introduced but withdrawn and re-drafted. The manufacturers in this state have organized a Boiler Board to investigate the matter and report to the Governor. It is expected that the bill will pass at the next session. A bill is on the legislative calendar in Florida to which there is no opposition. In Nevada the next legislature meets in 1926 and a bill for the enactment of boiler legislation will be considered. In Iowa a bill was introduced and withdrawn. In Delaware a Boiler Board is organized and ready to function. A bill introduced in Arizona had to be killed. An average of two states or cities have adopted the Code each year. Three universities and colleges have been added to the list of those using the A. S. M. E. Code as a reference book in boiler design.

Power and Heat for the Small Plant

David Moffatt Myers, consulting engineer of New York, delivered a comprehensive paper on the subject of power and heat for the small manufacturing plant showing that in a plant where all exhaust steam from turbines, engines and pumps can be utilized for heating or process work, the fuel cost of power, which is the greatest element of cost in the generation of energy by steam, is the cheapest in the world, far less in fact than that of the largest and most modern electric generating stations. Mr. Myers' paper will be published in full in a later issue.

Industrial Democracy

The next speaker, Professor D. S. Kimball, dean of the College of Engineering at Cornell University, discussed the progress and limitations of industrial democracy, warning his hearers that the term, although containing no doubt the essence of a result greatly to be desired, may, unless properly understood and delimited, lead us into serious industrial difficulties.

He explained various directions in which industrial reformers have attempted to apply to industrial management the principle of government by representation. This movement has resulted in a great variety of organizations, of joint committees or works' councils, all having one feature in common, namely, they are all based upon representation chosen by and from the employees of an individual enterprise. All works' councils, he said, may be divided into two general types, the first including those organizations modeled after our Federal government, which are best adapted to plants of considerable size, and the second based on the committee system. That the latter type holds more hope of securing better industrial relations especially when the committees are joint committees of employers and employees was the belief of the speaker for the reason that this form of council offers more opportunity for personal contact between employer and employee than any other. He pointed out, however, that the extent of the activities of this system is confined chiefly to the realm of human relations and that its usefulness in other directions is limited. Relatively few works' councils concern themselves with the matter of production or with general management problems, but the joint committee offers a means of cooperative effort that will make available an immense amount of practical industrial knowledge in the possession of any group of skilled workers.

Guarantees on Boiler Performance

William H. Jacobi of the Springfield Boiler Company, Springfield, Ill., presented a paper on "Guarantees on Boiler Performance" in which he showed that present methods of determining boiler performance and of making guarantees thereon are loose and inconsistent. He argued that if guarantees must be made to cover the merits of boiler equipment, boiler manufacturers must of necessity have a consistent working plan on which to base these merits and a corresponding guarantee. Mr. Jacobi's discussion of this subject will be printed in full in a later issue. In conclusion he offered the following recommendations:

1. That the determining factor of boiler performance be the rate of uniform supply of combustion gases by weight containing definite heat value per pound or per cubic foot corresponding to the best combustion conditions obtainable for all fuels.

2. That in stating boiler performance, the ratio of the heat

transferred to the steam produced above the temperature of the boiler feed to the heat contained by the amount of gases supplied to the boiler above boiler room temperature, or, briefly, pounds of steam produced per pounds of combustion gases supplied, replace the boiler horse-power developed per pound of fuel burned, and

3. That guarantees on boiler performance be made on the basis of the above ratio with tolerances allowed to cover the variations inherent to the nature of the fuels used.

Upon motion of S. H. Barnum this matter was referred to the Boiler and Stoker Committee to be reported upon at the next semi-annual meeting with the possible adoption of a guarantee code next year. Mr. Jacobi was added to the boiler and stoker committee.

Sales Methods

A paper on this subject was presented by George W. Bach, which will be published in a later issue. F. G. Cox, of the Edge Moor Iron Company, chairman of the Commercial Committee, presented the following reports:

Field Erection

Questionnaires were sent out to ascertain the practice of members in regard to erection of boilers in the field. The subject naturally divided itself into two groups, horizontal return tubular and watertube boilers.

Horizontal Return Tubular Boilers. Of the 10 replies received, 2 sell all of their boilers either f.o.b. shop or job and the other 8 sell about half their boilers f.o.b. shop or job. These 8, in most cases, include all erection labor as part of the contract price, but occasionally include the services of an erector only.

Watertube Boilers. Practically all watertube manufacturers erect or help erect the boilers in the field. Of the 10 replies received, the majority most of the time include complete erection in the contract price. Only one concern occasionally sets a limit as to the maximum number of working days of erection. The amount allowed in the contract for erection is very seldom stated in the contract. The minority includes services of erector only, as a part of the contract price, and of these only two occasionally set a limit as to the number of days the erector is to be on the job without additional charge. Only a few close contracts which state that the services of the erector are to be furnished at so much a day plus expenses. The charge varies from $10 to $25, the average being $15 and expenses.

From the above it will be seen that the general practice among both the horizontal return tubular and watertube boiler manufacturers, when erecting boilers in the field, is to include complete erection (including common labor) as part of the contract price and set no limit as to the number of days in which the work is to be performed. That is, the price includes the boiler, freight and erection complete at the site. As a general rule this seems to the committee to be a rather loose method of doing business and it is hoped some agreement can be reached which will make the practice more uniform both among those who do all the erection work and among those companies who furnish an erecting superintendent only.

Use of Paragraph in Contracts to Protect Purchaser in Case of Accident

If the boiler manufacturer is to do all erection work (including all common labor) a paragraph based on the suggestion of W. C. Connelly is recommended, as follows:

"The contractor hereby agrees to save the owner harmless and indemnify him for any expense, liability or payment (voluntary payments accepted) by reason of any injury to any person or persons, including death (or any injury to property) suffered through any act or omission of the contractor or any sub-contractor, or any one directly or indirectly employed by either of them in the prosecution of the work included in this contract."

or

"The contractor shall comply with all laws, rules and regulations of properly constituted authorities in respect to workmen's compensation and to the extent permitted by law shall maintain such insurance as will protect himself, the owner (and the engineers) from any and all claims for damages for personal injury, including death (and injuries to property) which may arise from operations under this contract."

When a boiler manufacturer furnishes an erecting superintendent only, the committee would recommend that if the boiler manufacturer does not already include a paragraph in his printed specifications similar to the one given below that he incorporate such a paragraph in his contracts. This paragraph is practically the same as used by three different members of the association:

"If the purchaser shall furnish workmen for the erection of boilers or the contractor or his erecting superintendent shall employ such workmen for account of the purchaser, the purchaser is to indemnify the contractor and save contractor harmless from any liability or damage to such workmen or to other persons or property, resulting from accident or negligence of the workmen."

Supervision of Brickwork

Among the horizontal return tubular boiler manufacturers only 3 reported ever supervising installation of brickwork, and that only 50 percent of the time.

Of the watertube boiler manufacturers, 7 reported supervising brickwork part of the time. Of these 7, two supervised 90 percent of the time, two 50 percent of the time and 3 only 10 percent of the time.

The committee feels that for the satisfactory operation of a boiler, from the owner's point of view, proper installation of brickwork is almost as important as proper installation of the boiler itself.

In the case of public utilities the owner or engineers usually design and supervise the installation of the brickwork. However, for other watertube boiler jobs and for horizontal return tubular jobs the committee feels that the boiler manufacturer should, for his own good, take an interest in the installation of the brickwork to the extent that he knows that the proper kind of brick is being used and the design of the brickwork is in accordance with the best practice.

The committee, therefore, recommends that the boiler manufacturer give serious thought to this phase of the business and take an active interest in seeing that the brickwork is properly erected. As a general rule we do not think it necessary to have a representative of the manufacturer on the job all the time while the brickwork is being installed but the representative should be on the job frequently enough to see that the work is being installed in the proper manner.

F. G. Cox, Chairman.

At the close of this session resolutions were adopted regarding the death of E. C. Fisher of Wickes Boiler Company, Saginaw, Mich., vice president of the association.

WEDNESDAY MORNING SESSION

Except for routine business and the election of officers for the coming year the Wednesday morning session was given over almost entirely to the discussion of a paper on Tensile Strength and Ductility of Steel Boiler Plate and the Tetmayer Formula for Figuring Allowable Stresses presented by C. L. Huston, vice president of the Lukens Steel Company.

Tensile Strength and Ductility of Steel Boiler Plate and the Tetmayer Formula for Figuring Allowable Stresses

In presenting this subject Mr. Huston placed in the hands of the members reprints of an article on "The Testing of Boiler Plates," published in *Power* of May 20, 1924, and also in THE BOILER MAKER of September, 1924, in which it was stated that steel boiler plates, both for boilers and for other somewhat similar purposes, are being called for in much larger sizes and thicker gages than heretofore, so that new conditions have to be met to work them into shape satisfactorily and to secure the best results in service.

A great deal of the steel going into boilers and other similar structures is made, he said, by the straight carbon, or "effervescing" process, and varies somewhat in the tensile strength of the different parts of each plate, as also of the different melts made to meet a given specification, these conditions in practice requiring in the specification the present range of 10,000 pounds maximum or minimum, with a given location of test piece from a specified part of the plate.

As these tests are usually required to be made from the softest part of the plate, it follows that other parts of the plate, which may be harder, will run above the maximum limits provided for the standard location of the test piece. In making very large and thick plates, this harder part of the plate is the part which most causes concern on the part of the users of the material, both in its fabrication and in its service. It would seem desirable, therefore, that this material may be kept as soft as possible within practical manufacturing conditions, if some practical and thoroughly safe way can be found to do so.

To give certain suggestions as to how this might be carried out, and to submit the proposals to the judgment of practical boiler makers and designing engineers, Mr. Huston gave in the article referred to above, and still more completely in the "Supplement" which follows, a description of the earlier method of testing iron and steel boiler plate, as required under the then rules of the United States Supervising Inspecting Board of Steam Vessels, showing that, as compared with the given tensile strength in parallel specimens as now practiced, the steel in those days could be made much softer, and still produce the form of test piece then used, with the necessary tensile strength to secure the required pressure in the boiler.

The series of tests which Mr. Huston made, as shown in the Supplement, were made of different proportions from those in earlier use, under the United States Steamboat Rules, but were made to show approximately what might be safely figured as the tensile strength of the material remaining between the rivet holes of a boiler of standard construction, compared with the tensile strength of the usual parallel test specimen; that is to say, that in the thicknesses given in the illustration, viz., 3/8 inch and 1½ inches, there is a difference of 5,000 pounds between the parallel specimen and the grooved specimen, representing the material between the rivets in the joint, and in the material 1½ inches thick, a difference in the two forms of 5,500 pounds, giving good ground of conclusion that the material all the way between these two thicknesses, when tested in the form representing the body of metal left between two rivet holes in a joint, would be about 5,000 pounds tensile strength over what would be shown in the usual parallel specimen of the same thickness.

This illustration was given to show that if we should allow a 50,000-pound minimum tensile strength steel, as tested in the usual parallel form, it could be safely figured upon as having a value of 55,000 pounds between the rivet holes in the regular joint, and by the use of a factor of safety of 5, under present practice, would permit of the present 11,000 pounds per square inch maximum unit working stress.

Taking up Prof. Tetmayer's theory of what he termed the "Value Figure," a piece of steel with 50,000 pounds tensile strength, and 30 percent elongation in 8 inches, would be as good for service, because the product of these two figures, viz., 1,500,000, would be just the same as the 60,000 pounds, with 25 percent elongation and, if a test piece were taken from the hardest part of the hardest plate, and showing not in excess of 70,000 pounds tensile strength, and an elongation of 21.43 percent, the same product will be obtained, and, therefore, the hardest part of the hardest plate would

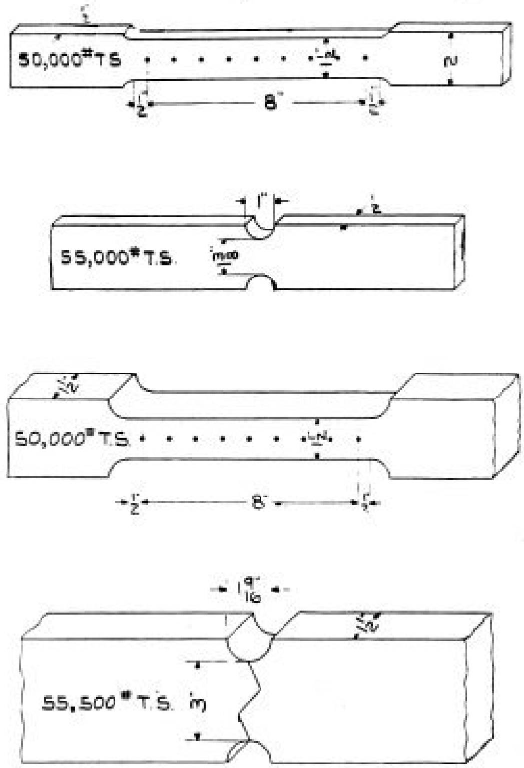


Fig. 4.—Showing approximate dimensions of tests representing metal between the rivets in standard A. S. M. E. rivet joint

have the same value figure as the softest part of the softest plate in the whole lot of plates in a specification.

Mr. Huston felt sure that the experience of boiler makers in using steel would support him in the contention that steel of this character would flange better, work into shape in every way better and, in the judgment of the boiler maker handling it, be safer in service than a higher tensile strength steel, in which the hardest part of the plates might be sufficiently high in tensile strength to tend to brittleness. Mr. Huston has investigated the subject sufficiently to say that this kind of steel could be made without extra cost, as compared with present American Society for Testing Materials' specification, by all makers of steel boiler plate.

In these days, when not only larger and heavier plates are being called for, but other requirements have to be met, such as forge welding, autogenous welding and other special conditions, steel could be made, which could safely be used to meet the present pressures allowed with the A. S. M. E. Boiler Code, or, without any change in specification, could be applied to meet most or all of the welding conditions so frequently called for by the trade. The adoption of such a method of figuring pressures, and such standards of material, would go far to reduce the problems now being met by steel boiler plate makers, and boiler manufacturers, in their efforts to make the best and safest structures obtainable under the present state of the art.

Mr. Huston hoped that the members of the association would read these papers carefully, and thoughtfully discuss them with men skilled in all the various branches of boiler making and designing, and other plate using arts, and see if they could not secure sufficient recognition and support of such a plan to enable it to be recognized in standard specifications.

Tank Plates in Stock

Makers of steel plates for boilers are obliged to carry on their books a sufficient number of orders for tank plates of the same thickness, so that when the boiler plates are condemned for not meeting the required physical or chemical test, they can be cut into the tank plates, and thus save the loss necessitated were they cut up into scrap. Users of tank plates prefer good soft working tank steel, and are more and more objecting to these "hand me down" condemned boiler plates, especially if condemned because of high tensile strength. This difficulty is likely to result in increased cost in the manufacture of plates for boilers, and that without adequate benefit in quality. A softer grade of steel, such as indicated, would go a long way towards removing this increasing problem.

Supplement

The accompanying illustrations in Fig. 4 correspond closely with the results shown in Table II and illustrate what might be reasonably found to be the strength of the metal between the rivets of a boiler made under A. S. M. E. Code.

That is, a test showing 50,000 pounds tensile strength in the usual parallel specimen would show 55,000 pounds or over in the section of metal between the rivets in thicknesses all the way from ½ to 1½ inches.

The curved sides of the metal between the two rivet holes account for the increase of tensile strength over that shown in the parallel specimen.

The peculiar zig-zag fracture indicated in the 1½-inch specimen is because the test section is much wider than usual, and, as steel is much lower in its resistance to shearing stress than it is to direct tensile strength, the metal in breaking inclines to take this zig-zag form.

A specification with a minimum tensile strength of 50,000 pounds, in the usual parallel specimen taken from the softest part of the plate, could be accompanied by a requirement of 70,000 pounds maximum taken at the top center of the plate.

This specimen might be taken transversely or longitudinally, as preferred by the steel manufacturer, the transverse specimen requiring less discard of good metal, while some steel manufacturers might prefer the longitudinal specimen.

Discussion

D. J. Champion asked if the use of soft rivets of from 45,000 to 55,000 pounds per square inch tensile strength is suitable in connection with thick high tensile plates for high pressure work.

C. L. Huston, referring to the zigzag fracture, shown Fig. 4 in his paper, stated that the strength of the riveting depended upon the shearing strength of the rivets which is less than the tensile strength and therefore the use of soft rivets should not harm the structure if the shearing and crushing strength gives an ample margin. He stressed the advantages of low tensile strength for boiler plate particularly in flange steel for fireboxes.

W. H. S. Bateman also advocated strongly the use of steel with low tensile strength for boiler plate and predicted that its use is bound to come sooner or later provided of course the elasticity and ductility are satisfactory.

Mr. Huston, in referring to the subject of caustic embrittlement, called attention to results obtained in Germany which lead to the conclusion that some effects of caustic embrittlement are due to the punching of the plate. They show that the effect of the heat as well as the pressure on the rivet has quite an effect on the structure of the plate. Mr. Huston also referred to the fact that in the matter of corrosion the use of copper bearing steel is found to be beneficial for various purposes.

Election of Officers

As stated earlier in this report, G. W. Bach was elected president and A. R. Goldie vice-president of the association for the coming year and H. N. Covell was re-elected secretary and treasurer. The following were elected members of the executive committee: E. R. Fish, G. S. Barnum, W. C. Connelly, W. A. Drake, F. G. Cox, J. F. Johnston, M. F. Moore, A. G. Pratt and J. H. Broderick.

Entertainment Features

The principal entertainment features at the convention consisted of golf tournaments on Monday and Tuesday afternoons and an informal banquet on Tuesday evening when the golf prizes were awarded.

Registration

The following members and guests of the association attended the convention:

H. E. Aldrich, Wickes Boiler Company, Saginaw, Mich.
George W. Bach, Union Iron Works, Erie, Pa.
Starr H. Barnum, Bigelow Company, New Haven, Conn.
Stanley L. Bateman, Champion Rivet Company and Parkesburg Iron Company, Philadelphia, Pa.
W. H. S. Bateman, Champion Rivet Company and Parkesburg Iron Company, Philadelphia, Pa.
F. G. Brinig, Erie City Iron Works, Erie, Pa.
J. H. Broderick, Broderick Boiler Company, Muncie, Ind.
M. F. Broderick, Broderick Boiler Company, Muncie, Ind.
B. N. Broido, Superheater Company, New York.
H. H. Brown, The Boiler Maker, New York.
Owsley Brown, Springfield Boiler Company, Springfield, O.
W. L. Cameron, Frost Manufacturing Company, Galesburg, Ill.
D. J. Champion, Champion Rivet Company, Cleveland, O.
Pierre Champion, Champion Rivet Company, Cleveland, O.
Fred W. Chipman, International Engineering Company, South Framingham, Mass.
J. F. Coburn, J. F. Corlett & Company, Cleveland, O.
W. C. Connelly, Connelly Boiler Works, Cleveland, O.
H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.
W. A. Drake, Brownell Company, Dayton, O.
J. G. Eury, Henry Vogt Machine Company, Louisville, Ky.
E. R. Fish, Heine Boiler Company, St. Louis, Mo.
R. M. Gates, Superheater Company, New York.
A. R. Goldie, Babcock & Wilcox and Goldie-McCulloch, Galt, Ont.
G. S. Gordon, Lukens Steel Company, Coatesville, Pa.
C. E. Gorton, Uniform Boiler Law Society, New York.
John J. Graham, Kewanee Boiler Company, Kewanee, Ill.
W. Heagerty, Oil City Boiler Works, Oil City, Pa.
Chas. L. Huston, Lukens Steel Company, Coatesville, Pa.
S. F. Jeter, Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.
J. F. Johnston, Johnston Boiler Works, Ferrysburg, Mich.
J. F. Kimerer, Oil Well Supply Company, Pittsburgh, Pa.
Harry Loeb, Lukens Steel Company, Philadelphia, Pa.
F. R. Low, *Power*, New York.
George R. McAleenan, McAleenan Bros. Company, Pittsburgh, Pa.
H. S. McCulloch, Babcock & Wilcox and Goldie-McCulloch, Galt, Ont.
W. G. McEwen, McEwen Bros., Wellsville, N. Y.
J. A. McKeown, John O'Brien Boiler Works, St. Louis, Mo.
J. S. Mason, *Power*, New York.
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M. F. Moore, Kewanee Boiler Company, Kewanee, Ill.
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H. M. Wolf, Broderick Boiler Company, Muncie, Ind.

May Shipments of Locomotives

The Department of Commerce has made public the locomotive shipments from principal establishments for May as follows:

Year and month 1925	Shipments			Unfilled orders end of month		
	Total	Domestic	Foreign	Total	Domestic	Foreign
January	90	45	45	407	351	56
February	85	73	12	397	343	54
March	109	93	16	447	351	96
April	92	82	10	477	362	115
May	96	68	28	467	353	114
Total 5 months	472	361	111	...	...	...

The Boiler Maker

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

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London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London

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Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

Subscription price; United States, Canada and Mexico, $2.00; foreign countries, $3.00. Single copy, 35 cents. Foreign subscriptions may be paid through our London office, 34 Victoria Street, S. W., 1, in £/s/d.

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

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CONTENTS

When the production capacity of an industry considerably exceeds the demand for its products, as is now the case with boiler making, that industry is in for a period of intense competition and a more or less prolonged struggle for the survival of the fittest. That the normal industrial growth of the country will eventually mean an increased demand for steam boilers is of course the reasonable expectation of all boiler manufacturers, but in the meantime the present situation must be met and the excess capacity of the shops either utilized in some other line of work or curtailed to reduce the overhead. One way out of the difficulty was suggested by the president of the American Boiler Manufacturers' Association in his annual address at the recent convention of the association, and that is by consolidation whereby general administrative activities may be centralized resulting in a decreased overhead and increased efficiency of operation together with a shutting down of the less efficiently equipped or managed or less favorably located shops, making it possible to operate the others more nearly at a normal rate and at a maximum efficiency. Theoretically such a procedure would offer an ideal solution for the problem and pave the way for a sounder growth of the industry in the future. Actually, however, the opportunities for such consolidation appear to be limited and relief in this direction, for the present, at least, is unlikely. As has been the case in many other industries since the war, the situation calls for renewed and more efficient efforts on the part of the manufacturers in the promotion of sales and the broadening of the market for their products as well as for more economical and efficient methods of production to reduce the overhead.

At the meeting of the Master Boiler Makers' Association in Chicago a number of items came up for discussion bearing on the welfare of the association and on its standing in railroad circles. It was suggested that a committee investigate the possibility of having the names of master boiler makers and general boiler foremen and others occupying similar positions under different titles included in the Official Railway Guide and in the Railway Pocket List. Practically every other mechanical official connected with the railroads is listed and it would seem to be right and proper that members of the association should be recognized for the important place that they hold in the scheme of railroad organization. THE BOILER MAKER cannot too strongly urge that superintendents of motive power and master mechanics throughout the country lend their aid in rectifying what must be an oversight on their part when the names of the mechanical staff are submitted to the Official Guides for publication.

Another point introduced into the discussion by Mr. Bentley in his address was that the name of the association did not convey a correct understanding of its organization which is made up largely of railroad master boiler makers. For this reason he felt that the body should be known as the "Railway Master Boiler Makers' Association." This might be done without in any way altering the status of membership of those outside the railroad field or the method of conducting the conventions. At the same time, he and many of the members felt that the standing of the association in the railroad field would be considerably advanced by the change.

A great deal of confusion is experienced by the varied terminology applied to boiler parts when they are under discussion. The association can accomplish a real service not only to themselves but to the technical world in general if a competent committee establishes for all time a standard nomenclature for all parts and fittings that go to make up a modern locomotive boiler. Certainly no group of individuals is better fitted to do this than the members of the association. It is to be hoped that such a committee will be appointed in the near future to investigate the matter and present a complete report on the subject at the 1926 convention.

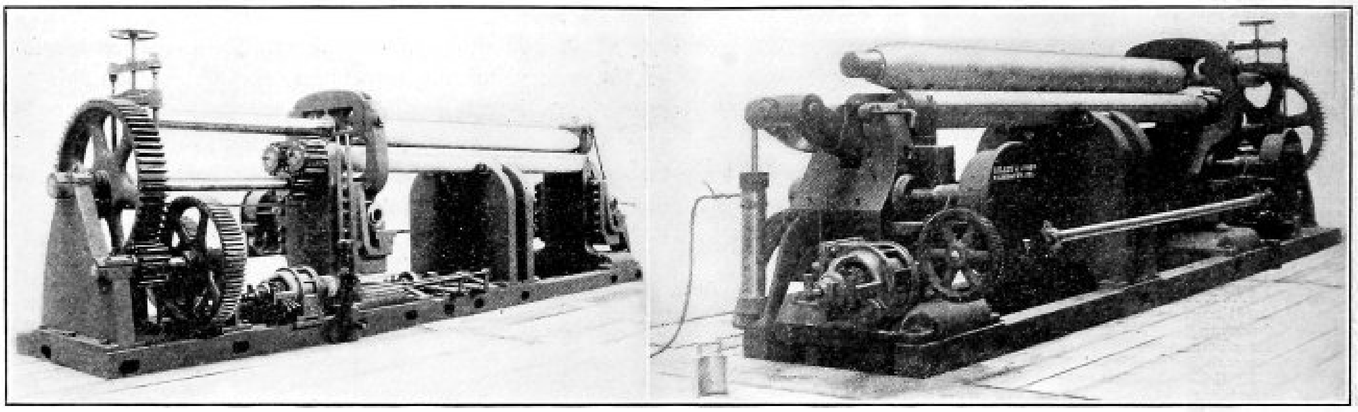
Engineering Specialties for Boiler Making

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

Bending Rolls for the Boiler and Tank Shop

ONE of the most troublesome problems in a tank and boiler shop is the flat place that is usually left on the edges of plates after being rolled on plate bending machines. Various methods of curving these edges have been employed for years, one the use of a heavy press, another mauling, and another the use of forming blocks on pyramid type rolls.

For a number of years the Hilles & Jones works of the Consolidated Machine Tool Corporation, Wilmington, Del., has been trying to evolve a plate bending machine, that would curve the sheet completely to the edge so that if desired the two edges may be welded, making a full cylindrical surface without any further work. Such a machine has recently been developed.



Front and rear views of bending rolls which curves the sheets completely to the edge

The capacity of the machine is rated to roll ⅜-inch soft plates 14 feet wide, or corresponding duty, and the same type of roll is made in other sizes. On the particular machine mentioned, the upper roll is 13½ inches in diameter and is adjustable vertically to provide for pinching the plate and also has horizontal adjustment so that it may be brought over to the center of either one of the lower rolls. It is this combination of the vertical and horizontal adjustment for this upper roll that provides the means for bending a plate to a true radius to the edge. The top roll is also provided with a solid forged extension for counter-balancing it when the back housing is dropped down for the removal of plates rolled to full circles.

The mechanism operating the vertical adjustment of the upper roll is such that both ends of the roll are raised and lowered simultaneously or each end independently. Positive clutches provide for this arrangement and there is a vertical adjustment of 4 inches to the upper roll. The horizontal adjustment of the upper roll is 14½ inches, or 7¼ inches each side of the center. The adjustments of the upper roll are by independent 10-horsepower motors, one motor for the vertical adjustment and another for the horizontal adjustment. This is necessary to provide an independent flexible control for the two motions. The lower rolls are each 10½ inches in diameter, with a center to center distance of 14½ inches.

An important feature of this design is the air cylinder which is provided for lowering the yoke for the removal of plates rolled to full circles. This air cylinder serves to eliminate the use of a crane, which is the usual practice for lowering the yoke, and this one feature materially increases the speed at which plates may be handled through the machine. The plate travel is 15 feet per minute. The driving of the lower rolls is by a 20-horsepower reversing motor.

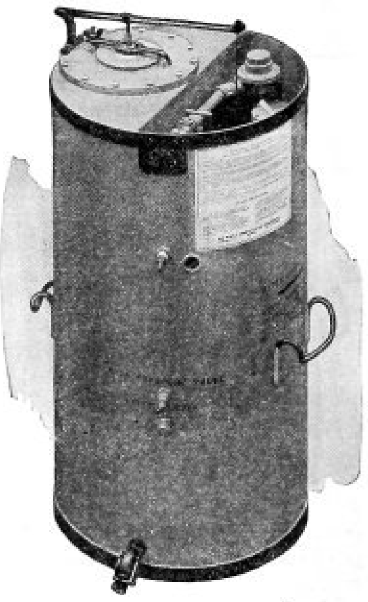
Worm and worm wheel drives are used for both the vertical and horizontal adjustments of the upper roll. Each worm and worm wheel are totally inclosed and run in oil. All gears have teeth cut from the solid. The weight of the machine without electrical equipment is 72,000 pounds.

New Portable Acetylene Generator

A SMALL generator for producing acetylene at low pressure for welding and cutting has recently been developed by the Oxweld Acetylene Company, 30 East 42nd street, New York. This supplements a line of larger generators, a great many of which are used to supply pipe lines in shops where much cutting and welding is done.

The new generator, which takes 35 pounds of carbide at one charge, can be transported readily from place to place, thus providing a portable supply of generated acetylene gas. Empty, the generator weighs only 210 pounds.

An entirely new principle of feed control is used which might be called a "heavier-than-water" float. A vertical partition, extending nearly to the bottom into a water seal, divides the generator shell. One side is gas tight and contains the carbide hopper at the top. The upper part of the other side contains gas regulating and protective devices, and an automatic carbide feed control. Generation of the first acetylene causes water to rise on this side of the partition high enough to all but submerge a pan full of water, hung to a control lever. This pan normally acts as a weight acting counter to a spring, but as the water rises about it, its apparent weight is diminished and the carbide hopper valve is closed by the action of the spring. As acetylene is drawn off, water rises in the gas compartment and correspondingly lowers under the float, relieves some of the buoyancy under the water pan, which, gathering weight with the receding water, depresses the spring and allows a small amount of carbide to drop into the generator, and restores equilibrium conditions.



Low pressure generator

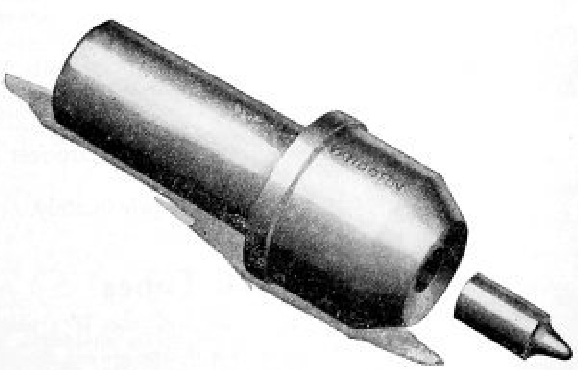
Because of its low center of gravity, the generator rights itself when tilted at an angle of 30 degrees. It works perfectly at an inclination of upwards of 10 degrees. No adverse effects result if a generator while in operation is knocked over. Nearly all fittings are enclosed in the cylindrical shell and there is little, if anything, projecting which may be injured by a fall on a concrete pavement.

This generator has been submitted to the Underwriters' Laboratories, Inc., and has been listed by them as an acceptable device for installation on insured premises.

New Staybolt Riveting Die

A NEW staybolt riveting die that does away with the necessity of drilling staybolt heads to open the tell-tale hole is now on the market as the Van Dorn staybolt riveting die, manufactured by the Van Dorn Iron Works Company, Cleveland, Ohio.

The claims for this die are that it swedges the bolt to the sheet before riveting, spreads the tell-tale hole, rivets



Riveting die with removable tip

the head and cuts off the fins in one operation. It turns out a faster, cleaner job than can be accomplished by any other method.

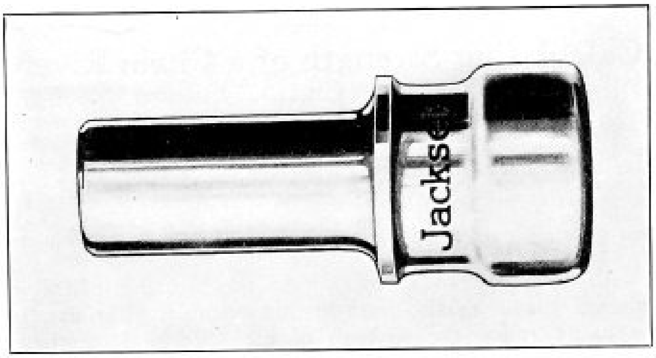
The marked difference between this die and other types of riveting dies lies in the fact that this die has a removable tip, shown in the illustration, which can be replaced at a cost of a few cents, and which eliminates the need of scrapping the die if the tip gets broken.

The die is made in standard sizes and the tip is made for a driving fit, so that it cannot drop or come out while in operation. Full information can be obtained by writing the Van Dorn Iron Works Company, Cleveland, Ohio.

Triple Service Alloy Steel Rivet Sets

INGERSOLL-RAND COMPANY, 11 Broadway, New York, has now produced a rivet set for pneumatic hammers which it claims will last longer than three, four or even more ordinary sets. Users are finding it the most economical set they can buy because of the great increase in rivets driven per set and the avoiding of delays and losses of time due to breakage. This new set is called the "Jackset."

It is made of a high quality alloy steel, which will stand a much greater degree of heat from hot rivets, without the temper becoming drawn. It is specially forged and then heat treated by a new process. This new set is the result



Ingersoll-Rand alloy steel rivet set

of years of experience in building rivet sets and of hundreds of tests on different steels and heat treatments, made in the effort to produce a tool better able to withstand the stresses of riveting service than the ordinary carbon steel rivet set.

Cleveland Punch and Shear Works Expands Facilities

THE Cleveland Punch & Shear Works Company, Cleveland, Ohio, has completed a plant extension program including the addition of considerable new equipment that will result in an increase of about 50 percent in its capacity. In addition the company has strengthened its organization by the appointment of Robert J. Pardee as vice-president and works manager, and Arthur Schloz as press engineer. Both have been connected with the Toledo Machine and Tool Company, Toledo, O., for about 15 years, Mr. Pardee as assistant to the president and Mr. Schloz as head designer. Mr. Schloz recently designed what is said to have been the largest crank toggle press ever built, weighing when complete 450,000 pounds and having a capacity of 1,500 tons. An important feature of this machine is the small number of bearings and joints required to operate the blank holder, thereby resulting in a saving of power and upkeep.

At the last regular meeting of the board of directors the following officers were elected: W. D. Sayle, president; W. C. Sayle, first vice-president and general manager; A. L. Bechtel, vice-president and chief engineer; R. J. Pardee, vice-president and works manager; H. C. Sayle, vice-president and metallurgist; A. C. Eckert, secretary and treasurer; H. J. Corrin, sales manager; W. J. Stewart, advertising manager.

Questions and Answers for Boiler Makers

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

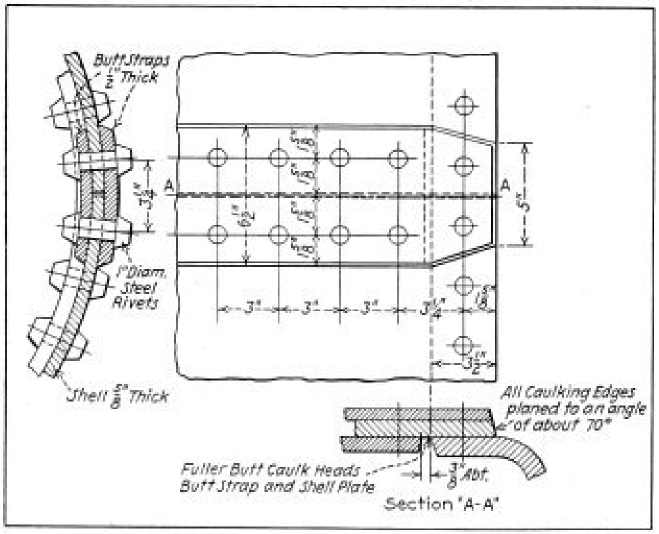
Conducted by C. B. Lindstrom

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

Calculating Strength of a Chain Riveted Joint

Q.—I am inclosing a copy of a blue print sketch, showing a special type of butt joint as used for a watertube boiler drum construction. I am at a loss to arrive at the proper way to calculate the efficiency of this joint to conform to the *A. S. M. E. Boiler Code requirements* or determine probable method of failure. As you will note, there is only one row of rivets on each side of the joint, and they are in double shear. I would certainly appreciate your opinion and the method you would recommend for calculating the above.—G. H. A.

A.—The factors entering into the figuring of *zig-zag* riveted joints are also used in this example. The first step is to determine the strength of the solid plate section in



Special type butt joint

pounds for the given pitch, then the strength of each part of the joint in pounds. The strength of the weakest section of the joint divided by the strength of the solid plate section in pounds gives the efficiency of the joint in percentage.

Let,

P = pitch of rivets, inches.
t = thickness of shell plate, inches.
t_1 = thickness of butt straps, inches.
a = cross sectional area of rivet after driving, in square inches.
S = shearing strength of rivet in double shear = 88,000 pounds per square inch for steel rivets.
T = tensile strength of steel plate = 55,000 pounds per square inch.
c = crushing strength of steel plate = 95,000 pounds per square inch of cross section area.
n = number of rivets in the given pitch.

Substitute the values given for the example in the following formulas:

(1) Strength of solid plate section $= P \times t \times T = 3 \times 5/8 \times 55{,}000 = 103{,}125$ pounds.

(2) Strength of plate between rivets in the given pitch $= (P - d) \times t \times T = (3 - 1) \times 5/8 \times 55{,}000 = 68{,}750$ pounds.

(3) Shearing strength of rivets in double shear $= S \times a \times n = 88{,}000 \times 0.7854 \times 1 = 69{,}115$ pounds.

(4) Crushing strength of shell plate in front of rivets $= n \times d \times t \times c = 1 \times 1 \times 5/8 \times 95{,}000 = 59{,}375$ pounds.

(5) Crushing strength of butt straps in front of rivets $= n \times d \times t_1 \times c = 1 \times 1 \times 1 \times 95{,}000 = 95{,}000$ pounds.

The weakest section of this joint is found from the formula (4) by dividing this value by the strength of the solid plate section (1). The quotient will be the efficiency of the joint.

Size of Boiler for Drying Chamber

Q.—Please advise relative to the following:
An airtight wool-heating or drying chamber is 40 feet long, 15 feet wide and 10 feet high and is heated by means of pipe coil of usual design made of 2,500 feet of 1¼-inch pipe. The temperature to be maintained in the chamber is 160 degrees F. The air is changed only once per day. How is the proper size boiler arrived at to serve the above coils, considering such boiler as low pressure of 15 pounds?—R. C. W.

A.—There is no simple relation between the heating surface of a boiler and the radiating surface of the coil in the drying chamber you refer to. A safe rule in this case is to figure 12 square feet of boiler heating surface the equivalent of 1 boiler horsepower, and that each boiler horsepower will supply 125 square feet of radiation. On this basis, first figure the square feet of radiating surface in the coils, which equals closely

$$\frac{1\tfrac{1}{4}^2 \times 0.7854 \times 12 \times 2{,}500}{144} = 813 \text{ square feet}$$

$$813 \div 125 = 6\tfrac{1}{2} \text{ horsepower approximately.}$$

Welding Arch Tubes

Q.—Will you kindly inform me concerning arch tubes on a locomotive. On the road on which I am employed, we are having considerable trouble with arch tubes leaking. I would like to know if there are any objections by the federal inspectors to the welding of arch tubes? Also, if there are no objections to welding the tubes in the sheet, and, if it is being done on other roads, what success are they having in welding arch tubes?—G. A. T.

A.—The installation of arch tubes by welding the tubes to the door and throat sheet would produce a stronger construction than expanded and beaded tubes; also there is less liability of leaks in the welded joints.

We know of no objections to the welding of arch tubes provided the work is properly done. Consult your inspector on this subject.

Registration of Members

(*Continued from page* 164)

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Wilson, W. M., G. F. B. M., C. R. I. & P. Ry., 1677 First Ave., East, Horton, Kans.
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Young, C. F., B. I., L. S. & M. S. R. R., 920 Willard St., Elkhart, Ind.
Young, E. W., Mech. Asst. to G. S. M. P., C. M. & St. P. R. R., 787 Caledonia Pl., Dubuque, Ia.
Young, M. J., G. B. F., Texas & Pacific, 1000 Humphill St., Ft. Worth, Tex.

OBITUARY

ELBERT C. FISHER, vice-president of the Wickes Boiler Company, Saginaw, Mich., and well-known boiler code authority, died suddenly on May 18. He was born in Scranton, Pa., in 1865. He prepared for college in the School of Lackawanna, Scranton, and graduated from Cornell University with the degree of M. E. in 1890. For one year he worked in the locomotive repair shop of the Delaware, Lackawanna & Western Railroad in Scranton and then went for a year to Westinghouse, Church, Kerr & Company, in Chicago. Then for four years he was manager of the Murphy Iron Works in the Chicago office. In 1895 he became associated with the Wickes Brothers and was made vice-president and general manager of the Wickes Boiler Company in 1908, a position which he held until his death. Mr. Fisher was a prominent member of the A. S. M. E. Boiler Code Committee, having served continuously since 1914. He was also a member of the Board of Boiler Rules of the State of Michigan and was on the executive committee of the American Boiler Manufacturers' Association. The news of his death comes as a shock to his many friends and associates in the power-plant field.

E. C. Fisher

Letters from Practical Boiler Makers

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

Why Not Publish Prices?

THE writer has never been able to understand why publishers of catalogues are so careful about omitting prices. They will pack a catalogue full of words about the history, manufacture, uses, advantages, appearance, weight, strength, dimensions, length of life, and everything else but do not give prices.

All of these things are important of course and prospective purchasers want to know as much as possible about the things they are going to purchase but what interests the average purchaser more than anything else after he is interested is: How much will it cost?

He looks for the price, can't find it, and immediately thinks to himself, "The price is so high they are ashamed to print it," and thereupon he throws the catalogue aside and proceeds to forget the matter.

Cause of Lost Sales

The writer contends that a great many sales are lost because of this practice of omitting the price. True, a letter can be dictated or written inquiring about the price but that requires initiative, time, effort, and costs money. Furthermore, if the publisher of the catalogue is located at a considerable distance away from the prospect it may take a week or more before a reply is received and by that time, the prospect probably has spent his money for something else or has forgotten about his needs and has lost interest. It is therefore up to the publisher of the catalogue to re-kindle the prospect's interest which means that his chances to make the sale are materially reduced.

Newark, N. J. W. F. Schaphorst.

Comment on Welded Boiler Repairs*

WITH interest I noted the remarks of C. W. Carter, New York state boiler inspector, regarding my description of an electric welding job. Mr. Carter says that the whole job is not a monument towards "safety first." But it is difficult to observe where the limit of "safety first" is lying as this is only a measure of the thrust one can feel in electric welding.

In our case the damage occurred on the boiler of a French tug for which there was plenty of towing work. I was aware that it would be a difficult job and therefore took all precautions. As the boiler was under the supervision of Bureau Veritas I visited the surveyors to ask permission for this repair and after explaining how it would be performed got that permission.

Difficulties of Repair

The crack in the knuckles of the flanges was already V-shaped. It would have been better to have it cut broader but this was impossible. We could only clean it and scrape it painfully so that all dirt and rust were removed. The welding was not done by my own welder but by a special man of the Quasi Arc Welding Company recommended by Bureau Veritas. Careful examinations showed that it was really a trustworthy repair. Without doubt it would have been better to have applied a patch, but we know such a large patch is a very difficult job, full of risk, and would have made it necessary to dismantle the boiler and take it out of the boat which would have given much delay and high costs.

Perhaps we make more general use of electric welding in Europe than you in America as shipping welfare on our rivers does not admit of much repair expenses. I can say that I have not seen hand-made patches on damaged boiler parts for years, in nearly all cases repairs were performed by welding.

What would Mr. Carter say about the welding of the knuckles of the flanges of furnaces where riveted to the tube plates and of cracked tube plates between the tubes? But I have seen very many such repairs made with excellent results under the supervision of our Dutch state boiler inspectors who are highly educated scientific and practical men of much better quality than one could conclude from the description by Mr. George Cecil in The Boiler Maker of December, 1923, whose story of Frans, his life and duties, was very amusing but totally besides the truth.

However, shortness of money plays a more considerable part in Europe than in the United States and naturally this has a small influence on the factor of safety in general.

Dordrecht, Holland. D. Kooyman.

*The original article appeared on page 55 of the February issue, and Mr. Carter's comment on page 116 of the April issue.

Welding Locomotive Boiler Tubes

THE following is a description of a method of welding flues and fireboxes of internally-fired boilers and will perhaps be of interest to readers of The Boiler Maker. This method is employed by one of the leading English boiler makers manufacturing riveted and welded boilers of varied designs. The form of welding described has the approval of the principal insurance companies in Great Britain for all welded shells under compression such as vertical boiler fireboxes and uptakes.

Details of Method

The process consists of oxy-acetylene welding the shell and subsequently rolling under heavy hydraulic pressure, by means of a steel roller, in a machine specially designed for the purpose.

The plate is first bent to form and butt-welded by the oxy-acetylene process. It is then placed in position on a mandrel, curved to the correct radius and preheated by means of an oil flame. The oil burner is attached to the machine and is placed directly over the end of the mandrel. When the welded seam is at the correct heat, the steel roller is brought down and rolled along the weld under heavy hydraulic pressure.

The resulting weld is perfectly smooth and is very difficult to detect and under test has proved equal to or better than a good fire weld. In some of the tensile tests that have been made the test piece has fractured in the solid plate with the weld intact.

Halifax, England. H. Waterworth.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

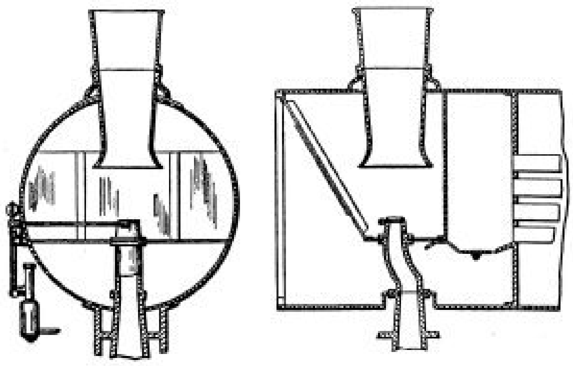
SELECTED BOILER PATENTS

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

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

1,537,331. EXHAUST NOZZLE COVER. HARRY A. CAMPBELL, OF PORTLAND, OREGON.

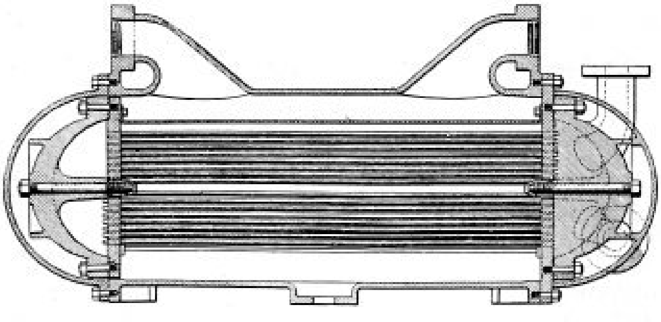
Claim 1.—In a locomotive boiler, the combination of an exhaust nozzle, a cover hingedly connected to close said nozzle, said cover mounted upon



a rotatable rod extending outwardly of the boiler shell, a steam cylinder connected with a source of steam supply under pressure controlled by the main engine throttle, and operative connections between said cylinder and said rod to open and close said nozzle through said cover. Four claims.

1,537,056. FEED WATER HEATER. EARL A. AVERILL, OF MOUNT VERNON, NEW YORK, ASSIGNOR TO LOCOMOTIVE FEED WATER HEATER COMPANY, A CORPORATION OF DELAWARE.

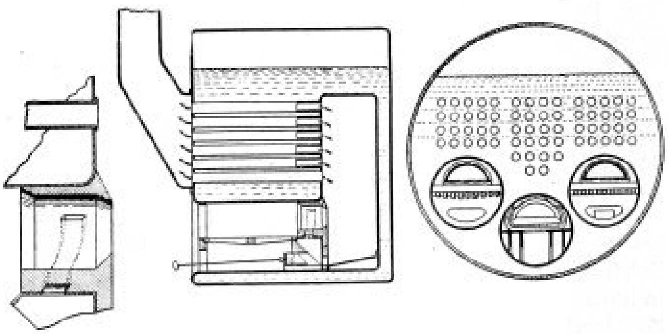
Claim 1.—In a feed water heater, the combination of a heater casing, and a heat transfer member removable as a unit and comprising a pair



of tube plates and a plurality of tubes secured in said plates, means for detachably securing the said member to the casing, and guard means extending longitudinally of and beneath the tubes for protecting the same upon insertion and removal of said member from the casing. Three claims.

1,536,147. COMPLETE COMBUSTION APPARATUS FOR MARINE BOILERS. TOKUSABURO SATO, OF OSAKA, JAPAN.

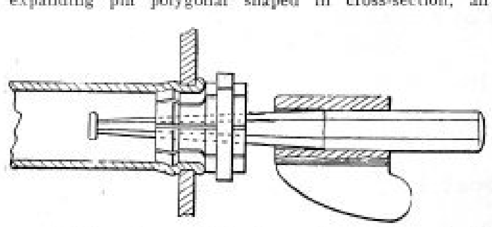
Claim.—In a furnace, a fire box, an ash pit, a bridge wall in rear of the ash pit and fire box and having an opening extending rearwardly from the fire box, and a combustion chamber into which said opening discharges, the said bridge wall having on its rear side a flange which depends there-



from and also presents a frusto-conical inner side forming a contraction of the rear end of said opening, the said bridge wall also having a hot air intake opening leading from the ash pit and a duct leading from said hot air intake opening formed in the mass of the bridge wall and discharging into one side of the first named opening therein and a frame supporting said bridge wall and against the rear side of which the said depending flange of the fire wall bears, said frame and flange also having an opening to establish direct communication between the ash pit and the combustion chamber, and means to control the passage of air through said opening and also through said hot air intake opening and said duct.

1,539,643. FLUE EXPANDER. CARL BUSH, OF MATTOON, ILLINOIS.

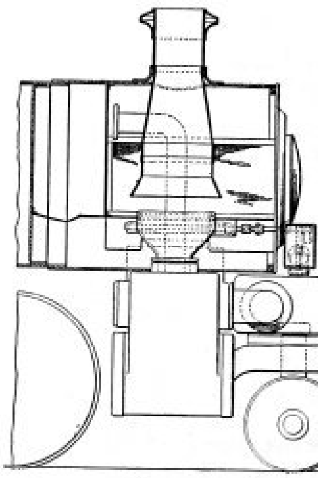
Claim 1.—In combination a flue expander including an expansible head, a tapered expanding pin polygonal shaped in cross-section, an extractor



mounted upon said pin and provided with a polygonal bore for fitting about the pin, said extractor adapted to have pressure applied thereto to release the expansible flue expanding head, and means for preventing removal of the expansible head from the pin. Two claims.

1,539,124. LOCOMOTIVE DRAFT APPLIANCE. DAVID M. LEWIS, OF CHICAGO, ILLINOIS.

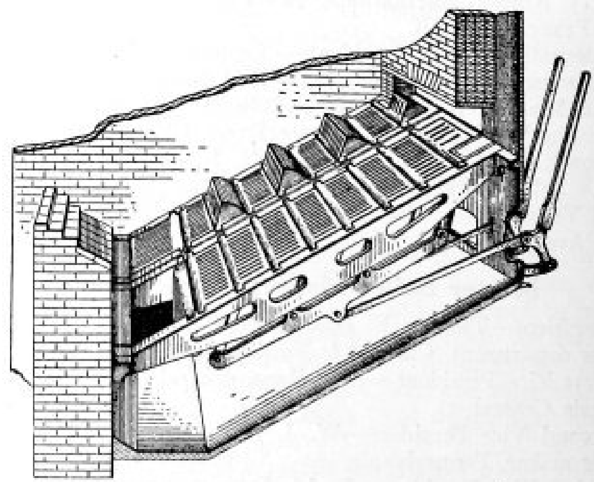
Claim 1.—In a locomotive draft appliance the combination of a cylinder, an exhaust passage, a nozzle and a receiver in parallel with the exhaust passage. In a locomotive draft appliance the combination of a pair of cylinders, a nozzle, exhaust passages leading from the cylinders to the



nozzle, and a receiver connected so as to be in parallel with the exhaust passages. In a locomotive draft appliance, the combination of a pair of cylinders having chests with outside exhaust passages and inside admission, a nozzle, a receiver and a connection between the receiver and each chest establishing communication between the river and the exhaust cavities of the chests. Nineteen claims.

1,526,922. VASIL MACKAY, OF WASHINGTON, DISTRICT OF COLUMBIA. FURNACE.

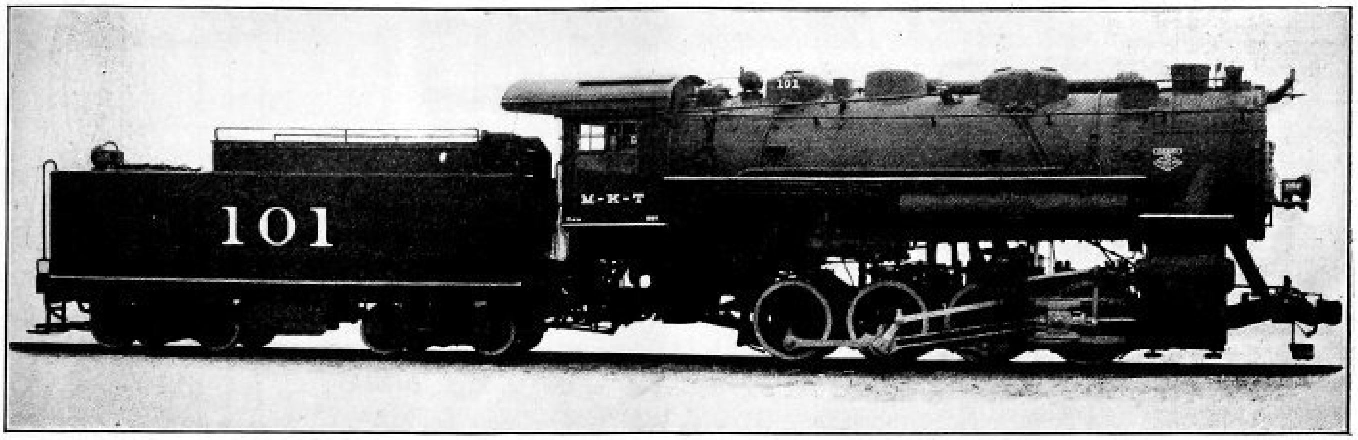
Claim 1.—In a furnace, the combination of its front wall having interior grate supporting means thereon, a rear support for the grate, adjoining series of grate sections located between and operatively associated with said supports, the sections of one series being arranged beside the sections of the adjoining series, the front wall of the furnace having an elongated



uninterrupted fuel admission opening common to the adjoining series of grate sections and of a length slightly short of the combined width of the adjoining sections, fuel feeding members whose combined length is substantially that of said opening having the forward portions thereof terminating in immediate proximity to said opening to directly receive the fuel passed through said opening, and fire proof protecting columns at the ends of the fuel feeding members and between the front wall of the furnace and the immediately adjacent grate sections. Ten claims.

THE BOILER MAKER

JULY, 1925

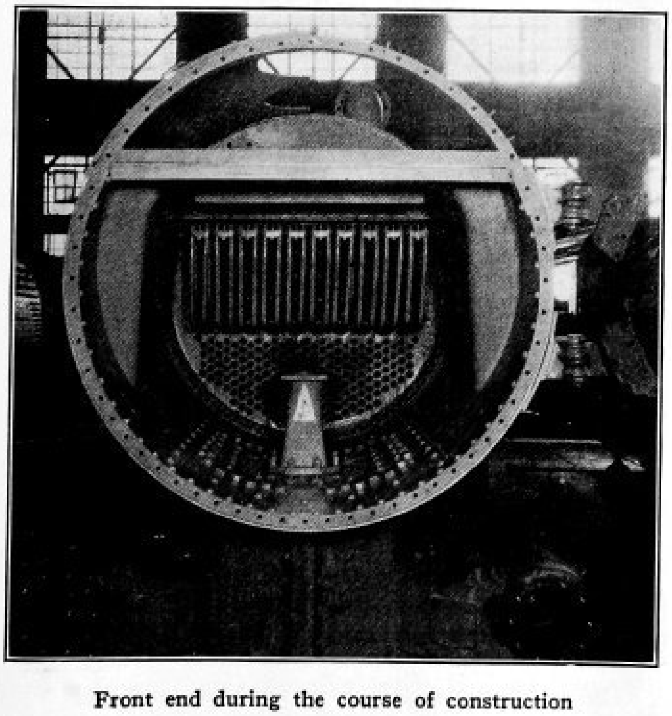


Missouri-Kansas-Texas eight-coupled switcher with a tractive force of 60,000 pounds

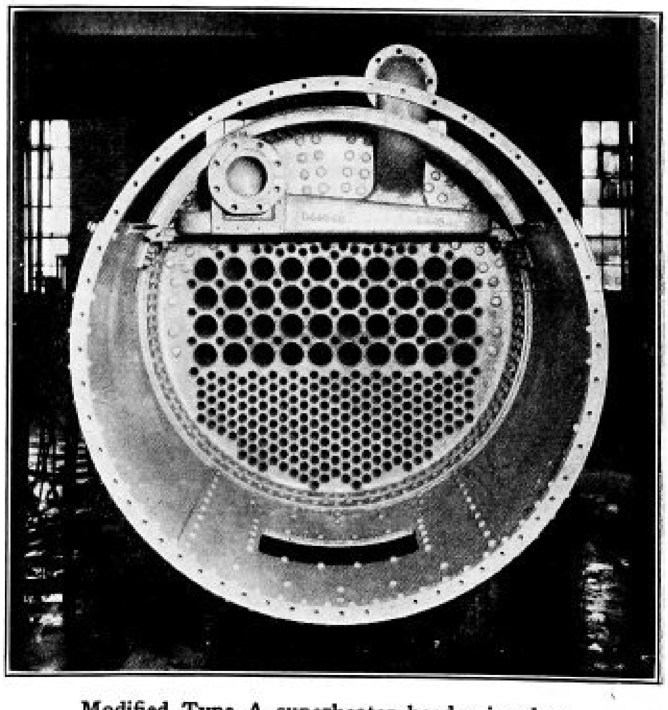
M.-K.-T. Switcher Has Novel Front End Arrangement

Smokebox airtight as dry pipe and branch pipes are on outside of boiler—Inspection and repairs simplified

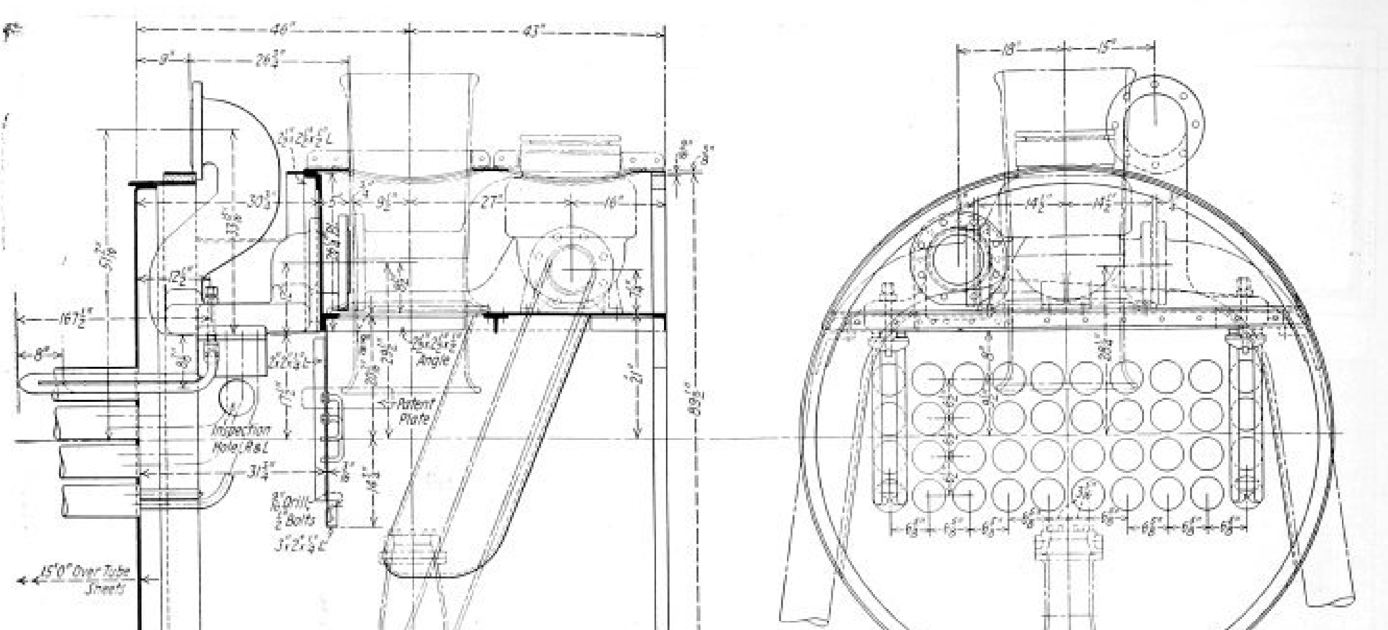
TEN eight-coupled switchers with a tractive force of 60,000 pounds were recently built by the Lima Locomotive Works, Ohio, for the Missouri-Kansas-Texas and have been put in service, four at Parsons, Kans., and the remaining six at Denison, Tex. In considering the design of these switchers, the motive power officers of the M.-K.-T. departed somewhat from the standard arrangement of the front end and created a design which has elim-



Front end during the course of construction



Modified Type A superheater header in place



General arrangement of the smokebox on the M.-K.-T. switcher

inated all possible openings into the smokebox through which air might enter and partially destroy the vacuum, and in which the various parts which are usually inside the boiler and smokebox are placed in a position so that inspection or repairs can be quickly and easily made.

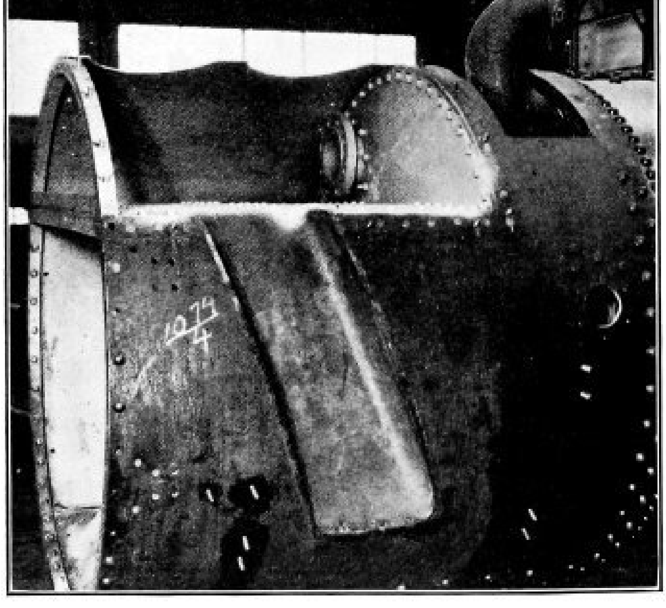
These locomotives are among the heaviest eight-coupled switchers that have been built. A comparison between these locomotives and a few other heavy, eight-wheel switchers recently built for other roads is given in the table below.

Road	Weight lb.	Rated tractive force lb.	Cylinders in.	Drivers in.	Steam pressure lb.
M. K. T.	244,000	60,000	26 by 28	51	190
Belt Ry. of Chicago	241,600	60,000	27 by 30	57	185
R. F. & P.	259,000	60,700	26 by 28	53	200
N. Y., N. H. & H.	245,500	60,600	3-22 by 28	57	200
C. R. R. of N. J.	238,500	53,400	24 by 30	55	200
U. S. R. A.	214,000	51,200	25 by 28	51	175

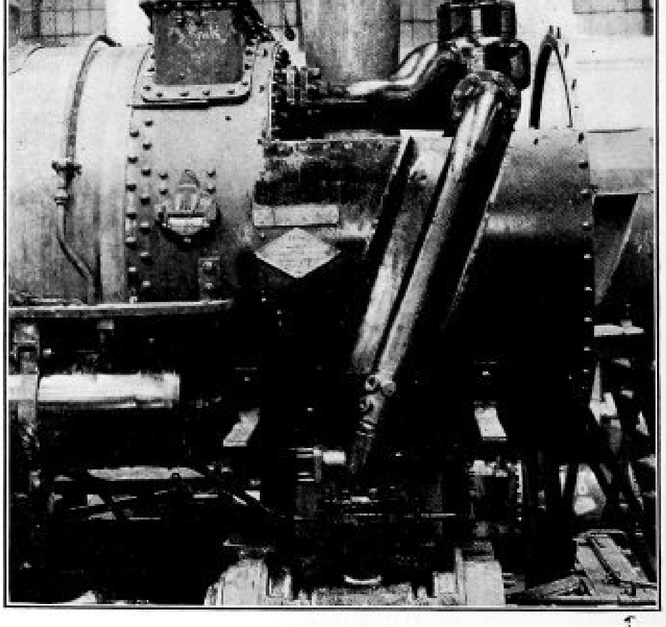
Front End Construction of Boiler Unique

The boiler has a straight top with a wide firebox which is 102⅛ inches long by 72⅛ inches wide inside. This size firebox provides a grate area of 51.1 square feet. The first course of the boiler is 86⅜ inches and the largest course, 87 15/16 inches in outside diameter. The firebox is radial stayed. There are 270, 2-inch tubes and 40, 5½-inch flues, 15 feet long, which give a combined heating surface of 2,965 square feet. This heating surface, combined with 205 square feet provided by the firebox and 725 square feet of superheating surface, gives a total of 3,995 square feet. The boiler pressure is 190 pounds. These engines have given excellent service since they were commissioned.

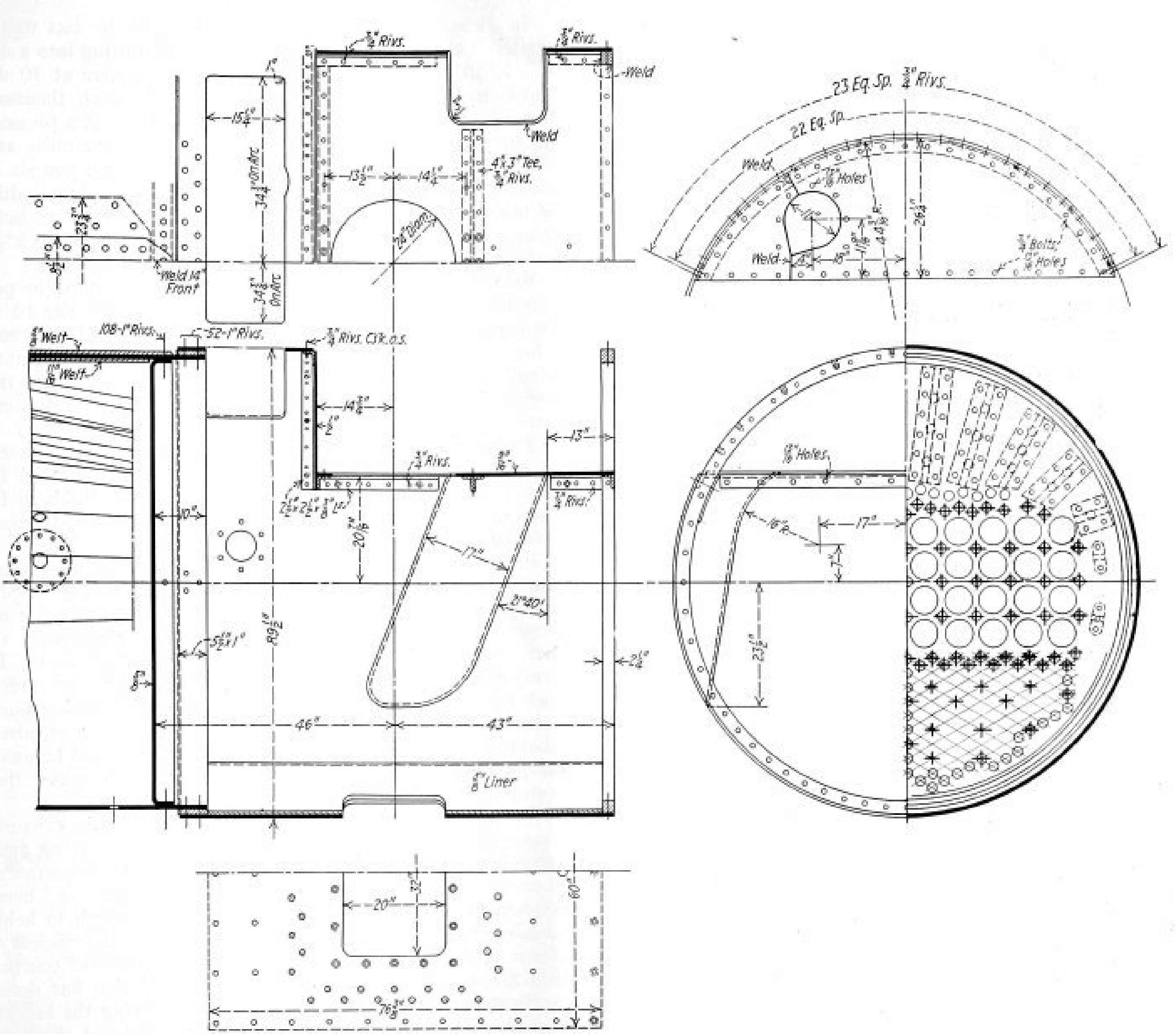
The dry pipe and the branch pipes to the cylinders have



Branch pipes fit in a formed recess which is welded in place



Branch pipes placed on the outside of the smokebox



Details of front end construction

been placed on the outside of the boiler. This arrangement has been made possible by a modification of the Type A superheater header and the use of the Chambers front end throttle, and involves a unique design of the smokebox shell.

Above the superheater header, an opening in the top of the smokebox permits access to the superheater unit bolts which are placed with the nuts at the top. Unit joints may thus be tightened without the necessity of entering the front end.

The front end is divided into two sections by a shelf of steel plates riveted and welded together. This shelf forms a section, entirely separate from the smokebox, which measures 26¼ inches down on the vertical center line of the smokebox and 57¾ inches from the outside of the smokebox ring to the vertical plate in front of the superheater header. Before this section is enclosed the superheater header, which is designed so that the dry pipe connection extends through the top of the smokebox wrapper sheet, is bolted in place on two brackets. The Chambers front end throttle, from which the branch pipes extend down on the outside of the smokebox, to the cylinders, is placed in the upper section of the front end, in front of the stack. The sheets of the smokebox are cut out and two formed pieces of boiler steel are electric welded in place to form the recesses in which the branch pipes are housed. Referring to the general view of the locomotive, it will be noticed that a jacket has been neatly bolted around the branch pipes which conforms in appearance to the conventional design, in which the branch pipes pass through the front end sheets to the steam chests. The fact that the branch pipes are on the outside of the boiler eliminates two openings into the smokebox, which in many cases have been found difficult to keep air-tight. A further advantage of this arrangement is that the superheater header and throttle valve may be easily inspected and repaired without disturbing the drafting arrangement in the smokebox.

The locomotives are equipped with Hancock H. No. 2 injectors. Other boiler fittings include three Ashton 3½-inch safety valves, one muffled and two open; one Okadee blow-off cock and blower valve, and a Hancock water column. The firebox is equipped with a Booth oil burner, and the draft pan is of Commonwealth cast steel design.

Tender Carries Water and Oil

The tender is the U-shape, level top type, mounted on a Commonwealth cast steel frame and carried on two four-wheel arch bar trucks. The 33-inch wheels are of the Edgewater rolled steel type. Wood three-tip roller side bearings are used on the truck. The tank has a capacity of 8,000 gallons of water and 2,500 gallons of oil.

Further particulars of these locomotives are given in the accompanying table of dimensions, weights and proportions.

Railroad	Missouri-Kansas-Texas
Type of Locomotive	0-8-0
Service	Switching
Cylinders, diameter and stroke	26 in. by 28 in.
Valve gear, type	Baker
Valves, piston type, size	12 in.
Weights in working order:	
On drivers	244,000 lb.
Total engine	244,000 lb.
Tender	160,000 lb.
Wheel bases:	
Driving	15 ft.
Total engine and tender	53 ft. 7½ in.
Wheels, diameter outside tires:	
Driving	51 in.
Boiler:	
Type	Straight top
Steam pressure	190 lb.
Fuel	Oil
Diameter, first ring, outside	85 11/16 in.
Firebox, length and width	102⅛ in. by 72¼ in.
Tubes, number and diameter	270, 2 in.
Flues, number and diameter	40, 5½ in.
Tubes and flues, length	15 ft.
Grate area	51.1 sq.. ft.
Heating surfaces:	
Firebox	205 sq. ft.
Tubes and flues	2,965 sq. ft.
Total evaporative	3,170 sq. ft.
Superheating	725 sq. ft.
Comb. evaporative and superheating	3,995 sq. ft.
Tender:	
Style	U-shape
Water capacity	8,000 gal.
Fuel capacity	Oil—2,500 gal.
Trucks	Four-wheel arch bar
General data, estimated:	
Rated tractive force, 85 percent	60,000 lb.
Cylinder horsepower (Cole)	2,312 hp.
Weight proportion:	
Weight on drivers ÷ tractive force	4.07
Total weight engine ÷ cylinder hp.	105.5
Total weight engine ÷ comb. heating surface	61

Promotion of Sales of Horizontal Return Tubular Boilers*

The promotion of the sales of return tubular boilers means the promotion of the comparatively small power plant.

There is no fixed rule or formula which may be used on every occasion to determine whether or not power should be generated in an isolated plant or purchased from a central station. There may be, and usually are, too many conditions surrounding the problem to make this possible. There are, however, certain underlying principles which may be used in the working out of any case, and it seems that some action should be taken by the boiler manufacturers to enable them to hold their own at least and place their product in plants where it rightfully belongs.

It is accepted in certain well defined cases that power should be purchased, but we all know that in many cases power is purchased at considerable loss yearly. The ideal situation would be attained if central station interests and private consumers would honestly co-operate to produce power in the most economical manner. The desire for more and more business often works to the disadvantage of a program of economy.

Use of Exhaust Steam the Big Factor

If there is use for the exhaust steam then the making of power becomes a by-product and the engine or turbine actually becomes a reducing valve. Almost all the heat is left in the steam, amounting to more than 90 percent of it. In this latitude heat is needed for about eight months in the year, so that plants must make provision to take care of this heating load. In addition to this, certain processes in manufacturing require steam, and exhaust steam is as efficient for use as live steam.

*Report presented before Horizontal Return Tube Boiler Section at annual convention of American Boiler Manufacturers' Association, Watkins, N. Y., June, 1925, by committee consisting of W. A. Drake, chairman, C. W. Edgerton, C. W. Obert and Cliff M. Tudor.

In *Power* of May 5 attention is called to the fact that a pound of steam at atmospheric pressure will bring into a dye tub 1,150.4 heat units, and, if the contents were at 70 degrees, would liberate enough heat to raise each thousand pounds of water 1.11 degrees. If the steam be at a pressure of 50 pounds gage, it would bring 1,178.5 heat units and liberate enough heat units to raise each thousand pounds of water 1.14 degrees, a difference of only three one-hundredths of one degree between exhaust and live steam at 50 pounds. The problem is to get the exhaust steam to the work in sufficient quantity because of its increased volume.

Commenting further on this article, it is absurd to put 1,100 to 1,400 heat units into a pound of steam, use 10 to 20 percent in power and throw the rest away and then run other boilers to do heating and process work. In the ordinary plant 90 percent of the heat of the steam which enters the engine is available in the exhaust for heating and process work.

To further increase efficiency, the exhaust can be condensed in radiators which act as condensers with a vacuum of 20 inches, as suggested in recent articles by C. L. Hubbard in *Power*. Various arrangements can be made use of to meet existing conditions.

In paper making many mills have not enough exhaust steam for drying purposes and must supplement the supply with live steam. In such cases the less expensive types of engines may be used to advantage, the power necessary to drive the machinery being secured at very little cost. It assuredly would not be profitable to purchase power under such conditions and use boilers for heating and drying purposes only. Economy of operation of the prime mover, also, would be of no consequence since all the exhaust can be used *all* the time. As the demand for exhaust steam decreases, the desirability of having an economical unit increases.

We have mentioned the availability of the heat in exhaust steam of the small plant and its use for heating, drying and process work. We have now to emphasize the importance of producing the steam at the least possible expense and here is where we, as boiler manufacturers, can do much to help ourselves.* Have we done all we can to increase the efficiency of our products? The design of the furnace has, of course, been given attention, and recently our association has done excellent work along this line, especially in fixing the height of settings. The design of furnaces offers, no doubt, the best field for work. We shall do well to continue our work and produce the most efficient unit possible, for, by so doing, the overall efficiency will be improved and the small power plant assisted in meeting its competition.

An illustration of what may be done is shown by the results at the Belvedere Hotel in Baltimore. This hotel installed a power plant in 1904 which was operated until 1914 at which time central station current was used. Central station current was used until late in 1924 when the plant was modernized, the voltage raised and other changes made at a cost of about $20,000. The plant has a total capacity of 450 kilowatts in three units. The first two months of operation after making the change showed a saving of $2,315.98 over the same period of the preceding year and it is estimated that the yearly saving will be about $13,000. The cost of the improvement becomes insignificant in view of the saving. Exhaust steam is used in this instance for heating when needed and in the laundry at all times.

*A very instructive paper on Saving Coal in Steam Power Plants, was issued by the Department of the Interior, Technical Power 217.

SUNBURY SHOPS CLOSED.—The locomotive repair shops of the Pennsylvania at Sunbury, Pa., were recently closed. Lack of facilities for repairing large locomotives has necessitated the assignment of this work to other shops.

Proceedings at National Board Meeting

Statistical report of power boiler conditions in the United States presented for consideration

An outline of the annual meeting of the National Board of Boiler and Pressure Vessel Inspectors appeared in the June issue of The Boiler Maker.

Below, the complete report of this meeting is published. The convention was held in conjunction with the spring meeting of the American Society of Mechanical Engineers, at Milwaukee, May 18, 19 and 20.

Joseph F. Scott presided at the sessions. His opening address is in part as follows:

Through the arrangement of our Secretary, we are once more assembled to review the work done by this Board for the last year with the hope that we will possibly be able to improve upon our future activities.

Inquiries among several, manufacturers have indicated their satisfaction with the results obtained by this Board since its inauguration, and this to my mind is the best criterion as to whether our existence is worth anything or not to the states and municipalities as a whole.

There is, however, room for improvement in the activities of this Board, but as there are other speakers to take up matters concerning them, I will leave this discussion to them.

One particular feature is interpretation. When an interpretation of the Boiler Code Committee has been completed and issued, it should be uniformly adopted by every member of this Board. It should be the only interpretation acceptable, thereby eliminating constant practice of individuals, whether inspectors, manufacturers, or boiler users, continually hammering at the Secretary of the Boiler Code Committee on his viewpoint on the boiler committee interpretations.

The question as to whether an annual convention is necessary ought to be given careful thought and be fully discussed at this meeting. Such practice may be expensive, but is it, when you consider the injection of greater interest, personal touch and the closer relationship which spring out of annual meetings of this nature. A Board of this kind can very easily die through the lack of proper attention and cooperation. On the other hand, with meetings, proper management and the whole-hearted interest in its activities, it should be more useful every year.

Secretary-Treasurer's Report

C. O. Myers of Ohio, Secretary and Treasurer, submitted the following report:

It gives me great pleasure to report at this convention that we are receiving the hearty cooperation of all of the interests affected by the efforts of the National Board of Boiler and Pressure Vessel Inspectors, to bring about uniformity and interchangeability of steam boilers in the various states having boiler inspection laws. We are receiving very encouraging reports from the insurance companies, the boiler manufacturers and the public in general who are using boilers which bear the National Board stamp.

It also gives me great pleasure to report that we are receiving very courteous consideration, as well as the whole-hearted support of the Boiler Code Committee of the American Society of Mechanical Engineers, in determining questions affecting the administration of the code.

We have been gradually working out the details necessary to bring about complete interchangeability of boilers through the proper inspection, stamping and registration, but there are still several things that should be ironed out before this meeting of the Board adjourns, the more important of which are, first—the question of individual registration of the boiler manufacturers; and, second—the individual commissioning of inspectors for shop inspections.

With reference to the registration of the manufacturers in each of the political subdivisions, this requirement was necessary before the creation of the National Board, and each of the states required their boilers to be stamped with their State Standard stamp. This method has been continued in some of the states when boilers are stamped with the National Board stamp. We believe that it is unnecessary to require a boiler manufacturer to register in each of the individual states when he is registering his boilers with the National Board, as it is required that he become registered with the Board and a copy of the facsimile of stamping, which is issued to him is forwarded to each of your offices for your files and identification of boilers which enter your various localities. If the states continue requiring the manufacturers to register when they are stamping in accordance with the rules of the National Board, it is a duplication and is really unnecessary.

The original intent when organizing the National Board of Boiler and Pressure Vessel Inspectors was to bring about a condition whereby uniformity and interchangeability of steam boilers could be obtained and also assure the state and municipal officials responsible for the enforcement of boiler inspection laws, that such boilers were constructed so as to insure safety of their operation. It is a well known fact that such safety in operation cannot be assured unless the inspector making the shop inspection is qualified and understands thoroughly the requirements necessary to construct a safe boiler. In the early days when each state or city was called upon to protect their constituents it was necessary that these inspectors be cautiously chosen by each of the individual states or cities.

Through the acquaintanceship obtained by the meetings of the National Board, I feel quite sure that all of the chief inspectors have acquired confidence in his neighbor to the extent that he can be assured that an inspector who has been qualified by him can be accepted to make shop inspections of boilers which are in the future to be operated in his locality.

The commissions which are issued by the National Board are only for the purpose of qualifying the inspector to make shop inspections and stamp the boilers National Board. It never was the intention of the National Board to provide commissions for inspectors to make field inspections as we have always realized that the existing conditions in each of the political subdivisions in the United States are different and will require different regulations with which the inspector should be acquainted, and it is our thought that each of the states and cities, who desire, should require the inspectors who are making the regular field inspections, to take the regular specified examinations for the state or city in which such inspections are made. However, there are some states and cities who have not the required administrative force to conduct an examination and we believe that they can feel sure that the persons holding National Board commissions are perfectly qualified, with the exception, possibly, of some rules which might be in force, affecting existing installations.

We would like very much to have this Board go on record, before adjourning, accepting inspectors holding National Board commissions for shop inspections only and eliminating the necessity of holding individual commissions for such inspections.

The importance of settling the above outlined details can best be understood by stating that we have registered at this time 85 boiler manufacturers, who are authorized to use the National Board stamp and 391 boiler inspectors commissioned as National Board inspectors. These boiler manufacturers and inspectors are located in all parts of the United States and during the past year 13,145 data reports have been received and filed in the office of the Secretary and Treasurer of the National Board.

With reference to the financial condition of the National Board, I am pleased to state that it is in a very good condition and to advise that our receipts for the past year were sufficient to bear the expense of this meeting and we sincerely trust that this work will continue to the extent that we can continue having annual meetings of this kind, which have proven to be very beneficial in the movement towards securing uniformity and interchangeability of steam boilers.

Statistical Report

E. W. Farmer of Rhode Island, statistician, submitted the following report:

Having been appointed statistician, I sent a questionnaire to all the departments of states and cities under code and boiler regulation as soon as the vacation season was over, also sent letters with questionnaire to the Secretary of State in all states not having boiler rules or regulations.

At the first request, I sent out sixty-three letters in all to which twenty-seven replied, mostly to the effect that they had no boiler regulations and no record was available.

Massachusetts was the first state having boiler rules to reply with the questionnaire filled in as far as records permitted. A printed report of Department of Public Safety was also submitted. State of Maine replied that they had one inspector employed three months during the year, but that they were going to try and have boiler rules with an inspector the year round.

I sent a more urgent request to all states and most cities that had not responded and met with a better response. Somehow Los Angeles, California, and Detroit, Michigan, were forgotten, but later sent them a questionnaire, which has not been filled out and returned. The inspectors have been very good and filled them out in detail as far as their records permitted them to do so and I wish to thank them all for their cooperation, past, present and future.

From four states I have not received any reply whatever. Of the sixteen code states, fourteen responded with questionnaire, filled or such figures as were available and two have not. Of the non-code states, five have replied with such figures as were possible without any records on the subject. Of the fifteen code cities, ten cities located in code states, five have responded and five have not and of the five cities located in non-code states, two have responded and three have not.

Ohio, New York and Minnesota made the most complete report in detail among the code states and Scranton, Pa., and Tulsa, Okla., among the code cities. I learned that the states of Colorado and Connecticut have boiler inspection, but did not require boilers to be constructed as provided in the A. S. M. E. Code. Montana also has a Boiler Inspection Department connected with a Department of Public Safety and the inspectors are guided by the A. S. M. E. Code and they ask all boilers built at the present time to conform to A. S. M. E. Code.

I sent to South Dakota and the request brought a reply from the State Heating Engineer, D. F. Radcliffe, who was interested and wished for a prospectus or other bulletin outlining the aims and purposes of the National Board. I understand that Florida has lately passed legislation adopting boiler rules and regulations.

The figures as tabulated from the departments of states and cities, mostly code states, are as follows:

Total number of boilers	215,599
Total number of boilers in cities having regulations but in non-code states, included in total	5,722
Number of boilers insured	156,019
There is a discrepancy as some departments had no record of division.	
Number of boilers found defective and unsafe	740
Number of boilers found defective and repaired	16,775
Number of new installations	3,167
Number of accidents as far as records show	21
Number killed as far as records show	13
Number injured as far as records show	11
Number of authorized state and city inspectors	108
Number of authorized insurance inspectors	839
Number of boiler manufacturers	248
Number of boilers manufactured	8,798
Number of engineers licensed	59,541
Number of firemen licensed	28,821

Figures tabulated from outside sources are as follows:—year 1922:

Explosions of power boilers	C57	
	N78	135
Explosions of heating boilers and pressure vessels		61
Could not make division of same		
Accidents to power boilers	C172	
	N124	296
Total		492
Killed by power boiler accidents	C42	
	N79	121
Injured by power boiler accidents	C194	
	N133	327
Total		448
Killed by heating boilers and pressure vessels		14
Injured by heating boilers and pressure vessels		44
Total		58
Total killed and injured by boilers and pressure vessels		448
Grand Total		506

Accidents by mechanical devices other than boilers:

Flywheel explosions	22	5	killed	4	injured
Steam turbine explosions	6	1	"	1	"
Total	28	6	"	5	"

Figures from outside sources for the year 1923 are as follows:

Explosions of power boilers	C39	
	N80	119
Explosions of heating and pressure vessels	HB24	
	PV44	68
Accidents to power boilers	C106	
	N139	245
Total		432
Killed by power boiler accidents	C 37	
	N113	150
Injured by power boiler accidents	C134	
	N189	323
Total		473
Killed by heating boilers		3
Injured by heating boilers		13
Killed by pressure vessels		7
Injured by pressure vessels		18
Grand Total		514

Accidents from other than power boilers:

Flywheel explosions	26	5	killed	12	injured
Steam turbine explosions	4		"	3	"
Steam blower explosions	1	6	"	2	"
Total	31	11	"	17	"

Figures from outside sources for the year 1924—January to July—are as follows:

Explosions of power boilers	C19	
	N39	58
Explosions of heating boilers		3
Explosions of pressure vessels		12
		73
Accidents to power boilers	C66	
	N48	114
Total		187
Killed by power boilers	C27	
	N33	60
Injured by power boilers	C80	
	N57	137
Total		197
Killed by pressure vessels		4
Injured by pressure vessels		24
Injured by heating boilers		8
Grand Total		233

Accidents from other than power boilers:

Flywheel explosions	28	10 killed	20 injured
Other accidents	11		3 "
Total	39	10 "	23 "

NOTE:—C refers to code states; N to non-code states; H. B. indicates heating boilers; P. V. indicates pressure vessels.

Your statistician wished to prove by actual facts and figures that it is very desirable to have boiler rules and regulations in all the states and large cities where a number of boilers are in operation and that they have a uniform law with regulations making the requirements for construction acceptable to all.

For the time being it would be advisable to lay aside the second section of questions as very few states have any records on the subject; and ask the departments of code states to keep a close record of number of boilers and accidents in their states, the nature of the same, and if possible, the probable cause as far as can be determined. I ask the cooperation of the insurance companies to give me all the figures that they can in states not having boiler rules and regulations.

One does not need to go into minute details, but it would possibly show that most of the accidents were due to some cause which was unavoidable on the part of the manufacturers who build boilers according to requirements of a uniform standard based on research and good engineering practice. I do not ask that any names be given, only nature, cause, date and location, city or town, so that I may separate the same from other sources of information and will not get one form of data mixed with the other.

I also invite suggestions or recommendations from the board as to a more effective way of obtaining accurate figures for recording our statistics.

Chairman Scott:

We have heard the report of Mr. Farmer, our statistician. We want to try to bring forth some real data which is worth while. Accidents and casualties happen in code states that must be taken and analyzed very thoroughly because you will find the majority of the industrial states are code states. I would think the ratio between the code and non-code states would show very much in favor of the code states where boilers are operated under code rules and regulations. Some of the code states show figures, which, however, do not show ratios because the analysis has not been carried out to the extent to give us this information. I think that the code states are very much advanced and I suggest that we give deep consideration to this matter.

Following up Mr. Farmer's report, it is a favorable branch of our work and every chief inspector and municipality ought to make it his business to make as correct a report as possible of accidents, explosions, etc., during the year. This is a line we ought to be informed on. His report shows states which are operated without regulations are having more explosions than the states which do have regulations for standard code constructed boilers.

I did not take very much interest in the start relative to statistical work but you can see from this report of the statistical work done that it should prove to be quite an asset throughout the country. It interests every inspector and through these reports we are able to find out what was the cause of these explosions, method of inspections, operation or whatever the cause may be.

C. W. Obert, secretary of the boiler code committee, addressed the meeting and an abstract of his remarks will be published in a later issue.

Abstract of Mr. Gorton's Remarks

Charles E. Gorton, chairman of the American Uniform Boiler Law Society, addressed the meeting as follows:

Uniform inspections, uniform registration, uniform examination, uniform rules, uniform stamping and uniform interpretation will be the subjects which I will discuss. Mr. Obert has practically covered uniform interpretations, but I want to go back and reminisce a bit for the younger members. I want to go back to a spring day in 1912 when Colonel Myers was president of the Mechanical Engineers. He and his friends realized the things and conditions which existed in this country at that time as far as boiler rules were concerned. He appointed a boiler code committee composed of seven members. These seven members got together and after going over the whole matter found it was entirely beyond them, that is, the work could not be done by seven men. As I understand it they went before the council and formed a committee and that committee was composed of seventeen of the best engineers throughout the country. These men got together and worked from 1912 to 1915.

On the fourteenth day of February, 1915, the complete rules were presented and they approved of those rules. When the boiler committee has had vital questions to meet and we did not know exactly how it would be taken by the different states, Mr. Obert communicated with your board and after we got replies back we found there was very little difficulty and if there were differences those differences were because of opinions that any man is bound to have.

Now the only way we can have a true interpretation of the code is to sit down and study the interpretations as they came from the boiler code committee. The simple reason that there are twenty-four states on the boiler code committee plus the code cities, is so that we will have a conference committee. All of you have a set of the rules and regulations as members of the boiler code committee, as conference committee men and should meet so that the boiler committee will reap the full benefit of your experience and deliberations. Mr. Obert said several things about what the conference committee men have done for them. It is an education for the boiler code committee.

Your secretary-treasurer brought up the subject of uniform stamping and a uniform registration. I hope and pray that before this meeting adjourns you will give careful consideration to uniform stamping and to uniform registration. Personally I cannot see why it is necessary for boiler manufacturers to register in the various code states and municipalities. The National Board is now five years old. The Board has gone along in leaps and bounds until today it seems to me that the right procedure would be for all manufacturers to register with the National Board. You men have access to the records of the National Board and the secretary-treasurer invites you as do the manufacturers who are registered with the Board, to use the records of the

National Board to the fullest extent for any information required in the conduct of your office.

When it comes to stamping of boilers, I do not know. I was out in the state of California two or three years ago when I found a boiler with twenty-two stamps on it and if it had been necessary to place the twenty-third stamp on this boiler it would have been necessary to have extended the plate of the boiler. Now we have it down so you very seldom see more than one or possibly three stamps. You will see a National Board stamp, possibly, if they are building what I like to call a composite boiler which one friend of mine said he had designed. Now we will find a National Board stamp, Massachusetts standard and a state stamp. There is a great deal of difference between three stamps and twenty-two. I hope some action will be taken here today which will eliminate practically all stampings with the exception of the National Board's stamp.

The question of inspections is a broad one—a mighty broad one. I think personally when it comes to a question of issuing a certificate to an inspector there should be practically two kinds of certificates issued—one issued by the National Board—the other issued by the state. A National Board certificate should cover shop inspection because the National Board, it seems to me, is in a better position to judge the qualifications of an inspector. It is easier for the National Board to keep track of National Board inspections as applied to shop inspections than it is for the state to keep such records. When it comes to the field inspection it seems to me that should be dealt with by the state itself.

Uniform examination: We know for a certainty that as soon as the National Board came into existence they worked for a higher grade of examination questions. We are having a higher grade of examination questions here because you men, members of the National Board, have given them due consideration. There can be only one result, that is, a better class of inspectors.

When it comes to a question of data sheets, we have to have uniform data sheets. By that I mean we shall have a data sheet that will serve the best purpose for the greater number here. In New York last year your chairman, your secretary and others that were at a code meeting were appointed as a sub-committee to draft a suitable data sheet. Those who are not vitally connected with this organization or the code may think you have drafted out the idea that will apply to all but you have not. When we start out with an innovation we do the best we can and that is all we can do.

Fred R. Low, editor of *Power* addressed the meeting and an abstract of his remarks will be published in a later issue.

E. R. Fish, president of the American Boiler Manufacturers Association, and vice president and general manager of the Heine Boiler Company, was the next speaker. An abstract of his address will be published in a later issue.

Mr. Edgar's Remarks

M. A. Edgar, Chief Boiler Inspector, State of Wisconsin, addressed the meeting as follows:

Many of the speakers explained the benefits derived from not being obliged to stamp boilers as much now as in the past, as now it is possible to build a 10 horsepower boiler and still have room enough for all stamps necessary. Some time in the past the 10 horsepower variety was threatened by not having surface enough.

No one mentioned one of the other important benefits derived from having a National Board composed of state inspectors in all of the states which have adopted a Code, that is, that the board has made it fairly reasonable for inspectors to secure certificates of competency or rather approval for shop inspections. I know that in this town in the past some of our manufacturers have had a lot of difficulty getting men who had an Ohio license, a Massachusetts license, Pennsylvania license or California license. Now that there is a standard examination the National Board is in a position to certify that the different state inspectors are qualified. The states can and do approve of boiler shop inspections made by these insurance inspectors. This is of considerable value also to the boiler insurance companies because they like to make shop inspections if possible and then later on secure a policy on it. In that way they can secure boiler insurance that would otherwise be gotten away from them. It is a benefit to the boiler insurance companies to be able to get their men approved by many states without going for examination. However, I think as far as field inspections are concerned, the insurance inspectors ought to come to the state, take an examination, get acquainted with the state boiler inspectors and prove they are qualified and leave a record at the state capitol to that effect, rather than let the man go out in the field, wander around in the field and find out he was not quite capable through an explosion or something of that sort. That is practically all I have to say.

Mr. Medcalf's Discussion

D. M. Medcalf, Chief Inspector of Boilers, Province of Ontario, Canada, addressed the meeting as follows:

A week ago I refused a trip to England and to Scotland, to pass on some boilers. I turned the boilers down because they were not constructed in accordance with the rules and regulations of Ontario.

I always wished that when our regulations were being formulated and adopted that we would have adopted the A. S. M. E. Code, and then it would be a universal law throughout America—and Canada is in America. Those were my sentiments in 1918 and our friend Gorton will find I am on record as favoring the Code but the powers that he did not. Therefore, we have our own Code.

Shortly before coming to this convention I interviewed my superior, as you know I have a superior, the head of the Department of Labor, and after discussing certain matters I told him what the National Board was doing in the United States. After a little discussion he said he would leave the matter of the acceptance of a boiler in the Province of Ontario, inspected by a national board representative, up to me. Therefore, gentlemen, I am very glad to be able to state at this time that boilers inspected by any boiler inspector of any state who is a National Board representative will be accepted for operation in the Province of Ontario.

I want you to understand that reports of those inspections are to be made on our forms and that I am now talking for the Province of Ontario and not for other provinces in Canada. When the inspectors send in the data sheets that are used in the United States by the A. S. M. E. Boiler Code Committee, insurance companies, or boiler manufacturers, such data sheets do not mean anything to us.

Mr. Huston's Remarks

C. L. Huston, Philadelphia, Pa., addressed the meeting as follows:

I am particularly interested in the making of steel for boilers, trying to make it right so it will give good service in the boiler and I assure you the work is of very great value to all of us who are connected with the industry.

I got out of quite a little predicament here within the last year. Some people who had not been accustomed to doing that kind of work undertook to work some steel plates but they had been accustomed to tank work and not boiler work and they proceeded to break the steel and when we got to look into it we found they had punched the holes full size. The plates were about 13/16-inch thick. They then proceeded to complete the operation. There was quite a dispute on it and they were going to make us pay for all the work they had done on a lot of completed construction. I simply cited the new rule that came into the Boiler Code and told them that that had been the opinion of the Code from the beginning, and that no punching should be done without a very considerable amount of reaming. That while they had not put it into the rule until just lately, the new edition, which I fortunately had received as a member of the committee, showed that plates of 5/8 inch thickness could not be punched at all and these were 13/16 inch thick, so the case was closed.

A general discussion occurred at this point.

WM. P. EALES, ASSISTANT SUPERINTENDENT OF THE TRAVELERS INSURANCE COMPANY, HARTFORD, CONN.: I was rather shocked at Mr. Farmer's report, at the number of explosions. I do not think they are fairly represented by what happened. I think Mr. Farmer or the board should right here and now frame a statistical record sheet, get it out in the field now so that a year from now we will have more conclusive information. I would like to know the number of boilers that exploded that are subject to Code supervision as compared with those that are exempt. The report is misleading in that respect although it is not Mr. Farmer's fault.

H. E. MCBRYDE, TULSA, OKLAHOMA: I can say this much, everything that comes into the city of Tulsa has to have the stamp on it according to the Code or it will be turned down regardless whether it is a boiler, tank or other pressure vessel.

About four months ago there was a complete water system put into town. The relief valve put on the water line was so connected that the back pressure would not trip the automatic check. The tank six feet high was located in the basement of a dwelling house right under the breakfast room. When the tank exploded it cut four 2-inch by 10-inch timbers, went through the breakfast room and out through the roof. If it had happened ten minutes later it would have killed everybody because breakfast was ready to be served.

I wrote Mr. Myers about it, also the company after taking the fire marshal out there to look the situation over, and made recommendations in the future to put the relief valves on the tank, and they agreed to do it.

We have had several boiler explosions down there. Mr. Land and myself have pictures of them and will be glad to show them to any one interested in that part of it.

I am obliged to say since I have been a boiler inspector for the City of Tulsa, I have the best cooperation of the Committee and Mr. Myers that I ever got from any organization I ever belonged to.

C. D. THOMAS, Chief Inspector of boilers for the State of Oregon: Way out in the northwest, in the wilderness as most people think it, we are progressing slowly but surely. We have never made a step in advance that we have had to retrace so far and we are taking it easy or rather slowly. We prefer that plan to trying to push things through rapidly and then have them fall back on our hands.

We had quite an experience the last six months—this with the second hand proposition. The Code requires, according to the existing installations in 1918, a factor of 5½ on second hand boilers. Now the intent of the Code, as I understand it, was to take care of the boilers in the state and not those boilers outside of the state. It seems that certain dealers in second hand boilers in conjunction with insurance inspectors and others got together and figured out how all of these boilers were used prior to the adoption of the code in the State of Oregon. They probably used a tensile strength of 60,000 pounds and probably increased the thickness of the plate 1/32 inch or thereabouts and in this way they brought these low non-code boilers up to about 145 pounds or in that neighborhood as against the new code boiler built for 150 pounds. It is a condition that we had to overcome in some way so I called the inspectors in and told them that the law for the State of Oregon was made for the State of Oregon and not for the outside; that according to the code all boilers shipped into the state are considered as new installations and consequently would have to comply with that part of the 1918 edition. They thought that was rather drastic, but after we got all of these dealers together with the inspectors and we laid the decision before them and told them they could either accept that or they could not ship second hand boilers into the state at all, because there was no provision made for taking care of boilers outside of the State of Oregon. The law applied to Oregon only and they could either accept that or else we would have to bar second hand boilers from coming into the state. They wanted to know what factor would apply regardless of construction. The State of Oregon must have a factor of 6. That brings the boiler down to 125 pounds consequently we have some chance for the manufacturer who is trying to comply with the code to bring in his boiler and get fair treatment from the State of Oregon.

In other words a Code boiler comes in for its regular rating, whatever this may be, and any other boilers from other states are penalized. Oregon is taking care of all their own boilers in the State of Oregon, prior to the adoption of the Code. We are using what you call the "common sense method," in other words, so long as a boiler is in safe condition, we will allow it to run at the original pressure for which it was made. I do not believe I can add anything more.

Meeting adjourned until 9:30 A. M. Wednesday, May 20, 1925.

Wednesday, May 20, 1925; 9:30 A. M.

Meeting called to order in the Hotel Pfister by Chairman Scott.

The report of C. O. Myers, Secretary-Treasurer, with reference to the individual registration of manufacturers in each of the political subdivisions and the acceptance of National Board commissioned inspectors, in lieu of issuing individual state commissions for shop inspections, was thoroughly discussed and resulted in the following direct questions being asked:

First: Will the representatives here present require boiler manufacturers, who are registered with the National Board, to also register in their individual states?

All of the members present answered to the effect that they would not require individual registration when the manufacturer is registered with the National Board, with the exception of the State of Michigan.

Second: Will representatives here present accept a National Board commissioned inspector for shop inspections without issuing an individual state commission to such inspector?

All the members present replied in the affirmative with the exceptions of the States of Pennsylvania and Michigan.

Wm. P. Eales, representing the State of Pennsylvania, advised that under the Pennsylvania Boiler Laws a boiler would be eligible for operation but it would require reinspection.

H. H. Mills, Chief Inspector of the City of Detroit, was not in a position to answer for the State of Michigan.

M. A. Edgar, Chief Inspector of Boilers for the State of Wisconsin, suggested that the Secretary of the National Board provide each member of the National Board with the name and address of each inspector commissioned at the time they are commissioned, and to notify each member of the Board when an inspector's commission is revoked.

The question of commissioning field inspectors and the reciprocity of the states in issuing commissions for field inspectors was thoroughly discussed and an expression from each representative present was requested, as to whether they will issue commissions to inspectors holding National Board commissions for inspections of existing installations without re-examination, which resulted in the following vote:

New Jersey	Yes	Wisconsin	No
Oklahoma	Yes	Nebraska	No
Oklahoma City	Yes	Detroit	No
Seattle	Yes	Pennsylvania	No
Oregon	Yes	New York City	No
Rhode Island	Yes	Chicago	No
Nashville	Yes	Ohio	No
Arkansas	Yes		
Minnesota	Yes		

It was unanimously ruled that we recommend to the A. S. M. E. Boiler Code Committee that the stamping provisions required in the Code relative to that part which refers to the registering of boilers be eliminated and that this matter be left entirely to the National Board of Boiler and Pressure Vessel Inspectors.

There was considerable discussion upon the proper manner in which specific designs of boilers and appurtenances should be submitted to the Board. Upon result of this discussion the following ruling was unanimously passed:

Any person desiring approval of a device necessary for the safe operation of steam boilers is to make application to the Secretary and Treasurer of the National Board of Boiler and Pressure Vessel Inspectors and the Secretary and Treasurer in turn is to refer the case to the State or Municipal inspector closest to where the device is manufactured for a complete investigation and test before it is finally submitted to the members of the National Board of Boiler and Pressure Vessel Inspectors for their disposition.

It was ruled that the devices submitted at this time be passed on and that the method outlined be adopted in the future.

W. C. Hackman of Milwaukee, Wisconsin, submitted a duplex fusible plug for the approval of the Board, and it was ruled that devices of this character should be submitted to each of the individual states where it is anticipated such devices will be used, for the reason that there may be some provision in the local state laws and ordinances governing such devices.

The Cleveland Heater Company of Cleveland, Ohio, submitted a hot water relief valve for the consideration of the Board and it was unanimously ruled that the Board had no jurisdiction over relief valves used for domestic hot water supply.

The Wulff Automatic Safety Valve Company of Chicago, Illinois, submitted an automatic water glass valve for the approval of the Board and it was unanimously ruled that this valve does not meet the requirements set forth in the A. S. M. E. Boiler Code and therefore cannot be considered. C. W. Obert, Secretary of the Boiler Code Committee, outlined in detail the case of the A. W. Cash Co. objecting to the ruling of the Code Committee on the use of rubber diaphragm seats in relief valves and asked the Board for an opinion on this matter and it was unanimously ruled that the Board recommend to the A. S. M. E. Boiler Code Committee that they do not favor rubber seat valves and that the committee adhere to previous ruling.

Dr. Theodore Veit of Mannheim, Germany, representing The Hanseatic Corporation of America of New York City, called in person before the Board and explained that his company is anticipating building boilers in Germany for use in the United States and requested an opinion as to how these boilers could be shop inspected until such time as they could be built in this country.

Dr. Veit was advised that the boilers used in this country must be constructed in accordance with the various state laws and municipal ordinances and all of the states and municipalities with the exception of the State of Massachusetts, have adopted the A. S. M. E. Boiler Code, and if those boilers comply with the requirements of this Code and were regularly shop inspected during construction by a qualified state or municipal inspector or an inspector in the employ of an insurance company, who is qualified to inspect boilers for the states or municipalities, they should be properly stamped and could then be operated in the various political subdivisions in the United States.

Dr. Veit was also advised that any inspector holding a National Board commission, if he is employed by an insurance company, or is on the regular payroll of the state or municipality, is authorized to take care of the inspection work for his company.

Election of Officers

The following officers were re-elected:

Joseph F. Scott, Chairman; C. O. Myers, Secretary-Treasurer, E. W. Farmer, Statistician.

C. D. Thomas, Chief Inspector of Boilers for the State of Oregon was elected Vice-Chairman to fill the vacancy existing from the retirement of R. L. Hemingway of California.

The question of the central states being represented on the Executive Board was thoroughly discussed and it was unanimously ruled that an additional member be added as a temporary member of the Executive Board, so that all sections of the country would be properly represented.

Harry Kohl, Chief Inspector of Boilers for the city of Chicago, was unanimously elected temporary member of the Executive Board. The Executive Board will decide where the next meeting will be held.

Causes and Prevention of Boiler Tube Failures

PROBABLY the most frequent cause of boiler tube failure is low water due to carelessness, to lack of adequate boiler feed equipment or to failure to keep equipment in good operating condition. However, there is another cause which has not been so generally recognized, and that is the use of gate valves on boiler feed lines. At one plant with which the writer was formerly connected seven tube failures occurred in one year, of which five were due to this cause. Even though a gate valve is provided with a rising stem it is impossible to tell the location of the valves by the position of the handwheel. Gates have been known to come loose from stems and the valves to remain closed when the stem has been brought into the open position. Two of the five failures were caused by this condition. The water tender had observed high water in the boiler and had closed the control valve, forcing the gates tight against the seat. When he again attempted to open the valves the gates pulled loose from the stem, leaving the valve entirely closed while the stem came into the open position.

Venturi Meter With Every Boiler

It has become the regular practice of the Consumers Power Company to install a Venturi meter with every boiler. When used with centrifugal pumps and pure water, they give very accurate results, and in case of low water they indicate whether or not the water is being supplied to the boilers. Had Venturi meters been installed in the boiler feed in a plant where five boiler explosions occurred, the explosions would have been prevented. The expense thrown on the company by any two of the explosions would have justified the cost of the installation of the meters on all boilers.

(Continued on page 212)

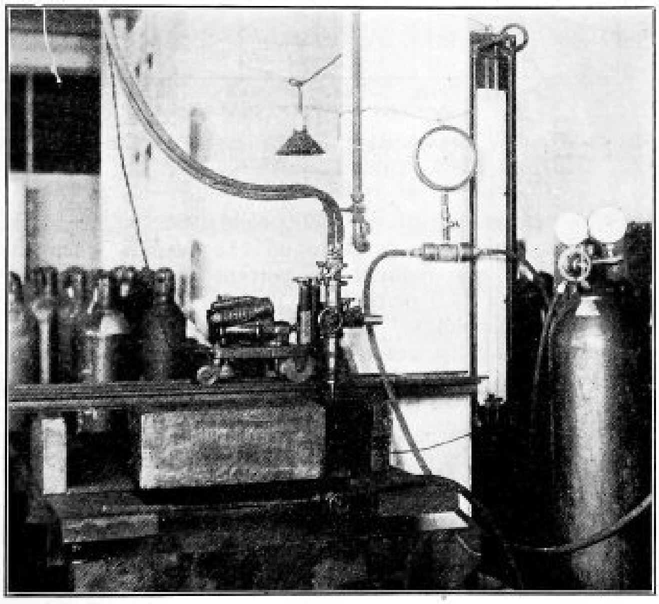
Economies Effected by the Use of High Purity Oxygen*

Consumption of the gas and the cutting time substantially reduced—Drag of cut improved

By John J. Crowe† and George L. Walker‡

UNTIL a comparatively recent date, all oxygen was produced by chemical or electro-chemical means, and some of the older users of oxy-acetylene torches will tell you that the oxygen produced for welding and cutting was very expensive and that it was about as impure as it was expensive when judged by our present standards. Today most of the oxygen used in oxy-acetylene welding and cutting is manufactured by the liquid air process.

The atmospheric air is liquefied by compressing and cooling, and the oxygen is obtained by what amounts to a distillation process. The boiling temperature of oxygen at atmospheric pressure being —296.5 degrees F., whereas the boiling point of nitrogen is approximately 24 degrees F. lower or —320.8 degrees F.



Radiograph controlled cutting torch

The discovery of the principle of the oxyacetylene torch was first announced by the famous French physicist Henri LeChatelier in 1895 in a paper read before the Academie de Sciences, on the temperatures of flames. He stated at that time that the temperature of the oxy-acetylene flame was 1,000 degrees C. higher than the oxy-hydrogen flame, and we know today that the temperature approximately 3,480 degrees C. (6,300 degrees F.) exceeds that of any other known flame and closely approaches the temperature of the carbon arc. Practice application was made of the principle of the oxy-acetylene flame by Fouché and Picard when they developed the first oxy-acetylene torch in 1901.

The first torches were for welding, but it was not long before application was made of the principle of iron and steel combustion in an atmosphere rich in oxygen when raised to their ignition temperatures.

Oxygen Purity

Until quite recently oxygen users were contented with oxygen of 97 to 98.5 percent purity, but today, at least in the United States, such is not the case. By improving the apparatus and operation of liquid air plants it has been found possible to manufacture, commercially, oxygen of much higher purity. By stages the purity of oxygen has been increased until now it is possible to obtain, continuously by that method, oxygen with a guaranteed purity of 99.5 percent, plus or minus a tolerance of 0.1 percent.

The question naturally arises, what benefits are to be derived from small increments in purity as we approach the ultimate limit of 100 percent oxygen. To answer this question the Air Reduction Sales Company has carried out two series of experiments extending over a period of several years, and it is the results of these experiments which are presented in this paper.

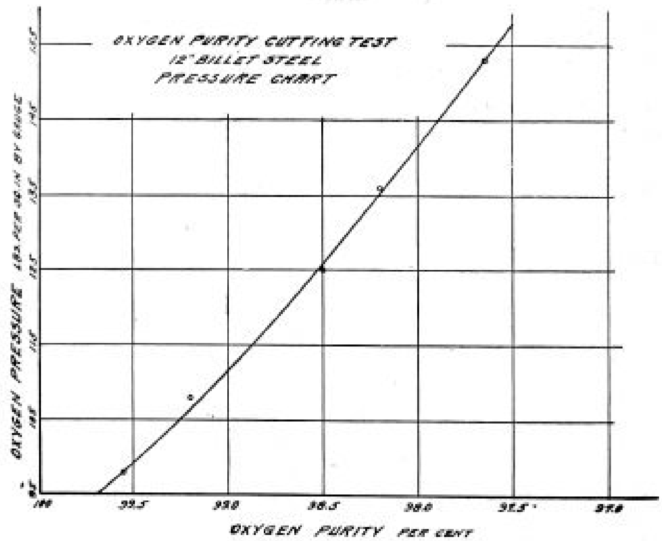


Fig. 1—Pressure chart which shows how the pressure increases as the purity of the oxygen decreases

Method of Making Tests

The experiments were made on steel plates and rolled steel billets, ranging in thickness from ⅜ inch to 12 inch. To eliminate the human element or personal equation as far as possible, all the cutting done in the first series was done with a hand torch mounted on a radiograph geared to give variable speeds from a few inches per minute up to 60

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*Abstract of a paper presented at the February 16 meeting of the American Welding Society, New York City. Copyright, 1925, by the Air Reduction Sales Company, New York.

†Engineer in charge of the apparatus research and development department, Air Reduction Sales Company.

‡Associate engineer of the apparatus research and development department, Air Reduction Sales Company.

inches or more per minute, and in the second test series the cutting was done with a machine torch mounted in the same manner.

The speed of the radiograph was checked with a stop watch. The pressures, where practicable, were measured with mercury manometers, and the higher pressures were measured with standard test gages, frequently calibrated and tested on a dead weight gage tester. The gas (oxygen and acetylene) consumptions were obtained by weighing the cylinders before and after using, on scales accurate to ¼ ounce, and these weights were checked up making up the loss in weight with shot and then weighing the shot on a separate balance. All the material was cooled to approximately the same temperature before cutting, and the experiments were carried out under laboratory conditions in which every variable was controlled as closely as it possibly could be.

Table I—Oxygen consumption of various purities required to cut metals of various thicknesses, using 100 cu. ft. of 99.5 percent oxygen as a basis of comparison.

Thickness of metal, in.	Series No.	Oxygen purity 99.5 per cent	99.0 per cent	98.5 per cent	98.0 per cent	97.5 per cent
¼	1	100.0	114.1	125.5	....	....
½	1	100.0	111.1	121.5	....	....
¾	1	100.0	116.0	140.0	....	....
1	1	100.0	115.4	135.0	....	....
2⅛	1	100.0	108.0	123.4	....	....
2 3/16	2	100.0	112.1	127.5	148.8	173.9
4⅜	1	100.0	113.3	141.5	....	....
6	1	100.0	108.8	133.6	....	....
6	2	100.0	114.8	131.7	150.1	169.3
12	1	100.0	108.4	119.5	....	....
12	2	100.0	108.9	122.0	139.0	161.0
Average consumption		100.0	111.9	129.2	145.9	168.1
Difference for each ½ per cent decrease in oxygen purity.....			11.9	17.3	16.7	21.5

The laboratory was furnished with an ample supply of oxygen varying in purity from 98.5 percent to 99.5 percent by steps of approximately ¼ percent for the first series and from 97.5 percent to 99.5 percent by ½ percent steps for the second series. The actual purities were determined at the time of manufacture, and were carefully checked in the laboratory.

Previous experiments in which oxygen of various purities manufactured by the electrolytic process compared with oxygen of the same purities manufactured by the liquid air process had shown no measurable difference.

RESULTS OF THE TESTS

In the typical graph shown in Fig. 1 the minimum pressures required to cut a 12-inch billet have been plotted against the purity of the oxygen used. To determine these pressures a large number of preliminary cuts were made on each thickness of metal with oxygen of each purity. The method of procedure followed was to start with a pressure that would make the cut without difficulty, and then to reduce the pressure by stages until the minimum pressure was found that would just make the cut.

Preliminary experiments were also made to determine the most economical size of tip and the speeds to use in making the final cuts. The curve shown is concave upwards but only slightly so, and this is typical of all curves plotted in this manner.

Taking Fig. 1 as an example it will be noted that the pressure required to cut a billet 12 inches thick using oxygen of 99.5 percent purity was 99 pounds per square inch, whereas it required a pressure of 112 pounds when the oxygen purity was reduced 0.5 percent and if the purity was dropped to 98.0 percent the pressure required was increased to 142 pounds.

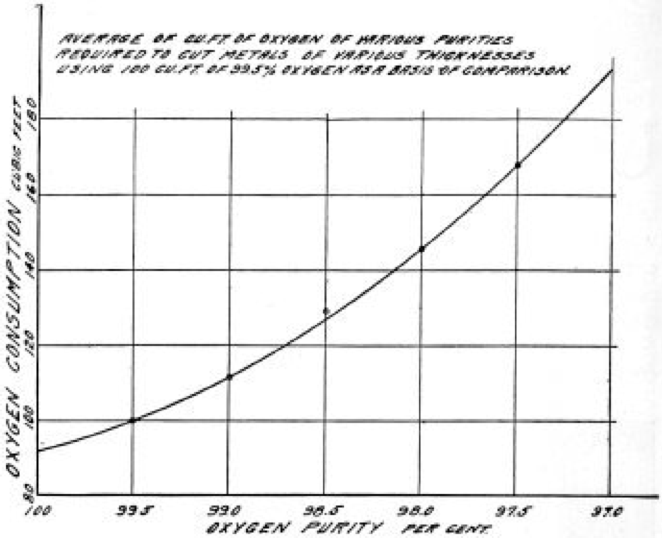


Fig. 2—Graphic presentation of the mean results given in Table I

As the cutting tip was the same for all cuts on the same thickness of metal the oxygen consumption for the same amount of cutting increases with the pressure required to make the cut.

In order that the data obtained may be more easily compared they have been tabulated in Table I after reducing to a common basis, that is, the number of cubic feet of oxygen of the various purities required to cut metals of the various thicknesses, using 100 cubic feet of 99.5 percent oxygen as a standard of comparison. The mean of the results given in the table is shown graphically in Fig. 2.

It will be noted that 11.9 percent more oxygen of 99.0 percent purity is required to do the same amount of cutting as was done with oxygen of 99.5 percent purity, and when the oxygen purity was dropped from 99.5 percent to 98.5 percent the increase in consumption was 29.2 percent. In

Table II—Actual time required to make cuts of given lengths of metals of various thicknesses using oxygen of various purities and time expressed in percentages using time required with oxygen of 99.5 per cent purity as a standard

Thickness of metal, in.	99.50 per cent: Time to make cut, min.	sec.	Per cent	99.25 per cent: Time to make cut, min.	sec.	Per cent	99.00 per cent: Time to make cut, min.	sec.	Per cent	98.75 per cent: Time to make cut, min.	sec.	Per cent	98.50 per cent: Time to make cut, min.	sec.	Per cent
¼	74	18	100	79	51	107.3	84	45	114.0	91	30	123.1	93	24	125.5
½	42	15	100	43	13	102.3	46	54	111.0	48	42	115.2	51	15	121.3
¾	35	45	100	38	3	106.4	41	27	115.9	48	48	122.5	50	5	140.1
[illegible]	35	20	100	37	18	105.6	40	45	115.3	43	0	121.7	47	39	135.0
2¼	26	7	100	27	4	103.7	28	12	105.0	29	40	113.7	32	14	123.5
4¾	14	29	100	15	25	106.5	16	25	113.4	18	32	128.0	20	27	141.3
Mean			100			105.3			112.9			120.7			131.0
Difference for ¼ per cent in oxygen purity				5.3 per cent			7.6 per cent			7.8 per cent			10.3 per cent		
Difference for ½ per cent in oxygen purity							12.9 per cent						18.1 per cent		

other words, it required 129.2 cubic feet of 98.5 percent oxygen to make the same length of cut as was made with 100 cubic feet of oxygen having a purity of 99.5 percent.

The preceding data have shown how the oxygen consumption increases with a decrease in oxygen purity without reference to time. The results of time studies made in the first series of experiments on sizes up to 4⅜ inches thick are given in Table II. Owing to the large amount of material involved, these experiments were not extended to cover the larger sizes, all the cutting on the 6-inch and 12-inch billets being made at constant speed. The actual time to make the various cuts is shown in Table II and in order to compare the results they have all been reduced to a common basis and expressed in percentages using the time obtained with 99.5 percent purity oxygen as a standard of comparison.

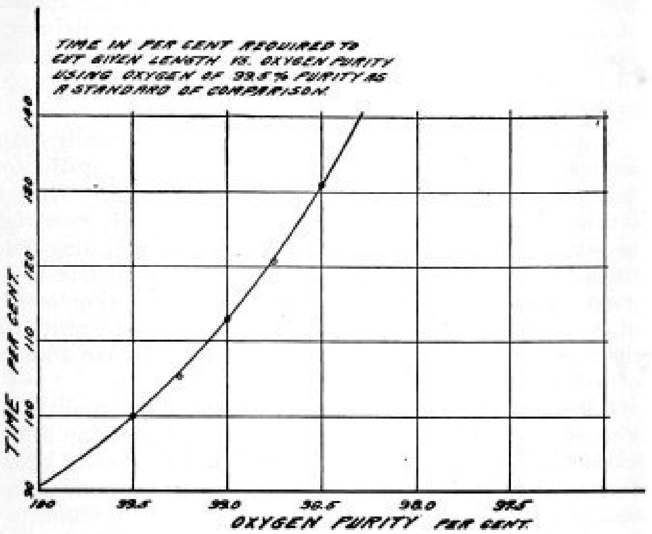


Fig. 3—Graphic presentation of the data given in Table II

The loss in time expressed in percentages very closely approximates the waste in oxygen as the purity decreases, and the two go together, that is, as the oxygen purity decreases the time required to make a given cut goes up as shown in Table II, and the consumption of oxygen in making the cut goes up at the same time as shown in Table I. The average of the results expressed in percentages as shown in Table II is shown graphically in Fig. 3.

How Pure Oxygen Effects Drag

The characteristic drags obtained on the 12-inch billets with oxygen of four different purities are given in Fig. 4. For some work, such as straight line cutting, the amount of drag may not be of serious consequence but in the machine cutting of intricate shapes the drag must be maintained at a minimum as otherwise the underside of the shape cut will not register with the top side.

To decrease the drag to correspond with that obtained with the high purity oxygen (99.5 percent) it would be necessary to increase greatly the pressures and it follows that the consumption for the lower purities would be much greater than those shown in the curves and tables.

It was not the purpose of this investigation to enter into any considerable number of practical applications in cutting with high purity oxygen and the results obtained, but anyone interested can easily demonstrate the superior cutting properties of high purity oxygen by making simple and practical tests, if they will obtain oxygen of, say 99.5 percent purity and oxygen of 99.0 percent purity or less and make cuts in the same steel plate or forging with both oxygens.

As a field check on the investigation made in the laboratory, a large number of oxygen cylinders analyzing 99.5 percent and an equal number of oxygen cylinders analyzing 99.0 percent were used for wrecking steel cars, and a careful study was made of the results obtained with the two oxygen purities. Ten cars were scrapped with each purity of oxygen, and to eliminate as far as possible the personal equation the operators were frequently changed from one oxygen purity to the other, and at no time were the operators informed as to the purity of the oxygen supplied them. Weather conditions were bad, the temperatures ranging from —30 degrees F. to +21 degrees F. and the cars were covered with snow. Working under these conditions and with operators some of whom had only a limited experience in oxy-acetylene cutting, a saving of 10 percent was shown in oxygen consumption and 11.2 percent saving in time, both in favor of the oxygen having a purity of 99.5 percent.

The following conclusions may now be arrived at:

First.—That small increases in oxygen purity greatly increase the efficiency of cutting operations, both as measured by oxygen consumption and by time required to complete a given amount of cutting.

Second.—That the difference of effect of small increases in oxygen purity decreases as 100 percent purity is approached, but the effect is of considerable magnitude for the interval of 99.0 percent to 99.5 percent oxygen purity showing a saving of approximately 12 percent for oxygen consumption and an equivalent saving in time.

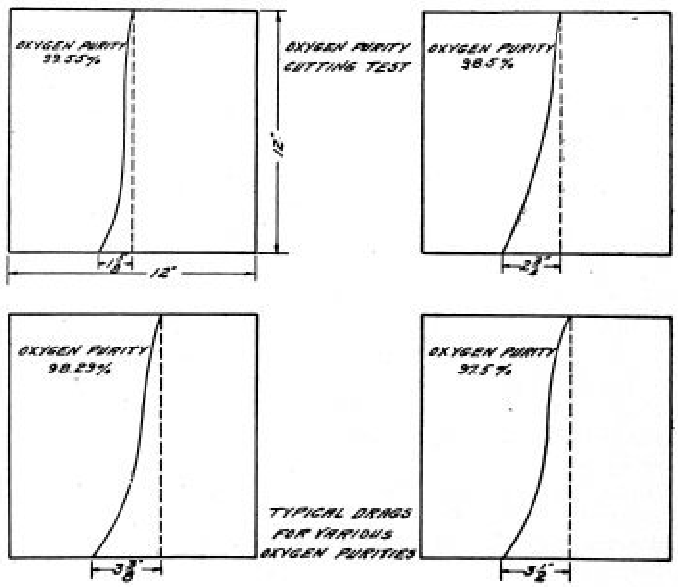


Fig. 4—Characteristic drags obtained on 12-inch billets with oxygen of four different purities

Third.—That decreases in consumption and time with small increases in oxygen purity found by the laboratory have been substantiated by practical applications made with oxygen of 99.5 percent and 99.0 percent purity.

CORRESPONDENCE COURSES.—Correspondence courses in structural engineering, as well as in subjects concerned with the different phases of mechanical and electrical engineering, are now offered by the division of university extension, Massachusetts department of education, at a nominal cost to all residents of the United States and Canada. A bulletin of the courses and their costs will be sent to anyone who writes to University Extension, State House, Boston 9, Mass.

Boiler Corrosion, Pitting and Grooving

Committee reports and discussion presented at recent annual convention of Master Boiler Makers' Association in Chicago

IT is greatly regretted that the report of the Committee on Pitting and Grooving can only be one of slight progress. No conclusions have been or could have been made.

This is not because no solutions to the problem have been offered; on the contrary, some have said that they have stopped pitting by various means, but upon investigation, doubt has arisen as to the general application of their conclusions.

The subject is one to which there is a particularly direct application of an oft-quoted adage: "A little knowledge is a dangerous thing." By "little knowledge," the uneducated man is not necessarily meant. Indeed, some of the most serious violators are numbered among the technically educated. For instance, those who should know better have argued that complete way-side treatment of boiler water would overcome pitting. This claim is refuted by information to the effect that the most serious pitting on the railways of United States and Canada is taking place in treated water districts.

When Edison invented the alkaline battery, he proved that a water charged with sodium salts is an electrolyte. Heretofore, we had supposed that batteries must use an acid as an electrolyte. The use of soda ash in the treatment of water, when used in quantities sufficient to completely treat a water high in calcium sulphate, leaves the water as it goes to the boilers, charged with sodium sulphate. This is the result of the way-side treatment.

Boilers do pit in treated water, and why not? Boilers also pit in acid waters, and it is inhibitive in the form of a simple neutralizing agent. Why not assume that there may be found a similarly effective inhibitive in the case of the former.

Unlike those who have been willing to assume that they have found the cure-all in feed water heaters by driving off the oxygen, or in copper fireboxes and flues (unsuccessful), or in over treatment of water with soda ash and life (unsuccessful), the chairman of this committee believes that a commercially cheap inhibitive is the cure for pitting in water either naturally alkaline or in water artificially rendered alkaline by way-side treatment.

At our latest previous convention, a firebox was exhibited by a southwestern railroad. This road had used a commercial inhibitive in the form of a boiler compound with absolute evidence of complete success. This is the first actual evidence of that nature ever presented to this association. It seems that we have given to it little attention. Since that convention several other roads have gone to the same method, including one important trunk line in the northwest.

Unfortunately, further results are not yet available. It is, therefore, requested that this committee be continued in the hope and expectation that a valuable report may be made next year.

Minority Report

The pitting and grooving of locomotive flues have caused the boiler men on the Burlington railroad an untold amount of grief. Some divisions are practically free from this menace, while other divisions are affected to a very great extent.

Three causes for pitting are commonly accepted by technical men. Of course, we all know, in a general way, that water is the factor that is responsible for this condition, and the following kinds of water are the most injurious: Distilled or pure water, acid water, and water containing a high concentration of alkaline salts.

Cause 1 and Prevention: Distilled or pure water has a tendency to dissolve iron, and if used without the addition of a small amount of lime will eat out boiler tubes in a very short time. This condition can be overcome by the addition of lime or by adulteration with natural water containing a small amount of lime. This kind of pitting is very seldom found in practical operation, and is of little importance due to the simplicity of prevention.

Cause 2 and Prevention: Acid water is usually found around mining districts, as in our Southern Illinois division, and generally is in the form of sulphuric acid. This, of course, is a very dilute form, but nevertheless it goes right to work on the flues, dissolving the metal and eating holes through the tubes where the metal is most responsive to the chemical reaction involved. This form of pitting is also of lesser importance as it is an easy matter to neutralize the acid and carry a small excess of alkaline by the addition of soda ash.

Cause 3 and Prevention: Particularly on divisions west of the Missouri river, water is found containing a high amount of alkali salts, and this water has what is known as a galvanic action on the flues, eating out holes and rings usually near the front end of the tubes and also found to a lesser degree over the entire surface. This action is the same as a wet cell; the lack of homogeneity of the metal enabling the formation of positive and negative poles, and, of course, the spot that happens to be the positive pole gives up the metal in the form of ferrous hydrate and is thus eaten away. This is by far the most important form of pitting, and where a better supply of water is not available this condition must be tolerated.

As yet we have discovered no complete prevention for this condition that is practical, but have been able to lessen this trouble, to some extent, by the use of lime soda ash treating plants. The procedure is to carry a high excess of sodium carbonate and sodium hydrate, but in doing this the foaming rating of the water is increased, and more boiler washing and blowing must be done.

This report was prepared by a committee composed of Lewis Nicholas, chairman; Frederick J. Howe.

The minority report was submitted by F. J. Howe.

Discussion

Dr. C. H. Koyl (C. M. & St. P.): On a subject which has been studied continuously for sixty years, and the solution not yet worked out, it is evident that there are going to be many explanations, each of which has something behind it, but probably none of which is complete.

Three years ago, I had the privilege of appearing before this Association for a few minutes to talk about pitting and to say that at that time it was perfectly evident that there were what we might call two kinds of pitting. There was a kind of pitting produced by acid water which was very distinctive in its appearance in the boiler, and pitting produced in alkali water, which was also distinctive and quite different from the other one. I asked that a committee be appointed to report the kinds of pitting that were found in the different parts of the country from which you men come. The report of that committee did not appear in the minutes of the meeting of the next year, and it was sent to me and was of the utmost value. It is plain from that report that when there is acid in the water, a very small amount, one grain per gallon, one-half grain per gallon, pitting will be produced in the boiler.

The distinctive mark of it is that it always begins in the hot end of the boiler, the firebox end, and it shows first where the steel is bent or where it has suffered any, what you might call, physical torture, where it has been heavily hammered, or anything done to change the fine finish on the surface of the steel. That is the place where this pitting first shows, and if it is a place where there is a rust spot, or where there has been a hammer blow or something like that it will show just as a plain pit of larger size, but it does not run along in the line. When pitting runs in a groove, it means so far as we know now that the iron or the steel surface may be bent or it has been stretched as in the front end of a flue, near the flue sheet where the flue has been expanded a little, and the surface stretched, and where you will find pitting all the way round the flue.

Now, at that stage of the game we began to learn something of the chemistry of it. There are some eminent chemists who probably know a little about boilers, know more than we do about chemistry, but they had worked up pitting in their laboratories, that all pitting, acid, or otherwise, results in the actual solution of the particles of the atoms of iron in the water.

Now, the amount of iron which can be dissolved in water is very, very small. I don't know exactly, but it is a very few parts of iron in a million parts of water. Therefore, if pitting were to start in a boiler, it would not be long until the water would have all the iron it could hold in solution. Every acid contains in itself a substance which is readily combined with the iron that is dissolved in the water, turn it into iron rust or iron carbonate, or iron sulphate or something, in which it disappears as plain iron dissolved in the water and makes room for more acid. That is the reason why pitting begins very soon in acid water and it continues until the acid is all used up. That is the cause of the rapidity and the extent of acid pitting.

Now, when you come to alkali water, the iron that leaves the flue is also dissolved in the water, but there is nothing in alkali water to combine with that iron and take it out.

I must say further, the chemists also stated at that time (though none of us boiler men knew about it at that time) that the two things which were ready to combine with iron in ordinary water were oxygen, derived from the air, and present in all water, and carbonic acid, also, derived from the air and present in all water. As I say, we boiler men did not know anything about that, though that was worked out several years ago, but the first thing that put us on the track of the continued pitting in alkali water was the fact that up in the Northwest, where there is true alkali water, not mixed with any other kind, switch engines were pitting very seriously, but stationary boilers which had feed water heaters did not pit. Those flues would run four years and you might find a few little pits at the end of four years, but it wasn't anything; whereas, the boilers of the switch engines would go to pieces in eight or ten months.

After we studied that out awhile, we could find no difference between the water in the switch engine and the water in the stationary boiler, except the water of the stationary boiler had been through a feed water heater and had had the air, oxygen, carbonic acid, either altogether chased out or turned into a gas, so that as soon as it got into the boiler it went up in the steam space and did not do any damage.

Then, we found something else. The boiler men began to ask me regularly on the Northwestern roads, "Why is it that pitting up here is always in the front half of the boiler? They say you have been telling us that the cause of the pitting is electric action between the hard spots and the soft spots and so forth in the flues." Now, at the hot end of the boiler is a copper ferrule around every flue. If there is a great deal of difference between copper and steel and there is between two spots on the surface of the flue, and if the cause of pitting is electric current between hard spots and soft spots, then there ought to be a much stronger electric current between iron and copper, and an iron flue down there ought to last, maybe, a week, whereas, up here you never see a pit on the hot end of a flue unless it has been in a boiler for two or three years, but in the early stages it is utterly unknown. Then we began to make examination because that was a most important point. That question was started by the boiler men of Montreal, Canada, the steel is of the same kind from one end of the boiler to the other, the water is of the same kind from one end of the boiler to the other, why is the pitting all in the front half of the boiler, usually the front sheet, and after a time it became evident that the only difference between what was the back part and front part was the oxygen and carbonic acid from the air which was partly used up by the steel and the balance had gone up in the steam space by the time the water was half way back to the firebox.

That is an adequate and perfect explanation and it didn't seem possible that any other explanation could be found for pitting in the front half of the boiler and not in the back half.

Working on that, we have done two things: In the first place, we have tried to find whether some chemical could be put in the boiler that would use up this oxygen. There are some such chemicals known as alkaline chromates and alkaline ptomates that will eat up oxygen. They do very well, indeed. They will keep a boiler in good condition for quite awhile, but when you get into the bad pitting waters, I wouldn't like to say, I am not so sure, but there is another method which can be used. If we take a feedwater heater, put it on a locomotive, we are bound to heat the water up to the point where the air, including oxygen and carbonic acid, is going to disappear in the steam space as soon as it can get a chance.

If the heater happens to be an open heater, a little hole in the casing so that as soon as the steam strikes the water and heats it the air and gas can escape through this little hole in the heater, that is all the better. We tested one of those heaters out every day for two months, we have been analyzing the amount of oxygen in the raw water and the amount of oxygen in the water when it came out of the heater and we found that on the average 80 percent of the oxygen escaped through that little hole in the heater and we had that much less to contend with in the boiler.

On general principles, I personally have maintained that since a feedwater heater saves 10 percent of the coal which the engine would otherwise burn, therefore, it pays for itself every year, that the feedwater heater is not only the cheapest thing to use to prevent pitting, but it is more than a cheap thing. It is a thing that returns a revenue. You save the coal. Now, if we are on a road where we can not afford to equip all the boilers, locomotives, with feedwater heaters, and we have to stop some pitting, I have no doubt that the best method or one of the best methods is one of these boiler compounds, chromate or ptomate that will eat up the oxygen before it gets to the boilers.

One other thing we tried, where there are water treating plants, we treat the water with lime and soda ash, the result of which is the production of caustic soda in the water. On the Great Northern road, I started back in 1918, and we found that we were cutting the pitting down gradually and since I came to the Milwaukee, my successor on the Great Northern told me that all the water treating plants turn out water ten or eleven grains of caustic soda per gallon, where pitting was very bad, where flues used to last nine or ten months, that now nearly all the flues go four years. They have very little trouble from foaming up there because the water is always treated down to one grain per gallon. Therefore, there is very little tendency to foam, and, therefore, they use this caustic soda with safety and satisfaction to every one. There would be roads on which it would be difficult to do this, and on such roads if chromate and ptomate were put in the boiler to eat up the oxygen it would be better, but as I said before, I personally hold and submit to the judgment of every one whether it is not cheaper in the end to put on a feedwater heater and save 10 percent coal and 10 percent water as well as stop the pitting than to use any other method.

R. C. BARDWELL (Chesapeake & Ohio Railroad): Gentlemen, it is with a great deal of temerity, as well as pleasure, that I take advantage of this opportunity to address you gentlemen. As a matter of fact, there is no question but what you are a great deal more familiar with conditions than I am.

On this matter of pitting and corrosion, along with Doctor Koyl, I have been investigating it very extensively for the last fifteen years and keeping in touch with all that has been done throughout the country.

I feel pretty sure that I am safe in saying that nobody yet has solved the question, and there is no specific "cure-all" that can be used for this problem.

I am very much pleased to see that the committee recommended that further study be given to the subject and report be made later at the next convention. The question is very involved. I was very fortunate in being present, in April, at the American Chemical Society meeting in Baltimore, where they had some of the most highly educated chemical brains in the United States present and heard them discuss this subject, and even there there was considerable difference of opinion.

To get back to the subject as we can all understand it, there is no question but what there are different kinds of pitting and corrosion, and one of the chief causes that we found, that you are all familiar with, is if you put back a pitted flue in the boiler, or a pitted sheet and let it remain there, you will find that pit hole goes right on through. In other words, when pitting once starts, it is a continuous action, and that is one of the features that we found of real importance.

Now, carrying that a little bit farther, the way the flues and material are stored, there is no question but what you will get pitting. In the second place, if you get good material, and store it out in the weather, you have rusting taking place, and in some cases I have noticed that happening very vigorously. You take a flue that has been exposed to the rust and atmospheric corrosion and put that in the boiler, that pitting is going on through and you are going to have bursted flues or pit holes, and there is something that is entirely foreign to water conditions. Of course, water conditions have to be present to cause actual results, but in the first place they weren't caused by water conditions, but by material in the first place.

That is one plea that I want to make to you gentlemen, to see that it is properly cared for in the first place, that the material when it goes into a boiler is in proper shape to go into the boiler, so that we will not be led astray in our study about corrosion caused by external rust before it goes into the boiler, instead of it happening after the material has gone into the boiler.

Another thing I noticed, the committee reports that boilers do pit in treated waters. They do pit in treated waters, in some instances. Fortunately, we, on the Chesapeake and Ohio Railroad, do not have the bad pitting conditions from the strong alkali water that they have in the West. Our problem is more or less neutralized and fairly readily controlled, but in the western countries, where you have the high alkali water conditions and the high electrolyte conditions in the boiler, we have found, for instance (I am talking now about the Missouri-Pacific) that by over-treating the water and carrying certain amount of excess treatment, the pitting and corrosion conditions can be very materially reduced. There may be isolated cases where it is not actually stopped, but the actual reduction of the pitting has been most marked; whereas, it was formerly necessary to scrap an entire set of flues after a year or eighteen months' service. Before I left out there, they were running from three to four years and scrapping, say 25 percent of the flues on account of the pitting. Of course, they, as well as you, have considerable to learn about this matter, but improvements have been sufficiently made to prove that work is done along the correct lines, and as I say, when the highly educated brains couldn't agree in that Chemical Convention, in Baltimore, I do not believe that we ignorant folks could expect to solve the question at one shot.

J. G. REESE (Chicago, Milwaukee and St. Paul): What I would like to know is what causes flues to pit in the front of the flue sheet, that is, next to the front flue sheet?

DR. C. H. KOYL: I probably omitted a definite statement when I was up there, but I intended to state that because the water goes in the front end of the boiler, to the boiler check and spreads around there before it starts for the firebox, that is the place where the oxygen gets in its work.

One other thing, I was reminded of it by Mr. Bardwell's fine classification of the subject, we have found on the Milwaukee road that when we get a boiler down on the plains, scaled up a little and pitted a little and we take it into the mountains where there isn't a thing in the water but a little air, oxygen, carbonic acid, nitrogen, the scale all comes off the flues in a week, but the pitting goes on just as Mr. Bardwell says. He was referring to ordinary water, but I am talking now of the water up in the mountains where a pit never would start. That water can not conduct these little electrolytic currents from one place to another in the boiler, and if a flue has a fine finish, nobody would find a pit, but if that pit has been started down in the plains, then there is enough on the steel to continue the current and the great amount of oxygen in that water does the rest.

L. M. STEWART (Atlantic Coast Lines): I want to know something about pitting in the back end. The gentleman has asked about the pitting in the front end of the boiler. Just recently, in Florida, we had a set of flues that had been in service four and one-half months and we had to remove the entire set on account of pitting of back end sheets.

K. E. FOGERTY (C. B. & Q. R. R.): This is a question that I have been interested in for a good many years, and Doctor Koyl, I believe, as he stated, addressed this convention about three years ago, and I was one of the gentlemen on that committee, writing up and giving pitting conditions in the Northwest, and at that time there were no other gentlemen in the convention that were having the trouble of deterioration pitting at the front flue sheet, except my friend, Mr. Lowe, and he wasn't getting any better results than I was getting.

A little over a year ago, we applied a copper sheet to every flue in the front flue sheet and extended it back one inch to the water side of the boiler, in order to determine whether the pitting would go down through the copper or go out through the edge of the flue. Ordinarily, we weren't getting 32,000 miles out of that power, but after removing that set of flues that had those copper sheets in, we got 46,000 miles and did not find one flue that was pitted. We tried it on two other engines and found the same results, so today we are applying the copper sheeting in every flue with that condition. At the firebox end, I have found that only in a few cases. There will be no pitting whatever in the flue within two feet or twenty-four inches of the back flue sheet. The rest of the body of the flue will be practically eaten up.

T. F. Powers (Northwestern): Now the road that I am connected with, Chicago-Northwestern, I guess we have every known form of pitting. We have pitting of the fireboxes in the hottest part of the boiler, grooving at the front flue sheets, pitting entire length of flues. We have radial stays in our Pacific and Mikado type engines that eat or groove as if they have been eaten by rats, half way through, after a year or year and a half service. We have had cases where we had to renew four flue sheets on some types of new Mikado engines that have only been in service for fourteen months, due to pitting and corrosion of the front knuckle of the flue sheets. The thing that gives us the most trouble is the fact that we have to renew so many boiler shells. I have seen more within the last five years than in fifteen years before that. Sometimes they say it is due to the steel we are getting, but the funny part is that we are renewing shells of locomotives that have been in service for twenty years, showing that the old steel is starting to pit. On the other hand, we have taken out shells that were pitted, getting unsafe, that have only been in three or four years. To illustrate how that works out, we had two boilers that were four years old, running in the same territory where it was necessary to renew the flue sheets on account of pitting, and the other engine running in the same territory and same age was not pitted at all. So it is the most baffling thing, the thing that is causing us the most trouble, and I believe we ought to continue the discussion of this subject and invite men like Doctor Koyl and Mr. Bardwell and others who are making a study of it to address us.

We are doing the same way as the Burlington is doing. We are running tests of various tubes. We do not believe there is much in the feedwater heater, not any more than there is where you do not have a feedwater heater. We have had flues pit with feedwater heaters on them and the shells of boilers pit with feedwater heaters on them.

Dr. C. H. Koyl: May I say something on the feedwater heater. When dependence is placed on the heating of the waer or on the feedwater heater to keep oxygen out of the boiler, it means that no other water must go into the boiler. It means that if the feedwater heater is on a waytrain and goes on a siding and remains for a longer or shorter time, the engine is not in motion, and oxygen gets into the boiler through the injector water. Of course, when the boiler is washed it will be filled with water that has some oxygen in it, but, perhaps, that can not be helped.

The main thing is in making the tests on feedwater heaters (and I am very pleased to hear from the Burlington), great pains should be taken to see that no water, except what has gone through the heater, gets into the boiler, and there is one more thing which I ran across this year to my great surprise. I found there is one kind of injector which when open, the overflow check doesn't work just right and it sucks air in the boiler when the injector is working. We have a lot of those open over-flow checks which are perfectly tight, no sign of oxygen getting in at all, but we have some where there is a steady stream of air being sucked in. But that is another thing to be watched, and these odd cases just mentioned on the Burlington road and other roads, I am unable to explain.

Whenever the general conclusion to which we have come is controverted by some special cases, such as are mentioned here, then is the time to look for some leaking injector, or for something that is feeding water into the boiler, not through the heater, or for some of these things of the boiler test. The important thing is to watch those tests with the heaters and other things to make sure that they are real tests.

J. F. Raps: During 1921, the Illinois Central bought 2-10 locomotives. Up to that time, when they went into service, the majority were put in treated water districts, and we were never bothered with grooving at front flue sheet. After service of two years, we started to have trouble and in going into the matter, I am firmly convinced that it is due to the poor circulation at the front end of the boiler.

Renewal of Staybolts Adjacent to Those Found Actually Broken*

(a) Best method of renewing staybolts—removal and application. (b) Sectional lagging and sectional jacket in staybolt breaking zones

These boiler repairs can to some extent be reduced by proper cooling off, regular washing-out and refilling boilers with warm water, thereby saving the firebox considerably from cracked and leaky sheets and broken and defective staybolts.

1: When the known broken staybolts have been removed, light should be put in through the holes into the water space, and the adjacent staybolts examined as carefully as possible, first from one side and then the other. This operation should be reversed so that these staybolts can be examined from both sides of the box. Staybolts showing any signs of grooving, pitting, or other defects and where the soundness of same is in doubt, should be removed and renewed.

A: The best method of performing this work is a question that depends greatly upon what kind of equipment and tools are at hand where the work is done. Shops equipped with modern tools, oxy-acetylene or electric cutting torches, power driven drilling machines, and other jigs gotten up to expedite this work, can do it more readily and easily, also at less cost, than those not so well equipped, and at outside points, where it is necessary to resort to the hand method of cutting staybolts out with hammer and cape chisel, tapping out and putting in staybolts by hand. The cost would vary accordingly with these conditions.

In applying staybolts it is important that the threads on staybolts and in sheet be full size and match threads on tap correctly, and should be tight enough to require at least a wrench 14 inches long to screw them into the sheets, set to about 2½ or 3 threads for riveting over before cutting them off.

B: The application of lagging and jacket over staybolts on outside of firebox not only gives the locomotive a more neat appearance, but also reduces the heat loss by radiation. It would be profitable to have the staybolts in the breaking zone, as well as those on back head and above the running boards on both sides, so covered. This can be readily done, and at a reasonable cost, by having the lagging secured to the jacket iron and so framed and made in sections and held to boiler by studs. Sections should be made to suit conditions encountered in the different types of locomotives so as to be easily removable when necessary to get at these staybolts.

This report was prepared by a committee composed of C. C. Dean, G. B. F., Wabash R. R., Decatur, Ill., chairman; J. P. Malley, F. A. Batchman.

Discussion

H. H. Service (Santa Fe): I notice in paragraph "A" there is a term there "or electric cutting torches." I would like to ask any one of this convention if they have had any experience with the removal of bolts under this

*Committee report and discussion presented at annual convention of Master Boiler Makers' Association, Chicago, Ill., May, 1925.

heading with the electric cutting torch, and as to what their procedure was and tools used.

MR. TAPKE (Missouri-Pacific): I would like to state in regard to removing staybolts under the acetylene process, if your cutter keeps continuously at cutting from the outside, it will shrink the sheet. The sheet will shrink after the staybolts are cut, and in the acetylene process I never see any of them, but it will so happen that the acetylene welder or cutter might get over-zealous in cutting, heat up this sheet, which will expand and I have seen it after all staybolts are cut that the sheet would contract at least one-sixteenth of an inch and pull on the rivet on the front sheet, as well as the back on the mud ring, showing very plainly that this sheet contracts and it should not be kept up too continuously.

L. M. STEWART: Do you burn off new staybolts or burn them out of the sheet?

MR. TAPKE: Burn them out of the sheet, completely loose from the outside wrapper. I have seen that happen.

T. F. POWERS: Burn out a whole side sheet?

MR. TAPKE: Burn out a half side sheet or whole fire-hard. Now, this man may have an oxygen, electric arc. If it is a fact, I would like to know it.

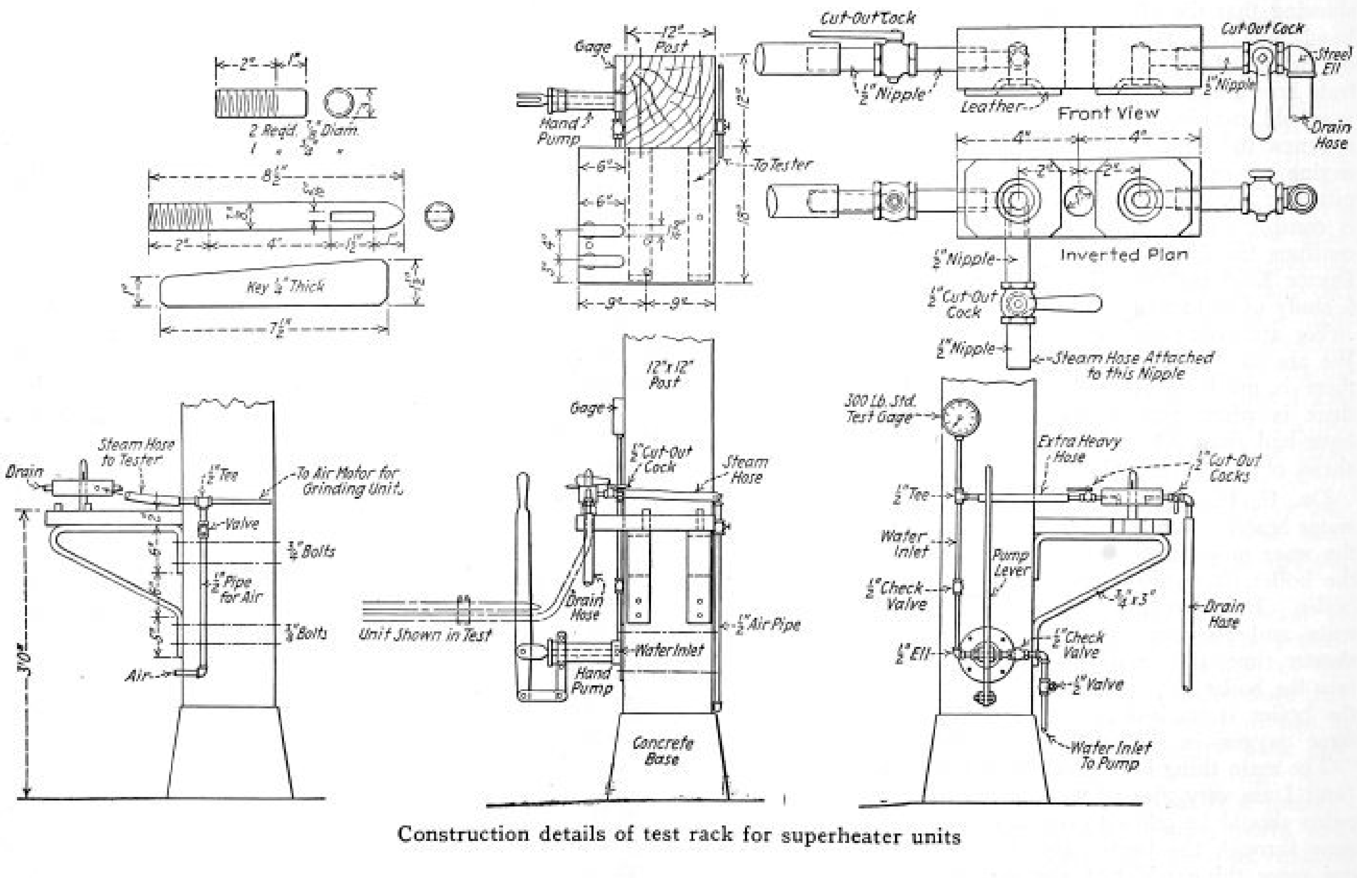
L. M. STEWART: That is what I would like to find out. I was in the shop the other day on our road and a fellow was burning over the rivets on a mud ring with electric torch, and he was just experimenting. He told me the next time I came around he would be able to tell me how he was renewing staybolts.

H. H. SERVICE: Before that Topic is closed, I would like to make a recommendation, that those four words on the fourth line of paragraph "A," "or electric cutting torches," be stricken out. That is misleading.

This motion was carried.

Superheater Unit Test Rack

IN the drawing accompanying this article is shown a remarkably simple yet efficient device developed for testing superheater units. It was designed and constructed at the Minneapolis shops of the Chicago, Milwaukee and St. Paul.



Construction details of test rack for superheater units

box. You could not notice it up higher, but you could notice it down by the mud ring, that the sheet contracted at the throat sheet and also at the back head.

H. H. SERVICE (Santa Fe): It is most likely that the committee investigated this condition before they wrote this report, and I think there is some one in this convention hall, at the present time, connected with this topic. This topic says, "or electric cutting torches." Should that be in there? Is that correct or is it not correct? Should it be stricken out? It is misleading to this effect, that report will be published with that in there and if it is not being done, it has no business in there. It will be expected of all of these men present to do it with the electric process. I have tried to do it with the carbon arc, but you will find adjacent to where you do that work becomes carbonized and it is

As shown in the drawing, the rack rests on a bar iron bracket which can be fastened to a convenient column in the shop. On the bracket is a block with two slots for the unit pipes. This block, or table plate, is stationary and a ⅞-inch bolt with key slot is screwed into it. The superheater unit is inserted in the slots in the table plate, the cap is slipped down over the key bolt on to the ball joints of the unit and a tapered key is driven into the slotted bolt with a slight hammer blow which forces the cap down on the joints. Pressure is applied by means of a small hand pump conveniently located for the operator to handle. Valves and cut-out cocks are so arranged that the units may be filled with water and pressure pumped up for hydrostatic test and when the test is completed the water and scale can be blown out into a drain.

Terms of Payment and Use of Sight Drafts and Trade Acceptances in Sale of Watertube Boilers*

By C. R. D. Meier†

PRACTICALLY all watertube boilers are sold under contract, with terms of payment agreed upon—sometimes as set forth by the seller, but too often determined by the purchaser or his consulting engineer without due consideration of the interests of the seller by whom no objections are ordinarily raised.

The standard terms of payment of the Heine Boiler Company as printed in their contract forms are as follows:

60 percent cash on sight draft with B/L attached.
30 percent by acceptance signed on delivery of B/L, due 30 days after date of B/L.
10 percent by acceptance signed on delivery of B/L, due 60 days after date of B/L.

The trade acceptance is nothing more than a draft specifying a definite date of payment and accepted in advance by the purchaser, who designates the bank through which it is to be presented. In the matter of collection it is handled exactly as a draft.

How a Trade Acceptance Is Handled

When a shipment is made the sight draft for first payment, acceptances for deferred payments, bill-of-lading and packing lists are deposited in our bank for presentation to the customer through his bank (usually designated on the sight draft), the acceptances executed by the customer being returned through the bank with payment of the sight draft. Later as the acceptances mature they are deposited in bank for collection the same as a draft, and it is very seldom that they are not paid promptly upon presentation.

We do not use an order-notify form of bill-of-lading as it is likely to cause demurrage charges and would be unnecessary except when the purchaser's credit is doubtful and it is advisable to collect in full before actual delivery.

Wherever possible we endeavor to apply our standard terms but we do not usually insist upon the sight draft and acceptances if the purchaser objects, even though they may be specified in the contract. Occasionally we find that the purchaser either does not read the terms of payment when signing the contract, or the person signing does not consult his treasury department. It is our custom to write the purchaser about two weeks before the expected date of shipment to make sure that he is ready to receive it, and in order to avoid any possibility of irritation to him and that he may be prepared to take care of sight draft for the first payment, we inquire through what bank he wishes it presented. Upon the rare occasions when the purchaser then requests us to omit sight draft and acceptances, we usually do so, thereby placing us in the position of granting a favor to him. Occasionally we regret making such a concession as the purchaser sometimes fails to meet his payments as agreed; in fact, where the sight draft and acceptance terms do not apply it is the exception rather than the rule for payments to be met promptly when due, particularly the deferred payments.

Trade Acceptances Expedite Collections

It is unfortunate that the American people are not more familiar with the use of drafts and trade acceptances, especially for this and similar lines of business. There is no question but that they simplify collections and materially reduce the time of outstanding receivables. Not only do they set a definite date for payment but the purchaser knows they will be presented through his bank at that time and cannot be held up for disposition at his convenience or left on the treasurer's desk while he is away on "vacation." Trade acceptances also place the manufacturer in better position with his bank as they can be more easily handled than open accounts. While we have never had occasion to use them in this way, our bankers have told us they would be glad to discount them at any time. Their main advantage is that they expedite collections, particularly the final payment.

From long established custom under the American credit methods the purchaser does not readily accept the use of sight drafts and trade acceptances, and some of them have the mistaken idea that the presentation of a draft reflects upon their credit. Some of the larger companies object to them because they differ from the usual routine. In addition to this the purchaser (particularly if he has not dealt with us before and is not aware that we make good our product regardless of status of collections) sometimes objects to setting a definite date for final payment because he wants to put the equipment into service to see that it meets specifications before final settlement. Installations cannot always be completed within sixty days after date of shipment, although the delay may be due to conditions at the purchaser's plant over which we have no control.

These objections on the part of the purchaser, together with the fact that our competitors do not ask for them, have somewhat retarded the use of sight drafts and trade acceptances. We regret to say that during the past few years a smaller percentage of our contracts have had these terms than heretofore. We attribute this to—

More purchases by hospitals, city and state institutions, where drafts and acceptances cannot readily be handled.
More sales under consulting engineers' specifications.
Apparent custom of the trade to accept almost any terms offered (this applies also to more objectionable features than terms of payment).
Buyers' market and fact that salesmen are not particularly concerned with collections.

In the case of hospitals, government, state and city institutions, the routine in vogue cannot easily be changed and the carrying charges will always be excessive. There should be an allowance in the contract for this but instead competition seems to be keenest on these jobs. Conditions would be greatly improved if a time limit was set for final payment and the first payment was required before shipment in case of delay by the purchaser.

Outstanding Receivables Reduced by Sight Drafts and Acceptances

The uniform use of sight drafts and acceptances would reduce outstanding receivables approximately 50 percent. While this ideal cannot be attained, a great improvement might be effected by a concerted effort to "soften" the usual terms of sales under consulting engineers' specifications, which are becoming more and more a handicap to collections as the demands for their services increase. Under their terms of payment ordinarily the value of materials delivered and work performed on job during the month, less 10 percent to 25 percent, is payable sometime during the following month, but frequently it is two months or more after shipment be-

*Address delivered before the thirty-seventh annual convention of the American Boiler Manufacturers' Association, Watkins, N. Y., June, 1925.

†President, Heine Boiler Company, St. Louis, Mo.

fore the first payment is made. Sometimes payment is based only on material erected in place and when changes in the status of the work take place shortly after the first of the month, no application for payment can be made until the end of the month. These monthly estimate terms are intended primarily for building contractors' work which is done entirely on the job, whereas, the greater part of our work is done in the shop. Very seldom is any time limit set upon the final payment, nor is there usually any provision for payment (especially the first) when work or shipment is held up by the purchaser. Payments are even slower when the sale is made through a general or heating contractor.

Injustice of Terms of Payment Specified by Consulting Engineers

We now have on our books two accounts which illustrate very forcibly the injustice of the terms of payment usually specified by consulting engineers. One of the sales was for a new installation sold through the heating contractor under terms of payment specified by the consulting engineer. Our work was entirely completed in May, 1924, but the contractor did not complete his work until December. Some controversy has arisen between the owner and the contractor in which our equipment is in no way involved but our final payment is held up along with his.

The other sale was made direct to the owner. First payment was delayed two months because he was not ready to receive shipment. All of our work has been completed except a few trimmings which the purchaser has requested that we retain until he is ready to put the boilers in service. This will not be done for at least six months and in the meantime under the contract terms we cannot ask for final payment.

Conditions would be materially improved, if all of the members of the association would apply the following policy:

Policy Suggested

Insist upon sight draft and acceptance terms wherever possible.

Change engineers' specifications so that pro-rata payments are made as work progresses in the shop, or at least set a time limit for first payment in case shipment is delayed by customer.

Limit the time for final payment and provide for interest where payments are deferred beyond contract dates.

Whether these or better recommendations are adopted by the association there will be little change for the better unless all of the members faithfully endeavor to carry out the policy agreed upon.

I would suggest that the members agree upon terms of payment that are fair and protect the interests of the manufacturer in connection with sales under engineers' specifications, and that a copy of such terms be mailed to all consulting engineers with the statement that they have been adopted by the association and requesting that these terms, or terms equally as fair and reasonable, be inserted in future specifications for boilers, and that all members of the association thereafter insist upon such terms. Joint action is the only way to get results, and not the adoption of the policy of letting George do it.

Alexander Milburn Company Offers Prizes.—In order to promote interest in welding in general the Alexander Milburn Company, Baltimore, Maryland, has offered a monthly prize to be awarded for the best photograph or sketch illustrating work done with apparatus made by the company. All readers of The Boiler Maker engaged in welding work are eligible for the competition. Entry cards may be obtained from "The Milburn O. A. Photo Contest," 1416-28 Baltimore street, Baltimore, Md.

Uniformity Under the National Board*

By Jos. F. Scott†

Since the organization of the board and the first meeting in Detroit in 1919 no annual meetings have been held until recently. The primary reason for not holding meetings in the beginning was financial; the secondary reason was because it was not thought necessary. The result of the last two years conclusively demonstrated the value of holding an annual meeting in order to have the members meet personally and thrash out their difficulties and misunderstandings that may occur between the manufacturers, insurance and inspection departments.

There is a feeling growing among the National Board members that each inspector, irrespective of the section of the country he hails from, can look with confidence towards the National Board, the manufacturers and insurance companies for cooperation and assistance in his activities. This in itself alone is a distinct and big step towards eliminating the suspicions which heretofore appeared to be pregnant in the steam boiler inspection field that somebody was always trying to put something over.

When an inspector now sees a boiler stamped with the National Board stamping he does not worry over its construction nor is he fearful that any underhand methods have been applied in getting the boiler into his territory. He does not stop to question the integrity of the inspector who inspected the boiler during construction as he knows that full cooperation has been carried out between the inspector and manufacturer.

Multiplicity of stamping has been eliminated and numerous examinations which inspectors were called upon to make have been done away with. The manufacturer of steel plate readily complies with the provisions of the A. S. M. E. Boiler Code and instead of questions, criticisms, correspondence and misunderstandings, which have been practically eliminated by the board, there is harmony and cooperation which spell *confidence* towards all in the boiler field.

The board can progress further in this work in the careful acceptance of new appliances. This feature of the work must be handled very carefully and no attempt should be made to act on a case too speedily or unjustly. When doubt exists as to the value or practicability of an appliance, it should be taken up with the A. S. M. E. Boiler Code Committee.

New appliances and boiler designs are springing up over night, due primarily to the continual advance towards higher boiler pressures and larger boiler units, necessitating changes in the equipment. Without extreme care inferior mechanisms are liable to be introduced and accepted and their unsuitability discovered only when some explosion or accident has taken place. These activities should be zealously guarded and watched at all times by members of the National Board.

The National Board can also be of great value and assistance to the A. S. M. E. Boiler Code Committee in the adoption or concurrence with the Boiler Code Committee in its interpretations which are issued from time to time. The practice of many individuals of writing to the committee and endeavoring to inject his interpretation after the matter has been passed upon by the committee is a source of considerable annoyance and creates misunderstandings and ought to be discouraged and stopped. The interpretations are given ample publication and everyone interested is given ample opportunity to present his objections or suggestions before its final adoption or interpretation.

The time will come, I hope, when not only shop inspectors but all field inspectors will be certified through the National Board. This, of course, is a matter for future consideration.

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*From an address delivered before the American Boiler Manufacturers' Association, Watkins, N. Y., June, 1925.

†Chairman of National Board of Boiler and Pressure Vessel Inspectors.

The Boiler Maker

Published Monthly by
SIMMONS-BOARDMAN PUBLISHING COMPANY
30 CHURCH STREET, NEW YORK, N. Y.

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San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London

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Entered at the Post Office at New York, N. Y., as mail matter of the second class. THE BOILER MAKER is registered in the United States Patent Office.

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

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

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

CONTENTS

Due to the numerous convention reports which required space in this issue, particularly the report of the National Board of Boiler and Pressure Vessel Inspectors' meeting, it was found necessary to omit publication of the serial article on "Laying Out Locomotive Boilers" in this number. The series will be resumed in the August number.

One direction in which manufacturers of horizontal return tubular boilers have an opportunity to broaden the market for their product is in the field comprised by the small power plant. Hitherto there has been a marked tendency among the users of relatively small amounts of power to buy power from central stations. In many cases this has been an economical method of meeting the power requirements but in many other cases the power user has other demands for steam which must be taken care of such as for heating, drying or process work and in these cases careful investigation of the situation will often reveal the fact that substantial savings can be made by installing a power plant and using the exhaust steam for the necessary heating and process work. In the discussion of this subject at the recent convention of the American Boiler Manufacturers' Association numerous cases were cited where the investment in a small isolated power plant resulted in a marked reduction in operating costs. Where there is use for the exhaust steam the making of power becomes a by-product and its cost is far cheaper than that of the power which can be purchased from a central station under the best conditions. While there is no hard and fast rule which applies to every case, the fact remains that where the power requirements are less than 500 kilowatts, it will usually pay the power user to investigate carefully the relative advantages and disadvantages of the isolated plant. Missionary work in this field by the manufacturers of horizontal return tubular boilers is likely to be productive of profitable business.

For the first time in the history of the boiler making industry in this country, an attempt has been made to compile statistics of existing power boiler installations, their number, condition and the extent of boiler failures and casualties from boiler explosions. The work has been done by the statistician of the National Board of Boiler and Pressure Vessel Inspectors who presented the results of his efforts in the form of a report at the recent annual meeting of the board. These statistics are published elsewhere in this issue in connection with the report of the meeting.

It seems strange that so little has previously been done by safety and other state departments to maintain accurate records of the power boilers coming under their jurisdiction. The states which have adopted the American Society of Mechanical Engineers' Boiler Code are now, however, with few exceptions attempting to collect reliable data covering the boiler field. As these states include practically all the major industrial centers of the country, a complete survey of conditions in these localities will provide a fairly accurate picture of conditions throughout the United States. The National Board office is the logical clearing house for all such statistical information on boilers that may be compiled by the individual states.

In addition to the information already collected, the records of construction and inspection that have been maintained in the office of the National Board since its inception will assist materially in this survey of conditions.

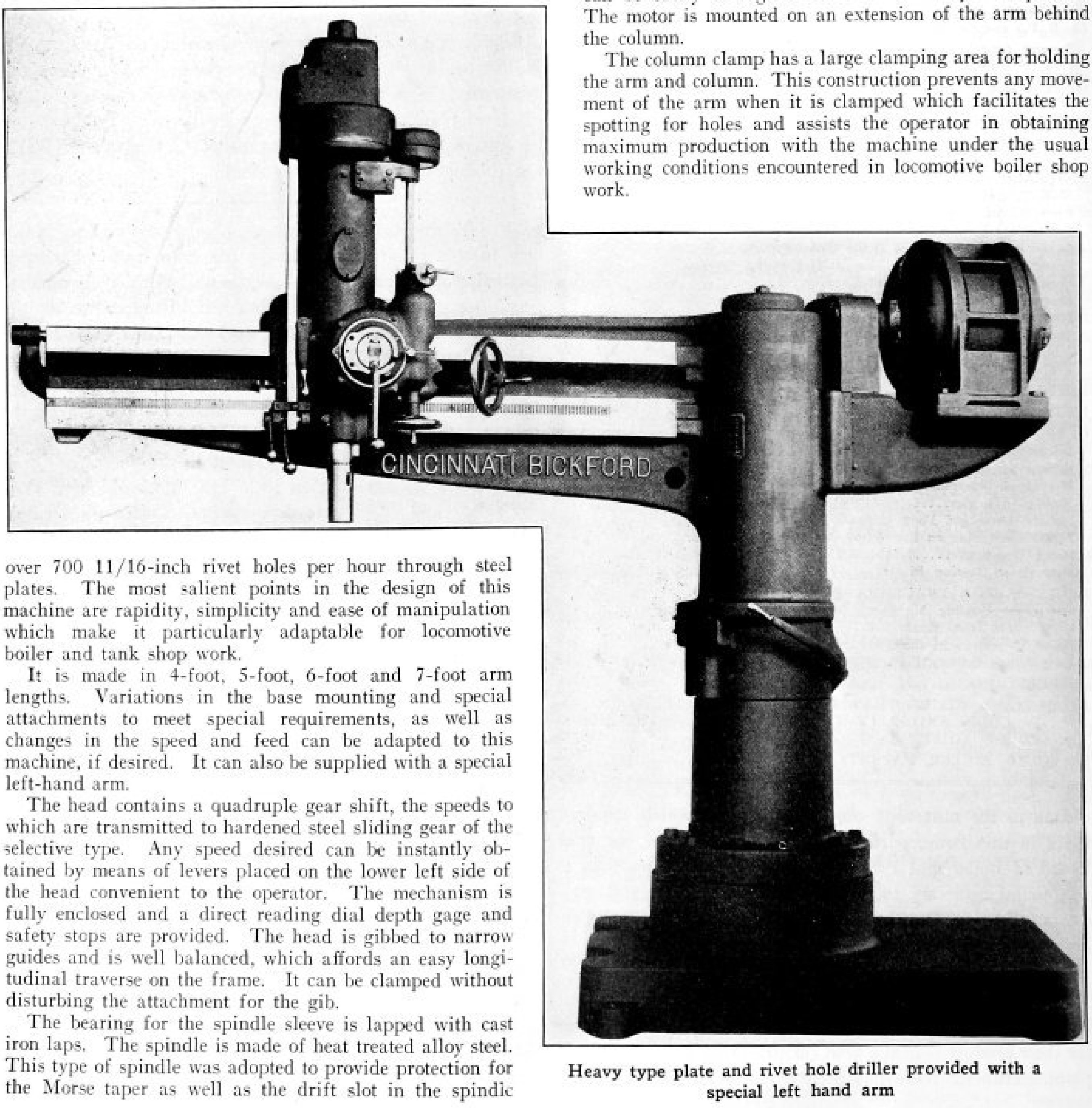
Since the members of the National Board are in control of the boiler situation in each of their provinces, the task of amplifying the data presented at this meeting does not offer any special difficulty. The whole matter demands complete cooperation between the several members of the board in order to give the country at large an accurate and comprehensive idea of boiler conditions.

Engineering Specialties for Boiler Making

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

Heavy Type Plate and Rivet Hole Drilling Machine

A HEAVY plate and rivet hole drilling machine has recently been placed on the market by the Cincinnati-Bickford Tool Company, Cincinnati, Ohio. It is claimed that with this machine one operator can drill



Heavy type plate and rivet hole driller provided with a special left hand arm

over 700 11/16-inch rivet holes per hour through steel plates. The most salient points in the design of this machine are rapidity, simplicity and ease of manipulation which make it particularly adaptable for locomotive boiler and tank shop work.

It is made in 4-foot, 5-foot, 6-foot and 7-foot arm lengths. Variations in the base mounting and special attachments to meet special requirements, as well as changes in the speed and feed can be adapted to this machine, if desired. It can also be supplied with a special left-hand arm.

The head contains a quadruple gear shift, the speeds to which are transmitted to hardened steel sliding gear of the selective type. Any speed desired can be instantly obtained by means of levers placed on the lower left side of the head convenient to the operator. The mechanism is fully enclosed and a direct reading dial depth gage and safety stops are provided. The head is gibbed to narrow guides and is well balanced, which affords an easy longitudinal traverse on the frame. It can be clamped without disturbing the attachment for the gib.

The bearing for the spindle sleeve is lapped with cast iron laps. The spindle is made of heat treated alloy steel. This type of spindle was adopted to provide protection for the Morse taper as well as the drift slot in the spindle nose. It is double splined and is provided with both hand and feed rapid advance and return. A long detachable lever can be supplied for special hand feed for use in countersinking holes.

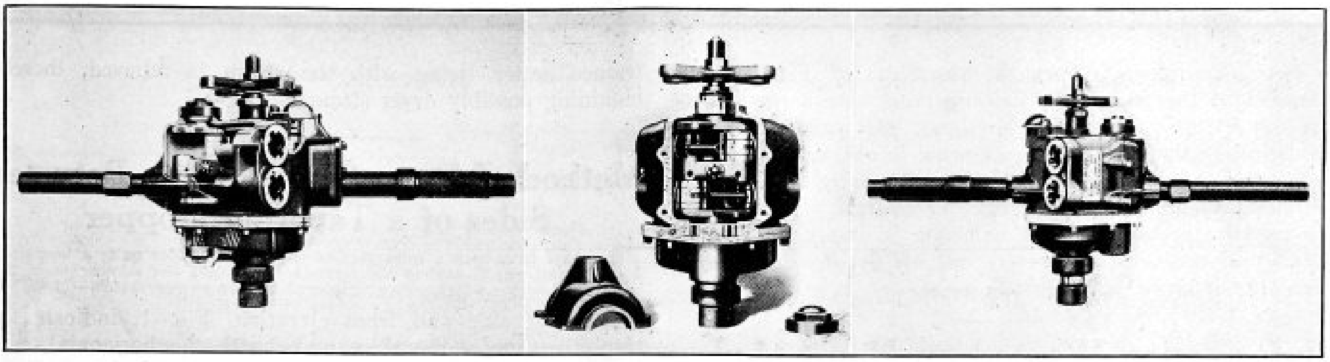
The arm is made in a box section, a design which affords a considerable degree of stiffness. The narrow guide-way is designed to eliminate all possibility of the head rocking sideways. Although the arm is of massive construction, it can be easily swung in either direction by the operator. The motor is mounted on an extension of the arm behind the column.

The column clamp has a large clamping area for holding the arm and column. This construction prevents any movement of the arm when it is clamped which facilitates the spotting for holes and assists the operator in obtaining maximum production with the machine under the usual working conditions encountered in locomotive boiler shop work.

Long-Stroke Pneumatic Drills

A NEW design of 4 cylinder pneumatic drills has been brought out by the Ingersoll-Rand Company, 11 Broadway, New York City. This new design has been developed to overcome troubles formerly experienced by the users of pneumatic drills.

A complete line of this type is now available, in both reversible and non-reversible sizes. One feature—the speed governor—will, it is claimed in approximately a year's time pay the entire cost of the drill in the amount of air saved. Furthermore, every wearing part is renewable at small expense. The following are some of the important features:



Reversible long stroke drill **Drill with crank cover removed** **Non-reversible type pneumatic drill**

A speed governor which limits the speed of a drill after it has passed the point of maximum horsepower and so prevents racing and extra consumption of air. In addition, it avoids the wear and tear on the drill of high free speeds, excessive friction heat and consequent lubrication troubles from this cause.

Cylinder liners—of special steel fitted into the steel casing and easily removable and renewable. A worn cylinder may be easily renewed at small cost. The cylinder case proper never wears out. With this construction, in addition, it is practically impossible to dent a cylinder and cause sticking of a piston. A space between the cylinder liner and cylinder case walls prevents this. The cylinder liners are held in place by cylinder heads which screw into the liner and shoulder against the case. The threads are in the liner and not in the case, so that stripped threads would necessitate only a new cylinder liner.

Crank pins are fitted with a sleeve held stationary on the crank pin, so that all the wear takes place on the sleeve instead of the crank pin. In other words, the wearing of the crank pin is impossible and it is only necessary to renew the worn crank pin sleeve.

Lubrication of the crank pins is from the inside as well as from the outside. All other drills have been lubricated by the crank shaft turning in the grease in the crank case. However, it has been found that centrifugal force throws the grease away, resulting in very little lubrication. With this new method a combination of the venting of the case with holes drilled through the crank, as in automobile engines, assures proper lubrication of the crank pin bearings.

Main valve is of large diameter with long bearing surfaces. It is air balanced so as to avoid wear on its bushing. It is gear timed so that no intricate valve mechanisms, toggles, levers or cranks are needed.

Gearing is of helical type giving stronger construction and smoother operation than straight spur teeth. The crank pinion is renewable independently of the crank, so that a damaged pinion does not mean the replacement of a complete crank shaft.

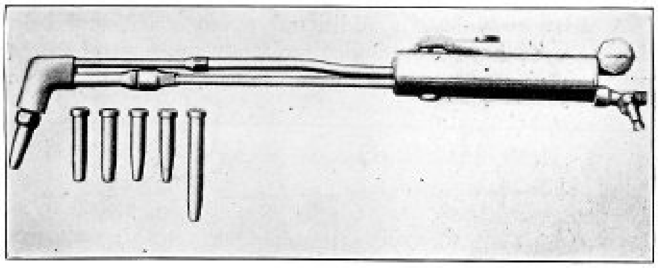
Connecting rods are of one-piece drop forgings. There are no straps, toggles, bolts or pins to adjust in cramped quarters.

Crank shaft construction permits the use of solid end connecting rods and renewable crank pin sleeves. It is accurately counterbalanced to insure smooth operation. The complete crankshaft with pistons and connecting rods can be assembled outside of the case and then inserted in place. This is a great labor and time saving feature, as well as insuring proper assembly of the parts.

Low Pressure Cutting and Welding Torch

A LOW pressure torch which will operate on either low or high pressure gas with equal efficiency is being manufactured by the Alexander Milburn Company, Baltimore, Maryland. It is especially constructed to operate with the low pressure acetylene gas, city gas or hydrogen It may also be used with a low pressure acetylene generator.

The manufacturer has utilized in the design of this torch the various parts of its standard cutting and welding torches.



Low pressure torch provided with solid copper tips

A correct and intimate mixture of the oxygen and acetylene has been obtained with non-flashback qualities. The torch may also be adapted for welding as well as for cutting by the interchange of tips. It is claimed that it can efficiently perform practically all the cutting and welding operations within range of the process.

It is constructed of bronze forgings and special seamless tubing, designed to withstand constant service. The tips are made of solid copper and are interchangeable on a large number of low pressure torches of other makes.

Rules for the safe handling of compressed gas cylinders have been compiled by the Compressed Gas Manufacturers' Association, 120 West 42d Street, New York City, covering the main safety rules to be observed. Copies of the rules may be obtained from the Association office.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Information Wanted on Home-Made Shears

Q.—Do you or any of the readers of THE BOILER MAKER know of a way to make home-made shears ¼-inch capacity?—J. F. D.

Horsepower and Domes

Q.—Please let me know how many pounds of steam equals 1 horsepower and what is the difference between a boiler with a dome and without a dome—return tubular boiler?—J. F. D.

A.—The *unit of boiler horsepower* is the evaporation of 30 pounds of water per hour *into steam*, from a feedwater temperature of 100 degrees F. at 70 pounds gage pressure; this is equivalent to 34.5 pounds of water evaporated from a feedwater temperature of 212 degrees F. into steam at the same temperature.

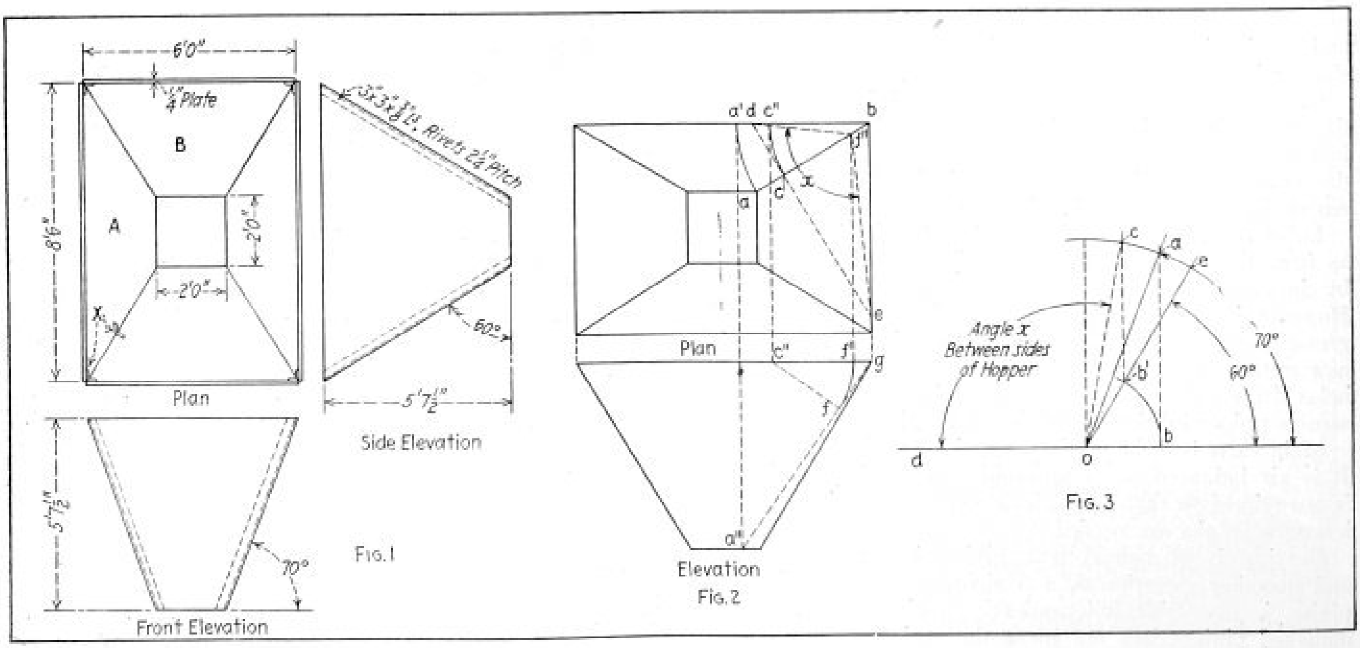
A dome provides an additional steam space, and being the highest point on the boiler the steam must travel farther before it enters the steam outlet, therefore some of the entrained water rising with the steam is relieved, thereby obtaining possibly dryer steam.

Method of Determining Angle Between Sides of a Tapering Hopper

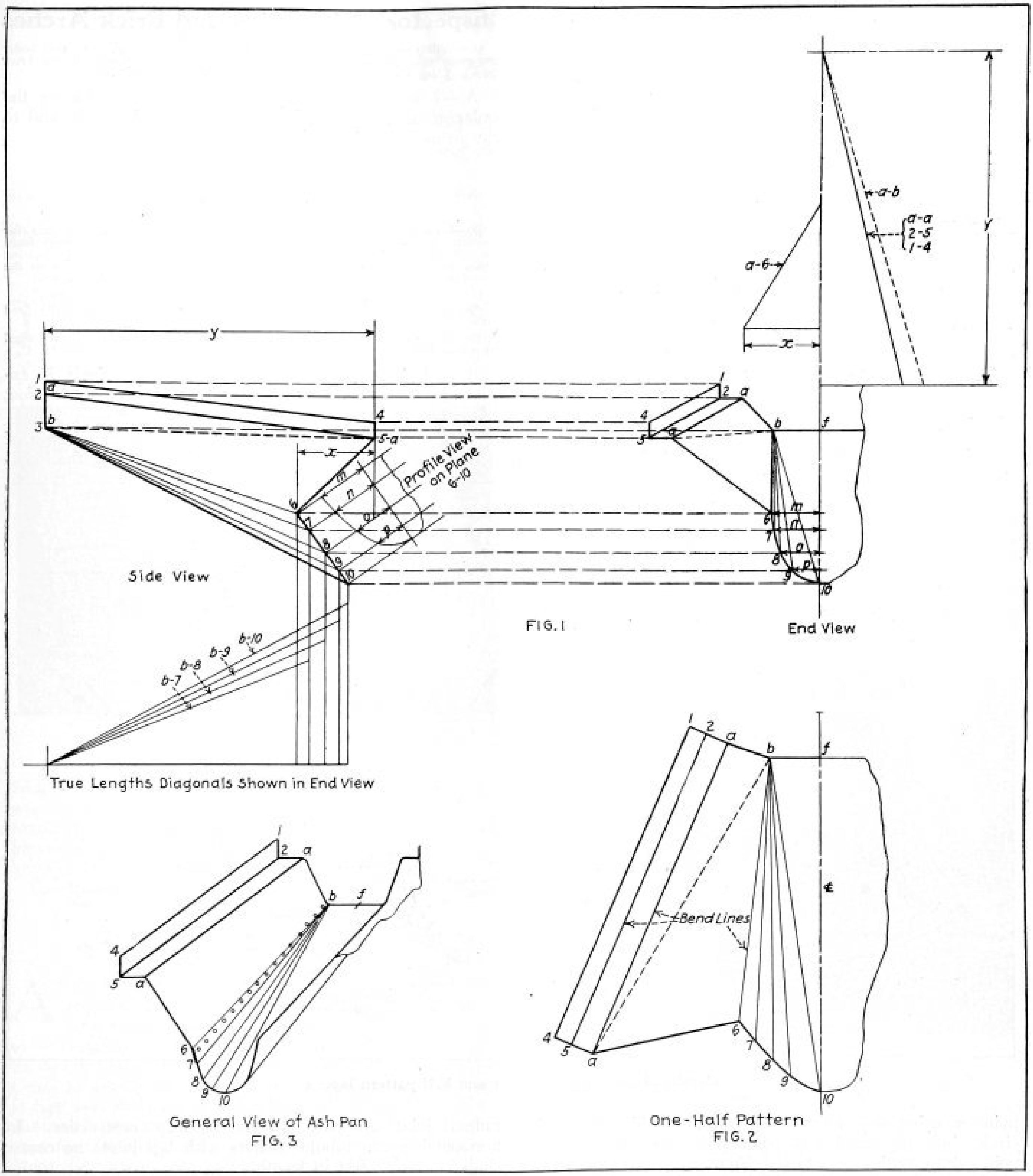
Q.—As I have been a subscriber of your magazine for quite a few years, I am asking you to explain the formula for finding the rake or bevel that the corner angles will have on a tapered hopper as per sketch.—M. E. H.

A.—The side and front elevation, Fig. 1, indicate the respective angles the sides make with the horizontal, and the plan shows the dimensions of the two openings. From these data the angle between the sloping sides *A* and *B* may be found graphically as shown in Fig. 2. Draw the line *d-e* from point *c* at right angles to *a-b*. With *b* as a center, revolve *c* to *c'* and *a* to *a'*. Project the points *c' to c''* in the elevation and *a'* to *a''* as shown in that view. Connect *a''* and *g* with a straight line. At right angles to *a''-g* and from point *c''* draw the line *c''-f*, with *c''* as a center revolve *f* to *f'*. Project *f'* vertically to position *f''* on line *a-b*. Connect *d*, *f''* and *e* and the angle *x* is the required angle between the sides of the hopper.

A shorter method is given in Fig. 3; in this case draw a horizontal line *d-o* and from point *o* lay off the angle that each side of hopper makes with the horizontal, namely 60 degrees and 70 degrees in this example. From any point on the 70-degree line as *a* draw the perpendicular *a-b*. With *o* as a center draw an arc with radius *o-b* to intersect the 60-degree line *o-e* at *b'*. Project point *b'* to intersect the arc drawn through point *a* as shown at *c*. The angle *d-o-c* is the required angle.



Graphical method of finding angle between sides of hopper



Development diagrams for the Maddin ash pan

Maddin Ash Pan

Q.—Will you kindly print a layout of the Maddin ash pan in your next monthly edition of THE BOILER MAKER?—T. V. S.

A.—Fig. 1 indicates the first step in making layouts of this kind. Two views are essential showing an end and side elevation to the required dimensions. The end view shows the front and back end profiles of the pan and also indicates the amount of flare. At the bottom the pan is composed of a flat triangular surface and a curved oval section radiating, as shown, in the point *b*. Having laid off the two views, draw a true profile on plane *6-10*, then determine the true lengths of the foreshortened lines of the development. Thus, the true length of the edge line *a-6* is found by constructing a right angled triangle using the dimension *x* of the side view and the end projection *a-6* as the legs of the triangle, the hypotenuse is the required length and can be used in completing the layout.

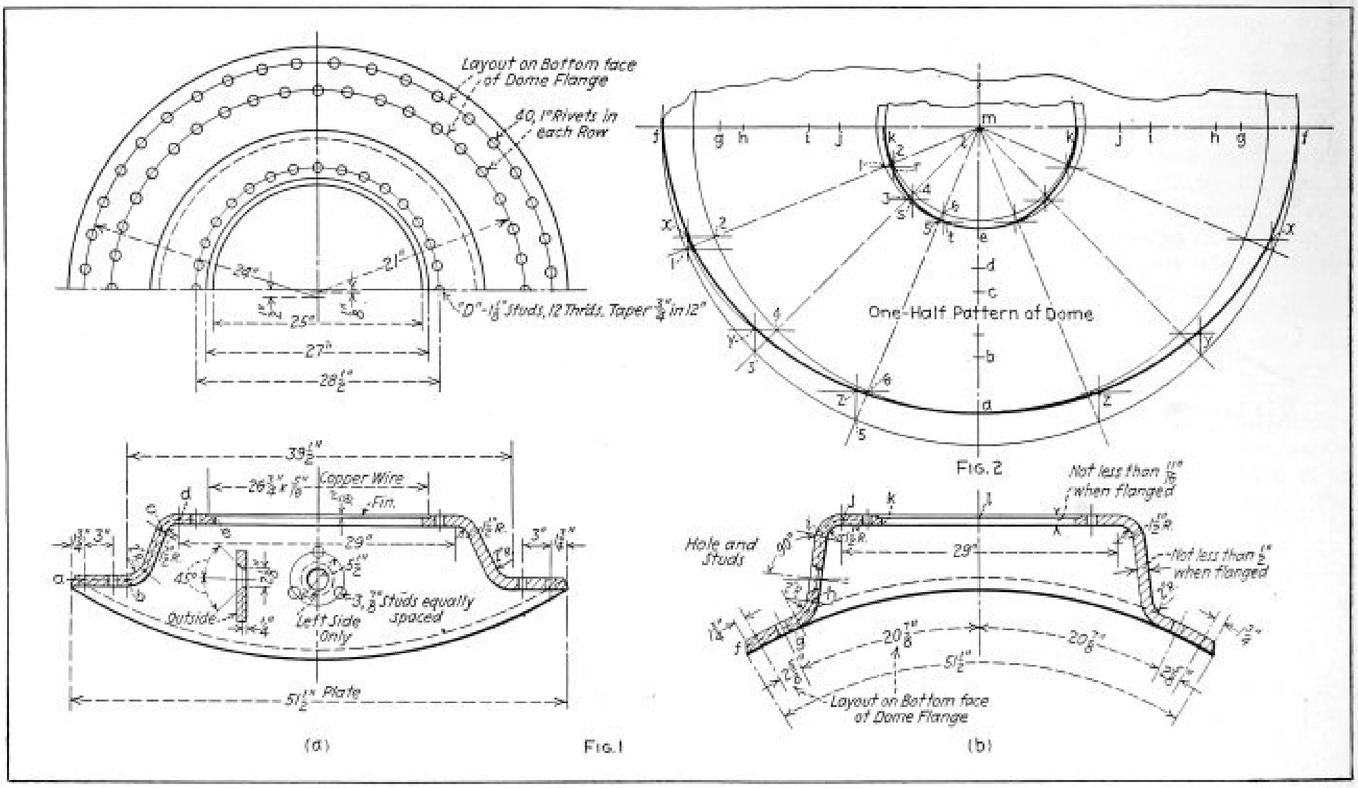
The true lengths of the other development lines are found as shown on the drawings, and as all lines are shown numbered the work should be readily understood.

In Fig. 2 is shown a half pattern. When the pan is too large it can be readily made in three pieces, namely, the bottom and two sides, bringing the seam on each side along the line *b*-*6* as shown in Fig. 3.

Pressed Dome and Dome Base

Q.—I am inclosing blueprints illustrating a one-piece pressed dome and a dome flange and would greatly appreciate it if you will outline in detail for me, either through the columns of THE BOILER MAKER or by mail, just how to develop this dome and dome flange; that is, to lay it out on a flat plate.—L. W. D.

A.—The solution for the dome is shown in Figs. 1 and 2. The one-half pattern, Fig. 2, is a development of an ellipse, for which the major axis is made equal to the lengths measured on the neutral axis of the plate between the points *l*-*k*, *k*-*g*, *j*-*i*, etc., indicated in Fig. 1 (b). The minor axis is made equal to the lengths between points *m*-*e*, *e*-*d*, *d*-*c*, etc. of Fig. 1 (a). These lengths are laid off on *m*-*f*, and *m*-*a* as shown in Fig. 2. The ellipse for the outer section may be drawn by first describing two circles from center point *m* using *m*-*f* and *m*-*a* as radii. Divide one of the circles into any number of equal parts and through these points draw radial lines to *m*. From the points *2*, *4* and *6* of the smaller circle draw horizontal lines and from the corresponding points on the large circle draw vertical lines intersecting the horizontal projectors as shown at *x*, *y* and *z*. These points lie in the ellipse. The projectors so drawn must run parallel with their respective axis. The inner ellipse for the opening is drawn in a similar manner, using *m*-*k* and *m*-*e* as radii for describing the required circles used in developing the ellipse. Due to the pressing and flanging processes the metal will stretch at the outer edges and gather at the bends. Some metal allowances may be required for machining the dome base. The dome flange is developed in a similar manner.



Details of dome development and half pattern layout

Inspector's Ruling on Bad Brick Arches

Q.—Will you please answer the following question? Can a federal boiler inspector take an engine out of service on account of having a bad brick arch? I can find nothing in the Federal Rules about this.—T. W.

A.—I would say that you would have to abide by the order of the inspector, as a defective arch is detrimental to the firing of the boiler and to the arch tubes.

Boiler Questions

Q.—I am a practical boiler maker by trade and am trying to qualify for the state boiler inspector's examination which comes up soon. My experience has all been within the scope of the locomotive and the upright heating boiler so I am going to ask you if you will give me the answer to the two following questions in regard to horizontal return tubular boilers:

(1) How is the rate of combustion usually measured and expressed?

(2) What is the maximum length of the fire sheet of an externally fired boiler? Why is the length limited?

(3) Why are the shell plates of the new horizontal tubular boilers limited to a half inch thickness at the circumferential seams? L. M. C.

A.—(1) The rate of combustion of solid fuels is expressed by the number of pounds burned per square foot of grate area.

(2) There is no rule governing the maximum length of a fire sheet of an externally fired boiler provided the longitudinal joints are butt and double strap construction. In horizontal return tubular boilers with lap joints no course shall exceed 12 feet in length.

(3) So that the metal in the circumferential joint will not overheat.

Methods of Testing Rivets

Q.—Please let me know through THE BOILER MAKER what you consider the best way to tell if a rivet driven by a pneumatic hammer fills the hole? Is cutting off the rivet with a side-set and backing it out, then calipering the hole and the rivet the right way, or should a rivet be driven in a separate piece, then cut through with a hacksaw? It is understood that the rivet sounds tight with the hammer test. W. I. H.

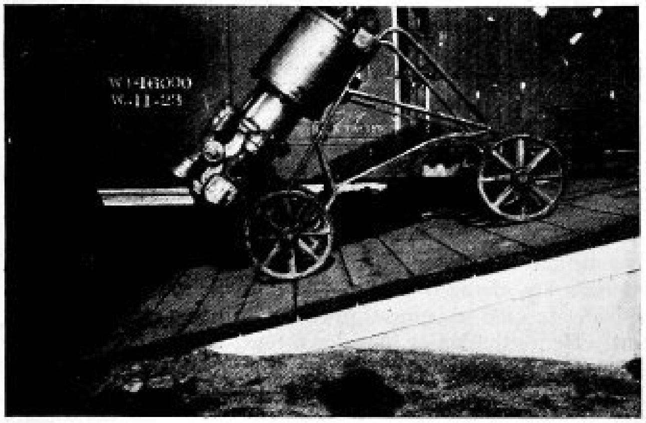
A.—I consider the method of cutting through the rivet as the best means for determining the condition referred to; however, the other method is also good.

Letters from Practical Boiler Makers

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

Device for Hauling Air Pumps Which Saves Labor and Time

THE accompanying illustration shows a labor saving and safety device for hauling an air pump which has been designed by U. S. Wood, labor foreman and constructed by J. Salkeld, boilermaker foreman of the



Special truck for hauling air pumps

Southern Pacific Company at Tracy, California. The wagon was made from scrap iron and has been used at the Tracy roundhouse very successfully. Seven or eight men were previously required to handle a pump which is now easily handled by five men in about half the time.

San Francisco, Cal. C. W. Geiger.

A Giant Sheet Iron Shear

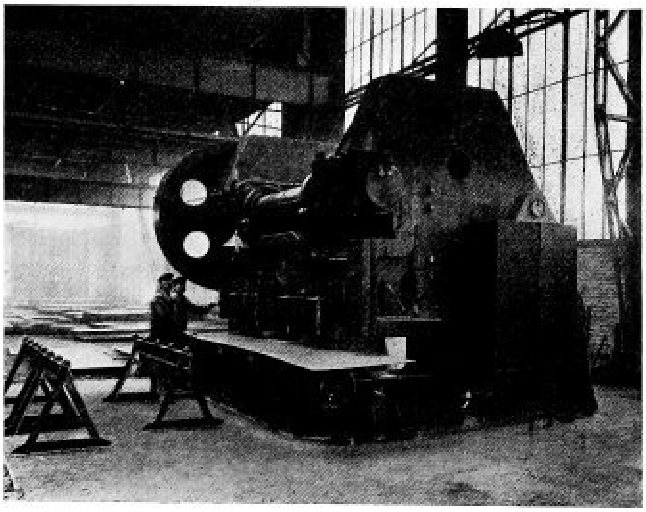
AS the pressure employed in boilers nowadays frequently requires the boiler to be constructed of 2-inch sheets, large shearing tables as shown by the illustration had to be designed. If such a shear is to operate economically, its design has to be adapted to the peculiarity of the operation. In general the actual working time of shearing tables is very low, since the actual cutting only takes very few seconds while the far larger balance of the operating time is used for the setting and preparing of machine and material. Since the cutting time cannot be reduced further and since such reduction would be of no importance in proportion to the total working time, the saving can be arrived at only by reducing the setting up and preparation time. Two ways are open for this purpose: the installation of adequate feeding devices (rollers, cranes, etc.); the selection of correct drive and control devices. The hydraulic drive has been almost entirely discarded as being too slow. The most effective method is individual motor drive.

Construction of Shear

The shear shown in the illustration is constructed without a flywheel and therefore permits of quick stopping and also of partial strokes. In the older types without flywheel, the eliminated driving power had to be compensated by more powerful, i. e. more expensive motors. For this new type a very flexible drive motor is used, which regulates its revolutions automatically in such manner that the working effect demanded from the motor remains more or less constant. If thick or hard material is to be cut, the speed of the motor is reduced, while in the recoil and in cutting thinner material the revolutions are automatically increased. The regulation of the speed is done by so-called "current guards" which act so that in a decreasing turning momentum the motor is sped up, while with increased working effect the number of revolutions is decreased. This naturally also prevents the overloading of the motor. If the maximum capacity is exceeded, the motor is stopped at once, another safeguard against overloading the machine proper.

Push Button Control

The machine is operated by push buttons marked: "Up," "Down," "Continuous," "Stop." "Up" lifts the knife boom



Shearing machine for 2-inch plate

to its highest position where it stops automatically. "Down" carries out the cutting operation to the lowest place of the knife, reverses and carries the knife back to its highest position. The button "Continuous" is provided with a stop which will hold it pressed down any desired length of time. If this button is pressed the machine will operate continuously until the stop is released. If the button "Stop" is pressed the machine stops immediately in any position. This control system simplifies the operation of the machine to a great extent. The cutting time is also automatically adjusted to the gage of the material to be cut.

The shear illustrated has a cutting length of about 13 feet and a weight of 65 tons. It was built by the Schiess Works, Düsseldorf, Germany.

New York, N. Y. G. H. Waetjen.

Boiler Inspection in the Field

SOME time ago I saw an article about the odd things a boiler inspector finds that are dangerous. I was a city boiler inspector for six years and found some strange things. While at first I had to locate many boilers and inspect them in the city oil fields I had quite a job watching them. They would drill a well and move to drill in another place. There was a 60 horsepower operating a drill a block away, working at 125 pounds steam pressure, with the original ball and lever ball out full length and a 5 gallon can of sand hanging thereto. I asked the driller what the safety valve blew off at. He said "a little over 100 pounds." "Well, you have 125 pounds on now and you must cut out that boiler and put on a spring acting safety." I tested the steam gage and that was 25 pounds slow. I got him right.

Another had just moved and was getting ready to fire up. I examined the fittings and found the first gage cock below the second row of tubes. He had a long nipple and a short one, and had put the short one below and the long one on top. We changed them and that raised it ten inches. I tested the steam gage to 250 pounds and it would not move. We took off the face and found there had been crude oil put on the gear and spring. It was baked on solid. We cleaned it off, greased up the spring and equallized it.

Another, I just happened along while the engineer was cleaning the boiler and said he had it clean. I said, "Don't you clean out the lower right angle pipe to the water column?" "It don't need it. We only put that on last year." We took out the plug on the tee and found that a hairpin could not be pushed through the pipe to the boiler. They had to put in a new pipe, then the same old Jake on the ball and lever safety valve.

"How is your safety valve?" "Oh," he said, "that worked fine yesterday." When I examined it, I found the main rafter of the boiler house down so tight on the lever that the lever was bent. "Well," I said, "It don't look like you have raised this boiler house for a year, and that safety never blew off without you raised that whole building." They had to get a new spring safety.

Another place, they called me down to set a 4½-inch spring safety. I asked the engineer "what kind of water do you use?" He said, "This well water." "I must test the water first." So I did and found it to be sulphur water. I told him I would not touch the safety valve until I could find the boiler dead. In a day or two he called up. I had the valve taken off and found the brass stem full of holes and places that were not as good as a one-quarter inch brass rod. If I had attempted to tighten that down, it would have blown my head off. I had them get a bronze stem.

Another place where there was a power house and four 250 horsepower watertube boilers. They had 3 tubes burned off and hanging from the top drum. It looked as if they had burst and instead of taking them out, they had plugged them up with wood and filled the other part with cement. Later they overhauled and moved the boilers and started up without an inspection. They ran two days and pulled out fifty tubes. They were going to discharge the foreman and engineer that were on watch. I came into the plant and said we must find where the fault is. It was low water, I knew, but what made it. When they said they had all the valves open and pumps on three boilers, I went on top and found a two-and-a-half inch Globe valve. I took off the bonnet to examine it and found the valve had been put on the wrong way. The disk had come off the stem and pump pressure kept it down on the seat, and that shut the water off from that boiler.

I had them put on a gate valve so it would keep wide open when used and dead shut when cleaning the boiler.

Hollywood, Cal. JOE HOLLOWAY.

Causes and Prevention of Boiler Tube Failures

(*Continued from page* 194)

Scale is another common cause of boiler tube failures. This can be prevented by frequent use of air or waterpower cleaners. The air cleaners are more economical where the plant is supplied with an air compressor of sufficient capacity, as they will operate more rapidly than a water-operated cleaner. This method of cleaning is very effective where a regular schedule is maintained to prevent undue accumulation of boiler scale. It necessitates, however, that the boilers be out of operation for a number of hours at frequent intervals. The work is often hot and tedious.

In virtually every case the proper use of soda ash or sodium silicate or lime and caustic soda or barium hydrate will produce better results than can be obtained with boiler compounds at anywhere from one-tenth to one-half the cost. In no case, however, should the treatment be carried on without competent, reliable tests being made for boiler alkalinity, free lime and amount of solids in solution. Some accurate check should also be made of boiler priming. Priming may be quite pronounced without material fluctuation of the water level in the gage glass.

BOILER WATER TREATMENT

A very simple method of boiler water treatment where the amount of sodium is low is by the use of a zeolite softener. This method has the disadvantage, however, that incrusting materials are changed into a soluble form and carried into the boiler instead of being thrown down in the treating equipment. Hence the boiler blowdown must be greater than with other methods of external feedwater treatment.

Evaporators provide a means of producing pure water for makeup purposes in limited quantities at a very reasonable cost and when properly installed and operated will keep the boilers almost entirely cleaned. There is no danger of priming or foaming and the blow-down can be almost entirely eliminated.

The presence of oil in boiler feed water has frequently caused serious tube troubles. This is usually indicated by small blisters on the boiler tube, which are generally smaller in diameter than those due to scale trouble. The only real proof of oil or lack of it is to send a small sample of the scale to a chemical laboratory, where ether can be passed through it until all the oil has been dissolved, after which the ether is evaporated, leaving the oil.—*J. W. MacKenzie, Electrical World.*

New British Colliery Boiler Plant

BECAUSE of the poor efficiency of colliery boiler plants in general in Great Britain, the Ashington Coal Company, Ltd., of Newcastle-on-Tyne, has arranged for the installation of 4 Stirling five-drum watertube boilers to replace the existing installation of Lancashire boilers. The new boilers will operate at 200 pounds pressure and each one is capable of evaporating on normal load 33,000 pounds of water per hour. These boilers are equipped to burn pulverized fuel so that the installation includes two 5-roll Raymond pulverizing mills and water screens. The boilers are also equipped with air heaters of the multiple plate type. The tendency in British practice is more and more towards the use of air heaters which are considered as essential a part of economizer equipment as superheaters, feedwater heaters and exhaust steam heaters. The estimated efficiency of the plant based on normal load condition is 86 percent. Coal to be used in the boilers has little or no commercial value, and will deliver only about 9,000 to 9,500 British thermal units per pound.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

SELECTED BOILER PATENTS

Compiled by

DWIGHT B. GALT, Patent Attorney,

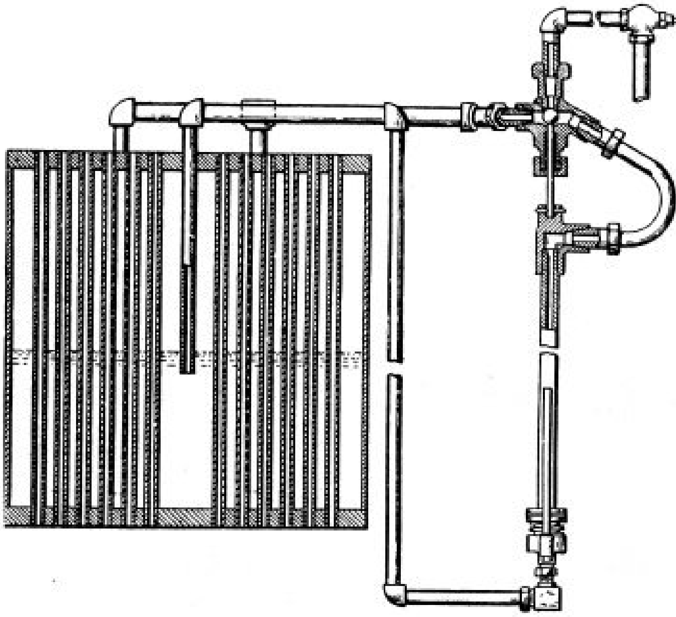
Washington Loan and Trust Building

Washington, D. C.

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

1,525,341. CHARLES UEBELMESSER, OF NEW YORK, N. Y. MEANS FOR ELIMINATING SEDIMENT FROM STEAM GENERATORS, BOILERS, ETC.

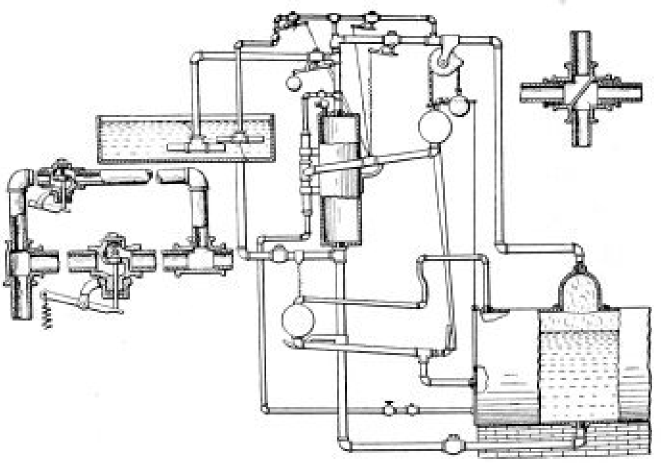
Claim 1.—In combination with a steam pressure generator of the character designated, a sediment discharge pipe extending nearly to the bottom thereof, a higher level steam discharge pipe extending below the proximate normal liquid level in said generator, both of said discharge pipes being connected with a coupling head common to both said coupling



head, a valve positioned therein to automatically stop the discharge of both fluids, and mounted upon a push rod rigidly connected with an expansible stand pipe forming part of the aforesaid steam discharge, said expansible valve stand pipe, and an initial control ejector valve connected with said coupling head, substantially in the manner and for the purpose set forth. Seven claims.

1,528,815. BOILER-FEED-WATER SYSTEM. GEORGE W. COPE, OF OIL CITY, LOUISIANA.

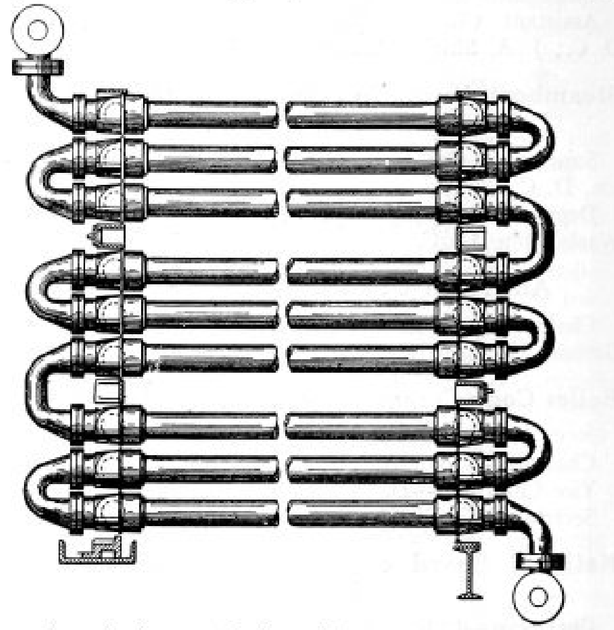
Claim 1.—In a feed water system, a boiler, a water reservoir, a stationary charging tank situated above the boiler and having a valved water inlet, a valved water discharge connection between the tank and the water space of



the boiler, a valved exhaust pipe leading from the tank, an air inlet and outlet, a primary valved steam connection between the stationary charging tank and the boiler, a secondary valved steam connection between the stationary charging tank and said boiler, a vibratory receptacle the top of which has a valved steam connection with the said charging tank and the bottom of which has discharge and return water connection with the boilers water space, said vibratory receptacle arranged to receive and return water from and to the boiler, said receptacle being provided with an exhaust valve, means for limiting the movement of said vibratory receptacle, means for automatically vibrating said vibratory receptacle, means connecting the vibratory receptacle with the valve of the exhaust pipe and the valve of the primary steam connection of the stationary charging tank to thereby operate said valves, and an elastic connection between the vibratory receptacle and the valve of the secondary steam connection of the stationary charging tank to thereby effect the operation of said valve. Five claims.

1,531,154. FUEL ECONOMIZER FOR STEAM BOILERS. GEORGE EDWARD TANSLEY, OF WAKEFIELD, ENGLAND, ASSIGNOR TO E. GREEN AND SON, LIMITED, OF WAKEFIELD, ENGLAND.

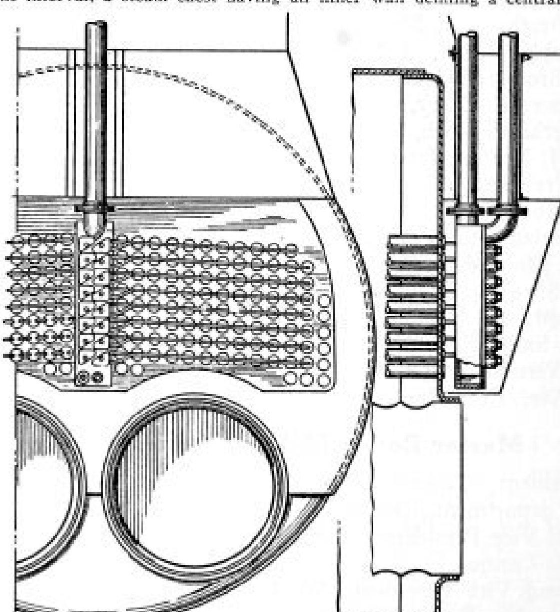
Claim.—A fuel economizer comprising a framework having ledges, a plurality of horizontal tubes arranged in separated sections with a similar number in each section and having headers connected to opposite ends thereof, the ledges of the framework supporting the headers of the sections of tubes



so that each section is supported clear of the next adjacent section and is free to expand or contract independently of the next adjacent section, the headers forming the front and back walls of the economizer and arranged and carried by the framework in such manner that they will just clear each other with a negligible space between them to provide for the formation of gas-tight walls or connections, the sections of tubes being connected by bends which allow for a difference of expansion between one section and an adjacent section.

1,531,720. SUPERHEATER FOR STEAM BOILER. HEINRICH TOUSSAINT, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF GESELLSCHAFT M. B. H., OF CASSEL-WILHELMSHOHE, GERMANY, A CORPORATION OF GERMANY.

Claim 1.—In a superheater arrangement for ships' cylindrical boilers having smoke flues arranged in groups separated by and at either side of an upright interval, a steam chest having an inner wall defining a central steam



passage and an outer wall having a cross-sectional outline similar to that of the inner wall and surrounding and defining with said inner wall a pair of side steam passages, a wall closing all of said passages, a plurality of superheater elements arranged within the smoke flues of said boilers and means to connect said superheater elements with said passages comprising a plurality of triangular shaped connectors secured to said last named wall and arranged in pairs of overlapping relation, each of said connectors having a steam channel adjacent two of the apices thereof to furnish communication between said superheater elements and said passages. Four claims.

The Boiler Maker

Volume ~~XXIV~~ 25 August, 1925 Number 8

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

Edward A. Simmons, *Pres.*
L. B. Sherman, *Vice-Pres.*
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Chicago: 608 South Dearborn St.
Cleveland: 6007 Euclid Ace.
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Boston: 294 Washington St.
Washington: 17th and H Sts., N. W.
San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St.
Westminster, S. W. 1.
Cable address: Urasigmec, London

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

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

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

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

CONTENTS

Boiler Performance Guarantees

THE purchaser of a boiler naturally wants some guarantee that the steam generator he is buying will have sufficient capacity to meet his requirements and that it will do so under the conditions existing at his plant. That boiler manufacturers are having difficulty in making and meeting guarantees for the performance of their products is shown by the discussion of the subject at the last annual convention of the American Boiler Manufacturers' Association. A way out of the difficulty, described elsewhere in this issue, was proposed at that meeting and this should receive careful consideration by all boiler manufacturers. The matter has been referred to the Boiler and Stoker Committee of the association to be reported upon at a later meeting with the idea that eventually a useful and workable guarantee code may be adopted. If something better than the present loose and inconsistent methods of determining boiler performance and making guarantees to cover it can be devised, the whole boiler making industry will benefit immeasurably by it. Briefly, the new basis proposed for measuring boiler performance is the ratio of the heat transferred to the steam produced above the temperature of the boiler feed to the heat contained in the combustion gases supplied to the boiler above the boiler room temperature. It is suggested that guarantees can be safely made on the basis of this ratio, provided suitable allowances are made for variations existing in the different kinds of fuels used. Other proposals will of course be gladly welcomed in the endeavor to solve this troublesome problem.

Water Level Indicating Devices

LOCOMOTIVE boiler water level indicating devices have attracted considerable attention in railroad circles during the past few years. The problem of correctly registering the water conditions inside a boiler demands the best thought that the engineering staffs of the railroads can give, for the potentialities of disaster contained in a boiler are tremendous. The chief inspector of the Bureau of Locomotive Inspection in his annual reports for several years has stressed the necessity of adopting a safe standard for water level indicators. Finally, the American Railway Association, Mechanical Division has arrived at a basis for this standardization in a sub-committee report presented at the June meeting published elsewhere in this issue. Canada too has adopted a standard in the form of a water column which is welded to the boiler backhead. This column is now being applied to all locomotives of the Canadian National Railways.

It is possible that the Master Boiler Makers' Association can assist materially through the proper sources in the final development of a suitable standard for this country and certainly it is a subject which should be brought up at the annual meeting of this body next spring. The practical knowledge that exists and the experience of the members from all sections of the country on the best method of application should prove invaluable in formulating a final standard of water column practise.

Eye Safety

THERE is no such thing as a non-hazardous industry—this is the conclusion of the National Committee for the Prevention of Blindness as indicated in the report of an extensive study of eye hazards in industrial occupations recently completed by the Committee, a summary of which was recently issued by Lewis H. Carris, Managing Director of the Committee.

The report declares that "of the 100,000 blind persons in the United States approximately 15,000 are the industrial blind—persons who have lost their sight in the pursuit of industrial occupations—and there is in addition to the totally blind a much larger number of men, women and children whose vision has been so impaired by the eye hazards of industry that they are handicapped throughout life. Both of these classes, the industrial blind and the workers whose vision has been seriously impaired by the hazards of other industrial environment, grow larger each year."

The section of the report dealing with the nature and cause of eye injuries closes with the statement: "Until industry knows exactly where, when, how, and why eye accidents occur it will not be in a position to do justice to the existing opportunities for the elimination of such accidents, much less to develop new means of prevention. The keeping of detailed and accurate records of the nature, causes, and costs of eye injuries on the standard basis developed by the International Association of Industrial Accident Boards and Commissions is, therefore, recommended as the first step in any campaign for the prevention of eye accidents in the individual industrial plant or in an entire industry."

Boiler Production

IN the article outlining the plant and methods employed by the Coatesville Boiler Works, published elsewhere in this issue, little is said about the underlying causes for the success of this company. The same principles for promoting the morale of the staff—steady, regular work, interest in the human side of the industry, a spirit of cooperation—that exist here must be present in any successfully-run business today if the bugbear of low demands and keen competition is to be met. The first essential to the upbuilding of an efficient staff is the assurance of steady employment—not necessarily at high wages, but at wages that will make it possible to live comfortably and provide some of the luxuries of life. This desirable condition has been reached by the works at Coatesville through the energy of its executives and the cooperation of its staff, accomplished during a period when, to say the least, the demand for boilers has been at a minimum.

The first requirement on which the sales staff works is to keep the shop busy with profitable business if possible, but to keep it busy in any event. This is possible because of the adaptability of the plant to the construction of either the heaviest boilers or light tanks throughout the whole range of steel plate work. So successful has the policy been that orders are on hand at present to keep the shop working to capacity for nearly eight months in advance.

Another policy of the company that bears fruit in better production is to provide new equipment whenever such additions are found necessary. If the shop superintendent, after consulting with his department heads and his technical assistant, decides that a new machine is essential to the more efficient working of the shop, the executives of the company will supply it without loss of time. When it is considered that the average boiler shop has equipment that dates back several decades, the gradual purchase of new machines to replace those that are practically worn out and belong to another age of production should be logical. There is no reason why the same savings in fabricating boilers cannot be made with modern equipment that have been accomplished in other industries. The Coatesville Works is an excellent example that such savings can be made.

Master Boiler Makers' Meeting

AT a recent meeting of the executive board of the Master Boiler Makers' Association, held in Buffalo to discuss plans for the 1926 convention, it was definitely decided that the Hotel Statler in Buffalo would be the scene of the meeting. The dates selected are May 25 to 28 inclusive.

LETTERS TO THE EDITOR

Values of Second-Hand Boilers

TO THE EDITOR:

THE article on "Depreciating Values of Second-Hand Boilers" in the April issue of THE BOILER MAKER, page 116, by the writer, explains several points of caution which should guide those connected with supervision of boilers, as well as those interested and contemplating buying boilers for power generation.

In this instance, besides the exactions of the state laws in connection with boilers and other references noted in the article on depreciating values, I wish to take this opportunity of adding several remarks from an analytical standpoint, believing they will serve a purpose which may prove profitable in their application.

The many factors deserving due consideration in this matter on behalf of the purchaser, when summed up for a decision, will in the majority of cases, present evidence towards the advisability of abandoning the installation of second-hand boilers, with a warranted sense of satisfaction.

THE PURCHASER'S VIEWPOINT

The ultimate desire of a purchaser of boilers for power and steam generation is the material gain that should be obtained from its use. This goal would be far from being attained by purchasing and installing a second-hand boiler in view of the following phases which must be considered and taken into account:

If the boiler is not of A. S. M. E. construction, or if constructed before the Code went into effect and allowed by the state to be installed (which is very doubtful) it will be a decided detriment to the owner. It must first be sensed that the state boiler inspection commissions or boards and insurance companies are availing themselves of every opportunity to criticize and sometimes disqualify the slightest defect observed in an effort to rid the state of the so-called *rusty tin cans.* The factor of safety of the boiler will be determined from the age or date built and subsequently reduced with each succeeding term. Will this reduction of the factor of safety, and consequently the reduction in allowed steam working pressure, provide the required power at the time of installation, also as well in succeeding years thereafter with continued reductions?

After twenty years from date the boiler was constructed, would it be profitable to prepare the boiler for annual hydrostatic test having the entire external surface (according to type) stripped of jackets, lagging, brick work or other obstructions to enable external inspection which of course is followed by an internal inspection?

Would it pay to *waste* fuel in order to provide the required pressure or steam volume, due to the water surfaces being covered with hard adhering scale which could not be removed without injury or replacement to any part of the boiler?

Is it a promising chance to take in view of occasional necessary repairs to be made after the boiler is installed, due to a hundred and one different causes?

Will it provide an additional amount of power in case it is necessary to meet a requirement in accordance with the growth of business, without endangering safety?

Would it be advisable to afford the extra floor or volume space required for a boiler reduced in allowable steam working pressure, when a new boiler would meet the requirements with less displacement?

Does the structure into which the boiler is desired to be placed admit its entrance and setting with a minimum amount of expense incurred in tearing out, replacing or changing any part of the building? Consider also the possible repetition of this condition before it may reasonably be expected.

Would it be wise to keep the maintenance forces disgruntled by imposing extra effort and labor upon them without a chance of advanced results therefrom?

Would the management or owner feel secure and contented when at or away from place of business?

With second-hand boilers of A. S. M. E. construction, nearly all the above factors are also applicable and should be considered, but in a lesser degree and of course depending upon the condition and age.

There are numerous other considerations which have a reasonable bearing in determining the efficient utility or ultimate value of *moved* second-hand boilers, but not of sufficient importance to sway the judgment in deriving a decision.

Ascertaining the Results

In conclusion, the discretion of the problem varies in accordance with local circumstances and proportionately revolves around the fact that safety is the predominant purpose sought by the American Society of Mechanical Engineers. Their Boiler Code was therefore formulated by technical and practical men versed in the subject for the relief of the danger that results from the uninformed and indiscreet, and in turn approved and enacted by legislation for the protection of the general public.

From the analysis of the above searching questions and remarks it will be realized that due recognition of them was deserving, thereby in all probability offsetting the favor of a cheap first cost. *Does It Pay?*

Jersey City, N. J. T. P. Tulin.

Why Catalogues Do Not Contain Prices

To the Editor:

I observed in the June issue of The Boiler Maker that W. F. Schaphorst was lamenting that prices of products were not given in catalogues, and he wants to know the reason why. Well, there are numerous reasons why many firms do not publish their price lists and with the consent of our editor, I will endeavor to enlighten our mutual friend. One reason, and probably the vital one, why prices are not given, is that competitors would learn each others figures and that spoils healthy competition. Another reason is that the fluctuating market prices of raw materials, such as plates, angles, tees, joints, channels, hoops, rods, billets, pig-iron, coal, coke, etc., would make a price list useless for any length of time. When manufacturers do work to a basis price list, they are compelled from time to time to advise their clientele something like this: "We beg to advise you that our list price is plus four percent, less two and one-half percent," and the following week along comes a further increase or reduction and, when you really do want the present-day price, why you just 'phone 2788 Gerrard.

Price lists are all right for products such as tubes, rivets, bolts, studs, and Ford cars, also for such other products that are repeating themselves from time to time where precedent builds upon precedent and costing is in fractional parts. In such cases as these one invariably finds that there is very little difference between two or three firms' prices.

Confining ourselves to the boiler making trade, anyone with a fair experience must know that boiler makers make all sorts of things out of steel as well as boilers and a price list would be useless. Further, the various articles of the trade can be made in various ways and the prospective buyer generally gives some indication or a full specification how he wants it made.

Contrary to Mr. Schaphorst's remarks, that firms are ashamed to quote their prices and that sales are lost through the absence of the price, I venture to advise him that any buyer who means business will not only write for the price of the article, but will even send out five or six inquiries to firms who manufacture that article and all those fortunate enough to get the inquiry will jump at the opportunity to quote a competitive price and even send a salesman out with alternative designs and quotations to book the order.

Leeds, England. John Gordon Kirkland.

Finding the Neutral Axis of Heavy Plate

To the Editor:

On several occasions when I have been laying out cylinders, the ratio of whose diameters compared to the thickness of steel used, has been comparatively small. I have found that no matter how accurately I figured out the required length of plate, the finished cylinder would come oversize. I first came up against the problem in 1915 when I had some steel cylinders to make out of ¾-inch plate and either 8 inches or 10 inches diameter which were used for making piston rings. I figured them in the usual way by multiplying the neutral diameter of the plate by pi (3.1416) yet the cylinders came too large and I had to notice how much too big they came and make allowance to suit on the second lot. As at the time I was working day and night, I had no time to study the matter then and as in the several times since, I have noticed it, the work has been individual items I have never had any opportunity to verify the apparent discrepancies or to obtain any figures to work with.

However, lately I have had brought to my notice the same trouble again, this time in the drums of high pressure water-tube boilers. Convinced in my own mind that the trouble was caused by the plate stretching, I made a number of careful tests with steel of various thicknesses in excess of 1 inch and rolled to diameters varying between 42 inches and 60 inches, and tabulated the results. On both sides of the flat plate I measured off 24 inches and marked the plate with a center punch. On 1 7/16 inch plate I found in every case that after it had been bent to 42 inch diameter the difference between the stretch on the outside and the contraction on the inside was ⅛ inch. In other words, the measurements after bending were 23¼ inches on the inside and 24⅞ inches on the outside. But if the neutral axis lay through the center of thickness, if the inside measurement had contracted ¾ inch, the outside ought to have expanded ¾ inch. I then tested other thicknesses of steel bent to different diameters and in each case found the amount of expansion greater than the amount of contraction in proportion to the ratio between the plate thickness and diameter. This proved to me that the metal did stretch which accounted for the increased diameter of the finished drums. I then set out to find the reason for the stretching. I have arrived at the following deductions. The principle of obtaining the length of a stretchout from the neutral axis of the plate is right, but the application is wrong. If the neutral axis lay through the center of the plate, it would be all right, but such is not the case.

All steel plate used in boiler making at the present time has a tensile strength of from 50,000 pounds to 60,000 pounds per square inch, but the compressive strength ranges between 90,000 pounds and 100,000 pounds per square inch. Hence, since in rolling a plate to a circular form the inside of the plate is subject to compressive stress and the outside to tensile stress, the inside of the plate is almost twice as strong to resist the bending stress as the outside is and consequently the plate following the line of least resistance stretches as I have proved in the tests. I know quite a number will argue that I must be wrong because boilers have been made for such a long time and so far as I know this is the first time that doubt has been cast upon the accepted methods of obtaining the length of stretchout. To such criticism I would reply that with light or medium heavy steel the error would be so small as not to be noticed and that any looseness on a head would be taken up at the seams to a certain extent. Again, in the old days when boiler making was in its infancy, iron played a prominent part in boiler construction and as the compressive and tensile strength of iron are practically equal, the men who taught the principles of laying out were right in taking the semi-thickness of plate as the neutral axis. This was also proved to me in my experiments because in the tests I made with bar iron from 1 inch to 2½-inch thick in every case the increase was equal to the decrease on the measured length proving that there was no stretch. Since at the present time there is an increasing demand for larger units and higher boiler pressures, the thickness of plate is increased and boilers of 1¾-inch plate are already made and being made. Also for the same reasons greater accuracy is necessary and it sometimes happens that the specifications call for the heads being shrunk into the shells. Thus it is readily seen that any errors occurring in such work would prove serious to any firm and that every effort ought to be made to eliminate all chances of mistakes.

In order to obtain the views of as many people as possible, I am asking The Boiler Maker to publish this letter and would particularly like such firms as have rolled heavy boiler plates to inform me if they have experienced any stretching, or if the use of πD (D being the neutral diameter as at present used) gives them satisfactory results. If I have the right idea, then to obtain the correct neutral axis make a graph in the following manner. Erect a perpendicular making it equal to 55,000 pounds to any convenient scale. Through the middle of it draw a horizontal line and divide it into 10 parts. At the end of the horizontal line erect another perpendicular making it equal to 95,000 pounds by the same scale. We know that on the inner skin there is the greatest compressive stress which decreases to zero as we near the center of thickness and then increases to a maximum of 55,000 pounds tensile stress. If we represent this on our graph by straight lines joining the opposite extremities of our force or stress lines, their intersection will give us the location of zero pressure or the neutral axis and will be found 0.37 of the horizontal distance. Therefore, by my methods the required length for a heavy cylinder of external diameter D and thickness, it would be $\pi [D - 2t + (2 \times 0.37t)]$, or taking a concrete case: Boiler 48 inches outside diameter of 1½-inch plate, would be $\pi [48 - (3 + 1.11)] = 46.11 \pi$. In the old way, it would be $46\frac{1}{2} \pi$ or about 1¼ inch difference in the length. One theory advanced to me was that the stretching might be due to the plates being formed instead of rolled, but personally I can't see that the bending medium makes any difference and I believe that the difference between the tensile and compressive strength of the boiler plate is the cause of the trouble.

Hoping that I have made the above case clear and through the medium of The Boiler Maker to have some wholesome criticism, I remain, James Winthorpe.

Chattanooga, Tenn.

NEW BOOKS

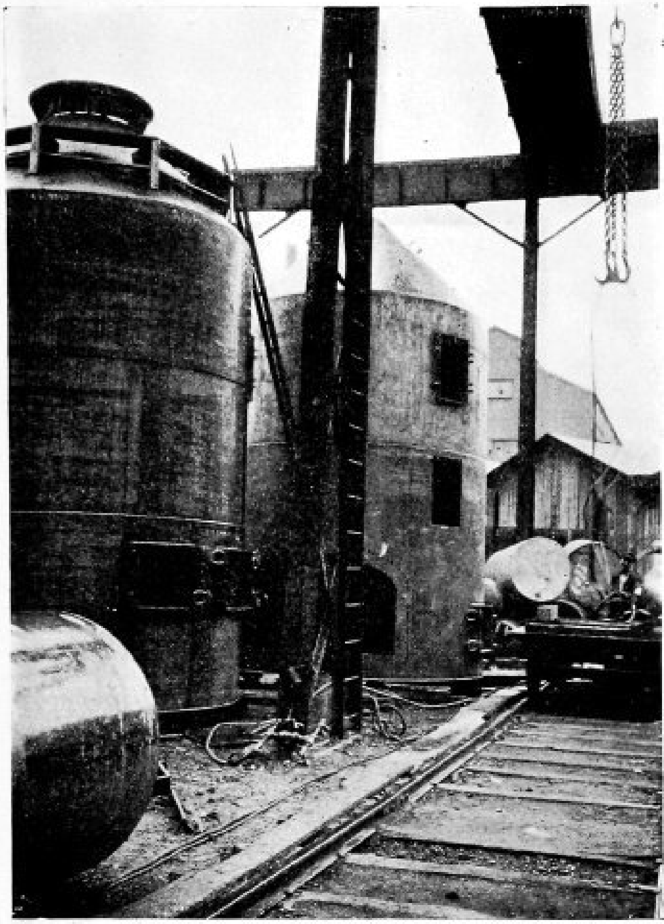
Superheat Engineering Data—A Handbook on the Generation and Use of Superheated Steam. Sixth edition revised. (Superseding Data Book for Engineers.) Size, 4½ by 7 inches. Pages 208. Illustrations, 85. Tables, 69. New York and Chicago, 1925: The Superheater Company.

This handbook contains condensed data for steam power plant engineers and operators. A feature of the book is the index consisting of 16 pages, assuring ready reference. Superheated steam, its advantages over saturated steam, and the proper design and performance of superheaters, are briefly discussed. It illustrates superheater arrangements in practically all stationary, marine and locomotive type boilers commonly made in America. Waste heat, portable and separately fired superheaters are also shown. Brief comparative data are given as to sizes, tube sizes, arrangement of tubes, etc., for the stationary watertube boilers illustrated. The steam tables cover pressures from below atmospheric to 600 pounds, absolute, and include properties of superheated steam from 50 to 300 degrees F. superheat.

The section on piping includes information for figuring piping for handling water, saturated and superheated steam, and velocity and pressure drop of water and steam flowing through piping. In this section is included also the proposed American standards for high pressures. Superheat Engineering Data also contains engineering data on coal and oil-fired boilers, which include tables of heat values for gaseous, liquid and solid fuels. Other miscellaneous data include complete conversion tables and data on bolts and screw threads, with the recent work of the American Engineering Standards Committee, and the National Screw Thread Commission. There are also many miscellaneous tables frequently used by steam engineers.

Laying Out for Boiler Makers. Fourth edition. Size, 8½ inches by 12 inches. Pages, 385. Illustrations, 550. New York, 1925: Simmons-Boardman Publishing Company.

The fourth edition of this book, which has been well known for many years in the field of boiler making, has been completely revised and amplified. New chapters have been added on the layout of return tubular boilers and on the locomotive boiler. These chapters were specially prepared by authorities on the subject and are the last word in modern layout practice. The principles of triangulation and projection are discussed in the opening chapters of the book and applied to practically every form of layout work that is required in a modern shop. A chapter is devoted to marine boiler construction with the practice of one of the largest shipyards in the country taken as a basis. Other chapters are devoted to layout problems, including uptakes, Y problems, stacks, tanks, breeching, tapering sections, chutes, buoys, transition pieces, pipe layouts, elbows, hoppers, hoods, ventilators and numerous other miscellaneous problems. The book has been divided into fourteen chapters and these have been completely cross-indexed for ready reference to any problem that might come up in the course of work in nearly any plate or boiler shop.



Waste heat boilers in the storage yard

Boiler and Tank Construction at Coatesville

Plant and Methods of the Coatesville Boiler Works — Welding Plays Important Part in Operations

STRATEGICALLY located between the steel mills of the Bethlehem and Lukens Companies, the Coatesville Boiler Works at Coatesville, Pa., has been able to maintain a capacity production of boiler and tank work during a period which has, in general, been considered dull by the boiler manufacturing industry. The location adjacent to the steel mills has the advantage of making the plant more or less independent of maintaining a large stock of plates for current work. Considerable time is saved by the elimination of rail delivery of material and by the ready check on special plate orders going through the mill. The one drawback in this location, however, is the lack of room for expansion and of storage space for finished material. This limitation is well indicated on the accompanying layout of the plant.

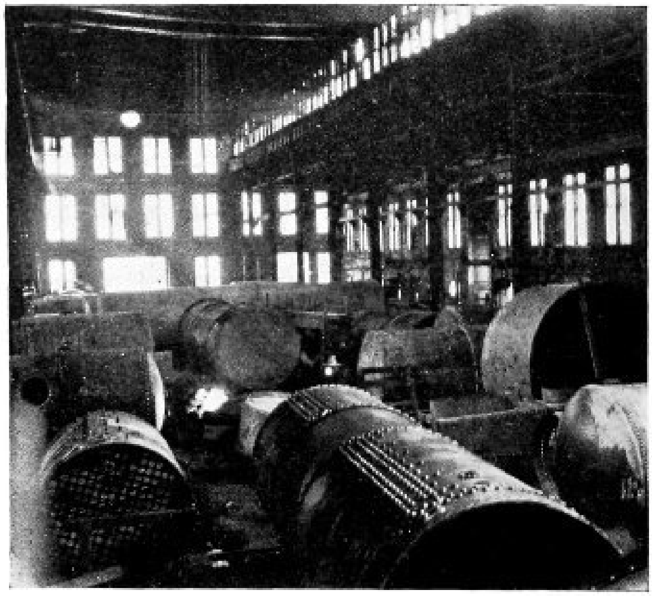
The building itself, while built many years ago, has incorporated in its construction many of the features of modern plants of a similar character. The arrangement for production is such that material follows a direct line from the laying out floor to the testing department. Lighting facilities, both natural and artificial, are adequate in every way.

Machine equipment is available to meet practically any requirement to which it my be put, from the construction of light tank work to the building of the heaviest type boilers. The policy of the company is to provide all necessary new machinery whenever the demands of production require it. In this connection the latest addition of equipment to the shop is in the form of two Cincinnati-Bickford 7-foot radial drills having a fixed elevation. These are located so that a movable table runs between them. This table was specially constructed in the shop. The drills are used on multiple unit jobs for both boiler and plate work when material is ⅝ inch or over. At least three light plates of like patterns are necessary on a job before the drills are employed. As many as 15 light plates on an oil tank order are put through the drilling operations on this machine at one time. In the case of heavy boiler work, four 1 3/16-inch plates are considered capacity. The location and arrangement of departments and machines are shown in the accompanying layout.

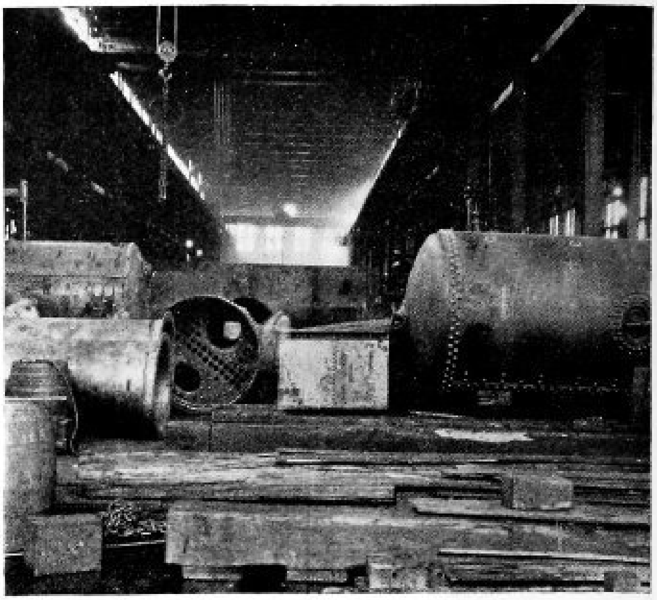
Shop Organization

The executive offices of the company are located in Philadelphia, while at the plant the shop comes under control of the plant manager. In Philadelphia also are located the estimating department, sales organization and other branches than production. The drafting force is located in Coatesville. The shop organization proper comes under the control of the shop superintendent and his assistant who is also production manager. The organization chart shown herewith indicates the subdivision of authority under the superintendent. Production is divided into the following departments: laying out, punching, drilling, machine shop, flanging and fitting up, finishing, welding and cutting, testing, painting, and loading.

According to the chart, the staff consists of three clerks and messengers who come directly under the production manager, 36 welders and cutters, 7 layerouts, 17 punching, shearing, rolling, etc., 10 drillers, 12 flangers and blacksmiths, 14 in the bull riveting gang of the upper shop, 10 on plant maintenance and machine work, 30 in the fitting-up department of the lower shop, 30 in the finishing and hand riveting department, 7 in the testing department, 12 electricians and crane men, 4 engineers and firemen, 3 inspectors, 5 painters and shippers. In addition, a road force of from 15 to 30 men reports to the superintendent. The whole force is composed



General view of the finishing department



This view gives an idea of the variety of work handled

of about 200 men regularly employed. There is also a night force of about 30 men engaged on rush jobs and to balance production. The layersout work to 100 percent capacity days; punching department, 50 percent days; the welders, 100 percent days and nights; fitting up and finishing department, 100 percent days and 10 percent nights.

Classes of Work

Metal plate work of all kinds is contracted for by this plant—no work is too light nor too heavy. The range includes galvanized tanks made from 14 gage metal, black steel tanks made from 16 gage, up to such work as the 40-ton waste heat boilers now being constructed in the plant. These boilers, of which eight are on order at the present time, are built for 250 pounds working pressure and are of 1 3/16-inch plate. The rivets used practically throughout are 1⅜ inches in diameter. The shell of the boiler is 28 feet long and 7 feet 6 inches in diameter. There are 292, 4-inch No. 8 tubes, 22 feet long, installed.

The total daily capacity of the plant is five 10,000 to 20,000 gallon tanks, two horizontal tubular boilers of standard sizes, 40 to 50 miscellaneous small tanks, heating and special power boilers, besides the general run of plate work. The production of the shop is about 1,000 tons a month of finished material. As many as 180 full car loads of finished products are shipped a month. It is estimated that the average number of car loads per month for the year will be 120.

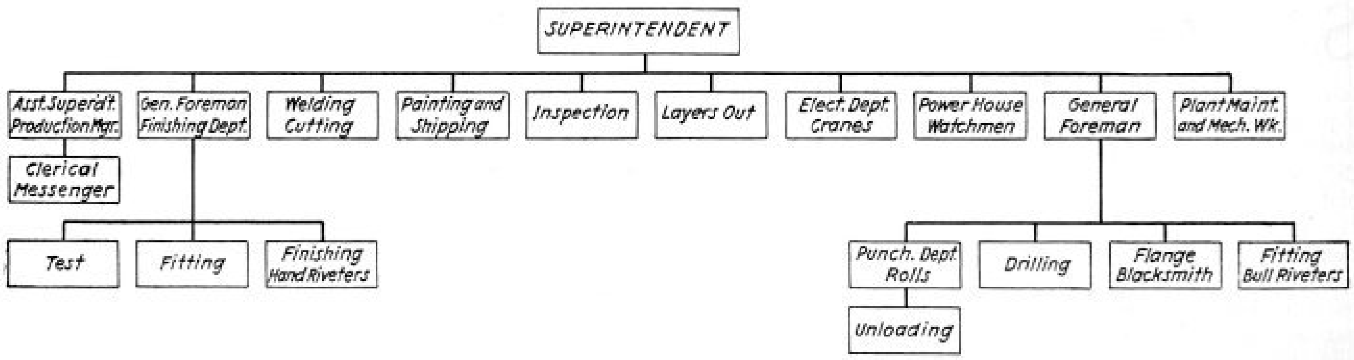
Shop Operations

The bulk of the steel used comes to the unloading wharf direct from either the Bethlehem or Lukens plants. As previously noted, the material shipping time saved amounts to four or five days in its receipt. Sundries are purchased in the open market. The bulk of the castings used is made at the company's foundry located across-town. This foundry employs about 50 men.

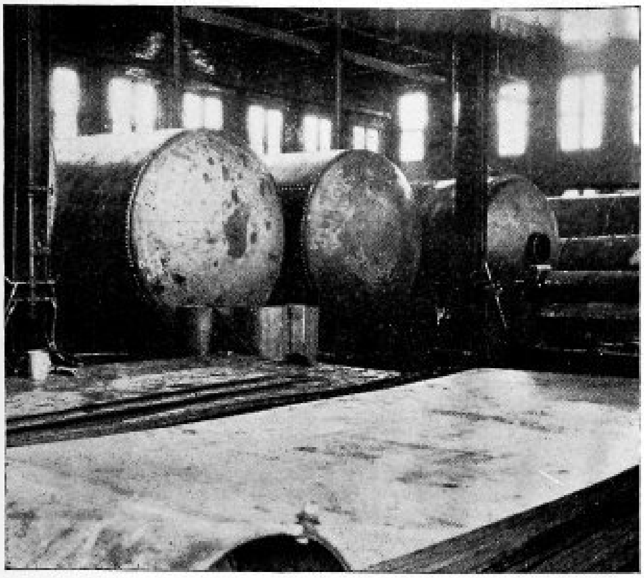
As material comes to the yard, it is sorted into the various job orders and assigned to the members of the layout staff. Time is charged against each specific order when the material enters the plant. The punching department gang has the duty of handling material and bringing it to the layout floor. After it is laid out it goes to the punching and drilling departments and then it is planed and bevelled also in the fabricating department.

Following this operation it is taken to the rolls which are also located in the upper or fabricating shop, or to the power brakes or flanging department.

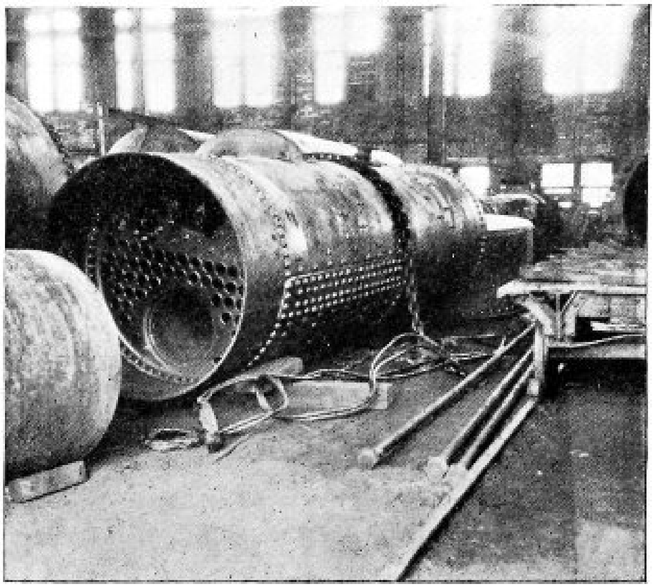
The next department to which the material is sent is either the welding or fitting-up gang; sometimes both sections being required to work on it. In the fitting-up department as much work as can be completed on the bull riveter is carried out. From here it is taken to the finishing department where for single tanks it only remains to install one head. If a closed tank, it is riveted here and the fittings and castings are attached, after which it is calked. In the



Organization chart of shop staff



Battery of large tanks in process of fabrication



Internally fired boilers are specialties of this plant

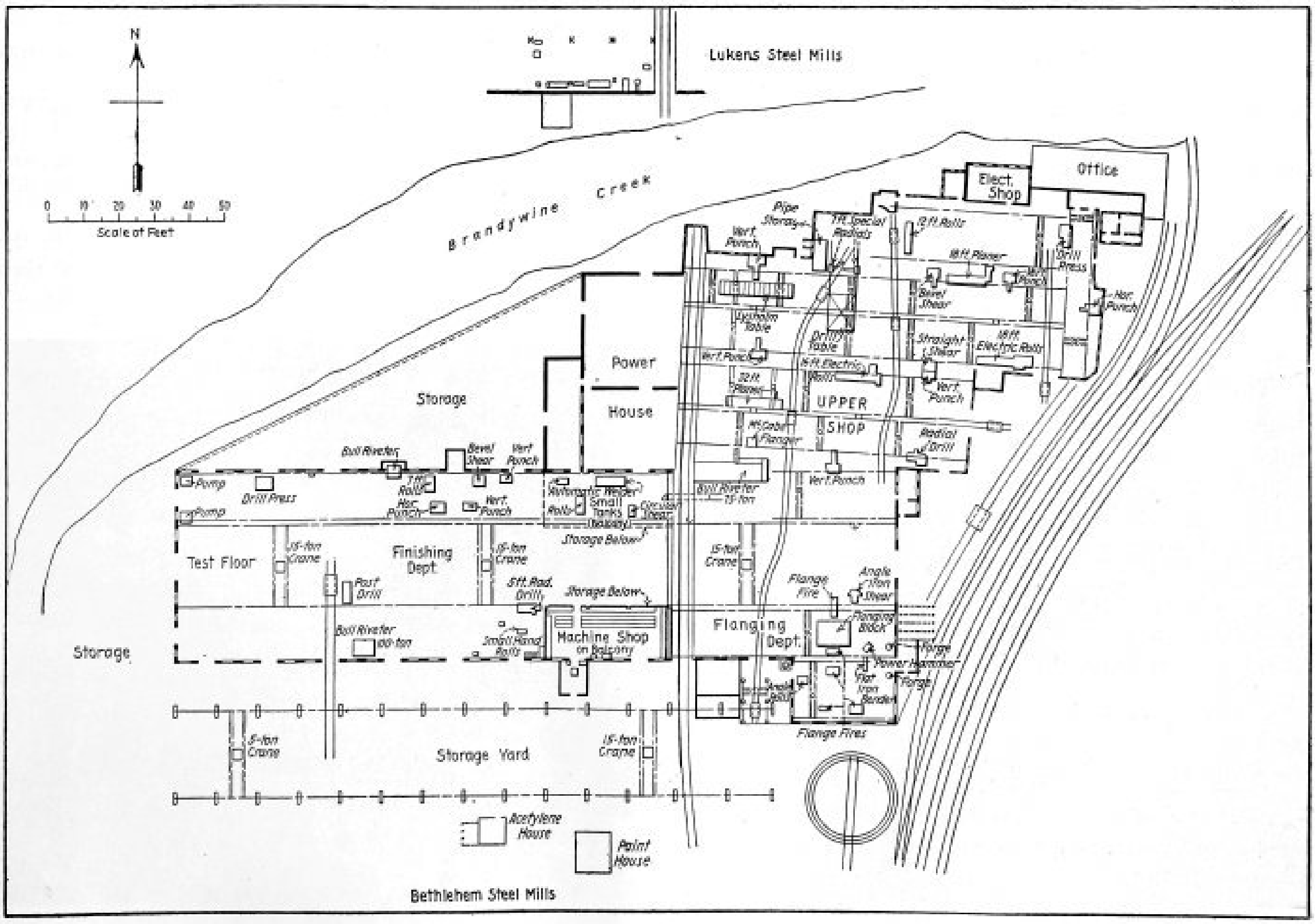
case of boilers, braces and tubes and sometimes one head are installed in the finishing department. All staybolt and complicated tank work is also done here.

Work then goes to the testing department and is subject to shop tests and the tests designated by the customer or insurance company. Finally, it comes into the hands of the painting and shipping department for final disposition.

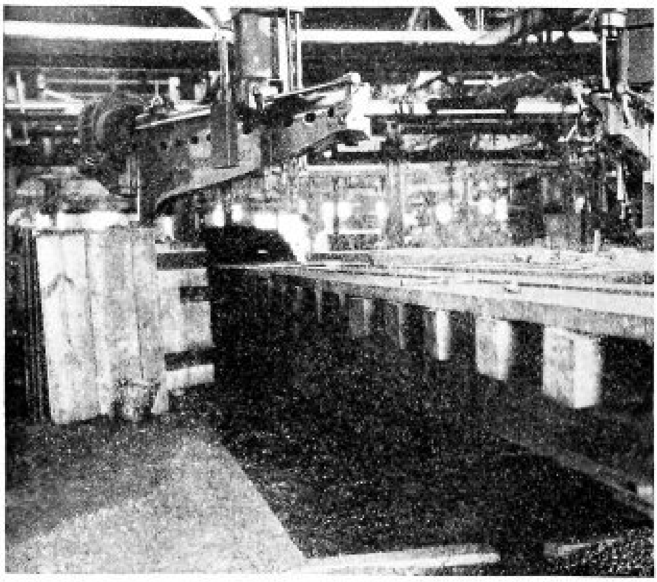
All work is subject to two or more inspections and by one or two inspectors while it is going through the ship and finally by the chief plant inspector. It is always subject to the examination of the customer's or insurance inspectors.

Welding Department

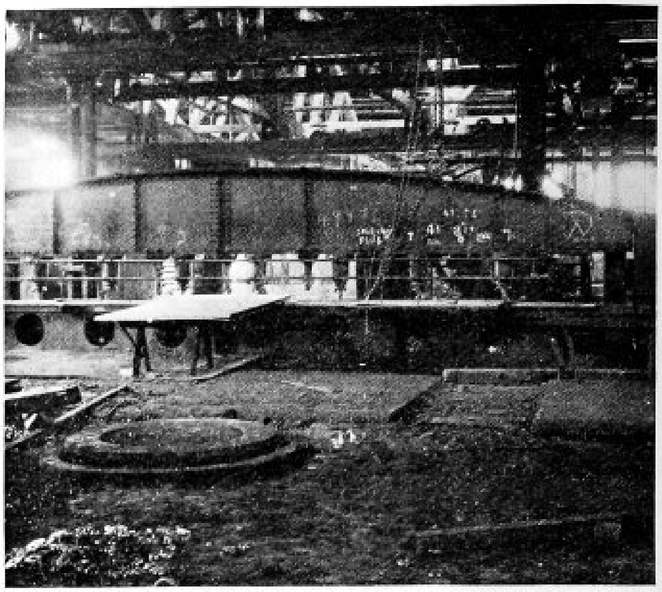
It has been stated that welding has a wider application in



Machine and floor layout of Coatesville Boiler Works



Two 7-foot radial drills help speed up production



Thirty-two foot planer with pneumatic clamps

this shop than in any other mixed shop in the east. The welding equipment includes 20 single, heavy self-contained welding machines and two automatics of General Electric and Westinghouse makes. The 22 arcs thus available are kept working night and day. Besides there is a full equipment of acetylene welding and cutting torches. A generator house is located at one side of the plant for the manufacture of all gas used here.

Although welding is not applied to meet strength requirements, it finds application wherever tightness is necessary and has in fact, practically replaced calking on tank work. In pressure work it is only used to supplement riveting where the stress is taken by bracing or other means to meet the requirements of the American Society of Mechanical Engineers. In tank work, 50 pounds is the highest pressure used although some tanks have been tested up to 1,000 pounds pressure.

In small vertical boilers built here, welding is used in the construction so that the fire door is eliminated. Tack welds are used to hold all plates in place on some heavy work instead of bolting up.

All reinforcings on the inside of a tank or boiler are welded.

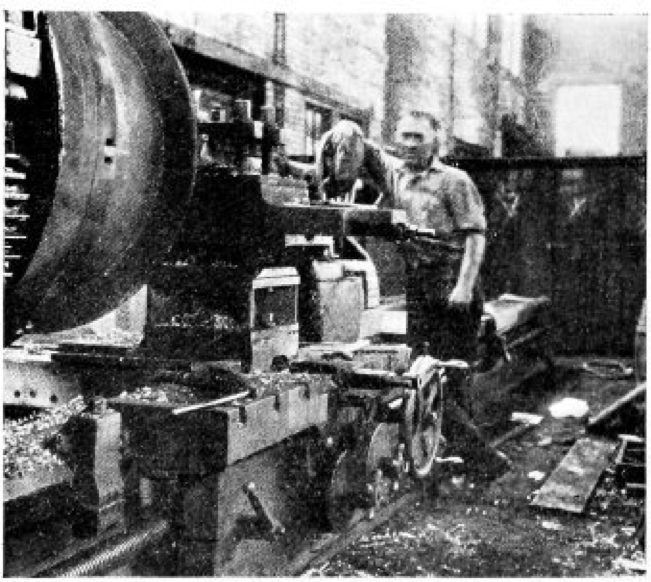
In boilers or tanks of more than one ring, instead of scarfing the straps under the outer ring, the space between the butt strap and shell is welded. The job is neater and stronger and does away with a point that was formerly very liable to corrode.

On any parts supported by staybolts such as the inner steel of a firebox where the weld will not be in tension welding is used.

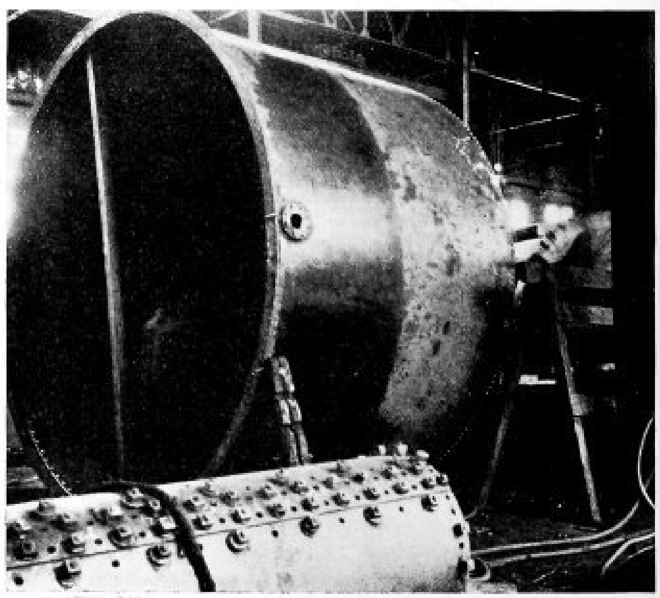
It is also used at the ends of all rings where calking was formerly employed.

Before straps are put on long seams, the plates are V'd out, welded and chipped smooth. Where false heads are used, the spaces between seams are welded, as in compartment tanks where each compartment can be made thoroughly tight by this means.

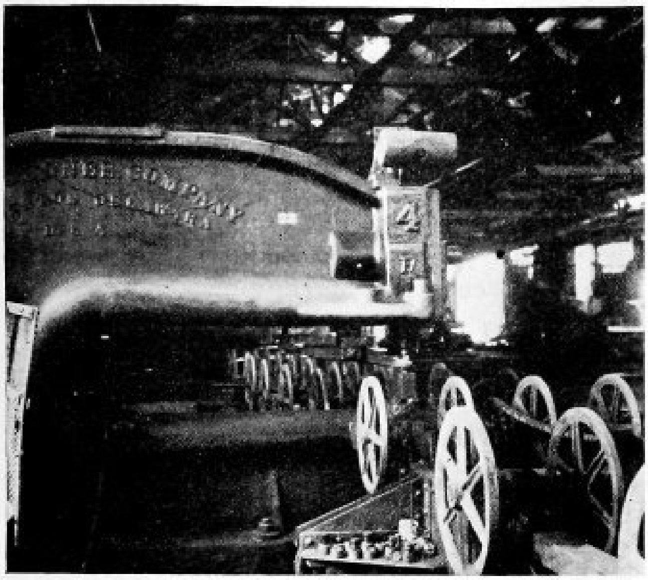
The arc is used to aid in fitting-up, for example, in the case of laying up two flanges for match marking and then drilling and reaming. This is done while the plates are



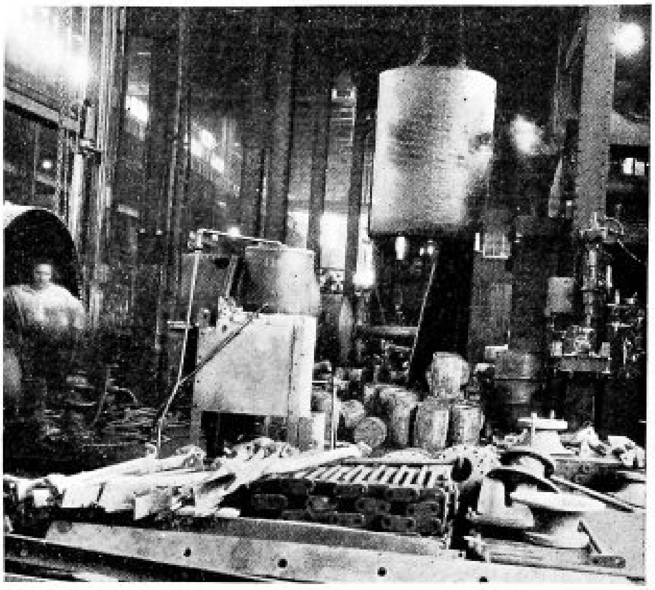
Facing off the uptake of a waste heat boiler



Section of waste heat boiler under construction



Punch equipped with Lysholm table



Bull riveter operation in fitting-up department

tacked together. After completion, the tacks can be cut and the work lined up exactly.

Where steady rests are required on large work, angles are welded in place and used for this purpose, then cut away.

The torch is used for salvaging material where holes have been punched wrong. The plates so salvaged are used in non-pressure work.

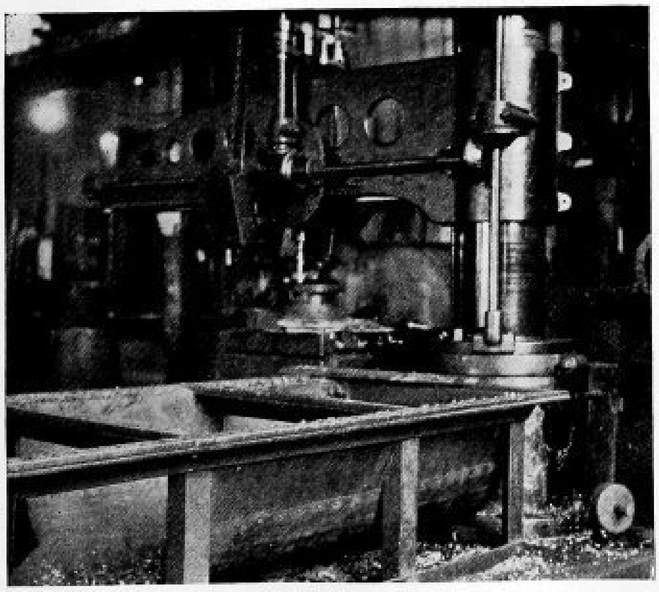
In oil tanks, less rivets are used and all the seams welded. Calking is thus unnecessary in this class of tank construction.

All inaccessible places that would be apt to leak after being in service for a while are welded—such as inside certain types of fireboxes.

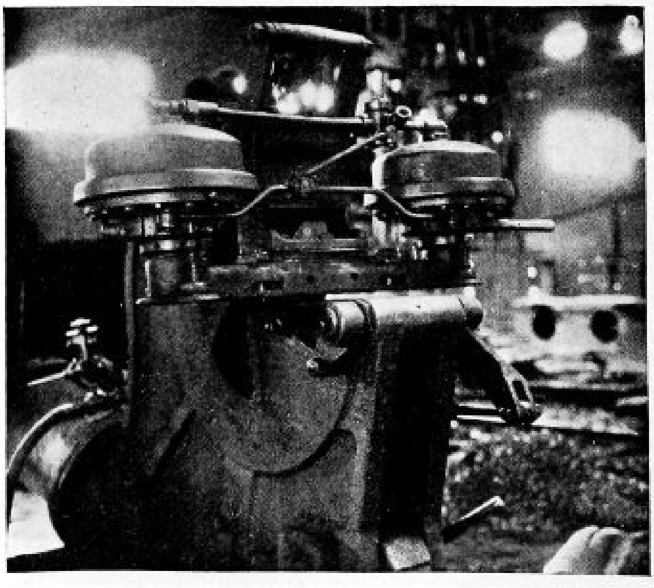
Production Department

The production department at this plant is confronted with the serious difficulty of trying to reduce individual special jobs to a production-time-basis. Extensive uniform orders, such as standard tanks, are readily susceptible to the ordinary requirements of a production scheme. The range and diversity of contracts at Coatesville offer a difficult problem to the department; however, certain elements in any job can be efficiently handled by this branch of the shop staff. For example, all estimates made by the Philadelphia office on work are submitted to the production manager for check and for his suggestions. After a contract is placed and drawings made for the job, it is again sent to him for further check and simplification, if possible. Knowing the capacity and limitations of each department in the plant, his efforts in this direction supply a contact between the theoretical design and its practical working out. After the design department has finally completed the drawings, they are put on shop order by the production department and each job split into its various component parts and order slips issued to each department that will be engaged in the work.

Three records are kept by the department; one form for material on order which is marked when finished and ready to ship; forms for the layout, punching and finishing departments and a delay sheet.



The shop is equipped to handle heavy work

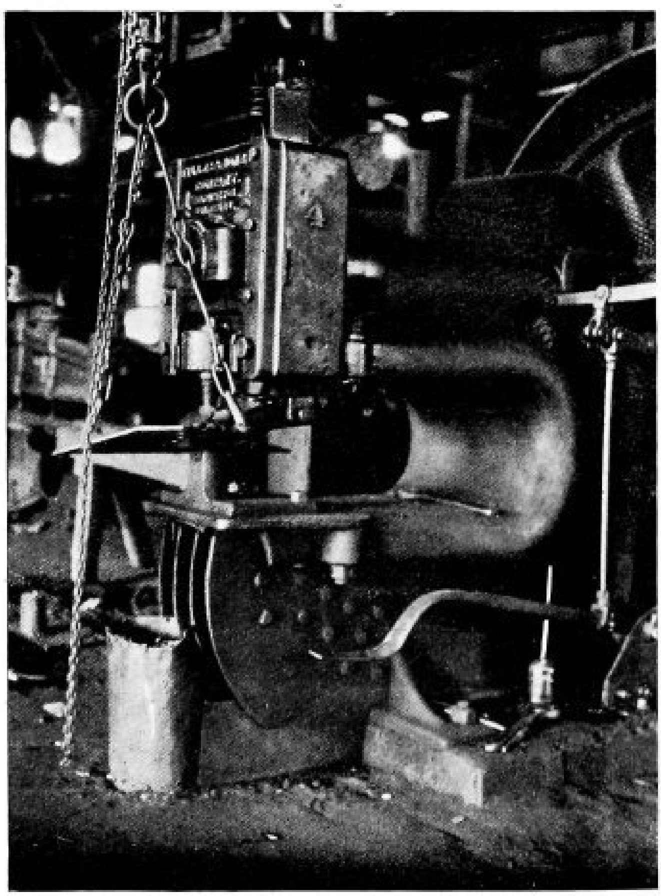


A McCabe flanger takes care of heavy flanging operations

Finished material ready for shipment

Each noon, for half an hour, the superintendent, his assistant, head of the shipping department, foreman, chief draftsman and one or two others interested, hold a get-together meeting to discuss the status of work in the shop, check up on delays in any department or material, shipping orders, etc.

Once a month, the executives of the company, superintendents, department heads, layerouts, draftsmen and a few others, hold a dinner at which current work and work in prospect are thoroughly discussed and all difficulties in the way of production and schedules ironed out and policies settled. This scheme has proved satisfactory in bringing the departments closer together.



Funches are used mainly on tank work

Trade Associations Both Legal and Desirable

ORGANIZING the units of an industry into a trade association to deal with its common problems is both legal and desirable declared E. W. McCullough, manager of the Department of Manufacture of the United States, in a recent address delivered before the Society of Brass Manufacturers in Detroit.

Decisions of Supreme Court

"Moreover," he continued, "recent decisions of the United States Supreme Court have made it clear that important information vital to the industry may be gathered and passed on by the association to its members and made available to the public without governmental interference, provided that, at all times, such information is not used any way as a vehicle for price-fixing or curtailing production."

Mr. McCullough went on to say that "the largest units in industry have their organization and equipment for gathering factual information useful for intelligent management. The smaller units, unable to finance individually the gathering of similar information, if we construe the recent Supreme Court decisions correctly, may organize an association and set up within such organization machinery for rendering a like service and without contravention of law.

"After a trial of more than a half century," he said, "the trade association has proven its worth as a medium for service to the members of an industry who, although they continue their relations as competitors, yet work together cooperatively in dealing with non-competitive problems which come before them from time to time.

"Among the studies which have profited such associations most are those relating to research, scientific and general, simplification and standardization, cost accounting, setting up qualified standards, arbitrating differences, setting up of codes of recognized trade practices, the establishment of technical schools, etc. In other words, those problems the study of which is valuable as information to the industry and the solution of trade questions, marks advancement.

"Trade associations in their early beginnings were largely organized for defensive or offensive purposes—a sort of protective agency—while today the objectives of the modern trade association are largely, if not altogether, for the enlightenment and progress of the industry rather than for direct personal benefit of its members.

"The Chamber of Commerce of the United States, whose constituent membership represents so large a percentage of trade associations, has continually given attention to the problems and the progress of these associations and has rendered most valuable aid in working with the Government for a better understanding as to what they might or might not do.

Cooperation of Department of Commerce

"In the Referendum of the Chamber on trade association activities it frankly placed before the business organizations of the country, eight questions relating to vital issues and received the unanimous endorsement of the position taken concerning them. This position has been confirmed as correct in the Supreme Court decisions recently delivered."

"It is well to keep in mind," Mr. McCullough suggests, "that the decisions referred to change no laws and give no greater liberty to associations than before, but they do make clear the fact that many activities in which trade associations generally desire to engage are not in themselves under ban of law, and if they are used intelligently and for the common good and not to create restraints in trade, there will be no interference with them."

Guarantees on Boiler Performance*

Author proposes that guarantees be based on ratio of pounds of steam produced to pounds of combustion gases supplied

By William H. Jacobi†

THE proposition of making guarantees on boiler performance has long been considered and the general conclusion arrived at that no sound guarantees could be made, and any guarantees that might be given meant nothing. Still, in the process of purchasing boiler equipment, guarantees on its performance are demanded. Usually no conditions are stipulated, scarcely, if ever, the fuel to be used is mentioned, and a great deal is taken for granted.

Within the very recent past, we have learned more about boiler operation and fire than in all the former years back to the eventful days when the first steam boiler was made. We have accomplished much in the attainment of efficiencies, superior fuel burning equipment, excellence in boiler designs, better understanding about stacks (though not so much concerning the significance of draft) and of the value of measuring instruments, but we still have the irrelevant boiler horsepower, factors of evaporation, catechisms of rules and of "don'ts," the "percents of rating" as a measure of boiler capacity, and not yet has even a definition of the determinants of boiler performance been given, to say nothing of the basis for making guarantees to cover same. In this respect, all we have is a free for all method of making assumptions, taking a great deal for granted under cover of conventions and opinions. The result is that often the steam producing equipment, and usually the boilers and the superheaters get the brunt of it, does not function as anticipated and in consequence the manufacturers are unfairly penalized.

In many instances, guarantees as to the performance of the boiler proper, such as exit gas temperatures, are required from and given by the manufacturer of fuel burning equipment, the absurdity of which is obvious. The peculiar part of this procedure is that the manufacturer of fuel burning equipment either secures his information from the boiler manufacturer or makes his own thereby leading to vexing complications.

Methods of Measuring Boiler Performances Out of Date

Briefly, the truth back of this situation is that our methods of measuring performance of steam producing equipment have not kept pace with the progress made in the development of the equipment itself and of other power equipment, and we are limping along under the burden of technicalities and hereditary uncertainties of the past.

Formerly, when the name "boiler" meant the entire contrivance from ash pit to stack supplied by one man and boilers seldom operated at more than the so called "rating," steam pressures were low, superheat not generally understood, water rates for engines were high and fuel and labor cheap, guarantees could be made without a murmur; the unknown margin of safety afforded generous protection for wild guesses, and the circumstances permitted the construction of a working whole which concealed its shortcomings and often exceeded its expectations. But nowadays when the fuel burning equipment, the boiler itself, the superheater, the stack, etc., even though they are intended to be parts of a whole, are each supplied by different trades, what means have we to tie them into a consistent working unit and guarantee its performance?

The Input-Output Measure of Economy

Not long ago, based on the commercial input-output method of gaging economy and production, the quantity of fuel burned per unit area of grate was regarded as a fair measure of capacity and performance. This was followed by its near equivalent "pounds of fuel per developed boiler horsepower." The fallacy of this method is self-manifest. Costly experience not only revealed that a pound of coal was not a pound of fuel, but in succeeding steps indicated that the rate of burning fuel per unit grate area or furnace volume was not so much the index of good performance and economy as to burn it properly; along this line of thought, the highest degree of perfect combustion gaged by the amount of carbon dioxide contained in the resulting gases was and still is looked upon as the index of good over-all performance. Further experience confronts us with the fact that a high proportion of CO_2 produced in the combustion gases may not only result in poor economy but, under particular conditions in bad performance. From these considerations, the question again arises, what then shall be the measure of boiler performance and what the guarantees?

The laborious task of selecting boilers for any one particular installation reflects only too clearly the awkwardness of our present methods, and it is to be remarked with a sense of kindly warning rather than with satisfaction that we are fortunate in not having worse difficulties than we have often had to remedy.

Sooner or later for our convenience and to facilitate keeping pace with our progress in other channels, we are bound to change and conventionalize our methods of measuring boiler performance, if we must endure with comfort the exacting demands of impending future requirements. Heretofore, the difficulty in taking a step in that direction seems to have centered on the diversity of varying conditions attending the combustion of available fuels. Observations in the performance of well operated boilers reveal, however, that the heating difficulty is more apparent than real, and rather than the nature of fuels incident to the intricacies of their combustion we are to be concerned more with the development of suitable means to burn them properly. No doubt there are other factors which must be considered to fulfill the requirements of each particular case, but within the range of practical results as obtained today the variations that seemed unsurmountable become insignificant by comparison and as regards their effects on the actual performance of the boilers are negligible.

Guarantee Based on Heating Value of Fuel Fallacious

On the basis of heating value, to say that with so much fuel we shall or ought to produce so much steam is obviously irrelevant and a promise on which no guarantee can be given since fuel may be burned very completely under a boiler and fail to produce the anticipated results, without this outcome being a fault of the boiler, possibly not

* Paper read before American Boiler Manufacturers Association, Watkins, N. Y., June, 1925.
† Springfield Boiler Company, Springfield, Ill.

TABLE I—COMPOSITION OF TYPICAL COMMERCIAL FUELS (AS RECEIVED OR AS FIRED), THEIR HEATING VALUE AND THEORETICAL (100 PERCENT) AIR REQUIREMENTS FOR THEIR COMBUSTION.

Fuel No.	Kind of fuel	Composition per lb. fuel in percent: C	H	O	S	Ash	Percent moisture	B.t.u. per lb. as fired	100 percent air per lb. of fuel as fired: lb.	Cu. ft. at 60° F.
1	Low grade lignite	39.4	6.8	43.8	.7	9.3	36.2	6,600	5.0	65.5
2	High grade lignite	57.8	6.0	31.0	.4	4.8	20.7	9,940	7.5	98.0
3	Low grade bitum.	60.9	5.8	19.2	3.7	10.4	12.7	10,990	8.4	110.0
4	Medium grade bitum.	70.5	5.4	11.2	2.9	10.0	5.2	12,735	9.7	127.0
5	High grade bitum.	75.7	5.4	10.3	1.2	7.4	3.5	13,700	10.3	135.0
6	Low grade semi-bitum.	80.7	4.3	3.2	1.4	10.4	1.2	14,096	10.8	141.5
7	High grade semi-bitum.	84.3	4.7	5.2	.7	5.1	3.1	14,688	11.2	146.5
8	Average anthracite	75.2	2.8	4.1	.8	17.1	2.1	12,472	9.6	125.5
9	Average fuel oil	86.7	11.8	0.5	1.0	0.0	1.0	18,570	14.1	184.5
10	Natural gas	$98.2\ CH_4 + .1\ C_6H_6 + .25\ CO + .25\ O_2$						21,300	17.0	223.0
11	Average coke oven gas	$6\ CO + 42\ H_2 + 34.3\ CH_4 + 2\ C_2H_4 + 2\ C_6H_6 + 1.1\ O_2 + 2.6\ CO_2 + 10\ N$						14,384	11.35	149.0
12	Average producer's gas	$14.34\ CO + 2.8\ H_2 + 5.56\ CH_4 + .1\ O_2 + 10.5\ CO_2 + 66.7\ N_2$						1,397	.92	12.1

even of the attending operating skill. If we observe a properly operated boiler setting, specially a well designed one, we can not help being impressed with the uniformity of the fire and of the distribution of gases within the furnace, which condition reveals at once not only thorough combustion but, without question, thoroughly mixed and uniformly heated gases before entering the boiler. Guided by the results, under such conditions which approximate our theoretical anticipations, no doubt guarantee on the performance can be safely given. Accordingly, on the input-output basis with relation to the boiler proper, to state that with a certain rate of combustion gases containing the available heat of the fuel burned, flowing through the passes of a boiler and a certain amount of steam may be produced is not only consistent with the facts, but a surer measure of performance and by far a better basis on which to make guarantees. On this point, it is pertinent to state that as a practical proposition for all cases it is hopeless ever to expect similarity of results or anywhere near 100 percent uniformity in the rate of flow or in the heat content of the gases of combustion; nevertheless an average rate of uniform flow and of heat content of combustion gases is not only possible but easily obtainable for all kinds of commercial fuels.

The accompanying tables have been prepared to illustrate the heat conditions exhibited by gases of combustion of a wide selection of typical commercial fuels. Table 1 shows the composition and corresponding heating value of the

TABLE II.—HEAT CONTENT AND QUANTITY OF GASES RESULTING FROM THE COMBUSTION OF TYPICAL COMMERCIAL FUELS WITH VARYING AMOUNT OF AIR SUPPLY

Fuel No.		Values	Percent Combustion Air: 100	120	140	160	180	200
	a	lb. air	5.0	6.0	7.0	8.0	9.0	10.0
1	b	lb. comb. gases	5.9	6.9	7.9	8.9	9.9	10.9
	c	cu. ft. comb. gases	65.5	78.7	91.8	105.0	118.0	131.0
6,600	d	B.t.u. per lb. comb. gasas	1,120	956	835	742	666	605
B.t.u.	e	B.t.u. per cu. ft. comb. gases	101	84	72	63	56	50
	a	lb. air	7.50	9.00	10.50	12.00	13.50	15.00
2	b	lb. comb. gases	8.45	9.95	11.45	12.95	14.45	15.95
	c	cu. ft. comb. gases	98	117.7	137.4	157	176.5	196
9,940	d	B.t.u. per lb. comb. gases	1,180	1,000	870	768	688	623
B.t.u.	e	B.t.u. per cu. ft. comb. gases	101.5	85.2	72.3	63.4	56.4	50.7
	a	lb. air	8.4	10.1	11.77	13.45	15.15	16.8
3	b	lb. comb. gases	9.3	11.0	12.7	14.35	16.05	17.7
	c	cu. ft. comb. gases	110	132	154	176	198	220
10,900	d	B.t.u. per lb. comb. gases	1,180	1,000	865	765	685	620
B.t.u.	e	B.t.u. per cu. ft. comb. gases	100	83.3	71.5	62.5	55.5	49.7
	a	lb. air	9.7	11.65	13.6	15.5	17.5	19.4
4	b	lb. comb. gases	10.6	12.55	14.5	16.4	18.4	20.3
	c	cu. ft. comb. gases	127	152.5	178	203	229	254
12,735	d	B.t.u. per lb. comb. gases	1,200	1,012	875	775	690	625
B.t.u.	e	B.t.u. per cu. ft. comb. gases	100	83.5	71.4	62.5	55.5	50
	a	lb. air	10.3	12.35	14.4	16.5	18.5	20.6
5	b	lb. comb. gases	11.22	13.27	15.32	17.42	19.42	21.52
	c	cu. ft. comb. gases	135	162	189	216	243	270
13,700	d	B.t.u. per lb. comb. gases	1,220	1,035	894	786	705	637
B.t.u.	e	B.t.u. per cu. ft. comb. gases	102	84.5	72.5	63.5	56.5	50.8
	a	lb. air	10.8	12.95	15.1	17.3	19.5	21.6
6	b	lb. comb. gases	11.7	13.85	16.0	18.2	20.4	22.5
	c	cu. ft. comb. gases	141.5	170	198	226	254	283
14,100	d	B.t.u. per lb. comb. gases	1,205	1,015	878	772	690	625
B.t.u.	e	B.t.u. per cu. ft. comb. gases	99.5	83	71	62.5	55.5	49.8
	a	lb. air	11.2	13.45	15.7	17.9	20.2	22.4
7	b	lb. comb. gases	12.15	14.4	16.65	18.85	21.15	23.35
	c	cu. ft. comb. gases	146.5	175.8	205	234	264	293
14,700	d	B.t.u. per lb. comb. gases	1,210	1,020	885	780	695	630
B.t.u.	e	B.t.u. per cu. ft.	100	83.5	71.7	63	55.7	50
	a	lb. air	9.6	11.52	13.45	15.36	17.30	19.2
8	b	lb. comb. gases	10.45	12.37	14.3	16.4	18.15	20.05
	c	cu. ft. comb. gases	125.5	151	176	201	226	251
12,500	d	B.t.u. per lb. comb. gases	1,200	1,010	875	763	675	625
B.t.u.	e	B.t.u. per cu. ft. comb. gases	99.5	83	71	62.4	55.4	49.8
	a	lb. air	14.1	16.9	19.75	22.55	25.4	28.2
9	b	lb. comb. gases	15	17.9	20.75	23.55	26.4	29.2
	c	cu. ft. comb. gases	184.5	221.5	258	295	332	369
18,600	d	B.t.u. per lb. comb. gases	1,240	1,040	895	790	705	637
B.t.u.	e	B.t.u. per cu. ft. comb. gases	101	84	72.4	63	56	50.5
	a	lb. air	17	20.4	23.8	27.2	30.6	34
10	b	lb. comb. gases	18	21.4	24.8	28.2	31.6	35
	c	cu. ft. comb. gases	223	268	312	357	401	446
21,300	d	B.t.u. per lb. comb. gases	1,185	995	858	755	675	608
B.t.u.	e	B.t.u. per cu. ft. comb. gases	95.5	79.5	68.3	59.7	53	47.7
	a	lb. air	11.35	13.6	15.9	18.2	20.4	22.7
11	b	lb. comb. gases	12.35	14.6	16.9	19.2	21.4	23.7
	c	cu. ft. comb. gases	149	179	209	238	268	298
14,400	d	B.t.u. per lb. comb. gases	1,170	985	852	750	674	608
B.t.u.	e	B.t.u. per cu. ft. comb. gases	96.5	80.5	69	60.5	53.8	48.4
	a	lb. air	.92	1.105	1.29	1.47	1.66	1.84
12	b	lb. comb. gases	1.92	2.105	2.29	2.47	2.66	2.84
	c	cu. ft. comb. gases	12.1	14.5	16.9	19.4	21.8	24.2
1,400	d	B.t.u. per lb. comb. gases	730	665	636	567	526	493
B.t.u.	e	B.t.u. per cu. ft. comb. gases	115	96.4	82.8	72.8	64.2	57.8

fuels selected. Table II is a tabulation giving the combustion data for the same fuels with varying amount of air from theoretical requirements to 200 percent of those requirements. Fig. 1 shows in the form of curves the heat values per pound and per cubic foot indicated on Table II. In each case, the curves are drawn double to indicate the high and low limits determined by computation. A third broken-line curve interpolated between the other two is also drawn to represent probable average conditions.

Without going into laborious technical details, the closeness of the results obtained may be taken as an index of uniform heating quality for all commercial fuels with relation to the gases produced and corresponding amounts of air supplied. Besides the closeness of the heating values so obtained for all fuels, the interesting part of the curves so drawn is that they afford a guide to better judgment in estimating the gas conditions likely to develop under particular curcumstances applicable to the performance of boilers within the limits indicated by the high and low lines which may be considered as the limits of permissible tolerance for the results expected from any fuel.

Rate-of-Gas-Supply Measure of Performance

All of us who have had anything to do with figuring out combustion data as applied to boiler performance have recognized the value and convenience of dealing directly with the quantity of gases produced by the combustion of fuels, conceiving that they flow uniformly through the boiler passes, instead of pounds of fuel and again transposing in terms of percent of boiler rating. To state boiler performance in terms of uniform flow of combustion gases containing a certain amount of heat value would not only simplify matters and serve to line up all the component parts of a boiler setting into a consistent working whole but it would have the advantage of being of material assistance in better understanding the function of each component part and in the solution of many problems as well.

The mooted question of furnace design and proper proportioning of stacks will be greatly clarified by the adoption of this "rate-of-gas-supply" measure of performance. Just recently we have begun to measure the merits of furnace operation by the volume per pound of fuel burned or per boiler horsepower developed which admittedly is too arbitrary and irrelevant. The function of a furnace in conjunction with fuel and air feeding equipment as a producer of properly blended gases suitable for boiler operation has not yet been so stated, and with some confidence it may be said that it is not so understood. In general, it is conceded that a stoker or an oil spraying nozzle or a gas jet under the name of "burners" is to be credited with the burning of fuels, the furnace being only an accessory. If, instead of just burning or passing through so much fuel per unit grate area or nozzle or jet, the combined fuel feeding devices and furnace are required to deliver uniformly so many pounds of properly burned gases containing the highest amount of heat value possible, it is unquestionable that we will soon obtain better performances, reliable guarantees and greater compensation for our efforts.

Stacks are another lot of appurtenances suffering from our arbitrary methods of measurement. It is needless to say that many of our bad boiler performances and troubles are due to inadequate draft which invariably reflects poor stack proportions or arrangement. If stacks were designed on the "per-pound-rate-of-gases" produced with relation to the load they must serve, we would soon appreciate the folly of connecting four or more boilers to one stack and expect to operate one boiler with high degree of satisfaction when the other three boilers are down, or operating boilers at nominal rating with a stack designed to take care of 300 percent rating conditions.

Briefly, there is no end to the benefit that may be derived from employing this "per pound rate of combustion gas supply" as the index of boiler performance. More than this, it will furnish within the small margin of tolerance indicated by the high and low curves in Fig. 1, a reasonable basis for demanding and making commercial guarantees. In conclusion, it is to be stated that:

a. Our present methods of determining boiler performance and of making guarantees thereon are loose and inconsistent.

b. If guarantees must be made to cover the merits of boiler equipment, of necessity we must have a consistent

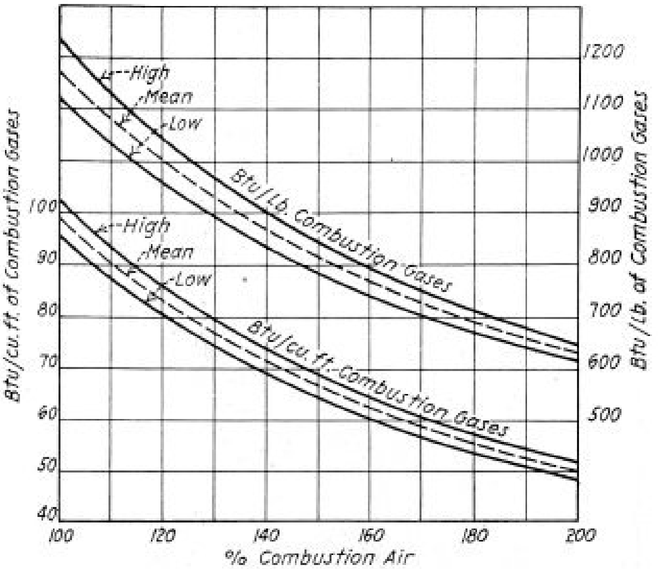


Fig. 1.—Heat value per pound and cubic foot indicated in Table II

working plan on which to base these merits and corresponding guarantee.

c. In view of the foregoing considerations and to safeguard the interests of the boiler manufacturers as well as an item of progress, subject to discussion and approval by this association, the following recommendations are made:

1. That the determining factor of boiler performance be the rate of uniform supply of combustion gases by weight containing definite heat value per pound or per cubic foot corresponding to the best combustion conditions obtainable for all fuels;

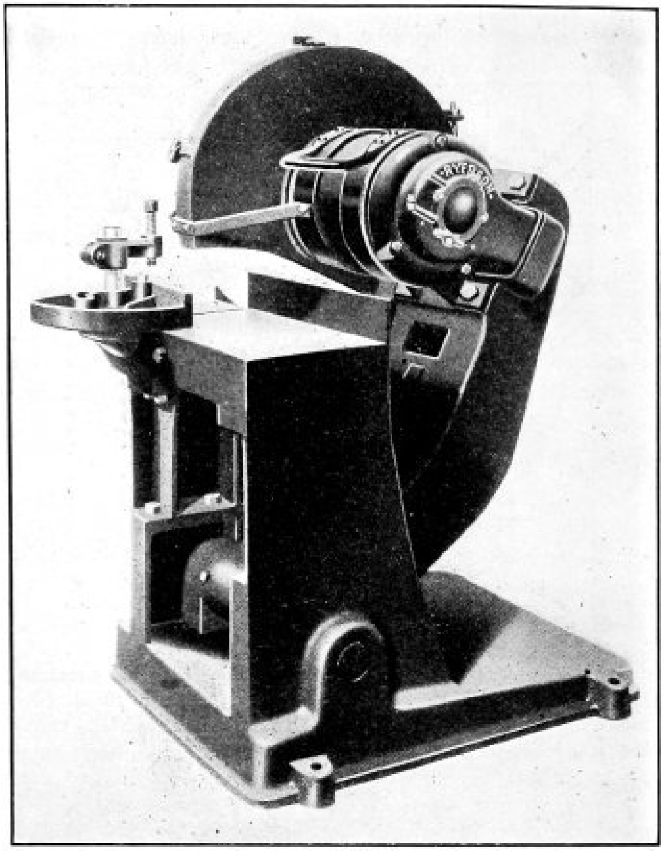
2. That in stating boiler performance the ratio of the heat transferred to the steam produced, above the temperature of boiler feed, to the heat contained by the amount of gases supplied to the boiler above boiler room temperature—or briefly, pounds of steam produced per pounds of combustion gases supplied—replace the boiler horsepower developed per pound of fuel burned, and

3. That guarantees on boiler performance be made on the basis of the above ratio, with tolerances allowed to cover the variations inherent to the nature of the fuels used.

Local and Assistant Inspector of Boilers.—Receipt of applications for positions of local and assistant inspector of boilers and the local and assistant inspector of hulls in the Steamboat Inspection Service will close on August 29. The entrance salaries are from $2,700 to $3,600 a year, depending upon the qualifications of the appointee as shown in the examination, and the duty to which assigned. Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of United States civil service examiners at any postoffice or customhouse.

High Speed Friction Saw Developed by Ryerson

JOSEPH T. RYERSON & SON, INC., Chicago, has placed on the market a small friction saw to meet the requirements of shops where small bars, structural shapes, pipe and round sections must be cut for fabrication. It occupies a space of only 28½ inches by 36 inches and is compact and small enough so that it can be easily moved



Ryerson's new high speed friction saw

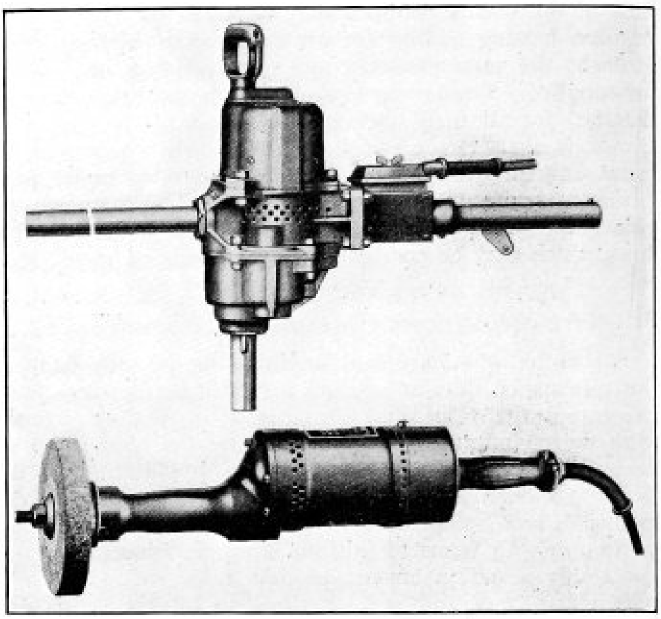
about for special jobs or to meet conditions that are continually arising in modern shops. It has a capacity for cutting 8-inch by 25½-pound I-beams, 8-inch channels, 4-inch pipe, 1½-inch round sections and 1¼-inch square sections.

This new saw, size No. O, operates on exactly the same principle as the larger sizes made by the company, gives a perfectly true cut without distortion and will cut 1½-inch rounds in one-fourth of a minute and 8-inch by 25½-pound I-beams in a fraction over a minute. The saw blades are 24½ inches by ¼ inch and are mounted direct on a 10 horsepower ball bearing high torque motor built specially for friction saw duty. The blade is fed into the stock by hand. The blade may be water-cooled if desired depending upon the size of the sections to be cut.

Induction Motor Applied to New Electric Reamer and Grinder

ELECTRIC reamers and grinders, incorporating the advantages of induction motor drive, are now being produced by the Chicago Pneumatic Tool Company, Chicago, Ill., under the name of Little Giant "Hicycle" tools. The development of these tools was brought about through the trade requirements which call for electric tools with more power, less weight and greater durability.

It is stated that induction motors which operate on 2 or 3 phase alternating current require less attention than the equivalent direct current motor due to the absence of commutator and brushes as well as to the more constant speed; in addition, the secondary element, usually the rotor in the induction motor, cannot be burned out. These advantages of the induction motor are applied to small motors of this



Little Giant "Hicycle" reamers and grinders are driven by electric induction motors

type used in portable electric tools. The chief drawback in the past has been that on standard power lines when 60 cycle current is available the maximum rotor speed is 3,600 revolutions per minute whereas on direct current much higher speeds are possible and common. The Chicago Pneumatic Tool Company in the new "Hicycle" tools has not only overcome this drawback but has carried the advantages to a point where greater speed, more power, less weight and rigidity of construction exceed these features in direct current tools.

In order to operate the "Hicycle" tools, a special generator is required to furnish the current of 180 cycles, 220 volts, 3 phase which has been adopted as standard. This frequency lends itself readily to 60 cycle induction motor drive, being a multiple of 60 cycles, so that direct connected generator sets can be supplied economically.

OBITUARY

WILLIAM O. DUNTLEY, former president of the Chicago Pneumatic Tool Company and later head of the W. O. Duntley Company, recently died at a sanatorium near Chicago to which he went after a breakdown several months ago. Mr. Duntley was fifty-eight years old at the time of his death. He was born in Wyandotte, Mich., and educated in the schools of Detroit. Going to Chicago in 1894, he became a salesman for the Chicago Pneumatic Tool Company. Through a series of steady promotions he became general sales agent, vice president, a director and general manager and in 1909 he succeeded his brother, J. W. Duntley, as president.

Modern Locomotive Developments*

Mechanical Division, American Railway Association, discusses boiler problems at June meeting

Standardization of Water Columns

THE Committee, after giving careful consideration to this subject, make the following recommendations for future installations:

1. All water columns and water glasses must stand vertically.

2. Water column should be not less than 3 inches inside diameter and of sufficient length to accommodate length of water glass required for the operating conditions and to have a clear opening for top connection of not less than $1\frac{1}{2}$ inches inside diameter and be connected to boiler with not less than $1\frac{1}{2}$ inches outside diameter copper pipe, tapped into boiler on top center or in a location not farther to the side than 9 inches and not nearer than 9 inches to the inside edge of back head seam.

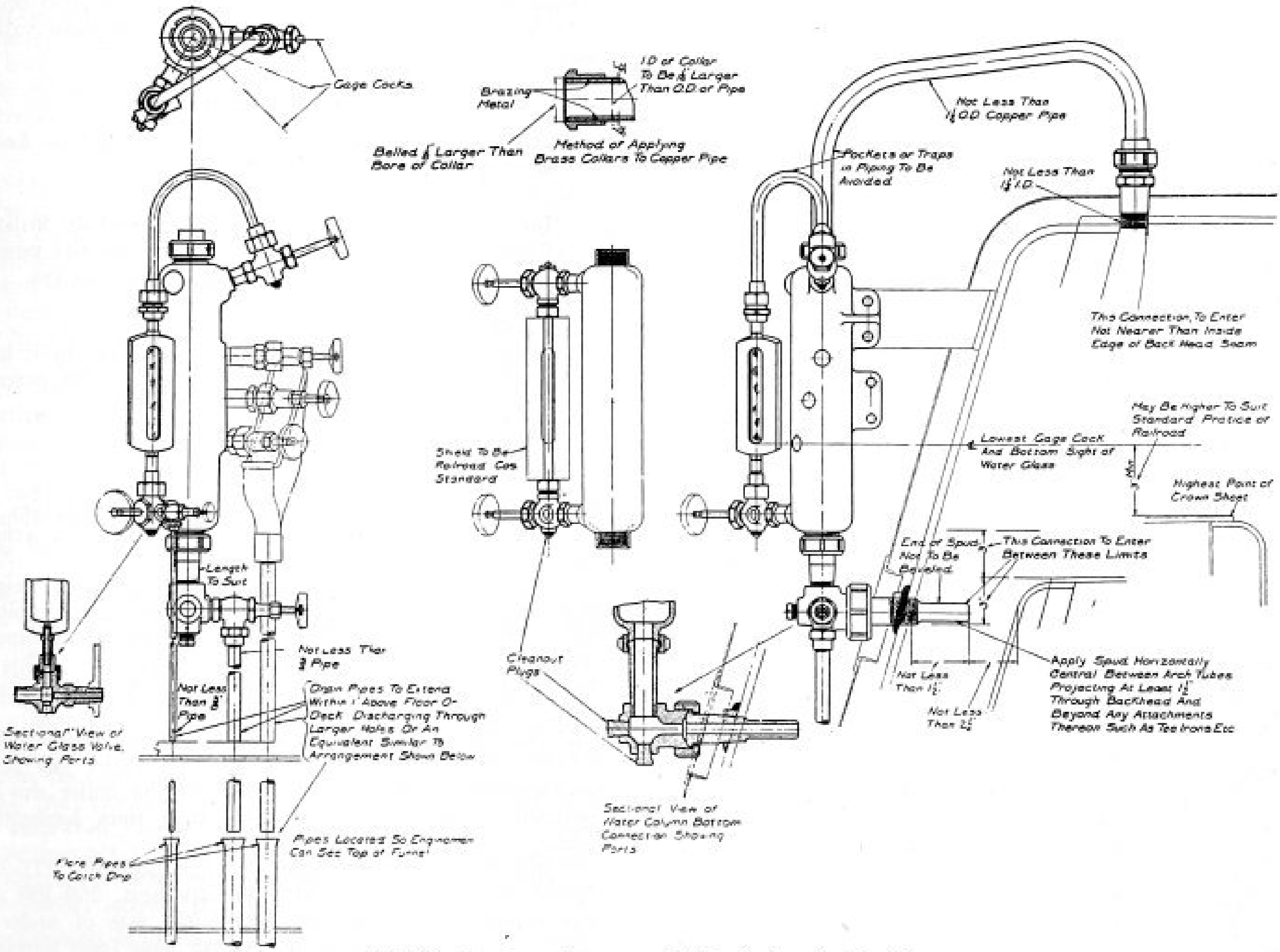
3. Top spud connection standard in boiler to be not less than $1\frac{1}{4}$ inches inside diameter.

4. Bottom end of column, to provide for vertical range in location, should be supported and connected to boiler with heavy cross connection and spud with clear straightway bored port $\frac{3}{4}$-inch diameter, with cleaning plugs located opposite horizontal and vertical ports. Spud should be of forged steel or bronze of ample strength to carry the weight of column and attachments.

5. Bottom water column vertical connection to be not less than $1\frac{1}{4}$ inches inside diameter, preferably larger.

6. Back head of sloping type may be reinforced with open hearth steel bevel washer welded in place to provide horizontal application of bottom spud.

7. Bottom spud must not be located in radius or knuckle of back head flange or immediately above arch tube opening.



Details of water columns applied to boiler backhead

8. Inner end of bottom spud must extend not less than $1\frac{1}{2}$ inches through the back head and beyond any attachments thereon, such as tee, angle iron, boiler braces, etc., to avoid location within water eddy or pocket where water may dam up.

9. Inner end of spud must not extend to or be less than $2\frac{1}{4}$ inches from firebox door sheet and be located in a vertical range between 3 inches below and 3 inches above the back end of firebox crown sheet.

10. Water column, vertical location, must be at such a height that the lowest gage cock attached therein, and the lowest visible reading of water gage shall be not less than

*Abstract of section committee reports and discussion that pertain to the field covered by readers of THE BOILER MAKER.

3 inches above the highest part of the crown sheet and may be located higher, to suit the standard practice of any railroad.

11. Bottom connection of water column must be equipped will not less than 3/4-inch drain pipe and valve (preferably one-inch), which can be easily opened and closed by hand, so that the water column and connection may be frequently blown out. The drain pipes should be well braced and extend separately to within one inch of the cab floor or deck, and discharge the waste steam or water through a hole, slightly larger than the diameter of the pipe, or an equivalent arrangement whereby the leakage discharged through these pipes may be observed above the deck.

12. Water columns should be located well toward center of back head of boiler to afford protection and to avoid violent fluctuation of the water while rounding curves. Extension handles to be applied to gage cocks when necessary, so as to bring them within easy reach of the engineman.

13. Gage cocks must be not less than 1/4 inch inside diameter.

14. Top end of water column to be securely braced to back head with a brace sufficiently heavy to carry the weight of column and overcome vibration.

15. Water column to be equipped with one water glass and three gage cocks.

16. Lowest reading of water glass to be on line with center of lowest gage cock.

17. Water glass of Klinger or other Reflex type should have stems not less than 5/8 inch outside diameter and 3/8 inch inside diameter.

18. Tubular glass when used to be 5/8 inch outside diameter.

19. Top and bottom pipe connection to water column and water glass must be applied without gaskets.

20. Water glass steam pipe connection not less than 1/2 inch outside diameter, preferably 5/8 inch outside diameter.

21. Water glass Klinger or Reflex type top and bottom valve connection bore 3/8 inch diameter.

22. Water glass tubular type top and bottom valve connection bore not less than 1/4 inch, preferably 5/16 inch.

23. Water glass vision not less than 6 inches, preferably 8 inches, depending on operating conditions.

24. Tubular type water glass when used must be equipped with a removable safety shield which will prevent glass from flying in case of breakage.

25. Water glass must be so located and maintained as to be quickly observable by enginemen.

26. Water glass must be equipped with bottom blowout valve and pipe not less than 3/8 inch diameter.

27. Steam pipes to be applied without sharp bends or pockets and provided with ball joint connections and belled at least 1/8 inch in diameter at end in bracing collar.

28. Application is shown by drawing, Fig. 1.

Note: After the above report was agreed to by the full committee, suggestion was later made by the Chairman of the Sub-Committee to add the following to items No. 21 and No. 22:

> "And bottom connection provided with cleaning plug located opposite vertical port and side outlet for the blow off pipe connection."

This suggestion was submitted to members of the full committee by letter, and majority have approved it, and the suggestion is, therefore, added to the report in this manner for consideration.

Locomotive Development

It must be apparent to most railway men that during the past few years there has been a remarkable reawakening of interest in increasing the efficiency of the modern locomotive, with two main objects in view—first: fuel economy; and second: increasing the utility of the machine.

While this movement is attributed by some to the demands of the general public, it is our opinion that it has been brought about by the absolute necessity of improving the locomotive to meet changing conditions of traffic and to keep pace with the great improvements in roadway, terminals and general industrial developments. Coincident with this, great interest has been aroused in fuel saving devices due to the great increase in fuel costs, forcing engineers, particularly in foreign countries, to investigate the possibilities of the turbine and internal combustion locomotive. These developments and the building of very heavy electrical locomotives have served as a means of advertising the shortcomings of the steam locomotive, unjustly, thereby preventing to a great extent, a realization of what is being done to increase the efficiency of orthodox types of steam locomotives.

It is mainly for this reason that in the following subdivisions of this paper we briefly summarize progress being made in steam locomotive development along conservative lines:

The Steam Locomotive

(A) *Major Improvements to Ordinary Designs of Locomotives.*

Briefly listed these are:

1. Increased boiler capacity and pressure, and the utilization of this capacity by auxiliaries to increase tractive power.
2. Regulation of cut-off by positive or other means.
3. The three-cylinder engine.

A (1) *Increased Boiler Capacity.*

Comparatively few years ago most locomotives built had boilers which are today termed 85 percent or 90 percent using the simple formula:

$$\frac{\text{Boiler H. P.}}{\text{Cylinder H. P.}}$$

the two factors being determined by empirical tables of evaporative values of firebox, flues, etc., based on actual tests.

Today, in the efficient locomotive, all saving in weight due to improvement in materials is being put into the boiler, with the following direct result: Development of maximum power without abnormal rate of fuel consumption. This is only possible by large firebox capacity as evidenced in recent designs of freight locomotives.

It also seems evident that the use of large diameter tubes and type "E" superheater throughout the entire gas area, has increased the evaporative value of the boiler due to improved circulation to a greater extent than locomotive builders' tables would indicate.

Combining this with moderately high pressure, 225-250 pounds per square inch, and high superheat, 250-300 degrees—gives us the possibility of a fuel rate of under 4 pounds of coal per drawbar horsepower hour from terminal to terminal.

Basically it is not economic to have boiler power capacity to sustain high speed without being able to utilize a greater amount of it for starting and primary acceleration. This justifies the use of the "Booster" provided there is boiler capacity to develop maximum power up to the limiting speed of the booster—15 miles per hour.

This necessity is brought significantly to our attention by the fact that, under what might be termed normal average operating conditions, the average drawbar horsepower developed is about 1/3 of the maximum.

To summarize, we suggest that the trend of modern steam locomotive design indicates the following for road locomotives:

Boiler capacity—over 100 percent

Grate Area—1 square foot to 50 square feet heating surface

Boiler pressure—225 pounds to 250 pounds

Superheat—300 degrees

Positive indication of steam pipe pressure and back pressure

Long Valve Travel.

A (2) *Positive Limited Cut-Off.*

The positive restriction of cut-off such as the 50 percent cut off developed on the P. R. R. is a distinct advance in fuel economy for locomotives in slow speed freight service on those divisions where the full power of the locomotive is developed for a large proportion of the time.

On account of the many detailed descriptions of this system of steam distribution we merely describe it as the increase of piston thrust by approximately 25 percent, so as to equalize the limiting of cut-off insofar as producing the same average torque and tractive power. This may be obtained primarily by increase of boiler pressure or cylinder diameter or both and calls for no additional parts of any kind, the only changes being in dimensions of combination lever and valve bushings. A small supplementary steam port is provided to supply steam at starting through full stroke.

A (3) *Three Cylinder.*

So much descriptive matter has been published in recent years on the three cylinder locomotive that we do not feel warranted in adding to what has already been done. The principle behind the use of a third cylinder is well described by the following quotation from a test report:

"In a two cylinder engine, the arrangement of the cranks is such that with 85 percent cut-off, if the mean tractive effort be 40,000 pounds, at one point in the revolution, the tractive effort will rise to 50,000 pounds, and unless there is sufficient weight on the drivers the engine will slip. In the case of the three cylinder arrangement with the same cut-off and mean tractive effort, the increase will only be 42,400 pounds, requiring much less adhesive weight to prevent slipping than the corresponding two cylinder design.

"It is thus seen that with the three cylinders we may readily get a very high starting torque uniformly applied, thus reducing the stress on the draft gears, and also, that with the train once in motion, it may be hauled with a much shorter cut-off. Roughly, with a train loaded up to the maximum starting capacity in each case, it may be hauled after starting at a 50 percent cut-off with a two cylinder engine, and at a 35 percent cut-off with a three cylinder engine, thus promoting the economical use of steam."

All the criticism directed at the three cylinder principle has been from the standpoint of maintenance and this Committee does not feel that this class of power has seen sufficient service yet to warrant the assumption that it will replace the two cylinder locomotive.

(B) *Changes in operation practices and their effect on Steam Locomotive Design.*

Increased utilization:

This matter is being given most careful study by a special committee of the American Railway Association and it is not intended to enlarge on the subject here other than to point out that the general characteristics covered by Summary of "A" are necessary to provide the possibility of running freight and passenger power on sufficiently long runs to make from 9,000 to 18,000 miles per month.

In addition to the design of the locomotive itself, the tender must be given serious thought and water and coal capacities of a minimum of 15,000 gals., and 20 tons coal respectively should be supplied. The large capacity tank in addition to reducing water stops must have a very important bearing on boiler maintenance as a result of the possibility of choosing suitable boiler water in many places.

(C) *Special design of Steam Locomotive.*

C (1) *Condensing Locomotives.*

As a typical example of the condensing locomotive, we submit the following on the Ljungstrom Condensing Turbine Locomotive:

Length overall	72 feet
Total weight	250,000 lbs.
Boiler pressure	300 lbs.
Turbine H.P. (indicated)	2,000
Maximum speed	60 m.p.h.
Maximum speed (Turbine)	12,000 r.p.m.
Tractive power	27,000
Diameter drivers	56 inches approx.

The turbine which is of the impulse reaction type is mounted on the front end of what we would call the tender, but what is in reality, the engine end of the unit. Power is transmitted through double reduction gears, and idle gear for reversing, to a cranked jack shaft somewhat similar to the jack shaft on many electric locomotives.

Other unusual features which space does not permit us to describe in detail are the use of turbines for all auxiliary work except air compressing, induced draft—the heating of air to 300 degrees F. before going to closed pan—radiating type of condenser and heating of feedwater to a temperature of about 295 degrees. The boiler itself is unusual in that tubes are only 10 feet long.

C (2) *High Pressure Water Tube Boiler Type.*

Experiments are under way on a locomotive of special design on the D. & H. description of which is in all technical magazines.

Briefly this engine is a cross compound non-condensing superheated locomotive, with a watertube boiler carrying 350 pounds steam pressure.

The Committee was unable to obtain any data of interest with regard to the operation of this locomotive.

THE McCLELLON WATERTUBE FIREBOX LOCOMOTIVE

The McClellon firebox consists essentially of a hollow cast steel mud ring connected to a crown sheet composed of three longitudinal drums by a row of vertical watertubes which form the sides and back head of the firebox. The combustion chamber is formed by a row of curved tubes connected to the crown sheet drums at the top and to a trough leading from the third course of the boiler at the bottom. This trough is connected at the back end and to a riveted and stayed throat sheet leg which also forms the front connection and feeder of the U shaped mud ring.

McClellon watertube fireboxes were placed in service on the N. Y., N. H. & H. R. R. in 1916 on two Mikados of 45,000 pounds tractive effort and are still in service with good operating results and low firebox maintenance cost.

Recently a 250 pounds pressure boiler with McClellon firebox, was applied to a mountain type locomotive generally similar in details to the U. S. R. A. light mountain type engine. This engine is now undergoing tests and valuable data will be available in a few months. On account of the heavy maintenance cost of large capacity locomotive fireboxes, we recommend that tests of the watertube firebox be closely followed.

C (3) *High Pressure Locomotive.*

The use of high pressure steam, 600—1,200 pounds pressure, has been experimented with in Europe in stationary practice for over ten years with success. It is pictured by some engineers that this is the only unexplored field of development for the steam locomotive in order to obtain greater efficiency than at present being delivered.

The application of 1,000 pounds pressure steam in locomotive service must of necessity, introduce serious changes in boiler construction, as the present design is entirely unsuited for such pressures and in addition, must force the use of multi-stage engines of some sort with re-heating between the stages. Such radical changes and complications cannot be justified in order to secure a greater thermal recovery from a pound of steam until we have exhausted the possibilities of our present locomotive design by securing through the medium of ample boiler and superheater capacity, what we feel is now possible. It must be appreciated by those who advocate the application of the only remaining means of increasing the efficiency of stationary power plants to locomotive service that the locomotive boiler is constantly called on to produce from 500 percent to 900 percent overload as compared with stationary boilers producing from 200 percent to 400 percent on the same evaporative basis. Tests show that at such loads the efficiency of the locomotive boiler may fall below 50 percent and without doubt, the efficiency of the superheater is also seriously affected as at this rate of evaporation, it is possible that approximately 15 percent moisture is being carried over in the saturated steam. The only answer to such a condition is increase the efficiency and at the same time, the relative capacity of the boiler and of the superheater. The latest designs of boilers with Class "E" Superheater, increased grate area, and greater relative firebox heating surface will go a long way towards attaining this end.

The report was signed by H. T. Bentley (chairman), C. & N. W.; H. A. Hoke (vice-chairman), Penna.; A. Kearney, N. & W.; George McCormick, S. P.; W. L. Bean, N. Y., N. H. & H.; C. B. Young, C. B. & Q.; M. F. Cox, L. & N.; W. I. Cantley, Lehigh Valley; C. E. Brooks, C. N.; G. H. Emerson, B. & O.; H. H. Lanning, A. T. & S. F.; A. H. Fetters, U. P.; M. C. M. Hatch, M.-K.-T.; S. Zwight, N. P., and R. M. Brown, N. Y. C.

Discussion

V. L. JONES (N. Y., N. H. & H.): The first engine equipped with a McClellon firebox was built for the Boston & Maine, and, like anything else that is very much in its infancy, it had troubles. The New Haven purchased the next two in 1916. They were built on the designs furnished by James McClellon. These locomotives went into service at that time, but after a while developed some troubles primarily in the backhead tubes and combustion chamber. There was no provision at that time for any part of the construction to take the column stresses, and the tendency of the firebox to weave around, away from the tubes; in other words, the tubes had to act as water carriers and at the same time form the strength of the fireboxes. These two engines went into the shop in 1920. We rebuilt the backhead and the bottom of the combustion chamber tubes and put them back into service. Since then they have run right through, including the strike, and have only cost for the two fireboxes, about $300 for maintenance from 1920 up to the present time.

A road test was run on those two locomotives which indicated that we were getting something better than 10 percent in the way of overall efficiency, fuel and water, although we have had no accurate boiler test and were forced to run road tests where some errors crept in. We let the two engines go along for about four years to see whether or not we had the right idea, and then went to work in connection with the American Locomotive Company on the locomotive that is on exhibition during this convention. We were able with a new locomotive, of course, to start from the ground up and design new, whereas, with a rebuilt job there were naturally some limitations.

The troubles in the way of the backhead tubes were overcome by providing separate braces and taking away from the tubes any other duty except simply to carry water and steam, and so placing them that they were able to weave around and expand and contract as much as they liked without interfering with the firebox strength in any way. This particular engine was primarily the U. S. R. A. light mountain type, and in order to avoid bringing in too many new features on one locomotive we confined all of the development work and the new features to the firebox construction and kept the machinery and the rest of the engine essentially the same as it was. We did, however, take advantage of the watertube construction and raised the pressure up to 250 pounds. That necessitated stiffening up the rods and also required some modification of the valve gear, so that our valve motion in full gear cuts off at 70 percent of the stroke instead of near 90 percent. We have provided on this engine no auxiliary starting ports, and so far no difficulty has developed from the engine being slippery in getting out of holes with a heavy train.

The character of service that we have dictates the use of about a 69-inch driving wheel to move most of our main line freight for the simple reason that we have so much passenger business that the freight has to keep moving almost on a passenger schedule in order to keep out of the way. Otherwise, it would be outlawed and run up all sorts of expense. For that reason it may seem strange that a freight engine has a 27-inch by 30-inch cylinder and a 69-inch wheel. However, that is a matter of local conditions.

(Mr. Jones exhibited a number of slides showing the detailed construction of the McClellon firebox locomotive, accompanied by an explanation.)

B. P. FLORY (N. Y., O. & W.): Does it take any longer to wash out this boiler than it does an ordinary boiler? If so, about how much longer?

MR. JONES: We find it takes no longer; if anything, it is a little quicker. There are other engines under the same conditions using the same water and performing the same service, but these engines are noticeably cleaner, especially in the small pocket area. In other words, they do not accumulate the scale as rapidly as the ordinary construction. We trace that to the circulation which is more rapid and has some scouring action. It takes, as a rule, about two-thirds of the time to wash out this style of boiler as the ordinary one, and we can get at some of the bottom corners a whole lot more readily.

H. H. LANNING (A. T. & S. F.): How is the operation of scaling the tubes performed and how frequently?

MR. JONES: New England water is notably good, so that I can answer that question only from our own conditions. We have never had occasion as yet to clean any tubes. On the side tubes of the original engines we find a light 1/16-inch scale up at the top where the tubes bend into the drums. The rest of the tube is entirely clean.

We had hoped to have by this time real operating information in the way of fuel and water consumption, but there was not an opportunity to obtain the use of the dynamometer car. So I cannot refer you to actual test figures on this locomotive. But from information that we have kept right along it is apparent that we are getting probably about 15 percent more for a given amount of weight and space. I say that advisedly until such a time as complete test data are available for study.

A. H. FETTERS (U. P.): I should like to ask Mr. Jones if he has made any determination of front end flue gas temperatures.

MR. JONES: Not on this particular engine. On the two original engines we get about 20 degrees more. From road tests we get a little lower flue gas temperature in the front and a little higher superheat.

MR. FETTER: Is there any tendency of the flues to burn out on account of water leaving the surface due to rapid circulation?

MR. JONES: No. Those engines carry their water better than the ordinary type.

MR. FETTERS: Any tendency to prime noticeable?

Mr. Jones: No.

G. S. Edmonds (D. & H.): I want to touch the high spots in the actual operation of the "Horatio Allen" more particularly at this time with reference to the 350 pounds boiler pressure. The locomotive is a cross compound, and that at the present time is somewhat novel in locomotive practice in America. Remember, that in the firebox of this particular locomotive we have 57 percent of the total evaporation surface and roughly evaporation surface in the firebox of the average locomotive boiler will range from five to ten percent of the total. This engine was delivered to us last June. The boiler to date, for maintenance, has not involved an expenditure I should say to exceed $50. Four staybolts in the throat sheet have given us some little trouble from leakage. We did not put flexible bolts in these headers. Therein I think we made a mistake. We have taken out two of those bolts and the troubles have ceased. There remain two more to take out. The tubes which connect the upper and lower drums have not given us even a simmer, to say nothing of leakage, and during the last winter this locomotive operated in a territory where the temperatures were 15 degrees below zero and the snow was heavy. It takes a little longer to wash this boiler than normal. I should say it takes about two hours longer. We run the cleaner through all the tubes at each washout. Our practice is to blow out the flues at each end of the run. We started an experiment; we first ran the locomotive one month without blowing out the flues. They were then washed out. This practice was followed for a month or two and then instructions were issued not to blow or wash the flues until the indications showed that it was necessary. These flues have been run three months without blowing, and that in itself is an item worthy of consideration. It was found that the engine carries water equally well if not better than the normal locomotive.

Unfortunately, there were no precedents to govern the design and as received the locomotive was somewhat heavier than the specifications, which necessitates running it at lower speeds than our other locomotives. The highest normal operating speed is 25 miles an hour, with the limitation of 30 miles an hour. Notwithstanding these speed limitations which are strictly adhered to, this locomotive gets over the division much more rapidly than the other locomotives.

The results with the high boiler pressure make me very firmly feel that the day is not far distant when high pressures will become the predominating, or at least one of the predominating characteristics of American locomotives. From my observations, a 350 pounds or higher pressure will put our Pacifics up into what is now the Mountain type class.

J. Purcell (A. T. & S. F.): How many miles has this locomotive made?

Mr. Edmonds: She has made now between 20,000 and 25,000 miles.

Mr. Purcell: Have you developed any flat spots in the tires?

Mr. Edmonds: No, she shows no such indications.

Mr. Purcell: Have you made a dynamometer test yet?

Mr. Edmonds: We have had the dynamometer back of her, but we have not made exhaustive tests. The normal engine takes coal at Delanson going north and Delanson going south, which is some 60 or 65 miles out of Oneonta. This engine has been making trips from Oneonta and back without taking coal. We have got this engine rated slightly above our normal engine. We have had on her slightly below 3,500 tons on an 0.8 percent grade.

Mr. Brooks: It seems reasonable to suppose that with pressures as high as 350 pounds we can probably use a two-stage engine such as you are doing, Mr. Edmonds, but when you get up into the range of from 600 to 1,200 pounds pressure you must go beyond that. Not only will you have to go to a multi-stage engine, but you will have to go to those devices which will rejuvenate the steam in between stages as well, and that means severe complication.

Grafton Greenough (Baldwin Locomotive Works): I believe we are all working along with the idea of seeing what is best to do, because the locomotive industry cannot stand still. We can't build engines much wider or higher without rebuilding our entire transportation system, and it is necessary to get more power and more efficiency in a given space. The high pressure boiler is certainly one of the objects that is well worth while to strive for, and I think the work that is going on is valuable not only for the present but for the future of the industry.

C. A. Seley (Locomotive Firebox Company): The amount of superheat, however, as stated in this report is 300 degrees F., which, I take it, is additional to the normal steam temperature.

I have recently had some correspondence with the technical department of an engine building firm in Germany, and in the course of that correspondence the question of superheat came up and the statement was made that for a good engine they considered 660 degrees F. as a necessary steam temperature. The temperature of 200 pounds steam, our general average, is 387 degrees F. If we add 300 degrees, as recommended by the committee, that makes a total of 687 degrees, which is somewhat higher than the recommended German practice. I am of the opinion that the general pracice of our country is below rather than above that of Germany. I think we will find ordinarily 200 degrees superheat is more nearly the average used, bringing up the temperature to 587 degrees.

This is speaking in averages and not extremes, as the German practice would run from 725 degrees down. If 200 degrees superheat is added to the average already reached you will easily get a maximum of 620 or 630 degrees at times.

I might say one word further in regard to the actual status of superheat that we obtain. We can figure theoretically what we want on the locomotive in point of superheat, and put in the equipment, but what you get is something possibly different, due to the fact that in arranging the front end devices and making other adjustments in arriving at the diameter of the stack and of the nozzle, we have in mind only the proper combustion as the end to be obtained; to burn a level fire and to produce the necessary draft without extreme back pressure.

I am of the opinion, therefore, that the superheat of 300 degrees, as recommended by the committee, should be defined, whether an average or a maximum, and if an average whether we should not more nearly follow our general practice.

Mr. Brooks: In reply to Mr. Seley's remarks, I would briefly state as follows: Today we are buying locomotives with supposedly 200 degrees of superheat. If we were to consider that this is the average degree of superheat we were getting, there would be something wrong with us, because we are not getting anything like that, and all you have to do is get the pyrometer on any modern locomotive and you will find that this degree of superheat which we are guaranteed by the builders and by the superheater company when we buy the equipment, we are not getting it on an average. I would say that under average operating conditions in freight service we are not getting on a supposedly 200 degrees superheat locomotive over 135 degrees of superheat.

When this committee points out that we should consider a higher degree of superheat than 250 to 300 degrees, we are trying to indicate that we should get or strive for at least 100 degrees more than we have in the past because we know that we are not getting what we thought we were in the past, and it is simply an added mark and something which will give us increased efficiency.

We do not figure that we should obtain this 300 degrees of superheat by increasing the smokebox temperature abnormally. We believe that good combustion means a smokebox temperature of probably 550 degrees F., and we believe, in addition, that instead of trailing along with 125 or 135 degrees of superheat under average operating conditions, the average should come up to 225 or 250 degrees, and that our maximum may go even as high as 350 degrees without any serious trouble.

G. S. GOODWIN (C. R. I. & P.): Should the maximum superheat be based on the point at which you would not waste any superheat out of the exhaust? Isn't that the point that we want to work to—to overcome condensation?

MR. BROOKS: Tests which we have witnessed during the past year on modern power where our superheat has been about 235 to 240 degrees, we have noticed under those particular conditions probably ten to fifteen degrees of superheat going over in the exhaust and the first indication that probably any of us got of that was from the temperature of water that the feedwater heater delivered to the boiler.

I do not believe that anybody could say definitely today just what that dividing point is that you are looking for. I believe that we can go to a much higher average superheat than we are going today without losing any abnormal amount of superheat in the exhaust. A few degrees, up to possibly 10 degrees of superheat in the exhaust, I do not believe will do any of us much harm.

PROF. R. E. ENDSLEY (University of Pittsburgh): Just a word about the amount of superheat going out of the exhaust. Get all the superheat that you can lubricate, and then the amount going out of the exhaust will be added to by the increased volume of the steam as it enters the cylinder. You take steam at 200 pounds pressure; it occupies a certain volume. Superheated steam at 200 degrees does not fill anywhere near that same space. Add another 100 degrees, and then exhaust 50 degrees and you are going to gain from the increased volume. So get all the superheat that you can lubricate and get the maximum efficiency.

Water Columns

A. H. FETTERS (Union Pacific): I would like to suggest that in the illustration in the report showing the water column the lugs be changed from the horizontal hold type to the vertical hold type as a number of roads have experienced considerable trouble with the shearing of the bolts. Changing to the ledge or vertical bolts takes the shear off the bolts. That column is pretty heavy, and the usual ½ inch or ⅝ inch bolts won't stand up. Vertical bolts make just as good security and they are relieved from that shearing strain.

A. G. TRUMBULL (Erie): I would like to suggest for the consideration of the committee that the design as shown with the bottom connection as indicated is very likely to be stopped up if any sluggage accumulates on the bottom of the column. It seems to me it might be preferable if that connection were made in such a way as to provide a mud pocket below the lower connection. That might be accomplished by making the connection above the bottom of the column. It seems to me highly important, especially for those railroads which have bad water conditions to contend with.

MR. BENTLEY: I think a lot of us have had experience with the suggestion to roll the pipe over the end collar which is known as the mechanical joint, and if my experience is like anybody else's it is a very unsatisfactory arrangement. In regard to the flanges instead of the nuts, I believe the suggestion is an excellent one. The use of nuts around an engine on steam or water connections is obsolete, for they always give trouble. With a bolt and flange connection practically all of that trouble is overcome.

MR. LANNING: From the standpoint of our own experience we think the manufacturers still have something to work out in connection with the construction of a lubricator. Several of them have succeeded so far in building lubricators that will feed oil provided conditions are right, that is, if the temperature is correct. That is the principal item, but I don't think any of them have taken any definite steps toward automatic means for controlling the temperature of the oil as I think they are going to have to do before the force feed lubricator will become an ultimate success. The report here points out some of the features for making temperature control desirable. I think the railroads will have to work out for themselves the matter of the proper drive for the lubricator.

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

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

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

Below are given interpretations of the Committee in Cases Nos. 481, 491, 492, 493, and 494, as formulated at the meeting of April 24, 1925, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

CASE NO. 491.—*Inquiry*: Is it permissible under Par. U-61 to transfer the stampings on steel plate without the authorization of an inspector for such transfer of markings under the power boiler rules?

Reply: It is the opinion of the Committee that the requirement of Par. U-61 regarding the transferring of stamps applies to the cutting of large sheets into smaller ones, as well as laying out. Attention is called, however, to the requirement in the last sentence of this paragraph that the form of stamping shall be such that it can be readily distinguished from the original plate-maker's stamping.

CASE NO. 492.—*Inquiry*: Is the maximum unit working stress of 8550 pounds per square inch for brazed vessels applicable in the formula for the calculation of dished heads, when such heads are brazed into the vessel? This would force the manufacturers to use heavier heads for brazed tanks than required for tanks of riveted construction.

Reply: Attention is called to the fact that the maximum unit working stress for brazed vessels as given in Par. U-94 is applicable for the determination of the stresses in the shell where affected by the brazed joint. For the original calculation of the dished head the stresses specified in Par. U-36 are applicable, and the requirement of Par. U-94 applies to the connection of the heads to the shell in the vessel.

CASE NO. 493.—(In the hands of the Committee.)

CASE NO. 494.—*Inquiry*: Is it permissible in the construction of large riveted vessels for storage of compressed air to use nozzles of cast-iron construction, riveted to the shell, for either 6-inch, 8-inch and 10-inch pipe-size connections?

Reply: The Code for Unfired Pressure Vessels does not place any restrictions upon material required for nozzles or connections to such vessels. It is the opinion of the Committee that the use of properly designed cast-iron nozzles riveted to the shells of air tanks will constitute safe practic-

Laying Out Locomotive Boiler—VII[*]

Flanged sheet development — Backhead and firebox back sheet—Tapering flange radius

SLOPING back sheets, with a straight flange radius for the backhead and a tapering corner flange radius for the firebox back sheet, are dealt with in this section. Referring to locomotive boiler Fig.1 will be found the kind of back sheets as described above.

Fig. 17 is the backhead and Fig. 18 the firebox back sheet development shop drawings. These drawings show the shape of plate required to make the flanged sheets and also all other information necessary for making the sheets.

Backhead.—Due to this sheet being in a sloped plane it will be evident that the contour of the flange bend line will not be a true radius as shown by the boiler cross section Fig. 2. To determine this shape the short method as shown by Fig. 19 is used with good results.

After the inner bend line is laid in as described by Fig. 19 refer to the quarter circumference table No. 2[‡] and find the development or circumference of the flange radius. To this add the width of the backhead and roof seam plus ½ inch for flanging allowance. As a rule the roof sheet begins at the tangent point (as shown) of the flange radius—when this is otherwise a corresponding allowance must be made.

The bottom half of the sheet below the boiler center line is found by first stepping off on the diagram the neutral line of the bent part of the sheet (at the bottom) and then scaling this length from the boiler center line to the bottom of the sheet. Because of the bend in the firebox ring at the back end an additional allowance must be made at the bottom outer edge of the sheet to take care of the scarfed part that fits along the ring. This is determined by scaling the distance (from Fig. 3) the scarfed edge is below the bottom of the back end of the firebox ring. Add a little for allowance—make the dimension an even inch if it scales ½ inch or a little over, etc. This condition seldom occurs—the sheet is usually straight across the bottom and no allowance is made in the length dimension below the boiler center line.

The width of the sheet at the bottom is determined as follows:

Thickness of the backhead sheet plus the ring corner radius from one-half the width of the ring gives the first bend line. Quarter circumference table No. 2 will give the developed length of the corner radius plus the remaining distance to the end of the scarf which equals half the width of the plate. No allowance is made beyond the scarf. The width dimension above the bottom of the sheet is taken at the point where the backhead flange radius begins to taper into the firebox ring flange radius. Refer to diagram.

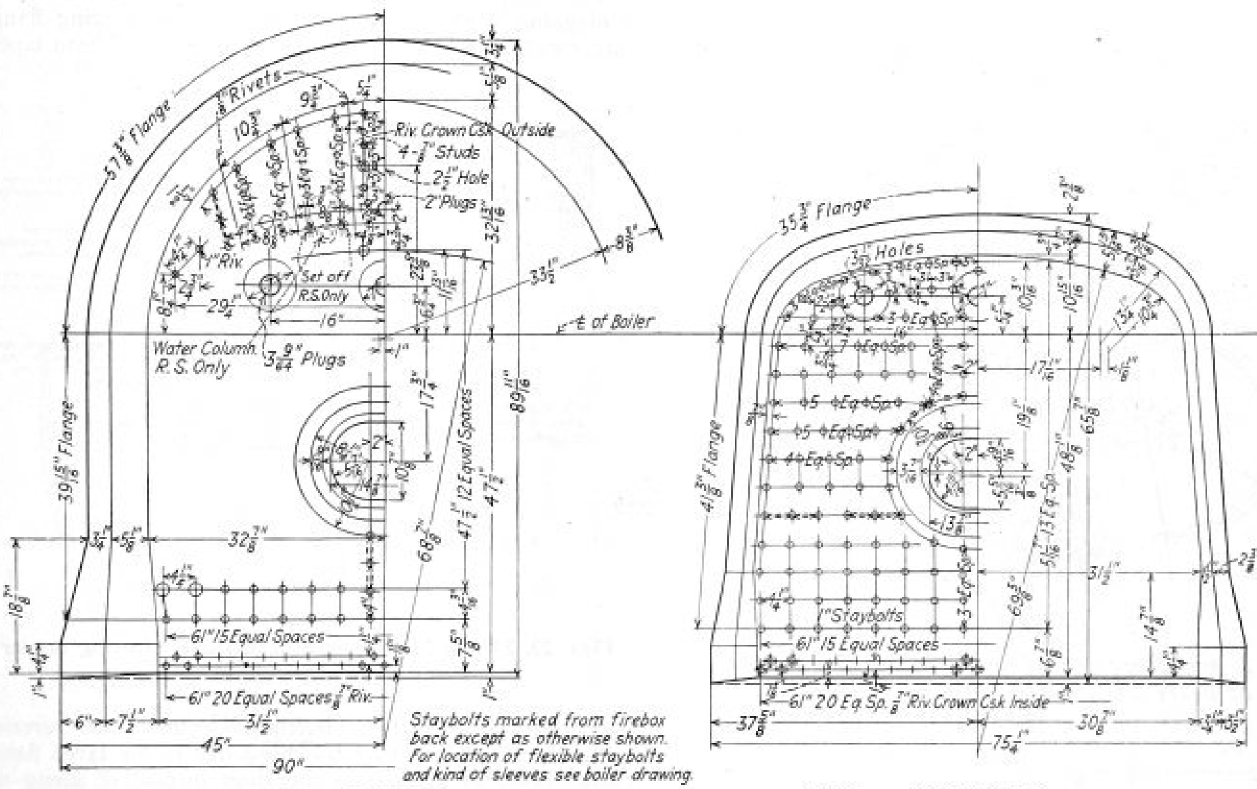


FIG. 17 BACKHEAD ½" Plate

FIG. 18 FIREBOX BACK ⅜" Plate

Figs. 17 and 18.—Details of backhead and firebox back sheet

*Previous installments of this article appeared on page 1, January issue; page 40, February issue; page 72, March issue; page 99, April issue; page 129, May issue, and page 166, June issue.

†Boiler Designing Department, American Locomotive Company, Schenectady, New York.

‡Page 41 of the February issue.

At the bottom of the corner radius Fig. 3 project a horizontal line to the cross section as shown. From the scale dimension as indicated (if side line slopes very much, scale

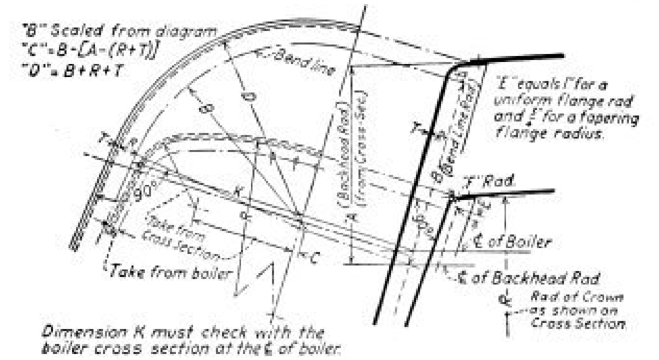
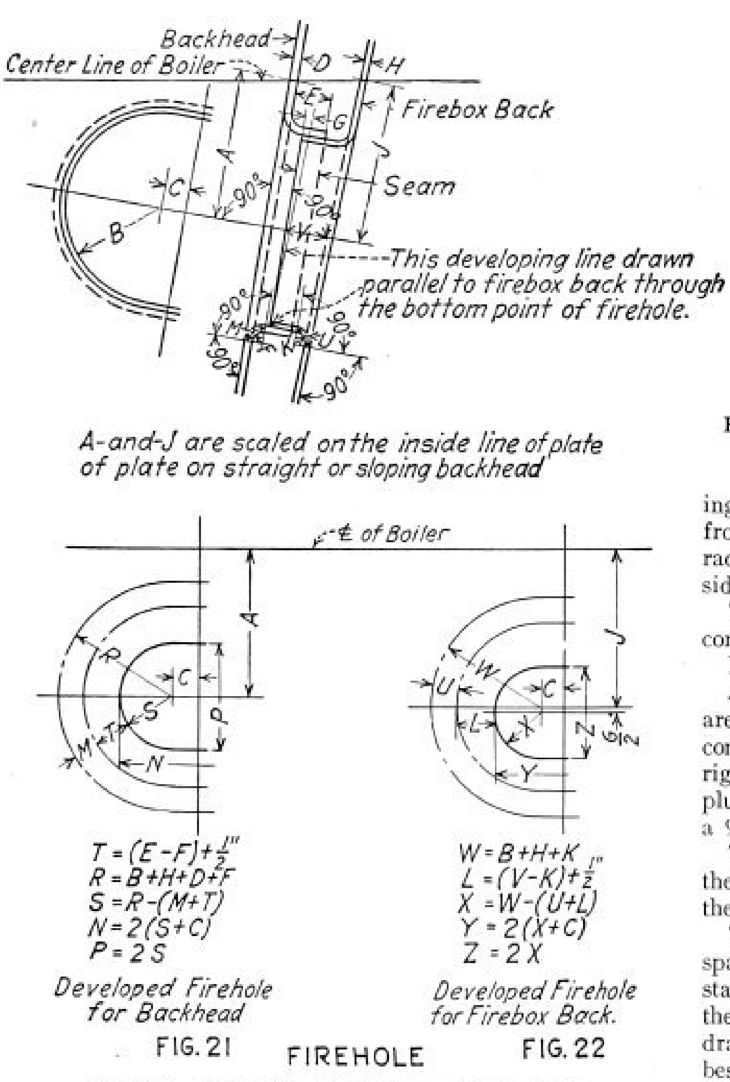


Fig. 19.—Method of finding backhead bend line for a straight flange radius

dimension should be measured as shown for back sheet on diagram section) subtract half the thickness of the roof sheet plus the backhead thickness plus the flange radius.



Figs. 20, 21 and 22.—Development of fire hole

This gives the dimension 32⅞ inches as shown on the plate Fig. 17. The dimension 18⅞ inches from the bottom of the plate up to the above transverse dimension is scaled from the diagram. Add the developed flange radius plus the width of the backhead seam plus ½ inch for flanging allowance; connect these points with the upper part of the sheet, completing the outline.

Lay in the firehole next.

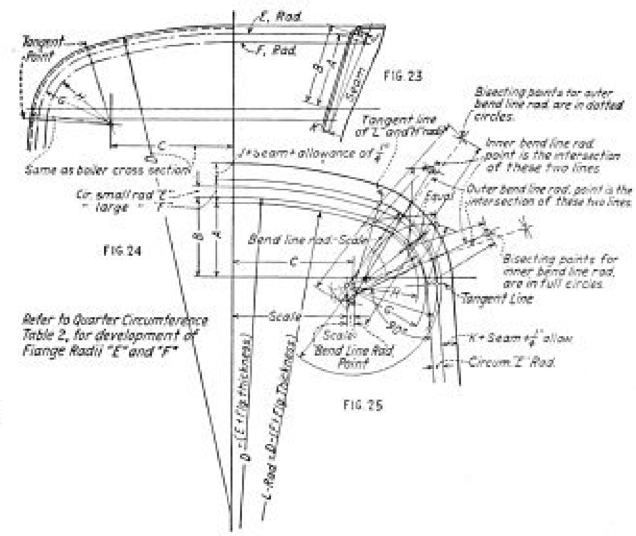
Figs. 20, 21 and 22 give the information for developing the plain style of firehole as shown on this boiler. O'Connor firehole flanges and other irregular shapes should be stepped off with the dividers and scaled.

Some fireholes are difficult to develop and should be thoroughly studied for the size of hole opening and its location before sending the drawing to the shop.

The firebox back sheet outline should be laid out next, before the staybolt holes, etc., are laid in on the backhead.

Firebox Back Sheet Development

The outline of this sheet is determined with the aid of a diagram, similar to the backhead. The tapering flange corner radius is found in like manner to the backhead taper-



Figs. 23, 24 and 25.—Firebox back sheet, tapering corner radius

ing flange radius. The bisecting operations are reversed from that of the tapering backhead due to the large flange radius being at the top of the sheet instead of along the side as for the backhead.

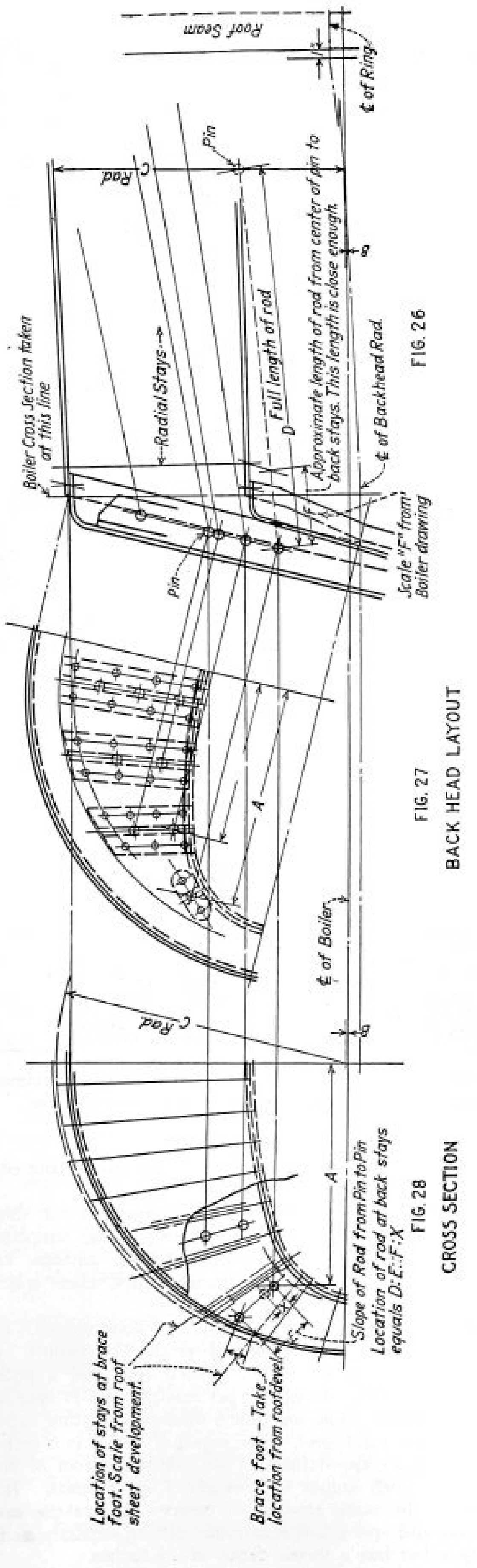
The method and instruction for developing a tapering corner radius are shown by Figs. 23, 24 and 25.

Lay in the firebox ring rivets on both sheets.

Staybolts.—The staybolt holes and the arch tube holes are to be laid in next. The staybolts are (except when coming in the bottom bend, when they are radial) at a right angle to the firebox back sheet. Also, the arch tube plug holes in the backhead sheet are located by projecting a 90-degree line through from the firebox back sheet.

The arch tube plug holes should be at a right angle to the back sheet for reason of keeping the staybolts around the tube hole 90 degrees to the back sheet.

The general dimensions giving the number of staybolt spaces are shown on the boiler drawing. The broken up staybolts or those not located in one or both directions by the general dimensions are to be scaled from the boiler drawing, or re-spaced with the dividers, whichever seems best in the judgment of the draftsman to place the staybolts in the best location for supporting the sheets. It requires considerable experience to make a good looking backhead or throat sheet staybolt layout. One that looks good and uniform to the experienced eye is one that usually supports the sheets the best. Great care should be taken to see that



Figs. 26, 27 and 28.—Method of locating longitudinal brace rod between stays

no single staybolt supports more than the allowed maximum fiber stress per square inch of the net area of the staybolt. Also, the general spacing of the staybolts as calculated for the boiler should not be exceeded.

The inside firebox sheets are to be considered for staybolt bracing and not the outside sheets. Often around arch tubes without plug holes, etc., it will be found necessary to move staybolts off the regular spacing line on the outside sheets. When this is done, in all cases where possible, the bolt location in the firebox sheet should not be moved.

All staybolt holes are laid out on the firebox back sheet. Only those that have a different spacing than the back sheet are shown on the backhead; such as the bolts that are radial to the bottom bend, those around O'Connor and other odd shaped firehole flanges and those that are set off the regular line on the backhead to make room for washout plugs or other accessories, etc. The remaining staybolt hole locations on the backhead are marked from the firebox back sheet. The holes that are to be used for flexible staybolt sleeves are taken from the boiler drawing after the location has been marked from the back sheet.

An experienced boiler designer must approve all staybolt layouts.

Referring again to the backhead sheet we find the longitudinal brace tee iron rivets, washout plugs, throttle stuffing-box hole, etc., to lay in. It is not necessary to pencil these in on the backhead development drawing. This work is traced direct from the boiler layout or boiler tracing. The location dimensions of the rivets not given on the boiler drawing are to be scaled from that drawing.

The location of the tee iron and brace feet, as laid in on the boiler drawing, should allow the longitudinal brace rods to pass central or as nearly central between the radial stays as the distribution of the tee irons and brace feet will allow the backhead sheet to be sufficiently braced.

Sometimes it will be found that the outer tee iron and brace foot as located on the boiler drawing will bring the longitudinal brace rod close to the line of radial stays.

It would make serious trouble if a brace rod did not clear the radial stays, therefore it is well to check the location as shown on the boiler drawing before giving the location dimensions for the tee iron and brace feet rivets on the plate development.

The method for determining the exact location of a brace rod at the back row of radial stays (it is obvious if a brace rod clears the back row of radial stays it will clear all a-head of the back row) is as follows:

Refer to Figs. 26, 27 and 28. With a large pair of dividers, gage the distance (boiler backhead view Fig. 27) between the boiler center line and the brace rod. Follow this projected center line down to the longitudinal view, Fig. 26. With the dividers on the projected center line and in line with the brace pin hole in the tee iron (keep upper leg on paper) raise the lower leg of the dividers up on the horizontal center line of boiler. The space between the divider points when shortened is the exact height of the brace rod pin above the boiler center line.

Transfer the dividers with this last set to the boiler cross section, Fig. 28, placing same on the boiler center line, prick a hole in the radial stay space that the rod passes through, draw a short horizontal line through this point. Refer again to the boiler backhead view, take off the distance between the vertical boiler center line and the brace rod, transfer to the boiler cross section. This is the exact location of the rod at the pin, for the location at the back radial stay the slope of the rod has to be determined at that point. A formula for finding the slope is given on Fig. 28.

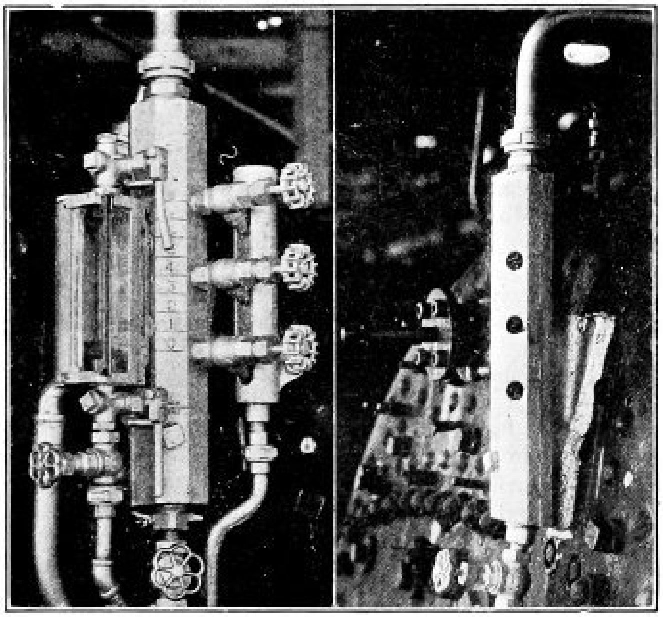
The top and bottom flange dimension shown around the outline of the plates is what the sheet should measure after it is flanged. These dimensions are used by the flanger to check the plate for correct flanged size.

This completes the layout work for the backhead and firebox back sheet Figs. 17 and 18 respectively. Add the dimensions and notes as shown, which is a typical example of the information required on these drawings to avoid shop errors.

(To be continued)

Cast Steel Water Column Used by Canadian National Railways

IN view of the interest being shown by the railroad field in the question of satisfactory water columns, the accompanying details of the L. and C. cast steel water column, which has become standard on the Canadian National Railways, should offer useful suggestions to those working on this problem. Up to the present time over 300 locomotives have been equipped with this column. It is of a compact and rigid design and is welded directly to the backhead of a boiler without the use of separate brackets. This method keeps the application close enough to the face plate to give the engineer an unobstructed view of all gages. This condition, together with the elimination of bolts or studs for securing it to the boiler, is a particular feature of the L. & C. column. The welding pad which is cast integrally with the column permits over 30 inches of welding and this pad is so designed as to fit on to a boiler without covering any tee-iron rivets.



General view of water column and method of welding to backhead

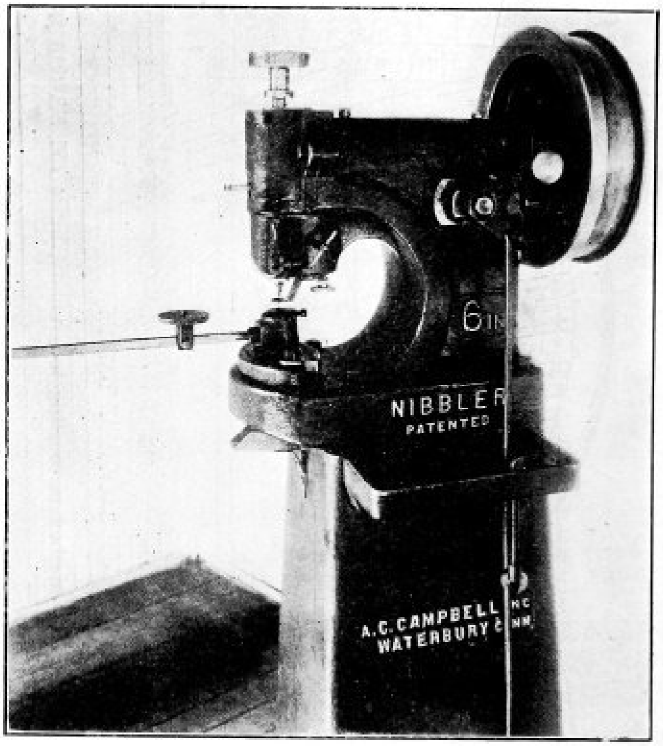
The first L. & C. columns applied had a bore of 2 inches, but later applications were given a 3-inch diameter bore. The bottom connection into the boiler, which is made of cold-rolled brass, is provided with a ¾-inch opening and is applied in such a manner as to provide additional fastening to the boiler. By removing the plug in the face of the column, the bottom connection can be readily cleaned.

The water glass mountings are applied directly into the column in such a position that they project the least possible distance beyond its face while still being easily visible to both engineer and fireman. In the case of the Canadian National mountings, they project only 2½ inches beyond the face of the column.

Improvements Made in Campbell Nibbling Machine

RAPIDITY of action, faster cutting (20 to 30 inches per minute), no distortion of metal and long life of punches and dies with low replacement costs are the outstanding features claimed for the operation of the improved Campbell nibbling machine manufactured by Andrew C. Campbell, Inc., Bridgeport, Conn.

Other features of the Campbell nibbling machine, which brought it a Certificate of Merit at the National Exposition of Power and Mechanical Engineering at New York are: ability to cut either from a scribed outline or from a template, ease of changing machine or tool set-up, ease of lubrication—four oiling points—quick adjustment and setting of punch positions, simplicity of construction, quiet setting and locking of stripper plate, foot and hand clutch control, the elevating spring action in ram carrying punch which facilitates removal of work without altering tool set-up, and double-ended punches which may be inverted when one cutting edge becomes worn.



Campbell's nibbler No. 1 with 6 inch throat has maximum capacity for 3/16 inch steel. Larger sizes can cut steel up to ⅜-inch thick

Use of the nibbling machine is recommended for shops where valuable time may be saved in cutting templates, stripper plates, cans, gages, gaskets, flanges, patterns and in other miscellaneous and experimental work where special equipment would otherwise be necessary.

The Campbell nibbler No. 1 requires floor space 2 feet by 1½ feet. It is 4½ feet high and weighs 470 pounds. Its pulley size is 12 inches with a 2-inch face and a pulley speed of 450 to 500 revolutions per minute, and is operated by ½ horsepower. The machine's maximum cutting capacity is 3/16-inch mild steel. The depth of throat is 6 inches.

Type 1B takes approximately one additional foot of floor space, is one inch higher and weighs 1,000 pounds. It is operated by the same amount of power. It has the same pulley size and speed and maximum cutting capacity as the No. 1 type but has a throat depth of 24 inches.

Type No. 2 requires slightly more floor space than the No. 1 machine and is 5 feet high. It is equipped with a 15-inch diameter pulley with 3-inch face but takes a pulley speed of 300 revolutions per minute. Depth of the throat is 12 inches. One horsepower is required. The maximum cutting capacity is greater than the other types, 3/8-inch mild steel being easily workable.

Relationship Between National Board and Boiler Code Committee*

By C. W. Obert†

WITH a little over four years of the close relationship that exists between your organization and the A. S. M. E. Boiler Code Committee, it has been demonstrated that a form of cooperation may exist between us that is not only most useful but also friendly and intensely interesting. The organization of your National Board has, I believe, established a closer personal touch between the committee and your members than would have existed otherwise and the results already obtained promise future accomplishments for the National Board that are far ahead of the most sanguine expectation.

While the majority of your members may be fully acquainted with this relationship and the service which the boiler code committee is able to render for your organization, I beg leave to place before you for the benefit of the newer members, some of the outstanding features of the service that is embodied in this relationship.

Service Rendered by the Boiler Code Committee

In the first place, your constitution states that it is the object of the National Board to promote uniform boiler laws and rules throughout the jurisdiction of its members, and in its requirements for membership only such inspection department officials as are charged with the enforcement of inspection regulations by a political subdivision that has adopted any of the codes of the American Society of Mechanical Engineers are eligible. This brings us, therefore, to a common meeting ground, namely, the boiler code committee formulating and interpreting its codes, whereas your members enforce them in their respective localities.

By virtue of an early action of the council of our society, each state and municipality that has adopted the code has been invited to appoint a representative to act on a conference committee to the boiler code committee, and these invitations have in all cases been accepted. You are thus, in addition to your membership on the National Board, members of this sub-committee of the boiler code committee and thus actively at work with the committee on its major problems. The boiler code committee has been greatly indebted to the conference committee members for the enthusiastic cooperation and support, not only in the interpretation work but also on the revision work.

The keynote of the service that is open to you as members of our conference committee and of your national board, lies in the interpretations that are available at your call at any time. At the monthly meeting any question of the kind that is raised by any of your members is immediately acted upon in the most thoughtful and careful manner. Any questions from manufacturers or users of boilers that appear to affect any state or municipal inspection department is first referred to that department. Otherwise action is taken thereon by the boiler code committee at the next monthly meeting and thereupon submitted to the members for mail ballot. Any criticism or objection to a reply or interpretation causes the case to be withheld until the next meeting for reconsideration. In this manner, all interpretations, as well as revisions, are insured unanimous action.

Importance of Participation in This Service by National Board Members

The procedure of the boiler code committee office in handling records of the interpretations at each monthly meeting is as follows:

Immediately after the preparation of the minutes of the committee meeting, copies thereof are sent to all of the members of the committee and also of the conference committee with invitation for criticism if anything objectionable is found therein. Following this, a reasonable length of time is allowed for returns from the members before the interpretation in each case is submitted to the council of the society for approval and final issuance to the public. Early response from the members is essential if prompt service is to be rendered and the members receiving these reports are urged by the boiler code committee to give them immediate attention wherever possible. The earlier the responses are received the more certain we may be of intelligent and understandable action, the greater the possibility of correcting any inadvertent errors or making necessary modifications therein, and the earlier the interpretations may be issued and published.

When it is realized that in addition to the interpretation data sheets that are sent to the regular list of the members of the boiler code committee and to the members of the national board, the society sends out on regular subscriptions nearly three hundred copies thereof, some idea of the importance of this service to the public at large may be understood. The boiler manufacturers, many public utilities companies, and a large number of consulting engineers rely upon this interpretation data sheet to govern their boiler design work and regulate their steam boiler practice. Anything your members can do therefore to not only speed up the work of issuing these interpretations but also in assisting to keep them technically and mechanically correct, will add to the value of the service that our organizations are mutually rendering to the public at large.

*Abstract of address delivered at annual meeting of National Board of Boiler and Pressure Vessel Inspectors, Milwaukee, May, 1925.
†Secretary A. S. M. E. Boiler Code Committee.

Welding Society Announces Fall Meeting

PLANS are practically completed by the welding industry to make the Fall Meeting of the American Welding Society the largest and most successful ever held. Three days, October 21, 22 and 23 will be devoted to the various technical sessions, demonstrations, exhibits and entertainment. The headquarters for the meeting will be at the Massachusetts Institute of Technology, Cambridge, Mass.

Exhibits of welding, welded products and actual demonstrations of welding and cutting are to be featured at this meeting. Twenty thousand people including some of the leading industrial executives of the northeastern part of the United States are expected to be present. The applications of welding have more than trebled during the past few years. Possibilities for further extension with resulting economies are still limitless. It will be the object of these exhibits and demonstrations to show industrial managers and engineers what can be done.

Five technical sessions are scheduled on important subjects. The papers will be printed and distributed in advance and the greater part of the time of each session will be given over to a discussion by those present.

Sightseeing bus trips will be arranged in and around Boston for the ladies attending the convention. A theater party, dinners and special demonstrations will also be given.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Procedure to Obtain Underwriter's Approval

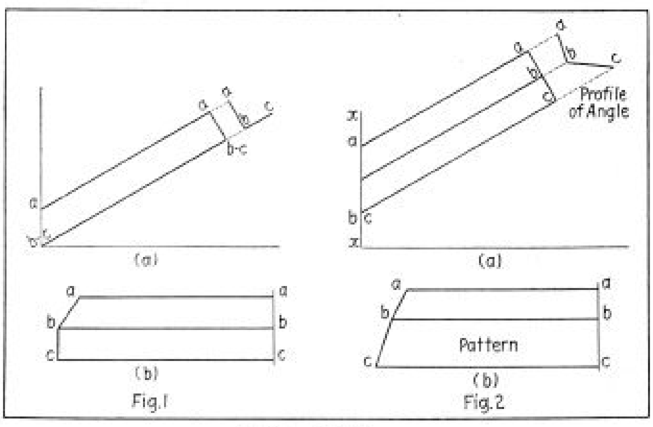
Q.—As I am a subscriber to THE BOILER MAKER I am taking the liberty of asking you for a little information: A friend of mine has invented and patented an acetylene generator, and we want to know what procedure to take to have underwriters pass on it.—W. N. S.

A.—Write direct to Underwriters Laboratories, 207 East Ohio street, Chicago, Ill., and state fully the particulars wanted. They will advise you how to proceed.

Miter Cut for Bent Plate Inclined to a Vertical Plane

Q.—Inclosed you will find a sketch of my problem. How can I arrive at the angle of the cut on the end of my plate so that it will lie up against the perpendicular surface after it is flanged? I can do this by a makeshift method, but would like to know the correct way. Thanking you for any information you may give.—R. L. M.

A.—The Figs. 1 and 2 illustrate two examples of finding the miter cut between an inclined bent plate and a perpendicular plane. Both problems involve the same principles of projection. In the view (a) Fig. 2, layoff the required elevation, showing the position of the profile or angle of the bent plate as *a-b-c*. Where the edge lines are cut by the plane *x-x* gives the data required for laying off the pattern as shown in (b). Draw the parallel lines *a-a*, *b-b* and *c-c* and make them equal in length to the corresponding lines of view (a).



Miter Problem

Staying Furnaces

Q.—A furnace for a vertical firetube boiler, 31 inches diameter, $\frac{3}{8}$-inch plate, $23\frac{1}{2}$-inch rivet centers, 200 pounds working pressure, is stayed with $\frac{7}{8}$-inch staybolts pitched $4\frac{1}{4}$ inches by $4\frac{1}{4}$ inches.

Inspector states this should have been stayed same as for a flat surface, making it necessary to use 1-inch bolts.

The old A. S. M. E. Code stated that furnaces over 38 inches diameter shall be stayed in accordance with the rules governing flat surfaces.

Therefore why can we not figure the value of the furnace unstayed + the value of the bolts which gives well over 200 pounds?—J. A. S.

A.—It is our opinion that if the unstayed furnace is not of sufficient strength to carry the required pressure, it is necessary to stay the furnace in accordance with rules prescribed for staying flat surfaces.

Classification of Locomotive Boilers

Q.—I am not sure of the classification of locomotive boilers, and would appreciate it if you would let me know the different classes of boilers and also the way to distinguish the wagon top and extended wagon top boilers from the others. I would like to know the proper formulæ for figuring the bearing pressure on rivets? J. M. W.

A.—Locomotive boilers are classified according to their shape, and to the shape of their firebox. From their shape they are known as the *conical, straight-top, wagon-top* and *extended wagon-top*. From the shape of their firebox, locomotive boilers are known as the *Belpaire firebox, narrow firebox, wide firebox, oil-burning firebox,* etc.

STRAIGHT-TOP BOILER

The sectional view, Fig. 1, illustrates a straight-top boiler. The cylindrical courses are made to a uniform diameter (no taper). The shell course connecting with the firebox throat sheet is also made tapered and the upper section cylindrical and in line with the other courses. The fireboxes of this type boiler are shallow.

WAGON-TOP BOILER

The roof sheet in the wagon-top boiler is higher than the shell courses, which necessitates a conical course to connect the shell and firebox. The dome is usually placed on the roof sheet.

EXTENDED WAGON-TOP BOILER

The extended wagon-top is a modification of the wagon-top. The steam dome is placed in front of the firebox on a cylindrical course, as shown in Fig. 2. A tapered course connects the dome course with the cylindrical shells. This form of boiler is to provide increased steam space by the arrangement of the dome ahead of the firebox.

CONICAL BOILER

There is not a great difference between the conical boiler and the extended wagon-top. The difference lies in the tapered course, in the conical type in this course the taper extends all around in the form of a cone, whereas in the extended wagon-top the taper is at the top and sides of the taper course. This condition will be seen by comparing Figs. 2 and 3.

Your last question is not clear. The bearing area of a rivet in single shear is the product of the rivet diameter and thickness of plate. The safe bearing strength of the rivet in single shear is usually taken at $1\frac{1}{2}$ times its compressive

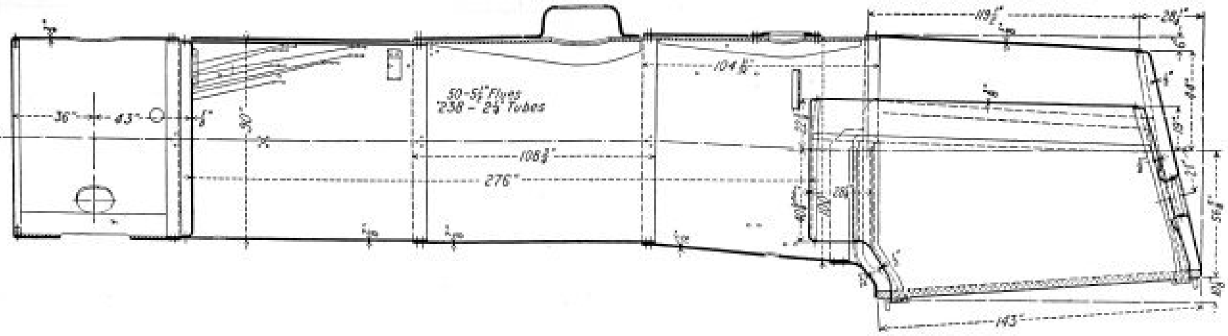


Fig. 1.—Section through straight top boiler

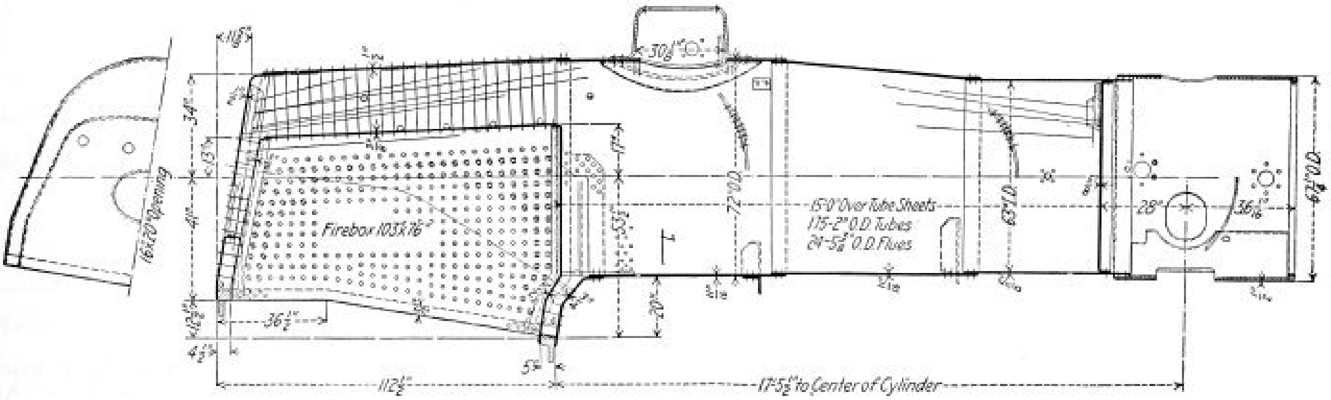


Fig. 2.—Extended wagon top boiler

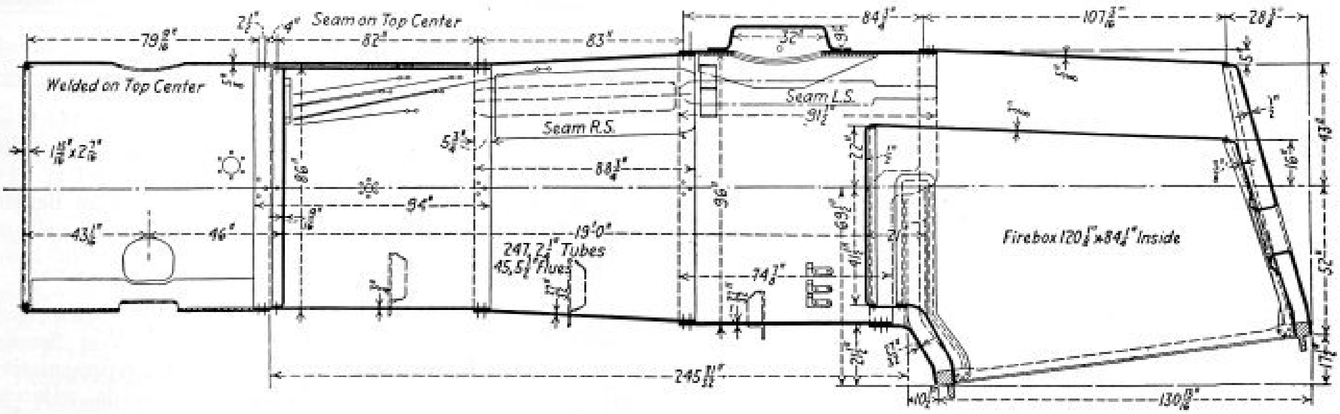


Fig. 3.—Conical type boiler

strength and for a rivet in double shear 2 times its compressive strength; divided by the factor of safety.

Determining Size of Concrete Foundations for Steel Stacks

Q.—I would like to know how to calculate the size of concrete foundations for self-supporting steel stacks. The one that I have in mind at present is 60 inches in diameter, 125 feet high overall. The base is 105 inches in diameter, tapering to 60 inches in 18 feet. There are six 2-inch bolts on a 9-foot 4-inch circle. The first 30 feet is $\frac{5}{16}$-inch steel; the second 50 feet is ¼-inch steel, and the top 45 feet is of $\frac{3}{16}$-inch steel.

I have been a subscriber to THE BOILER MAKER for about 15 years and wish to state that I fully appreciate its merits, as I have broadened my knowledge and obtained information on numerous points that otherwise I perhaps would never have thought of.—R. S.

A.—The stability of a stack against overturning around its base must be determined, as well as its strength to resist bending moment at any section. The overturning moment due to the wind pressure must not exceed the resistance moment about the base. For illustration, in Fig. 1 the pressure P due to the wind acts about the base on a lever arm equal to x, which tends to overturn the stack. The resistance to this load, is the weight of the stack W acting through a lever arm y. When these two moments are equal the stack can be considered safe, but it is advisable to make the arm y at least 1½ to 2 times greater than the calculated conditions.

The formula may be expressed as follows, for the stability of the stack:

$$P \times x = W \times y$$

and

$$y = \frac{Px}{W}$$

The total wind pressure may be figured as follows: Consider the pressure of the wind under hurricane conditions of 56 pounds per square foot and its effect on the cylindrical surface equal to one-half of that on a plane through the center of the stack:

$$\text{Total wind pressure} = \frac{56 \times d \times h}{2}$$

in which

d = diameter of stack in feet.
h = height of stack in feet.

With this information the width of the base can be calculated, and also the depth, assuming a heavy foundation with reinforcing bars as required.

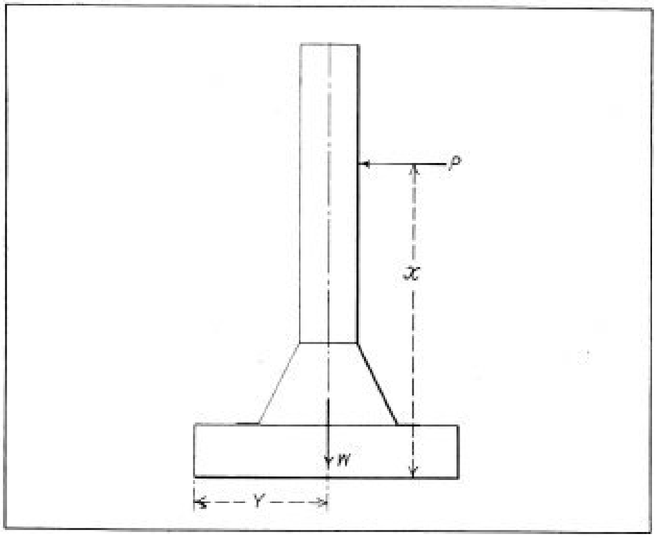


Fig. 1.—Forces acting on stack

The following formula may also be used to determine the stability of a stack:

$$W = \frac{h^2 \times dw}{b}$$

in which,

W = weight of stack, in pounds.
h = height of stack, in feet.
d = mean diameter of stack, in feet.
w = ½ of wind pressure, pounds per square feet under hurricane conditions.
b = width of base, in feet.

From the above formula the value of b may be found when the other factors are known, by transposing, thus:

$$b = \frac{W}{h^2 \times dw}$$

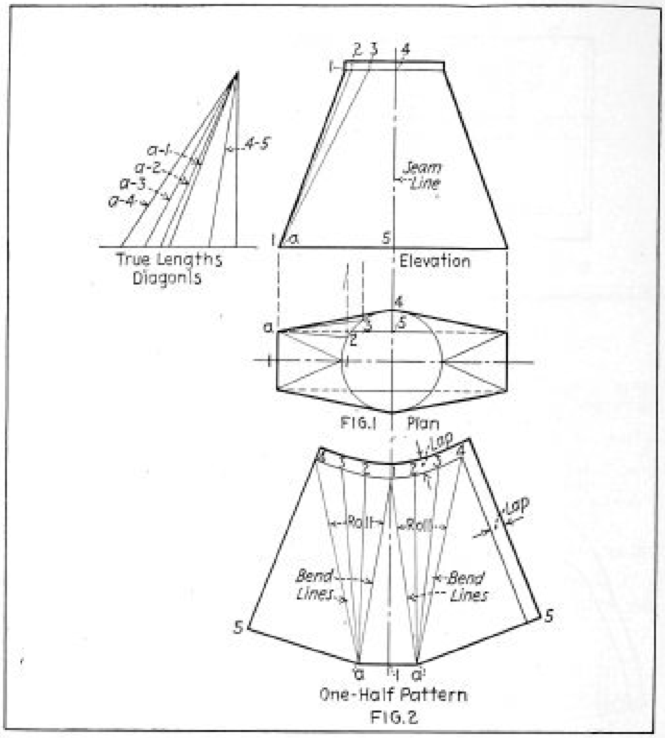
For the concrete base a cement mixture of 1-2-4 is recommended for which a compressive stress of 500 pounds per square inch may be assumed.

Stack Base

Q.—I am inclosing a sketch of a smoke stack base which I had to get out some time back. I did it by triangulation, but it did not come out good; however, it was good enough to use.

If you could give a way of getting it right I would certainly appreciate the information as I have to get out one very often similar to this one. —W. F. B.

A.—If you will send us a sketch showing how you applied the triangulation method to this form of tapering piece, we can determine your trouble in the layout. However, the drawing, Fig. 1, of the plan and elevation illustrates the development, as required preparatory for the pattern



Layout of smokestack base

layout shown in Fig. 2. In this case the seam line is made at the center of the long side of the transition piece. All developers are indicated in the three views by reference marks which should make the construction clear.

BUSINESS NOTES

The products of the W. A. Jones Foundry & Machine Company, Chicago, Ill., will be handled throughout the Minneapolis territory by the office which is located at 614 Builders' Exchange, Minneapolis, Minn. F. S. Van Bergen is district sales manager. The territory includes all of Minnesota, North Dakota, South Dakota, sections of Iowa and Wisconsin, adjoining Minnesota.

The Kuhlman Electric Company, Bay City, Mich., has appointed the Stevens Sales Company, 134 West Second South street, Salt Lake City, Utah, as district representative to the state of Utah, sections of Idaho and Nevada, adjacent to Utah.

The Gibb Welding Machines Company (successors to Gibb Instrument Company) of Bay City, Mich., manufacturers of electric welding equipment, announce the appointment of Arthur Jackson, 32 Glenholme avenue, Toronto, Ontario, as sales representative for Ontario and eastern Canada. The Gibb Welding Machine Company's line comprises arc, spot and seam welders.

The business of the Thomson Electric Welding Company, Lynn, Mass., in Philadelphia and surrounding territory is now being handled by a direct representative of the company, William T. Ober. Mr. Ober is located at 2006 Market street, Philadelphia.

Joseph V. Miller, western sales representative of the Prime Manufacturing Company, Milwaukee, Wis., has resigned to go to the Chicago, Milwaukee & St. Paul as assistant general storekeeper. C. Arthur Dunn, eastern sales representative of the Prime Manufacturing Company, with headquarters at Philadelphia, has been promoted to sales manager, railway division, with headquarters at Milwaukee.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.

Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

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

Secretary—C. W. Obert, 29 West 39th Street, New York.

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Vice-Chairman—R. L. Hemingway, San Francisco, Cal.

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J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.

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

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

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

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

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

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

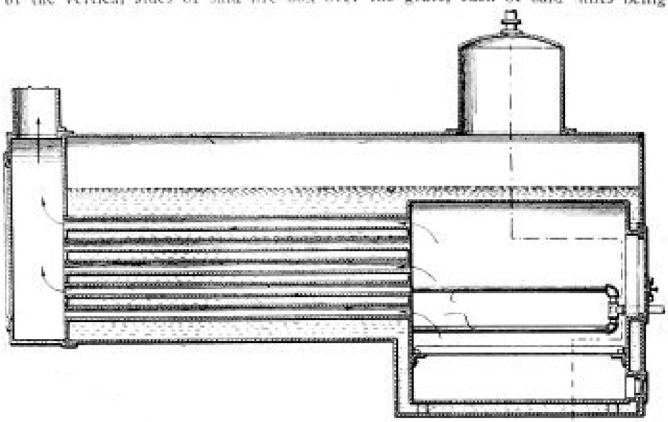
SELECTED BOILER PATENTS

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

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

1,532,507. WATER CIRCULATION UNIT FOR BOILERS. JOHN L. McKOWEN, OF SAPULPA, OKLAHOMA.

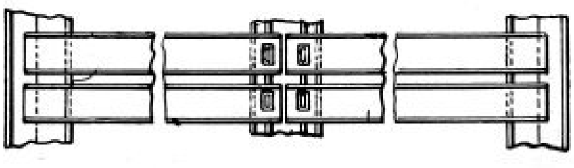
Claim—The combination with a boiler including a fire box surrounded by a portion of the boiler proper to form a water space around the fire box; of a pair of substantially U-shaped circulation units for heating the water passing therethrough, said units being supported on the inner faces of the vertical sides of said fire box over the grate, each of said units being



composed of a pair of horizontally disposed spaced pipes connected at their open ends with the flue-sheet of the fire box and connected together at their opposite ends by a four-way coupling, a short pipe connected with the side extension of the coupling and leading to the aforesaid water space, and a combined drain and blow-off pipe connected to the rear extension and passing through the rear end of the boiler.

1,532,526. FURNACE GRATE. GIOVANNI ZACH, OF POLA, ITALY.

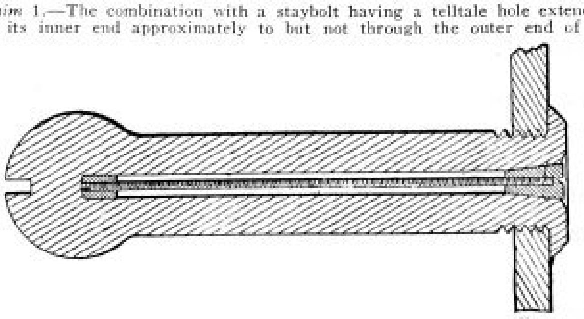
Claim 1.—A grate including a plurality of notched bearing members, a series of parallel arranged grate bars carried by said members and having their ends engaging the notches of said members, each of said bars being



of substantially U-shaped cross section in order to provide channels adapted to receive and retain ashes, each of said grate bars being provided with a notch, and a flange connected to one of said bearing members and extending into the notches of the grate bars.

1,532,736. STAYBOLT FOR BOILERS. ETHAN I. DODDS, OF CENTRAL VALLEY, NEW YORK, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

Claim 1.—The combination with a staybolt having a telltale hole extending from its inner end approximately to but not through the outer end of the



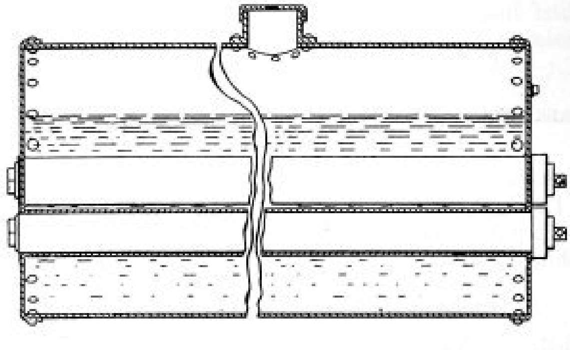
bolt, of an indicating rod located in said telltale hole and connected at its ends respectively to the bolt near respective ends of said telltale hole. Three claims.

1,502,886. FURNACE. WILMER M. SHALLCROSS, OF MILWAUKEE, WISCONSIN, ASSIGNOR TO SHALLCROSS CONTROL SYSTEMS CO., OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

Claim 1.—In a furnace, regulating means therefor including an electric motor, an electric circuit including said motor, means within said circuit for actuating said motor upon a change in the furnace condition from normal, and means within the circuit whereby a strong dynamic braking force is applied to said motor upon the furnace condition returning to normal. Five claims.

1,533,268. ELECTRIC STEAM BOILER. THOMAS A. REID, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

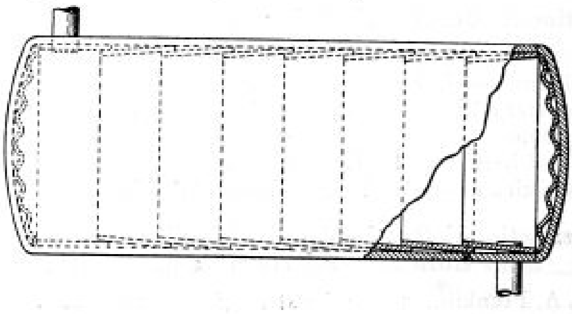
Claim 1.—In a heating unit for an electrically-heated boiler, in combination, a metal tube, a preformed relatively heavy resistor member in said



tube, a plurality of spaced refractory members in said tube for holding integral and parallel-extending portions of said resistor member in proper operative positions therein, and a filling of granular electric-insulating and heat-conducting material in said tube. Four claims.

1,533,807. BOILER CONSTRUCTION. CHARLES V. PATERNO, OF NEW YORK, N. Y., ASSIGNOR, BY MESNE ASSIGNMENTS TO ELLIOTT COMPANY, OF PITTBURGH, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

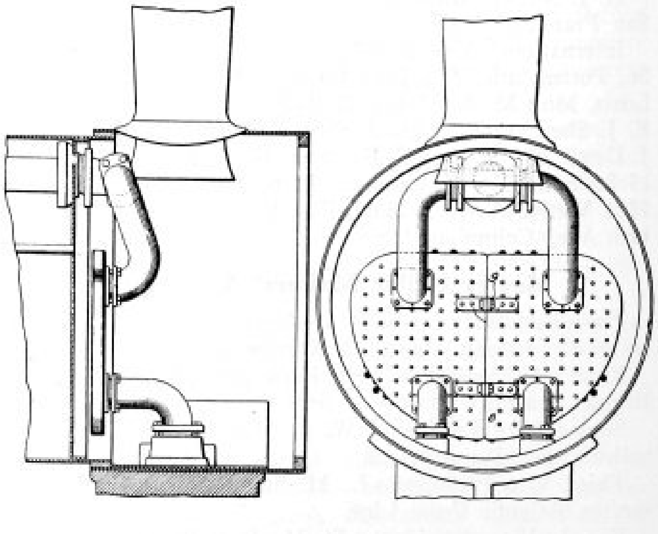
Claim 1.—A device of the class described, adapted for use with a tank, comprising a removable lining therefor adapted to react with the water



passing through said tank to remove the corrosive constituents from said water, said lining being made up of a series of tapering rings nested partially one within the other. Three claims.

1,534,402. COMBINED STEAM SUPERHEATER AND DRAFT-DISTRIBUTING DEFECTOR. TEODORO LARREY AND LUIS GODARD, OF MEXICO CITY, MEXICO.

Claim 1.—A steam superheater for boilers, comprising a hollow case dividing means in said case spaced from the front and rear walls thereof to form separate front and rear steam conduits or chambers, said dividing



means being marginally spaced from the peripheral wall of the case to provide a communication passage between the chambers thereof; piping for supplying saturated steam from the boiler to one chamber; and piping leading from the other chamber to deliver the superheated steam from the case for use, both the supply piping and the delivery piping opening through the same side of the case. Six claims.

The Boiler Maker

Volume XXIV 25 | September, 1925 | Number 9

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

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

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

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

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

CONTENTS

Procedure Control of Welding

THE leading article in this issue, describing procedure control in the fabrication of storage tanks by means of the oxy-acetylene process, outlines a system which constitutes a distinct advance in the art of welding. In developing procedure control the leading manufacturers of welding equipment and of the essential gases have recognized all the elements that go towards the making of safe welds and have arranged instructions covering these not only for the welding of tanks but also for many other forms of equipment where welding is employed.

Users of the process have recognized the fact that a successful welding job depends upon far more than the skill of the welder who does the work. It is vitally important to have an experienced and competent welder just as it is necessary to have an experienced and competent boiler maker when flanging or riveting a piece of tank steel. However, in either instance, the operator is only one of several essential factors. The whole organization must be arranged with a view towards the production of as sound and workmanlike a job as is possible by utilizing the methods installed in any particular shop. It is necessary for the entire organization to perform its duties conscientiously and there must be instilled in the minds of every member of the staff the fact that his sincere effort is necessary in order that the reputation of his firm may not suffer.

The completion of a satisfactory job in any boiler shop using any method whatever requires the intelligent attention of everyone from the president of the concern down to the apprentice. No shop could exist and prosper where practices were used which could be successfully covered from the eye of the final inspector—for the inspector can see no further on the inside of a riveted joint than he can on the inside of a welded joint. In either case, if the workman is competent, if the materials are properly inspected, if the design is right, if the job is set up properly and if the workman's technique is good, then the final test can be depended upon to indicate the excellence of the completed job. Otherwise there is always a suspicion that the work just passed and failure, partial or complete, would result on a moderate increase in stress over the approved test.

No agency in the welding field is better fitted to develop the proper methods and technique for carrying out any job of welding than the engineers and skilled operators employed by the equipment and gas manufacturers. In developing procedure control they have contributed a service to the field that will do more towards advancing the art in general than probably any form of isolated service could do. All the factors mentioned above that enter into welding production have been made a part of the study and preparation of procedure control and no one is of greater importance than any other. To obtain the best possible results all the factors must be properly balanced and coordinated—the result being a job that approaches the hundred percent mark.

It is hoped that further material on other phases and other applications of this subject will be available for later publication. Expressions of opinion on the value of this material from our readers will be appreciated.

Trade Associations Should Develop Business Statistics

DEVELOPMENT and proper use of business statistics by trade associations, along the lines laid down by the recent decisions of the United States Supreme Court, is strongly urged by the Department of Manufacture of the Chamber of Commerce of the United States in a bulletin just made public.

The bulletin starts out by saying that "for years trade associations have been faced with doubts about statistical activities in which they could lawfully engage. The members of many associations had come to fear that statistics of any kind were, in the opinion of prosecuting officials, inherently wrongful, when they related to economic activity, although in every other walk of life statistics were held in high esteem.

"In this situation the Supreme Court itself has granted relief. On June 1 it handed down its opinion in two cases brought by the Department of Justice against trade associations, holding that the statistical activities of these associations were lawful. Thus, these opinions serve to indicate for all trade associations that there is no violation of the federal anti-trust laws if they gather and distribute the essential business facts which the Supreme Court described.

"With the clearer understanding of this liberty under the law (which remains unchanged), there is no bar to the development and proper use of business statistics. This clearing of atmosphere should mark the passing of guessing as to the facts concerning our commodity production and distribution provided there is a willingness, at source, to supply the information. It is in the hands of each member of an industry to make possible complete and accurate figures for his line by his own contribution."

"It should be borne in mind," the bulletin goes on to say, "that the favorable rulings of the Court in the so-called 'Cement and Maple Flooring Cases' were based on the facts adduced in each case, just as their previous rulings in the Hardwood and Linseed Oil Cases, were predicated on facts obtaining in these cases the law remaining unchanged.

"With these rulings as a basis, trade associations will undoubtedly appreciate the opportunity of rendering to their constituency invaluable service by providing means for the gathering and reporting of statistics dealing with such important trade information as producing capacity, orders, shipments, stocks and markets as shown by prices on closed transactions.

SIMPLIFICATION OF ASSOCIATION FORMS

"In the renewing of statistical activities, it is timely to suggest simplification of methods and forms in order that the information which is found be obtained and presented as quickly and accurately as possible at the minimum of expense. Such uniformity will enable the transmission of information gathered in the form of charts or graphs when desired which is much less cumbersome than presenting great masses of figures. If uniformity of method is observed, it would greatly simplify the matter of not only charting a given line but also including such other lines as may be of collateral interest or important in comparing the trends of the industry. One of the important essentials of statistics is that they shall be fresh as well as dependable. A very encouraging number of trade associations are at present engaged actively in gathering and distributing such information and many others are familiar with the methods of doing so properly."

The Department of manufacture announced that it will cooperate with trade associations interested and will endeavor to bring about the contribution and interchange of information and experience which will prove of interest and value in this work.

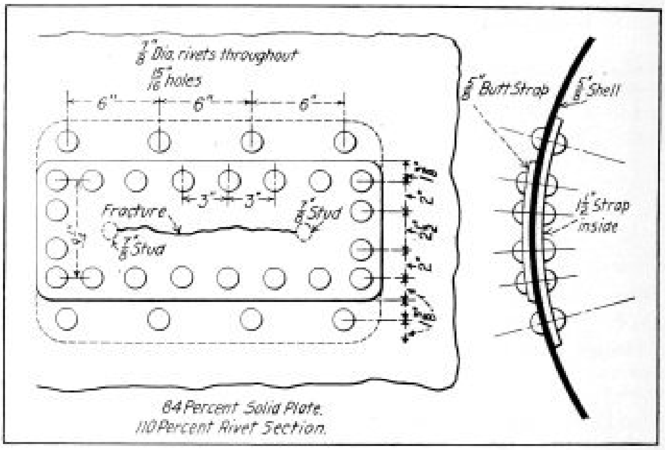
LETTERS TO THE EDITOR

Design for a Locomotive Boiler Barrel Patch

TO THE EDITOR:

ASSUMING that a fracture has occurred on the barrel of a locomotive boiler, the design of a suitable patch should be as nearly as possible in plate and rivet efficiency equal to that of the longitudinal seam, when the fracture runs longitudinally.

The wavy line in the center of the sketch shown herewith indicates the fracture. Proceeding to patch this up,



Method of repairing crack in boiler barrel sheet

the first thing to do is to put a stud at the extreme ends of the crack; rivet over and chip flush. The object of this is to prevent the crack from tearing further along the shell. The remainder of the instructions are explained by the sketch. This patch would be suitable for a high pressure boiler of almost any description.

Leeds, England. W. WILSON.

Why Do Boilers Explode?

IN the May issue of THE BOILER MAKER I was interested in an article under the above title and signed W. F. Schaphorst. Expecting to find such a vital matter as "why boilers explode" figured out and explained in detail, I settled myself down on the top of a 30-foot by 9-foot by 200-pound Lancashire boiler, which I was inspecting, and devoured the contents. I was amazed to find that the contents had nothing in keeping with the title, but was in reality an argument between the author and a gentleman of national importance as to whether a firetube boiler or a watertube boiler was more disastrous in explosion. The author of the article held that the former was more disastrous on account of its water capacity per horsepower, and the other gentleman claimed that he was wrong.

To satisfy himself Mr. Schaphorst inquired from a manufacturer whether a firetube boiler or a watertube boiler contained more water per horsepower and the reply came "beg to advise that a return tubular boiler will contain more water per horsepower than a watertube boiler." It will be fairly obvious that the argument was centered around the relative capacities of the boilers per rated horsepower, and the extent of damage done "if any" due to the quantity of water that each held respectively.

The question of pressure never entered into the debate, and we who have read the article are no better off now than we were before as to how, when, where or why boilers do explode, and we are all anxious to learn.

In my opinion boilers explode from one or a combination of the following circumstances obtaining, viz:

Deficiency of water
Defective steam gages
Defective water gages
Too high pressure for the construction
Defective feed valve
Choked water tubes
Defective safety valves
Defective steam stop valve
Collapse of furnace
Fractures and there are various lengthy explanations why boilers do explode.

Leeds, England. JOHN GORDON KIRKLAND.

Making Arch Tubes Tight

TO THE EDITOR:

THE request of subscriber "G. A. T." in the June issue for information regarding the possibility of welding arch tubes as a means of overcoming leakage, naturally calls up the question "why do these arch tubes in question leak?"

It is not my intention to engage in any controversy as to the advisability of welding arch tubes, but I have an idea that the Federal inspectors would object to it. From my own experience in the application and maintenance of arch tubes, which covers quite a few years, I find that for the securing of good service from arch tubes certain rules must be strictly adhered to.

The curvature of arch tubes in the various styles of firebox is so designed that the tube shall enter the holes at right angles with the sheets—both flue and door sheets. Whether we have one or two different bends in the tube, it is absolutely necessary that the tube be bent to conform strictly with this rule.

Next, we find that some classes of firebox call for an arch tube with a short bend coming within 8 to 10 inches of the flue sheet. This bend should be of such a radius that the effects of expansion and contraction shall be more evenly distributed.

The blue print may call for a 6-inch radius at the center line of the tube. In my opinion this is too short for two reasons; first, the short bend is not flexible enough; second, the inaccessibility for cleaning purposes. When the tubes are spaced closer together on the door sheet than they are at the flue sheet, the tubes have to be offset enough to cover the distance apart; so, if there is 3 inches difference, each tube would have to have an offset or bend of 1½ inches, commencing about 8 inches from the door sheet end of the tube and keeping in mind that the offset must be kept at right angles to the sheets.

In applying the tubes to the new sheets, the holes are drilled 1/32-inch larger than the outside diameter of the tube. When we are making renewals, if the holes are enlarged, it is better to apply a copper ferrule than to have to expand the tube beyond its elastic limit to make it tight. When the "life," to use a boiler maker's term, is rolled out of a flue, you will always have trouble with that flue.

With the sharp edges of the holes smoothed off and all scale filed off the end of the tube before applying, a good solid rolling given and the tube beaded over against the sheet, the chances are that the tubes will give good service, provided the water conditions are normal.

I would also suggest to "G. A. T." that if the staybolt should be very close to the bottom edge of the tube hole, he should examine the sheet carefully when the tube is removed, as there is a possibility of a very small check in the sheet above the staybolt, in which case a patch would have to be applied.

Lorain, Ohio JOSEPH SMITH.

Why It is Not Good Policy to Publish Prices

TO THE EDITOR:

EXCEPTION should be taken to the article published in the June issue of THE BOILER MAKER entitled "Why Not Publish Prices?" There are several reasons why it is not profitable or good policy to publish prices in catalogues and as there is no dire necessity for it the manufacturers are justified in withholding the printing of prices.

For the benefit of the writer of the article in question, let him take a copy of THE BOILER MAKER and see how many advertisers publish the price of their wares. He will not find two instances in the whole book. So if it is not the custom to publish prices of flues, machinery, etc., why should it be to publish boiler prices?

He states that the prospective buyer forgets his needs and that is an almost absurd accusation. Surely if the buyer were in need of a boiler, he wouldn't be very apt to forget it and could not lose interest for the inspectors in the field would not be very apt to forget or to let him forget.

Also the prices are constantly changing and it would keep the manufacturer busy having new catalogues printed every new moon. Also a prospective buyer might have a catalogue on hand and since the said catalogue was issued prices had been raised. The buyer having sent forward the amount he believed was right would be inconvenienced owing to the difference in price.

One can find a dealer in boilers in most any locality and can get the prices quoted in very short order. He does not have to wait very long either if he writes direct to the manufacturer for our mail service is very good nowadays.

The manufacturer is not a bit ashamed of his prices today for the average manufacturer knows that when he quotes a price to a prospective customer he is giving that customer the best product he can give him, but we will admit there are exceptions to the rule.

In conclusion, I would say that the writer's grounds are unfounded and that prices should not necessarily be published. This matter should be left to the discretion of the manufacturer. No sales are lost in omitting prices, that is if a buyer really wants the article he will purchase it regardless of whether he had prices quoted to him prior or had to write and obtain the price.

C. W. CARTER, JR.
Port Dickinson, N. Y. State Boiler Inspector.

High Pressures and How to Hold Them

TO THE EDITOR:

TODAY, with the economic demand for greater efficiencies, the engineer finds himself confronted with the problem of higher pressures and the increasingly difficult problem of how to hold them. When we are faced with a condition of 300 to as high as 700 pounds per square inch, we must realize that the difference from ordinary pressures up to 250 pounds cannot be compensated for alone by increasing the strength of the various members involved, but by increasing the degree of accuracy of the workmanship on those members. The design of vessels such as these is more difficult than in the ordinary vessel, but it is based on proved engineering principles, and can be depended upon for the factor of safety employed.

The execution of such a design, however, is a different matter. Heavier plates introduce new problems. By careful and intelligent inspection during melting, cropping, rolling and shearing, however, a manufacturer is quite assured of the quality of his plate material. Planing, drilling and reaming are mechanical operations requiring care but not involving the radical departure in fabrication that might be expected.

We now come to rivets and riveting, the final step in the assembly process. Bull riveting has reached a point where we can consider it almost an art because of the subtle skill of the modern operator. He knows his heat, his power and pressure and the time element necessary to a fine degree of precision. His skill, however, and the care and accuracy of his co-workers from the drafting room down to the bull riveter itself are entirely dependent upon the rivet in the hole. On this little piece of metal hangs the fate of the entire enterprise; it represents the difference between glowing, proud success, or dismal, profit-consuming failure.

A rivet may be considered as consisting of three parts, namely, the head, the shank and the driven head. Each part has its own functions and must perform them in co-operation with the other parts in order that the rivet fulfil its purpose satisfactorily. The two heads alone are useless without the tensile strength of the shank. They hold the plates together assisted by the shank and the gripping therefrom prevents the plates themselves from leaking. The shank furnishes the strength for the heads but does not in any other way assist in the gripping of the plates. Its other important function is to fill the hole. If it does not do this perfectly, a leak will be caused and the heads will not stop it.

Usually, when a rivet leaks, the manufacturer must resort to calking. Calking seals the head and will effectively stop seepage. At ordinary pressures this will suffice, but at high pressures, calking will not maintain the rivet's resistance to the leak. It may withstand the inspection test, but it will not withstand the test of service. The only way to seal a rivet hole permanently is to fill that hole completely. There can be no side-stepping of this issue and to fill completely means from one end to the other, entirely around the circumference.

Scale under the head will crack off and get into the hole, preventing perfect upsetting up to the surface of the plate. Scale cannot be tolerated. Fins along the shank interfere also. They are dense enough to resist compression, and the upsetting of the shank by great pressure has the tendency to force the fin into the body of the shank, thereby distorting the adjacent metal, producing a minute groove on each side of the fin. This condition eliminates the possibility of a completely filled hole and likewise cannot be tolerated.

The diameter of the rivet shank must be as close to the size of the reamed hole as possible. A clearance of 0.03125 inch is possible and practical, if the shank diameter is not within 0.0156 inch, or more than 0.047 inch of the reamer size. A slight out-of-round variation, not more than 0.0156 inch is permissible, as the bull riveter will have enough capacity to overcome that deviation in the upsetting process.

In conclusion, it will be seen that for vessels to withstand pressures of 300 to 700 pounds per square inch, design, workmanship and materials are of the utmost importance; of the last class, the rivets are the least, but most important element in the entire structure. They must be free from scale under the head, must have no fins or seams, must be concentric, must be round within 0.0156 inch and must not be less than 0.0156 inch under, or more than 0.0156 inch over the nominal size. With these requirements and the high class of skill and machinery available today, satisfactory high pressure vessels can be constructed.

THE CHAMPION RIVET COMPANY.

Cleveland, O.

NEW BOOKS

SHEET-METAL WORKER'S INSTRUCTOR. Seventh edition. First edition by Reuben Henry Warn. Seventh edition by Joseph G. Horner. Size, 4½ by 7 inches. Pages, 224. Illustrations, 412. New York, 1925: D. Van Nostrand Company.

This book deals with practical rules for describing the various patterns employed by zinc, sheet iron, copper and tin plate workers. Chapters I, III and VII give the preliminary details for developing the forms required for a great number of sheet metal jobs—based on geometry and mensuration. These are followed by the actual projection of patterns. The behavior of metals and their properties are dealt with in two chapters. Following this numerous forms of joints are described and illustrated with methods of union, tools used and appliances. The subject of all possible developments is far too extensive to be covered in one volume but the essential principles are given which have wide applications. Many forms which appear to be difficult when first approached are found to be extended applications and modifications of the simpler problems as given.

SHOP HANDBOOK ON TOOL STEEL. By G. Van Dyke. Size, 4½ by 7½ inches. Pages, 80. Numerous illustrations and tables. Chicago, 1925: Published by Joseph T. Ryerson & Son, Inc.

This book treats of a technical subject in a non-technical way for purchasing agents, shop superintendents and tool makers. The lack of understanding of tool steel hardening results every day in losses which are far greater than the average tool hardener realizes. These losses cover not only the value of the steel itself but also the labor which has been expended on the tool prior to hardening as well as the loss of time and production in the shop. It has been the writer's object to outline in this book the various elements in the hardening process that result in loss when not properly controlled.

The book is divided into four parts, the first outlining the selection of the proper steel for a given job; Part II gives the heat treatment of tool steel; Part III gives the specifications and uses for Ryolite tool steel and Part IV contains tables and general information on heat treatment.

A. S. M. E. Meeting

The American Society of Mechanical Engineers will hold a regional meeting on October 5, 6, 7 at Altoona, Pa. As the technical sessions will relate to transportation problems, a more appropriate surrounding for the meeting could not have been selected as the large manufacturing and repair shops of the Pennsylvania System are located at Altoona. Those attending he convention will be favored with the opportunity of visiting the Altoona shops, particularly the new $2,000,000 locomotive repair shop which has been completed within the last two years.

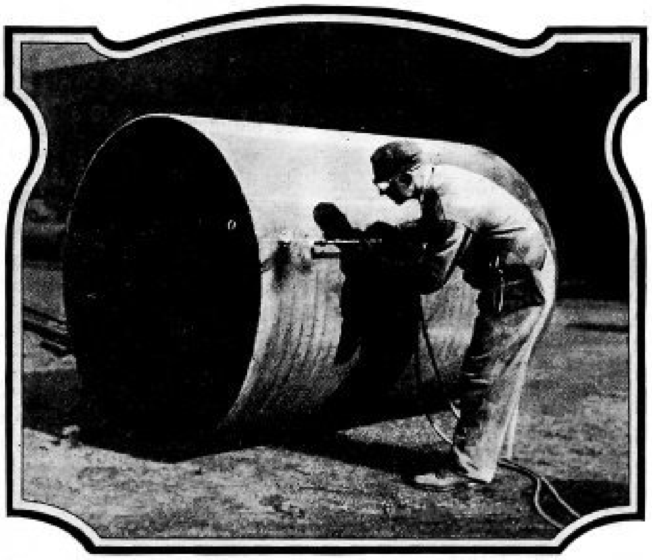
Meeting of General Foremen

The twentieth annual convention of the International Railway General Foremen's Association was held at the Hotel Sherman, Chicago, September 8 to 11. Among the interesting topics considered were automatic train control; supervision of repairs of special appliances such as boosters, reverse gears, etc.; straight line or spot system of car repairs and routing system to increase locomotive shop output.

Procedure Control in Welding a Storage Tank*

A summary of considerations involved in fabricating a tank of 3/16-inch plate, to hold 1,500 gallons of fuel oil under gravity pressure

SINCE experience has shown that real advances in oxwelding have always been associated with the possession of adequate information on several phases of the work, the following detailed data have been assembled so that the shop executive can be assured of success if he follow their plain implications. It will also emphasize the undoubted fact that welding, like any successful manufacturing operation, involves far more than a skilled workman. The workman is, of course, an essential link of the chain, but it is also necessary to pay much attention to other links, no less essential, such as sound metal, efficient equipment, proper design of joint, proper inspection and supervision, and adequate testing.



Welding the longitudinal seam

A. Check on the Welders

1. *Experience.*—The welders shall be experienced on plate welding and preferably on welded tank construction.

2. *Qualification Test.*—All welders must first successfully pass a qualification test, as follows:

The qualification test should consist of welding together two pieces of plate under the supervisor's observation. The plates should be prepared with a single 90 degree vee and should each be about 9 to 12 inches, the 12-inch side being beveled. The thickness of the plate should be equal to or greater than the thickness of the plates used in construction of the tank. The welder should be allowed to follow his own ideas with regard to size of tip, flame, welding rod and method of welding, the observer noting whether correct practices are being followed. Time allowed to make test welds should fall within the limits set for production work.

The plates should then be cut into strips 2 inches wide, torch cutting permissible. The strips should be clamped on a heavy anvil, or in a large vise, with the bottom of the vee at the top of the anvil or level with the vise jaw.

Three of the specimens should be bent forward or with the top of the vee on the convex side of the curve (top of the vee in tension) and should stand bending to a right angle without fracture. Three specimens should be bent backwards, or with the bottom of the vee on the convex side of the curve, until fracture occurs. The fracture will give a good idea of the ability of the welder, with regard to penetration and thorough fusion, and the fusion and the appearance of the weld metal will show his neatness and skill. The fracture of a good weld will show complete penetration, thorough fusion, no gas pockets, cold shuts, laps or other defects.

If facilities are available, tensile test pieces of the weld should be cut and tested; the tensile test should show not less than 40,000 pounds per square inch tensile strength.

B. Selection and Inspection of Material

1. *Plate Specification.*—The plate material should be of low carbon steel (carbon maximum 0.20). The steel should be free from appreciable quantities of non-metallic inclusions and laminations and should be of good weldable quality.

The plates should be sheared square to correct dimension, as this is of the utmost importance for ease of welding and appearance of the product.

The plates should be punched or drilled for the necessary outlets and connections before rolling. (Note: If holes are needed in shell and heads for any purpose after assembly, they may be made with a cutting torch, provided the cut surfaces are cleaned by chipping, filing, or by some other process that will insure the entire removal of the cutting oxide; and provided they are true, round and of proper size.)

The head plates should be flanged; the length of the flange should be not less than 1½ inches.

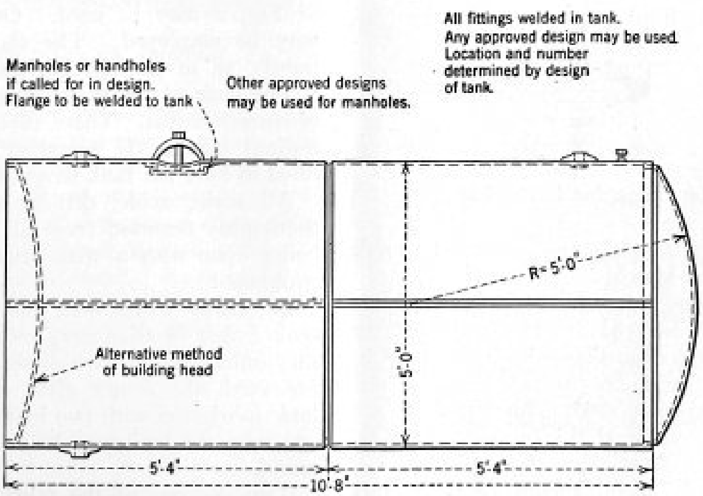


Fig. 1.—A typical tank

The head plates may be flat or dished. If dished the radius of curvature should be equal to the diameter of the tank. If flat heads are used they should be braced.

2. *Welding Rod.*—A welding rod of low carbon content (American Welding Society specifications or equal) that will flow freely and without detrimental action is recommended.

C. Design and Layout of Welded Joints

1. *Beveling Plates.* —

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The edges of the plates to be welded should be beveled to 45 degrees for full thickness of plate. Beveling of only one of the abutting edges is permissible, Fig. 2.

Any beveling done with cutting torch should be properly cleaned and all oxide removed by hammer and chisel or file.

2. *Spacing On Longitudinal Seams.*—The abutting edge of the longitudinal seams should be separated about 3/32-inch at the end where the welding of the longitudinal seams start, the separation of the edges increasing with the distance from the starting end. The separation of the edges

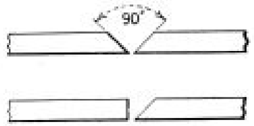


Fig. 2.—Preparation of edges for welding

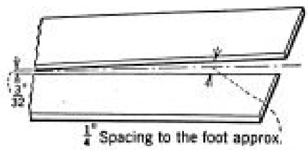


Fig. 3.—Spacing at plate edges

should increase about 2½ percent of the length of the seam to be welded, or an allowance of about ¼ inch to the foot, Fig. 3. This is to allow for the contraction of the cooling weld as the welding progresses from the starting end. (NOTE: The exact distance that the edges should be separated to allow for contraction is influenced by the length of the seam, the rate of welding, the application and intensity of the welding heat, etc., and can

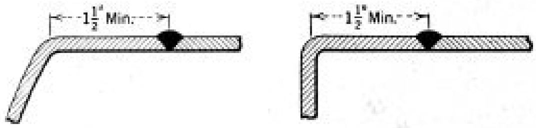


Fig. 4.—Depth of flange for butt welds

be accurately determined only by welding conditions during the fabrication of the tank.)

3. *Girth and Head Seams.*—For all girth and head

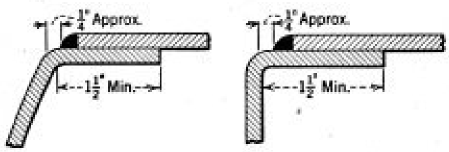


Fig. 5.—Position of flange for lap welds

seams, made with a butt weld Fig. 4, the edges should be separated about 3/16 inch before tacking.

For heads concave to the fluid pressure and flange in-

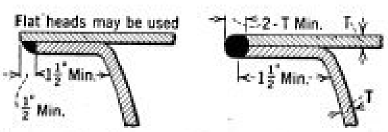


Fig. 6.—Position of flange for lap welds

serted inside the shell Fig. 5, the lap weld should be made about ¼ inch back from the knuckle.

Heads convex to the fluid pressure should be inserted into the shell about ½ inch in excess of the full length of the flange Fig. 6. As an alternative method, the heads may be inserted until the edges are even, but in welding with this method sufficient filler metal should be added to insure a weld equal in depth to the combined thickness of the shell and flange.

4. *Weld Metal.*—The weld metal should be thoroughly fused with the base metal at all sections of the weld.

As to physical characteristics, the weld metal should be thoroughly fused and free from laps, cold shuts, gas pockets, oxide inclusions or other defects that may affect the quality of the weld.

The width of the weld should be a minimum of 2½ times the thickness of the plate.

The weld should be reinforced about 25 percent; for 3/16-inch material about 3/64 inch.

5. *Location of the Longitudinal Seams.*—In welding

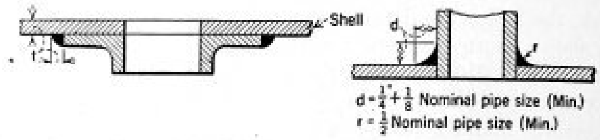


Fig. 7.—Details of Connections

sections of the shell together, the longitudinal seams should be staggered, preferably about 180 degrees apart.

6. *Welds for Connections.*—Two methods of attaching nozzles, threaded connections, hand-holes, flanges, etc., are shown in Fig. 7. An accessible drain plug should be welded in the bottom of the tank. The dimensions of the lap welds and fillet welds attaching fittings and connections to the tank are shown in the sketches.

D. PREPARATION OF THE PLATES FOR WELDING

1. *Longitudinal Seams.*—The plates, after being properly squared and rolled, should be placed on a solid and level base. The edges of the plates should be separated about 3/32 inch at the end where the welding is to begin. The other end or finishing end of the seam should be separated a distance equal to about ¼ inch per foot of seam length

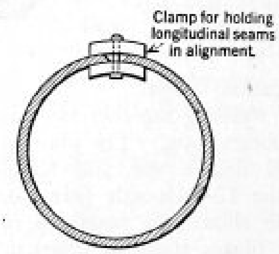


Fig. 8.—Alinement clamp

(see paragraph 2 under "Design and Layout of Welded Joint," above).

The edges of the plates should be held in line and to a true circle of correct curvature by jigs. The clamp shown in Fig. 8 may be used. Other suitable clamping devices may be employed. The shell should not be clamped so tightly as to prevent horizontal contraction of the plates.

The ends of the plate should line up true and to a circle of correct radius. There should be no flat spots at the longitudinal seams. If necessary, internal forms should be applied to hold the tank to a correct curvature.

All scale, oxide, dirt or other foreign matter should be thoroughly removed from all edges before welding, cleaning being done with a wire brush or with some other suitable equipment.

2. *Girth Seam.*—In the fabrication of a 1,500-gallon tank 5 feet in diameter, a center girth seam will be necessary unless special size plates are used. If extra large plates are used, the center girth seam may be omitted and the tank fabricated with two longitudinal seams. If small plates are used, the tank may be fabricated with two or more girth seams.

Two sections of the fabricated shell should be lined up perfectly straight in horizontal and vertical planes to form the completed shell of the tank. Rollers may be used for this purpose.

In lining up the section the longitudinal seams should be staggered (see under "Design and Layout of Welded Joint").

The abutting ends of the section should be concentric. The edges should line up reasonably straight. Slight eccentricity or offsetting of the shell sections should be avoided by springing the shell. This can be done in several ways. Timber placed at one end of the longer axis with a chain fastened to each end of the timber and extending over the shell can be used to spring the shell to the shape desired by driving wedges between the chain and the shell. A jig consisting of two timbers, angles, or channel irons with a heavy screw in one of them, can be used in the same way. Spreaders or jacks, or timber with wedges, can be applied inside the shell.

The ends of the shell sections should be spaced about

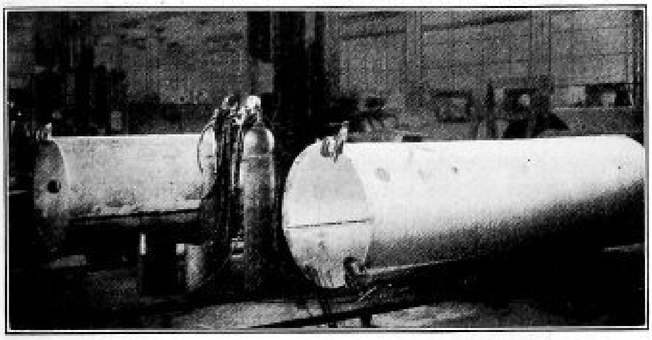


Fig. 9.—Sheets clamped in place for welding

3/16 inch apart, this to prevent sheets from lapping during welding. Spacing must be sufficient to accomplish this (see under "Design and Layout of Welded Joints").

After the sections are lined up and properly spaced they should be tacked, preferably by two welders welding 180 degrees apart on the circumference. The tacks should be

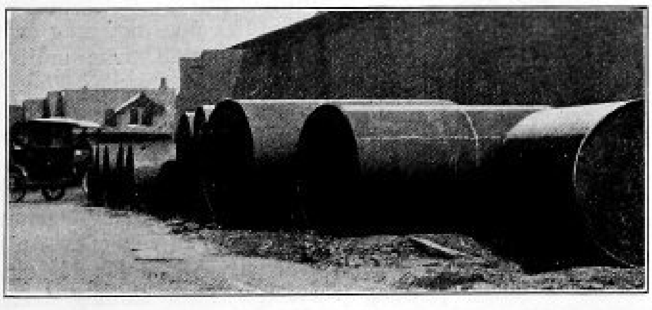


Fig. 10.—Finished tanks ready for shipment

spaced about 9 inches apart. The sequence of tacking should be first to tack at the quarter points and then at points midway between the completed tacks until the proper spacing between tacks is obtained. The purpose of tacking is to hold the section in alinement and to partially control the spacing between edges. The tack welds need not be greater than $\frac{1}{2}$ to 1 inch in length without reinforcement. In welding the seam, the tacks should be melted out and rewelded.

3. *Head Seams.*—Heads attached to the shell by a butt weld Fig. 4 should be spaced and tacked for welding in the same manner as that described above for welding the center girth seam.

Heads concave to the fluid pressure with flanges inserted in the shell Fig. 5, should fit tightly in the shell. The shell and flanges should be sprung if necessary. The flanges should be inserted into the shell until the knuckle of the

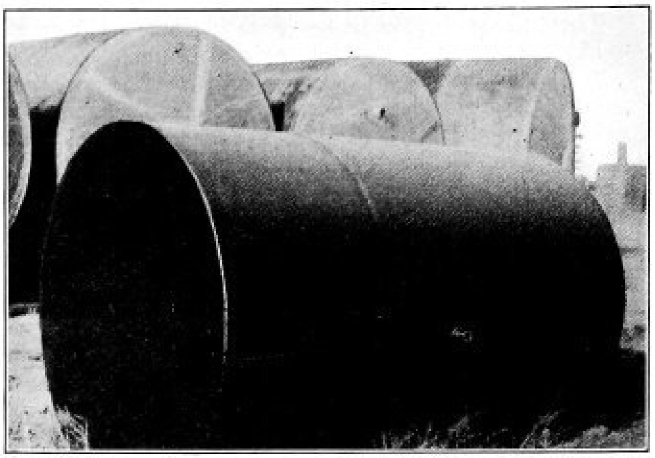


Fig. 11.—Welded tanks present nearly as smooth a surface as solid metal

flange is about $\frac{1}{4}$ to $\frac{3}{8}$ inch from the edge of the shell. The head should be tack-welded with a sufficient number of tacks to hold the head in position for welding.

Heads convex to the fluid pressure Fig. 6, should fit the shell tightly and be inserted preferably in excess of the full length of the flange. (The head should be tack-welded with a sufficient number of tacks to hold the head in position for welding.)

E. Welding Technique

1. *Longitudinal Seams.*—The rolled plates can be lined up, spaced and clamped for welding by welder helpers. The operator shall start welding the longitudinal seam at the end where the edges are spaced 3/32 inch and weld continuously until the longitudinal seam is completed.

The operator must watch and control the contraction of the edges of the plates and see that the spacing of the edges at the point of welding is maintained the proper distance throughout the welding of the full length of the seam. Wedges or pinch bars may be used, if necessary, to insure that plates draw together properly as welding progresses.

The shell should be reasonably round with no flat spots at the seam after welding.

If the welding has to be stopped for any reason, the welder shall re-heat the weld on restarting to a dull red for an overlapping distance of at least 3 inches and shall re-melt and reweld into the previously welded portion.

The tip sizes and gas pressure should be those specified in the tables furnished by the equipment manufacturer.

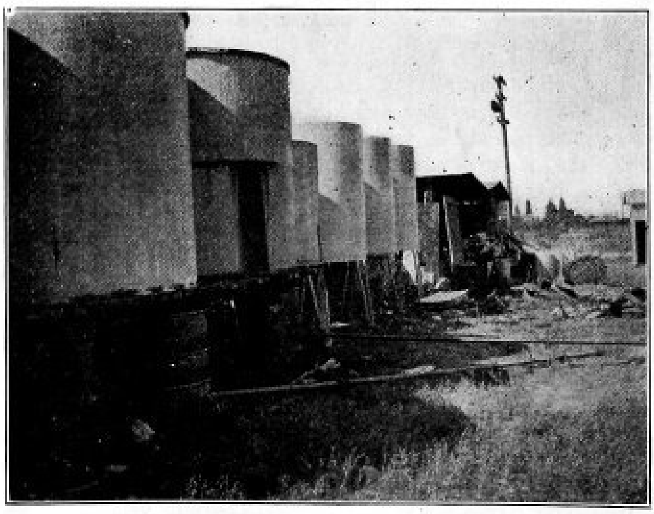


Fig. 12.—Battery of all-welded oil storage tanks

The type of weld may be either a ripple weld or a flat weld.

2. *Girth and Head Seams.*—The welders, welding at points 180 degrees apart on the circumference, should tack weld the heads to the shell. (See under "Preparation of the Plates for Welding" above.)

The welding of the seams should be done in the upper quadrant of the tank if possible, the tank being rotated so that the welding is always done in a position convenient to the operator.

The welder should re-heat the weld at all starting and finishing points to a dull red for an overlapping distance of 3 inches, and at the points where the weld ties into a previously welded portion the welder should re-melt and re-weld thoroughly.

All tacks should be melted out and re-welded.

3. *Special Fittings.*—All special fittings and pipe connections can be welded into the shell after the shell sections are fabricated. Fittings requiring welding on the inside of the tank must necessarily be done before heads are attached. Fittings required in heads can be welded after the edge of the head has been beveled.

As the tank is not subjected to pressures other than the weight of the fluid, the welds need not be tested for tensile strength, but the tank should be adequately tested for pinholes and leaks. One test that may be used is to subject the tank to a very small hydrostatic pressure of one or two pounds. The welds may be subjected to a hammer or impact test while under this pressure. This impact test should consist of striking the sheet on both sides of the weld a sharp vibratory blow with a 1½-pound hammer. The blows should not indent or distort the metal of the sheet.

Another test that may be used is to subject the tank to an air pressure test of about one pound, and apply soap and water over each seam and around each fitting to locate pinholes and leaks. The air pressure should not be built up excessively in this test and some safety measure should be taken to insure this. A simple device that may be used is to connect a hose or piping to one of the fittings and submerge the open end of the hose or pipe in water to a depth of approximately 2½ feet. The water seal thus formed is sufficient to retain the slight testing pressure required and also serve to release any excessive pressure.

Should the test reveal any leaks, the defective sections of the welded seam should be chipped or melted out and re-welded and a further test applied.

Bench Vise Made of Steel Drop Forgings

UNDER the trade name of "Dropfo," a vise that is made entirely of drop forgings, excepting only the handle, is now available. Each part is machined to be interchangeable with the same part on any other vise of the same size. The jaw plates are knurled and forged under the hammer and doweled onto the jaw. Thus it is possible to replace the jaw plates, which are naturally subject to wear.


Dropfo vise

The Dropfo vise is lighter in weight than the old-fashioned cast iron type. It is made with a swivel base and wedge lock that is quick to set and automatic in tightening up, and has a grip that cannot shake or break loose. It is also made in the stationary type.

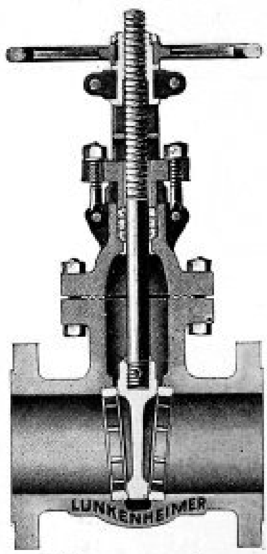
The Dropfo vise is made in four sizes: 3-inch with jaws opening 5½ inches; 4-inch with jaws opening 6 inches; 5-inch with jaws opening 8 inches; and 5-inch heavy duty with jaws opening 8 inches.

Each vise is sold under a full and unconditional guarantee on each part excepting jaw plates. The vise is manufactured by The Fulton Drop Forge Company of Canal Fulton, Ohio.

Lunkenheimer Develops New Line of Iron Body Gate Valves

THE Lunkenheimer Company, Cincinnati, Ohio, has released to the market an entirely new type of iron body gate valve containing special structural features. The valves are made in two types, stationary stem, inside screw and rising stem, outside screw and yoke. Either type is available in the standard pattern for 125 pounds working steam pressure or in the extra heavy pattern for 250 pounds, the total temperature being 450 degrees F.

All parts of the valve are renewable, including the seat rings. Attention is directed to the manner in which the seat rings are held in place as shown in the illustration. These rings are solidly backed by the walls of the body, thereby preventing any possibility of their becoming loose or being wedged out of place. The ribs, which act as guides for the disk and which are cast integral with the body, are machined as are also the grooves in the disk which engage the ribs. Side play of the disk is thus controlled by the finishing process and consequently the disk does not drag on the seats nor touch them until the valve is fully closed. The disk of the inside screw stationary stem pattern is hollowed out only to an extent sufficient to receive the stem. That of the outside screw and yoke rising stem pattern is solid throughout. An exceptionally big stuffing box provides a large packing surface. This stuffing box is repackable under pressure when the valves are wide open. Two lugs are provided within the yoke arms directly above the stuffing box gland. When it is necessary to repack the valve the gland is raised above the lugs and, by slightly turning it, the flange on the gland will rest upon these lugs, thereby dispensing with the usual method of tying up the gland while the stuffing box is being repacked.



New gate valve

Face to face dimensions of the flange end valves are what is generally accepted by the trade as standard. Therefore, replacements can be made without alteration of pipe lines. These new gate valves are regularly furnished with the body, bonnet, yoke and gland of iron and with the stem, disk faces, seats and yoke gland and stuffing box bushings of bronze.

Arthur Jackson, 32 Glenholme avenue, Toronto, Ontario, has been appointed sales representative for Ontario and Eastern Canada of the Gibb Welding Machines Company, Bay City, Mich.

Caustic Embrittlement of Boiler Plate*

The present status of investigation and research into this abnormal phenomenon of boiler operation

SEVERAL comprehensive studies of the phenomenon of caustic embrittlement have been made, while others are still under way in different laboratories. The phenomenon of crystallization and cracking of boiler plate at or near the seams—not due to corrosion or wasting away of the plate but rather from some very different action—has been observed and known for upwards of 30 years. The effect was first noticeable in the unexplainable leakage at the joints of certain boilers, followed in certain instances by explosions. In many such cases it was found possible to save the boiler by replacing the cracked sheet or head. These earlier experiences, wherever studied, were found to be characterized by the fact that: (a) they were experienced in distinct geographical districts; (b) the effect on the plates was in all cases below the water line; and (c) they practically all occurred in boilers using artesian well water.

During the past 10 or 15 years more pronounced examples of this trouble have arisen which have indicated that it may under certain circumstances prove a dire menace to the safety of boilers. In one case a new watertube boiler drum cracked from end to end, practically its full length, after only six months of use. In other cases it has been found that upon detection of this trouble in one boiler, further examination has revealed all the other boilers in the same plant have been similarly affected and their joint and shell strength greatly reduced. A common indication of this phenomenon of crystallization is the snapping off of rivet heads at the joints affected, which occurrence is usually accompanied by serious leakage. The rather mysterious and almost spectacular nature of these troubles have disturbed both manufacturers and users of boilers alike, and the manufacturers of the boiler plate are taking a keen interest in the investigations now under way.

Same Trouble Experienced on Naval Vessels

In addition to the above-mentioned troubles with land boilers, a very similar series of experiences have been noted with the boilers on certain vessels of the United States Navy where the usual care had been given to the boilers and condensate water only had been used in them, which was influenced only by possible slight condenser leakage and the use of boiler compound. In these cases, the characteristics of the cracking were practically identical with those of the previously mentioned cases. In the investigations that followed, it was determined that the boilers in which this trouble had been found had been subjected to heavy treatment with the boiler compound and the concentration of soda was blamed for the trouble. In similar vessels with identically the same boilers, where less compound had been used, no such trouble had been experienced.

In 1912, difficulties of this character with the boilers in the power plant at the University of Illinois at Urbana led to an investigation of the phenomenon from both chemical and physical viewpoints. This investigation attracted a great deal of attention, as this cracking trouble had then been experienced in three distinct localities in the Mississippi River valley where artesian well water was used in boilers. As it had then been pretty thoroughly established that the trouble was of a local character and had no apparent relation to the composition or characteristics of the steel plate, the analysis developed into a study of the embrittling effect of certain chemicals when brought into contact with steel and iron in such a manner as to set up a chemical reaction.

Conditions Common to All Cases

It may be interesting to note that certain conditions had been found to attend all of the cases where cracking of boiler plate had been experienced. To enumerate this it may be stated that the peculiar cracking of the plate occurred:

a. Below the water line.
b. In connection with leakage at seams and rivet holes.
c. Accompanied by an exterior accumulation of incrustation of strongly alkaline character.
d. Where the water employed contained a very considerable amount of caustic soda (NaOH).

The experiments, as a result of this general agreement in the conditions, were directed toward determining the effect of caustic soda upon steel or the indirect effect of hydrogen resulting from such action. In general there seemed to be sufficient data for concluding that:

a. Caustic soda of sufficient strength attacks iron with the generation of hydrogen. Indicating the reaction with the hydroxyl ion only, we would have $3\,Fe + 4OH = Fe_3O_4 + 4H$.
b. Hydrogen in the nascent state, whether generated by alkali or acid, enters into the texture of the iron in a way to modify its physical properties.
c. The hydrogen effect, at least in its first application, is transient, and after a period of rest or freedom from the hydrogen action, the iron reverts to its normal condition.
d. Sodium carbonate is without action on iron; there is, therefore, no generation of hydrogen. The hydrolysis of sodium carbonate is directly dependent upon the temperature maintained, the withdrawal of the vapor of CO_2, and the admission through the feed water of carbonated water. It is evident, therefore, that the chemical activity would vary with the ratio of hydrolization or the degree of concentration of the sodium hydroxide.
e. Certain accompanying salts, as the chromates, have an inhibitive effect. Other salts, as sulphates, have at least the effect of acting as diluents. The limits of concentration for maintaining a condition which would be below the danger point have not been studied, but are features of the case which are of the utmost importance.

Results of Investigation at University of Illinois

The investigation at the University of Illinois which was conducted by the Engineering Experiment Station, as related in Bulletin No. 94, issued January 1, 1917, was directed toward the effect of caustic soda on iron and the embrittling action of sodium hydroxide on soft steel. The details of the tensile tests, the impact tests and the alternate bending tests are interestingly described in the above mentioned bulletin of which Prof. S. W. Parr was the author. The results of these tests were tersely summarized by Paul D. Merica in an article in *Metallurgical and Chemical Engineering*, of May 1, 1917, as follows:

"It has been shown that alkaline solutions, such as those of NaOH, act upon steel of low carbon content at higher temperatures in such a way as to produce brittleness of the steel as indicated by the alternating stress and the impact test, not noticeable in the tensile test however. The brittleness is probably due to the absorption of 'nascent' hydrogen by the steel forming a less ductile or tough 'alloy' with the hydrogen; it is relieved by annealing even at low temperatures. The effect of alkalis on steel is discussed in relation to the failures of boiler plates at the seams, occurring in localities where the water contains sodium carbonate; it is believed that these failures are due, at least in part, to this effect.

"If such be the case, the elimination of such failures resolves itself into the question of the elimination of the alkali from the

*Paper presented before annual meeting of American Boiler Manufacturers Association, Watkins, N. Y., June, 1925, by committee consisting of C. W. Obert, chairman; C. W. Edgerton and A. G. Pratt.

boiler water, or at least from the seams of the boiler. This could be done by the addition of ferrous or magnesium sulphates which would precipitate the carbonate or hydroxide in the water. It is also shown that the action of the alkali is to a large extent inhibited by the presence of sodium chromate, such that this substance could be advantageously used as an addition to alkaline boiler waters exercising this effect on the seams of the boiler plate."

Professor Howe's Deductions

Prof. Henry M. Howe of Columbia University, one of the foremost metallurgists in the United States, carried out an investigation into this problem early in 1914 and in his report he commented on this phenomenon as follows:

"The mere fact that the cracks are confined to the part of the drum below the water level, and that they are invariably on what we might call the dry side of the rivets, is sufficient to show that some special conditions of service have caused these cracks and this brittleness. The brittleness arises in service and not in the preparation of the boiler. It would hardly seem possible to punch and assemble the boiler plates, if they were in this brittle condition and nothing was done to them. . . . subsequent to this punching which would cause this brittleness. Therefore, the brittleness must have arisen in service."

In a plant manufacturing caustic soda, an interesting experience was had about 1911 in an attempt to boil the caustic liquor directly in a boiler. The result was, however, that the drums simply cracked to pieces and it was necessary to give up the project. The boiler used for this purpose was a Babcock and Wilcox longitudinal drum header type boiler.

Conclusions Reached at the Massachusetts Institute of Technology

Another important investigation of this abnormal type of failure in mild steel characterized by intercrystalline cracking has for sometime been under way at the Massachusetts Institute of Technology, and Dr. R. S. Williams, Associate Professor, and V. O. Homerberg, Instructor in Metallography, have reported upon their investigations in a paper before the Boston Chapter of the American Society for Steel Treating, as follows:

"The results obtained from the tests lead to the following conclusions with regard to the intercrystalline cracking of steel under the influence of caustic solutions:

"1. During the crystallization of steel, the impurities, to a considerable extent, are rejected to the grain boundaries.

"2. The oxides and sulphides are two of the prime factors in caustic embrittlement.

"3. The oxides are reduced under the influence of cathodic hydrogen.

"4. The sulphides are removed due to the action of hot caustic soda solutions.

"5. The removal of the sulphides produces a surface condition favorable to progressive corrosion.

"6. Assuming that progressive corrosion starts with the removal of the sulphides, the corrosion will be greatly accelerated if the material is stressed. Furthermore, when the steel is under tension there is a tendency for the matrix to pull away from the inclusions at the grain boundaries and in this manner to produce small capillaries into which the corroding solution can penetrate.

"7. In stressed areas containing oxides, the volume increase due to the reaction with cathodic hydrogen, may produce stresses which, added to those initially present, may cause cracking.

"8. It seems evident that hydrogen acts in three ways to produce embrittlement; *first*, the temporary brittleness caused by absorbed hydrogen (as in acid pickling); *second*, it acts to reduce oxides; and *third*, its effect, due to the change in volume at the grain boundaries, resulting because of the production of water. This latter volume increase would create a stress which, added to those originally present, may cause cracking, especially at those points where these stresses are at a maximum."

Similar Experiences Occur Abroad

This country has not been alone in the experiences with the phenomenon of intercrystalline fracture in boiler plate. It has been detected in connection with the operation of boilers in many parts of Europe. C. E. Stromeyer, chief engineer of the Manchester (England) Steam Users Association, has investigated this phenomenon quite comprehensively and reported thereon to his association. Other boiler authorities, in both England and on the Continent, have investigated and expressed opinions on its occurrence and preventative measures therefor. A comprehensive investigation from the chemical standpoint was made by Stead and Carpenter, as reported in the *Journal of the Iron and Steel Institute* in 1913. Perhaps the most interesting of the several foreign investigations is that reported upon by J. H. Andrew, Research Fellow and Demonstrator of Metallurgy at the University of Manchester, which was communicated to the *Transactions of the Faraday Society* in December 1913. Prof. Andrew's conclusions are as follows:

"Wrought iron when immersed in a concentrated solution of caustic soda corrodes slowly, becomes highly crystalline, and eventually brittle.

"It has been suggested that the corrosion is due to the iron being constituted of two phases, a crystalline and an amorphous phase.

"When a duplex metal of this nature is immersed in an aqueous solution of caustic soda, electrolysis sets in, iron going into solution at the anode and hydrogen being liberated at the cathode, while sodium ferrite is formed in the solution.

"The hydrogen, after giving up its charge at the cathode, is partially liberated and escapes and is partially occluded by the metal.

"It is the occlusion of, and diffusion into, the interior of this hydrogen which brings about crystalline growth and brittleness in the metal, the hydrogen being first absorbed by the amorphous plate which exists between the crystals, thereby forcing the crystals apart.

"When both the amorphous and the crystalline metal have become saturated with hydrogen, or partially saturated, the potential difference between the amorphous and the crystalline metal will drop, with the result that the rate of corrosion will diminish.

"The initial brittleness of the iron decreases with time, and equilibrium between the metal and the gas being finally established.

"The brittleness is due rather to the molecular rearrangement brought about by occlusion or evolution of hydrogen than to the mere presence of hydrogen in solution.

"The passivity of iron produced by immersion in caustic soda is due to the small potential difference between the hydrogenized amorphous and hydrogenized crystalline phases.

"Precisely the same effects were noticed when using electrodeposited iron. If, however, the metal be previously charged with hydrogen, the rate of corrosion is less, proving that the rate of corrosion is dependent upon the hydrogen content.

"A 0.5 percent carbon steel is affected to a much less degree by caustic soda solution."

There has been much speculation as to what recommendation, if any, the Boiler Code Committee of the American Society of Mechanical Engineers might have to offer in regard to this troublesome phase of boiler operation. The committee has given the problem some consideration, but in view of the lack of authentic data concerning the phenomenon and the incomplete condition of the various investigations now under way upon it, it has been found impossible to dispose of the question with any definite recommendation as yet. A notation thereon which may be of interest to the members of our association has been inserted, however, in the new Section VII of the Code entitled: Suggested Rules for the Care of Power Boilers, in which there appears in the Appendix, relating to Feedwater Analysis, Treatment and Control, the following under Paragraph CA-5.

"Where feedwaters contain free soda as bicarbonate, carbonate or caustic, it is recommended to establish a relation between the total alkalinity in the boiler in terms of sodium carbonate and the sodium sulphates as follows:

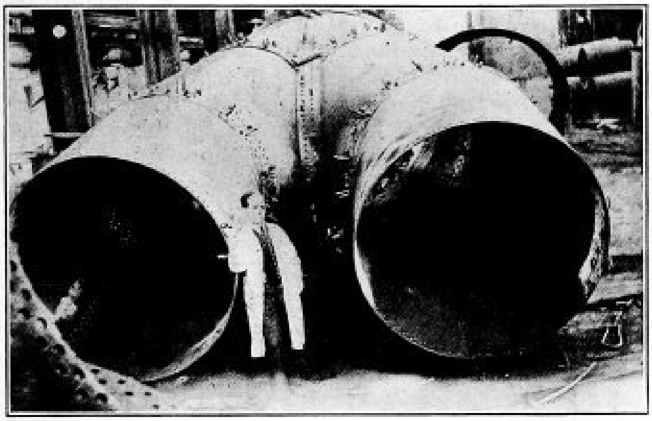
"For working pressures of 150 pounds and under, alkalinity not to exceed the sodium sulphate; for working pressures over 150 pounds and under 250 pounds, alkalinity not to exceed ½ the sodium sulphate; for working pressures of 250 pounds and higher, alkalinity not to exceed ⅓ the sodium sulphate.

"NOTE—The theory has been advanced that in the absence of sulphates in the boiler water, sodium hydroxide formed in the boiler saline may, by some corrosive action, accelerate the formation of cracks in overstressed material. This theory is based on the following facts: Cracks have been found in leaking riveted seams of a small number of steam boilers fed with natural artesian well waters high in sodium carbonate and very low in sulphates, and in certain geographical districts in some boilers fed with condensed steam from caustic evaporators, and in some boilers fed with water distilled from sea water to which considerable amounts of sodium carbonate were added. Others contend that such cracks may be entirely explained by faulty material of excessive internal stresses in the plates resulting from the manufacture or the operation of the boiler and by incorrect thermal or mechanical treatment of the plates, or by several of these causes combined. Nevertheless, the adherents of this theory suggest the maintenance of this sodium sulphate—carbonate ratio stated in Par. CA-5 in the hope that it will be beneficial and will help to decrease the number of cracks in riveted seams. Whether the control of the sodium sulphate-carbonate ratio will produce the desired results is a matter which experience over a considerable period alone can tell, and CA-5 is therefore suggested, pending the collection of further experience."

An Unusual Great Y Branch

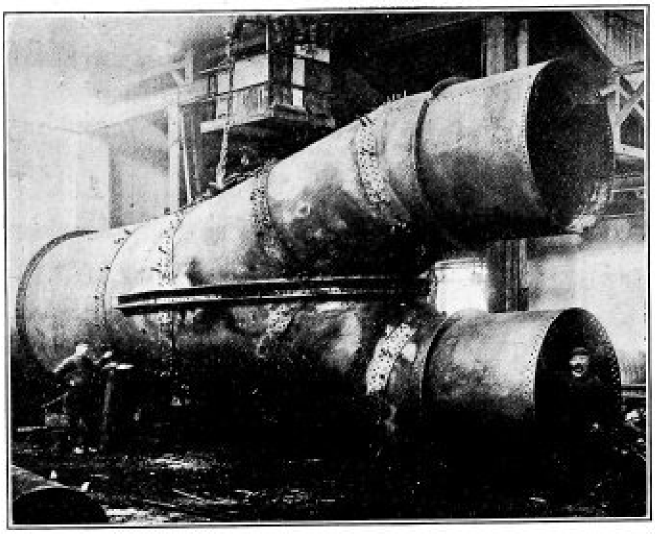
By John Jaschke

DURING the past year the hydro-electric plant on the Teigitoch in Styria, Austria, has been finished. For this plant one of the two pipe lines has been erected. On the mouth of the concrete channel a Y branch is used for distributing the water.



Y Branch in process of assembly

In constructing the Y branch it was said that there should be no water pool on the bottom, also no idle air on the top. Furthermore, its plates may be rolled in the

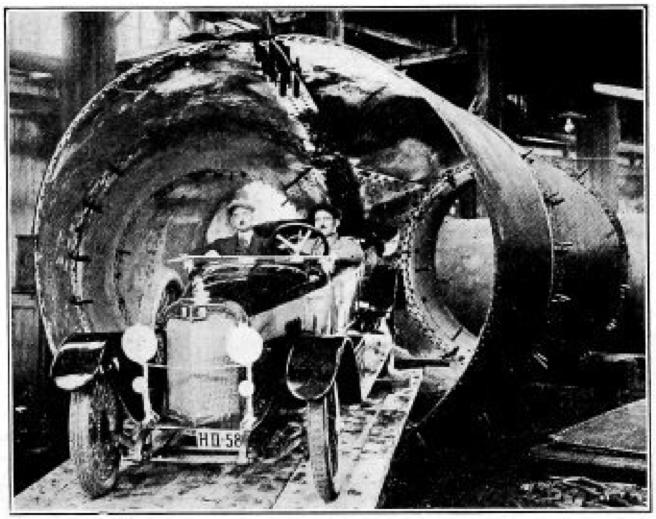


Side elevation of Y Branch during fabrication

usual manner, but all the cones must have an equal taper.

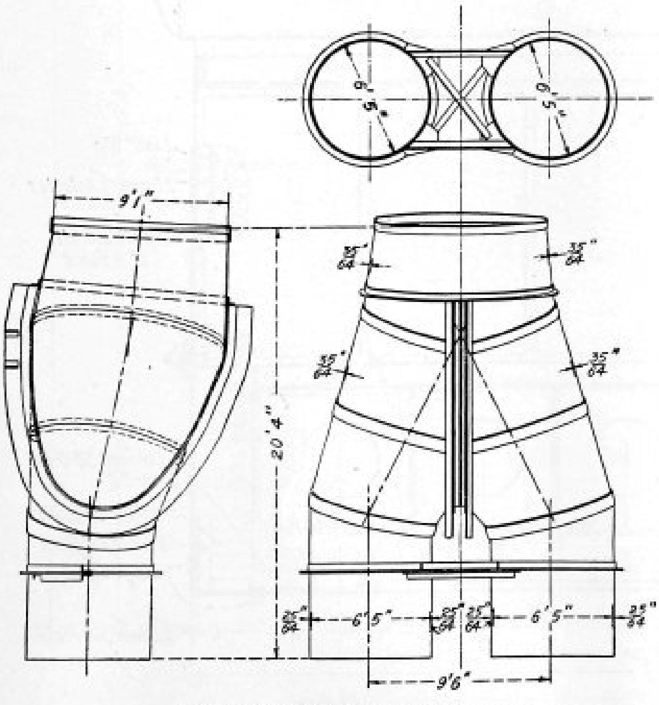
How it was built is shown in the accompanying illustrations.

The working pressure is 55 pounds per square inch. The longitudinal seams are triple and double riveted lap joint.



This view gives an excellent idea of the size of the branch

All the round seams are double riveted outer butt joints. The Y branch was built in the shops of the Waazner Biro Company.



Austrian design for Y Branch

Shock Kills Man Cleaning Boiler

Michael O'Brien, 30 years old, of 183 Bloomfield Avenue, Montclair, N. J., was shocked to death recently while working on the boiler of the Administration Building, Church and Range Roads in Montclair. Faulty insulation on the wire of a lamp which O'Brien had in his hand while he was in contact with the boiler completed a high tension circuit through his body.

John M. Horan, boiler inspector foreman of the Chicago, Milwaukee and St. Paul Railroad was honor guest at the convention of the road's Veteran's Association, held August 24, in Milwaukee. He has just completed his seventieth year with the road.

Boilers of the New Matson Line Steamship Malolo

The boilers of this vessel are designed to carry the highest working pressure of any marine boilers ever built in America

By Charles Johnson Post

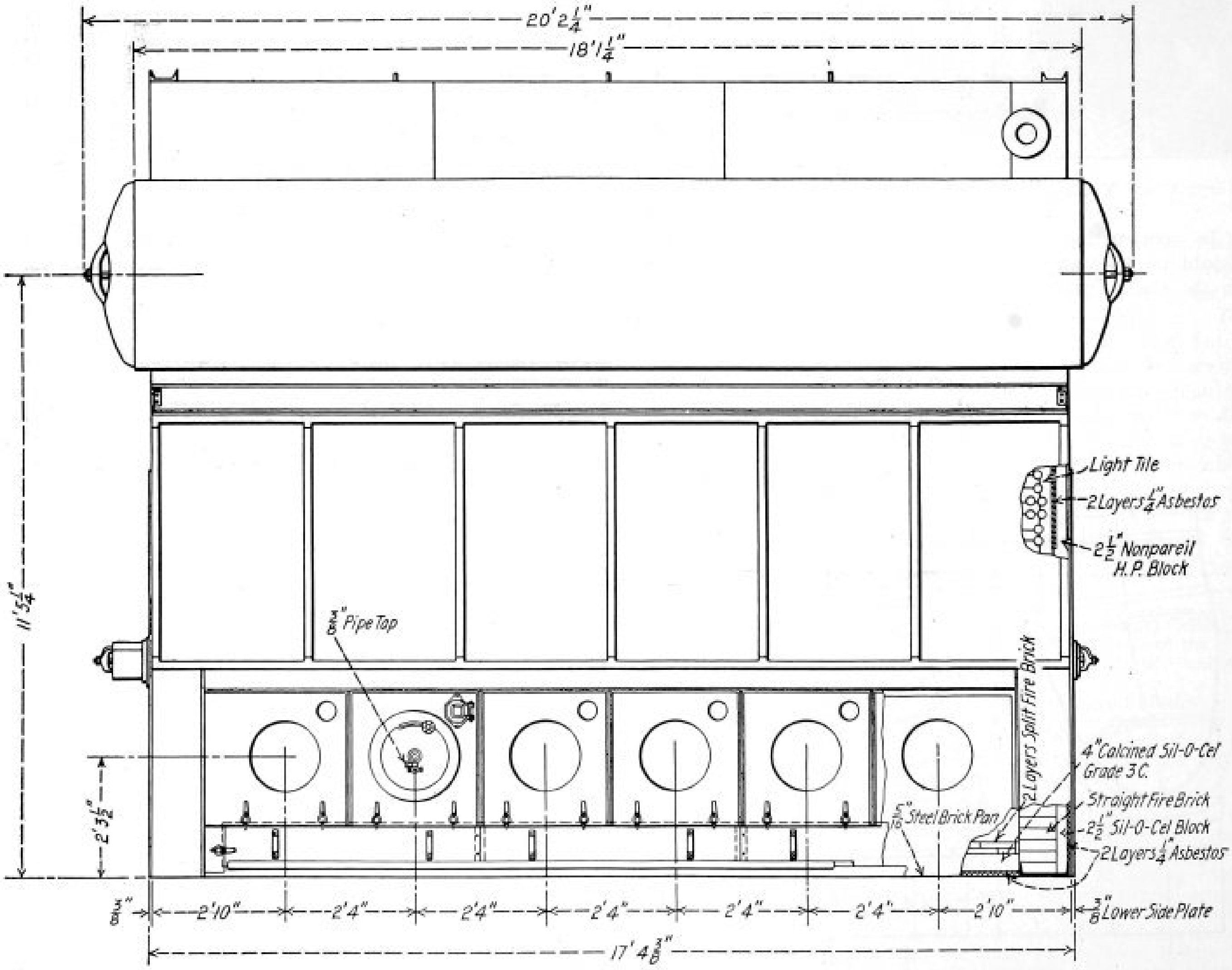
WHEN the steamship *Malolo* is completed she will be not only the largest and fastest high powered passenger vessel ever built in the United States but she will be driven by steam generated under higher pressure than has ever before been used on any American passenger steamship. Her working pressure will be 280 pounds per square inch generated in 12 watertube boilers.

The *Malolo* is now being built at the yards of William Cramp and Sons Ship and Engine Building Company, Philadelphia, Pa., on order from the American-Hawaiian Steamship Company, New York, for the service between San Francisco and Honolulu operated by the Matson Navigation Company. The ship was designed and is being built under the personal supervision of William Francis Gibbs, president of Gibbs Bros., Inc., New York, who was responsible for the work of reconditioning the *Leviathan.*

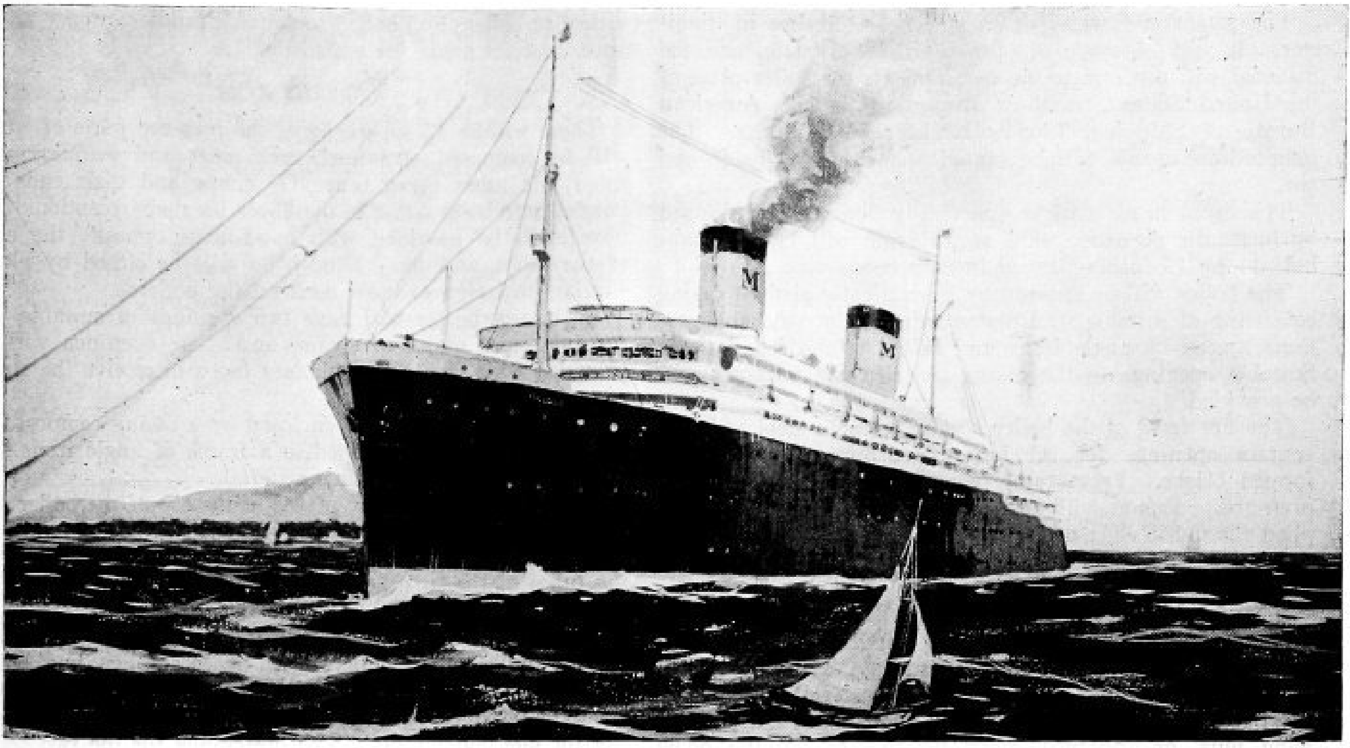
The *Malolo* has a length of 582 feet with a beam of 83 feet. Her displacement is 22,050 tons at 28 feet 6 inches draft. She will have a speed of 25 miles per hour.

There will be 12 watertube boilers of the Babcock and Wilcox marine type, built for a working steam pressure of 280 pounds gage and at least 100 degrees F. superheat as previously noted. The boilers will be equipped for burning oil under forced draft. The total evaporative surface will be about 55,760 square feet and the superheating surface about 11,160 square feet.

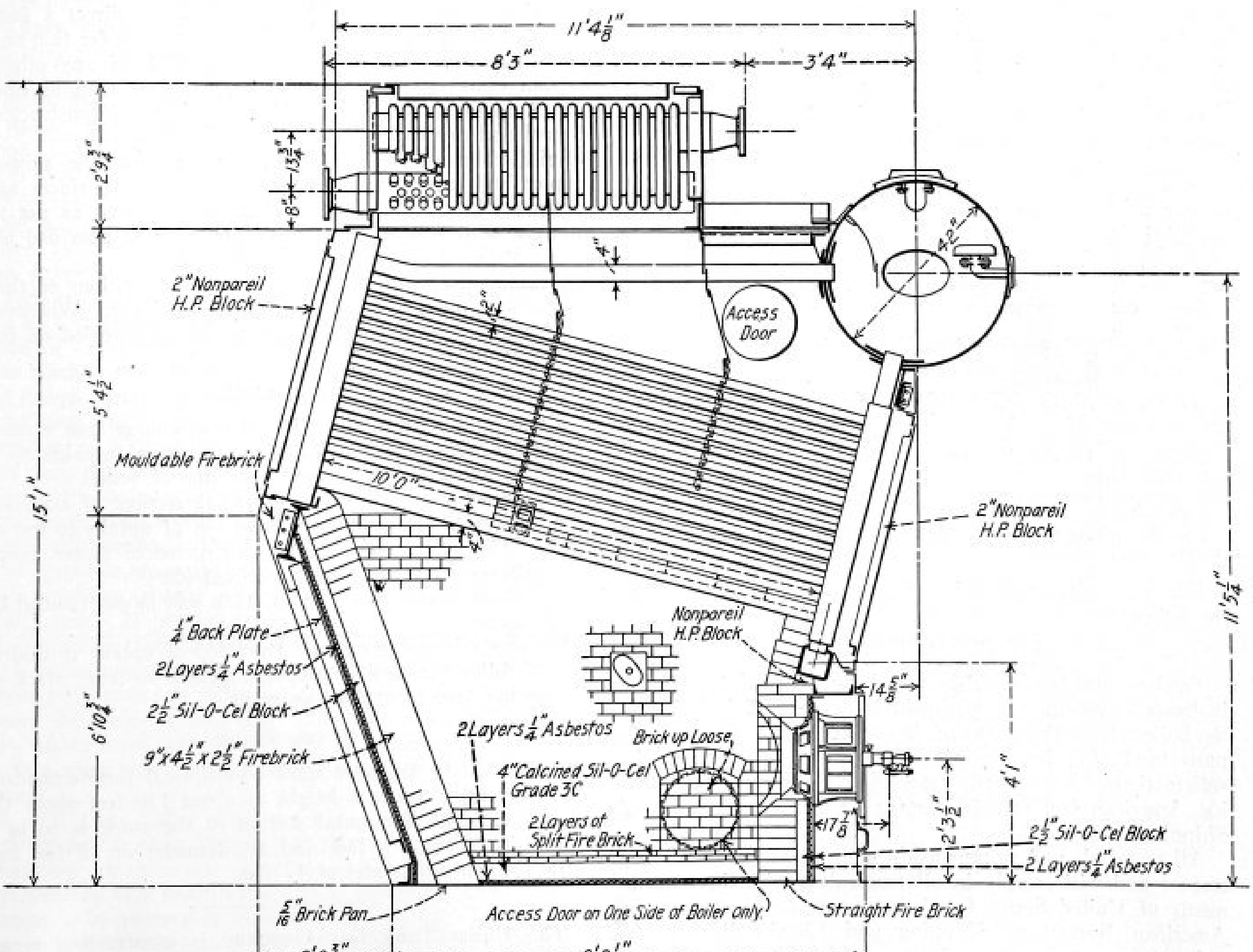
All pressure parts will be constructed entirely of open-hearth steel plate and seamless steel tubes. No malleable or cast iron or cast steel will be used under pressure. The tubes will be 2 and 4 inches in diameter and will be expanded at their ends into forced steel sinuous headers. Opposite the ends of each 4-inch tube, or each group of four or less 2-inch tubes, there well be placed a hand-hole of sufficient size to permit the inspection, cleaning, removal or renewal of a tube through the same. All tubes will be straight, made of seamless steel. The 2-inch tubes will be of No. 10 B.W.G., and the 4-inch of No. 6 B.W.G. in thickness.



Elevation of Malolo boiler designed for 325 pounds working pressure



Sketch of the Matson liner Malolo showing how she will look when completed



Cross section of Babcock and Wilcox Boiler for steamship Malolo

The steam and water drum will be 42 inches in diameter. It will be made of open-hearth steel plate, and the material will conform to the requirements for boiler plate of the United States Steamboat Inspection Service, American Bureau of Shipping, Lloyd's Register of Shipping. The longitudinal seams will be butted and strapped inside and out.

The drum heads will be spherically bumped and flanged by hydraulic pressure. The steam drum will have a manhole 11 by 15 inches flanged in each head.

The boiler will be encased by a practically airtight casing consisting of suitable steel plates arranged in removable sections braced by angle irons and bolted to the foundations. Suitable openings in the casing for cleaning purposes will be provided.

The fire front of the boiler will be wrought steel and will contain openings for oil burners surrounded by special formed bricks. Fronts and furnace walls will be suitably protected. Fronts will be arranged for forced draft supplied through a duct under each boiler.

Front and Rear Tube Doors

The front and rear tube doors will be of steel plate arranged in convenient sections for handling, riveted to an angle bar steel frame stiffened by gussets. These doors will be lined with 2-inch non-conducting material, backed by sheet copper, all secured by rivets. Forged steel latches with wing nuts, of approved heavy design, for holding doors tightly in place and suitable ring bolts for lifting doors and corresponding ring bolts overhead and a chain for keeping doors open are to be provided. The furnace bottoms will be of sheet steel properly insulated. Approved means will be provided for blowing soot off tubes while boilers are steaming.

In all boilers, zinc protectors and baskets will be fitted. Each boiler will be provided with the following:

1 auxiliary steam stop valve.
2 nickel seated safety valves with monel disks, of approved pattern set to blow at 280 pounds pressure.
1 brass rimmed steam gage.
2 glass water gages, fitted with Dewrance automatic closing device. Gage glasses to be of the "Klinger" type.
2 stop valves for main and auxiliary feeds.
3 gage cocks, arranged to operate from the fireroom floor.
1 bottom blow valve.
2 check valves for main and auxiliary feeds.
1 surface blow valve or scummer.

The steam drum will be fitted with dry pipe perforated on its upper side with holes.

1 stop valve for cleaning pipe connections.
1 fusible plug.
1 cleaning hose and lance.
1 air valve.
1 bronze fitting attached to drum for air valve, steam gage and cleaning hose connection.

Necessary pipes and fittings for attaching all the above to the boiler.

Boiler Tests

Sections and boxes will be tested and made tight under a hydrostatic pressure of 560 pounds per square inch before the boilers leave the works of the Babcock and Wilcox Company, and after installation boilers are to be tested to the satisfaction of the United States Steamboat Inspection Service, American Bureau of Shipping and Lloyd's Register of Shipping.

All materials and workmanship will be first class in every respect and will comply in all particulars with the requirements of United States Local Inspectors of Steam Vessels, American Bureau of Shipping and Lloyd's Register of Shipping.

The boilers will be secured in the vessel by brackets attached to boilers and bolted to suitable saddles, proper allowance between made for expansion.

Superheaters

There will be 12 superheaters, the pressure parts of which will be composed of forged steel boxes and seamless steel tubes, the tubes being bent "U" shape and their ends expanded into holes bored in the boxes for their reception. The boxes will be provided with hand-holes opposite the ends of the tubes, and these hand-holes will be closed by plates similar in design to those used on the boilers.

Each superheater will have two openings of suitable size for inlet and outlet of steam, and these openings will be provided with forged steel flanges faced to receive the steam pipes.

The superheater will be enclosed by a casing composed of wrought steel plates attached to a frame of angle irons and protected by non-conducting material.

The superheater will be placed at the top of the boiler and the baffles of the boiler will be extended in such manner as to cause the gases of combustion to pass through and among the tubes of the superheater.

General Description of Uptakes

The twelve main boilers will be located in two boiler rooms, six boilers in each. All six boilers in one boiler room are to be provided with uptake joining into a common breeching for one boiler room. The breechings for the two boiler rooms will in turn join into the base of the stack at a suitable height.

Particular attention is given to provide as direct a flow as possible from boilers to base of stack and in order that one boiler may not interfere with the operation of any other, division plates are provided between various sections and carried up to base of stack. Uptakes are to be constructed of steel and angles.

Suitable provision is made throughout for the proper support and expansion of uptakes and all flat surfaces are adequately braced by angle stiffeners so arranged as not to interfere with flow of gases. An air space is provided all around exposed surfaces of uptakes.

Cleaning doors are provided in suitable locations so that all parts of uptakes can be readily cleaned out. Wherever necessary, handgrips and ladders are to be provided on inside of casings.

Smokestack

All of the twelve main boilers will discharge into a common stack, this stack to extend from top of uptakes to a height of about 120 feet above base line of vessel.

The inner stack will be of elliptical section, of adequate area and carried continuously from top of uptake to top of stack. The inner stack will be constructed of plates, properly stiffened by vertical angles, on outside.

The lower section of the inner stack will be surrounded by an air space.

Lower stack casing extends from top of uptake to underside of fidley top, and is properly secured to inner stack at bottom but free to expand upwards.

Outer Stack

There will be an outer stack of elliptical form extending from the fidley top to a height of about 120 feet above the base line. The horizontal section of the stack is to be a true ellipse having a fore and aft diameter of 28 feet and an athwartship diameter of 17 feet.

The Union Tank Car Company is constructing repair shops, including a foundry, a machine shop, a power plant and a wheel shop, at Whiting, Ind.

Training Boiler Inspectors and Assistant Foremen

Committee report presented at annual convention of Master Boiler Makers Association—Includes report on safe slope of crown sheet and reliable water registering device

It is obvious that the Boiler Inspector should have sufficient training in the testing and inspecting of boilers to give a good description of the condition of boilers he has inspected, and also recommend the extent of repairs that may be necessary.

A man's education in any profession continues to broaden out, and he is constantly acquiring new information and new ideas so long as he continues in the work; therefore, whenever a man is started as an inspector or assistant boiler foreman, he has a foundation of training and experience to begin with, to which he adds as he continues in the work.

It would seem essential that anyone appointed to the position of shop or enginehouse boiler inspector should be qualified to perform any of the duties pertaining to the upkeep of those parts of the locomotive which are assigned to the boiler makers to be maintained. Staybolt testing and inspecting, and the proper rendering of reports, are certainly among the principal qualifications necessary, but it is also important that the shop or enginehouse boiler inspector should be entirely familiar with the running repair work, especially hot work.

It is necessary that he should have at least a year's training in a busy enginehouse, so that he may be familiar with the best methods of conducting running repairs, as practiced in enginehouses, and it should be his duty after being appointed to instruct others in the best methods of handling that class of work. His training for the position of boiler inspector should include the washing of boilers, inspection of tanks, condition of front ends, ashpans and draft appliances. Before he is competent to instruct others he should be competent to do the work himself. This competency can only be acquired by actually doing the work. It cannot be obtained from paper education.

Too many inspectors appear to be satisfied that if they are able to find broken or defective staybolts, and report a condition of cracks developing or something of that sort, they have reached the limit of requirements of an inspector, and any defects developing such as leaky bolts, cracking sheets, or bulging, are accepted by them as being incidental to the operation of a locomotive, and excite no apprehension on their part, that investigation might disclose the cause of these defects developing and would probably result in changes being made which would save further development of the defects and damage to the firebox or boiler.

An inspector, upon entering a firebox to make an inspection of its condition, should note any appearance of deterioration of any part. If bulging and cracking are developing it is quite probable that the cause for it may be discovered. If a crack or bulge develops and he is asked what caused it, the stereotyped answer of "contraction and expansion" does not answer the question, but, if he is trained to investigate and learn what caused this contraction and expansion, the chances are that something may be done which will prevent further damage.

A first class boiler inspector trains himself, in a way. Constant practice has developed in him that alertness in quick perception, which enables him to quickly recognize any imperfection or any undesirable condition which may be developing. In proportion as he exercises that sense of alertness and quick perception, the power of quick decision is acquired. Where at first it would take much time to study over and decide what was to be done, the more he practices his calling the easier it will become for him to note defects, and his recommendations will be more accurate and more valuable. This proficiency can only be acquired by actual practice.

The training of boiler inspectors and assistant boiler foremen, like the training of every other individual for any occupation or profession, or what should be done to train them, is a pretty difficult matter to define. First, we have the individual and his capacity. Next, we have the conditions under which he is to be trained, and then again, we have the standard we expect him to reach before he is appointed to the position. In trying to harmonize these features of training it is quite difficult to say just how much time should be devoted to any particular part of it, but, as previously stated, the man to be appointed should possess the qualification of honesty, which would give him the reliability that is necessary in making his inspections; that is, that he thoroughly inspects when he goes on a job, and honestly reports the conditions as he sees them. His experience added to that gives him a value, both to himself and his superiors in proportion as he excels others in the same line of endeavor. The development of a shop or enginehouse boiler inspector should particularly include the following, in which he should be competent:

To make out clear and legible reports.

Testing staybolts; testing and inspecting of boilers and fireboxes and the making of recommendations for repairs.

Washing of boilers and seeing that they are properly cleaned.

Inspection of all spark arresting and draft appliances.

The conducting of, or giving advice, in shop running repairs or hot work.

A thorough knowledge of government and railroad rules, and familiarity with reports to be handled.

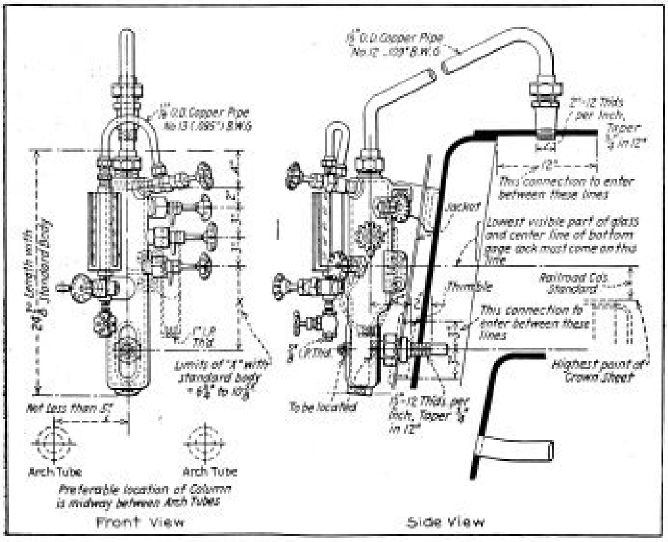
The amount of time to be allowed to each of these qualifications is dependent upon the individual and the conditions under which his training is to be conducted. A man would not get much training in the maintenance of spark arresting devices if he happened to be located at a point on a railroad where only oil burning engines were handled.

Training of Assistant Boiler Foremen

While the training and developing of assistant boiler foremen does not require so much enginehouse experience, it certainly requires a knowledge of running repair work in enginehouses. The assistant boiler foreman who is also familiar with enginehouse running repairs is in a much better position to judge the extent and quality of repairs necessary for a boiler or firebox, than one not having such experience, and any boiler foreman would be better qualified for a position who has had at least a year's enginehouse training. The assistant boiler foreman, of course, is training for the position of general boiler foreman and his training begins as he becomes a lead man or gang foreman. We do not know of, and could not suggest, any better line of training than what will be acquired when he begins his first supervisory position.

One important feature of regular boiler shop practices is the cost of the work. It is believed that any boiler shop run without a system of cost accounting, and with a foreman who does not have a system or knowledge of the cost of the work is being run at a loss. The boiler shop is the production shop and a strict record of the cost side of the work should never be lost sight of. The education of a foreman to keep track of his costs should begin with the man when he is first put in as a lead man or gang foreman.

Boiler inspection is also closely connected with the work of a boiler foreman. His success largely depends upon his knowledge of the conditions under which his locomotives are being operated as well as his experience relative to what parts should be repaired or renewed, and those parts which are in good enough condition to run until another shopping. For the assistant boiler foreman to acquire similar experience and training it is necessary that he should begin his training when he begins as a gang foreman or lead man, and make his inspections of the boilers. His recommendations must be subject to the approval of the boiler foreman who should



Water columns meeting Bureau Locomotive Inspection requirements

make the final decision as to what work is to be done. He should at this time start to train himself by hard study of boiler construction and strains and stresses. Complete familiarity with the Federal requirements governing steam locomotives is also essential. Most of all, he must learn to lead men, not to drive them, as the time for that is gone. He also must learn to be loyal to his employers and have good common horse-sense.

It is not expedient to mention every little item which might enter into the training of a man. When an individual is selected for appointment it is assumed that he has a great deal to learn, but the selection is made owing to confidence in his having a good foundation and is willing to develop, and that if he meets with problems he does not understand he will make use of available information and avoid mistakes.

Finally, the boiler inspector should have training in the shops, and the boiler foreman in the enginehouse. One or two years of such training would not be too much to prepare the ordinary individual for either position.

Proper and Safe Slopes of a Crown Sheet Per Foot

The proper slope of the crown sheet is to prevent the rear of the crown sheet from becoming uncovered when making stops, or passing over the tops of grades; also as a means of bringing the crown sheet a little closer to the fire, and a little less weight, due to the end of the boiler being a little lower than the front.

We do not know of any fixed rule for this slope and would think that ½ inch per foot would not be out of line with any type of boiler or grade. As it is the standard of the locomotive builders and appears to be entirely satisfactory, we recommend it.

The Most Reliable Water Registering Device

The most reliable water registering device is a combination of the water column, water glass and gage cocks. There is merit in the use of a water column with its accessories on the right side of the back head and a second water glass on the back head on the left side of the throttle. It gives a very reliable record of the height of water inside of the boiler under different conditions. Observations made in actual service have demonstrated that it will more accurately register the height of water when the boiler is working than if the gage cocks and water glass are applied directly to the boiler back head, especially on large locomotives and particularly on locomotives equipped with arch tubes.

There is a strong upward current of water in the back water leg due to the circulation of water in the boiler. It is increased by the fast circulation through the arch tubes, the latter being very active. This tends to raise the height of the water close to the door sheet a little higher than the water in a more forward position of the boiler and the water glass and gage cocks, attached direct to the boiler back head, are apt to be influenced by this excessive height close to the door sheet.

The advantage of the water column is that it is a more reliable indicator of the actual height throughout the boiler and over the various parts of the crown sheet. This, to a certain extent, is due to the water in the water column not being so much affected by the violent circulation of the water in the back water leg. The second and independent water glass has the advantage of checking the water glass to a certain extent, and also serves as a guide to the height of water in the boiler in the event of the glass breaking in the water column until such time as the water column glass can be promptly replaced. Another advantage is that in the event of boiler water foaming, the agitation of the water in this glass gives some indication of the activity of the water in the boiler.

No doubt you are all familiar with the Ninth Annual Report of the Chief Inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission, which contains the results of their comprehensive test, made for determining the action of water in the boiler on water indicating appliances with respect to their correct registration. These tests resulted in the conclusion and recommendation that a water column to which three gage cocks and a water glass are attached, will afford the safest and most practical method yet disclosed, for correctly indicating the true water level in the boiler under all conditions of service.

Acting upon the recommendations of the bureau the various railroads developed and made tests of water columns where the dimensions were considered the most practical for the construction of a water column which would dependably indicate the height of water inside of the boiler. The dimensions to which we refer are the opening from the water column to the boiler, the inside diameter of the water column and the size of pipe connecting the top of the water column to the top of the boiler.

There should be no intermediate valves in this top pipe between the water column and the connection to the boiler, that is, no valves in the upper part of the water column or any of its top connections. The pipe should be applied with continuous slope with bends as easy as possible, and with no pockets. The various fittings should be so located that they can be bored out and cleaned without removal from the boiler. It is very necessary that connections to water column, water glasses, gage cocks, and accessories shall be kept clean and free from obstructions and so constructed that the various openings can be cleaned out, and equipment surrounding these parts be so located as to allow free access in cleaning out these holes.

The two accompanying sketches give arrangements with dimensions of a water column that comply with the general arrangements as recommended by the Chief Inspector of the Bureau of Locomotive Inspection and adopted as recommended practice by the Committee on Standards of the United States Railroad Administration at its February, 1920, meeting.

The most satisfactory arrangement for the left water glass is the usual connection at the bottom of the water glass, but with a connection at the top for pipe extending from top connection of the water glass to the top of the boiler. It is better for the second water glass not to be connected with the inside of boiler by a spindle at the top of the water glass, but to make use of a long copper pipe as explained.

The committee recommends that the Master Boiler Makers' Association at its 1925 convention, adopt as Standard Practice, the water column with its water glass, gage cocks and accessories applied to the right side of the back head with a second water glass applied to the back head on the left side of throttle.

This report was prepared by a committee composed of A. F. Stiglmeier, chairman; Henry J. Raps.

Boiler Bootleggers*

More boilers have helped to violate the prohibition law than any other class of machinery built. In reading the papers, especially where a raid has been made by the prohibition officials, I always look to see what type of boiler they found that was doing business for the distilling of moonshine. In numerous instances we have tried to ferret out the history of such boilers. Many were smuggled in as quietly and secretly as the liquor was smuggled out and possibly the man who furnished the boiler paid out his good money for the liquor the boiler helped to make.

Recently we were asked to recover a boiler which was stolen during the night. Wires, giving the data covering this particular boiler, were sent to all inspectors and they were assigned as detectives to trace the stolen boiler. We had numerous clues but in each case it was not the boiler which had been stolen. I have been wondering if a high jacker sold the boiler to the original owner and then stole it afterwards. The application of this method could be employed in the boiler line as successfully as it has been applied in the bootlegging line.

We also have numerous cases where the boilers are smuggled into the state, sold and operated in this state until the inspector in the field runs across the boiler. He then advises the owner that the boiler will not pass and its operation must be discontinued. The owner usually maintains that he bought the boiler in good faith and thought the man from whom he purchased the boiler was absolutely honest. After making futile efforts to retain the boiler he expects us to get his money back for him.

Another phase of our work is the evasion that is attempted in connection with boiler inspections. Every sort of excuse is offered to delay the inspection. In many cases it is laziness on the part of the owner or the boiler is in such bad condition that they are afraid the inspector will discover defects necessitating dropping the steam pressure.

These are some of the numerous difficulties inspectors have to contend with, but we are progressing. Lap joint boilers are going out, better boilers are being installed, irresponsible operators are vanishing and every State will finally be operating in complete conformity with the A. S. M. E. boiler rules.

*From an address delivered before the American Boiler Manufacturers' Association by Jos. F. Scott, chairman of National Board of Boiler and Pressure Vessel Inspectors.

Cost Accounting*

The report of the Cost Accounting Committee, read by Starr H. Barnum, chairman, dealt with Overhead and Its Relation to Direct Labor. The first part of the report consisted of a quotation from an article by Robert S. Denham, chief engineer of the Denham Costfinding Company, as follows:

"Where does profit begin?

"*After the last cent of expense, or cost, has been paid, and not before.*

"What then is cost?

"The cost of an item of product is the sum of the expenditures involved in its production.

Cost

"There are usually about 130 purposes for which money is spent in the operation of a factory. Every expenditure is a definite amount, and procures a definite measure of either a definite service or a specified commodity, to be used for a definite purpose. There are, then, no indefinite expenses.

"Differences of opinion, or the addition or omission of items of expense, according to the wish or belief of the persons interested in results, in no way changes the cost. They may change the result of the calculation, but if in the end an overcharge is made, the business will suffer the loss of customers, and if items are omitted, the business will fail to make normal profits. Cost is an inexorable fact. It is definite, whether one likes it or not, and the penalty for skepticism, omissions, additions and arbitrary calculations is failure.

Salary of Owner

"Ten years ago many manufacturers assumed that their costs were less because they managed their own businesses and lived on the profits. The government income tax has been a very effective means of checking this practice although a few still cling to it.

"What has a manufacturing business to offer today, to the man who has, let us say, $100,000 invested in 5 percent securities? What promise does it hold out to induce him to sell his securities and engage in industry?

"Let us compare the probabilities of these types of investment.

"On the one hand, he can buy bonds maturing in, say, twenty years, the income from which is non-taxable and therefore he is assured of a net income of $5,000 per year for that time, and that at maturity he will have returned to him every dollar of the capital invested.

Returns From Business Investments

"On the other hand, the investment in business promises larger profits in return for the greater risk. What has business to show that its investors either receive large profits or are able to get their capital back at any future time?

"Government statistics show that 80 percent of manufacturers do not earn a net income equal to normal interest (6 percent) on their investment, and that 55 percent have no net income whatever.

"*Manufacturing can be made a sound and substantial investment,* able to fulfil its promise of security, interest and profits, if the men engaged in it will become open minded enough to abandon traditional practices and adopt modern methods.

"*Where does the profit begin?*

"After every dollar of materials used is paid for, or its payment provided for.

"After every cent of operating expenses has been included in cost of production."

Overhead

Overhead should be divided into two main parts, i.e.:

1. Factory overhead.
2. Administrative and selling overhead.

Factory overhead should be based on productive hours expended on the product manufactured; administrative overhead either on the number of productive hours in the product manufactured, or a percentage of the factory cost. There are, of course, variations in the rate of factory overhead; for example, you have in your plant a special machine that required a comparatively large investment to make a certain product while the major portion of your production does not normally require same. Then the man-hours expended in the operation of this machine should bear a greater amount of overhead than productive hours expended on work in gen-

*Committee report presented at annual convention of American Boiler Manufacturers' Association, Watkins, N. Y., June, 1925.

eral. Matters of this kind, however, are ramifications of the general principles involved that we will not try to touch upon.

Among the items included in the factory overhead are coal, oil, water, purchased power, automobile truck operation and upkeep, depreciation, except that that is applicable to administration; repairs to machinery, equipment, buildings, tools, etc.; salaries and wages applicable to factory work that is not put in production.

Administrative overhead should include such items as legal and professional services, telephone, telegraph, advertising, administrative and office salaries.

Of course, there are other items of both administrative and factory overhead that should be included, but the above gives a general idea of some of the principal accounts.

Depreciation

The matter of depreciation is one that is sometimes questioned, but anything that it put into a plant as a permanent fixture depreciates in value and, therefore, should be included in overhead. Each machine, building or whatever it may be that might be added to the present equipment should start to be depreciated after it is acquired, and the loss in any new equipment that is purchased, taking the place of old equipment which has not fully depreciated, should be considered.

Of course, the matter of uncertainty in the modern method of cost accounting is not what the amount of the overhead will be so much as the number of productive hours that your plant is going to run to take care of this overhead. It can, however, quite readily be determined what your probable productive hours will be over a period of years and determine from this, within reasonable accuracy, what the future will be. It also might be advisable to set up a reserve for variance in overhead, which should take care of the periods of low rate of production and could be credited during the periods of high rate of production.

Budget for Overhead

A budget for your overhead should be set up at the start of the year and the actual overhead checked monthly with the budget, and where variation from same takes place, find out why. In other words, determine in advance what you should operate your business for, and if you miss the mark in your actual expenses, find out why. Do not fool yourself by saying that you did not make your budget right; give the budget careful study and, when there is a variation from it, there is something else that is probably wrong other than your estimate for expenses.

In order to present the problem in a more comprehensive manner, we will make certain assumptions of a hypothetical plant, as follows:

(a)	Normal yearly rate of productive hours	100,000
(b)	Labor rate	60 cents
(c)	Factory overhead	$100,000
(d)	Administrative overhead	50,000

A typical estimate sheet of manufactured product would be as follows:

Material	280
300 hours labor at 60 cents	180
Bare cost	460
Factory overhead, 300 hours at $1	300
Factory cost	760
Administrative expenses, 300 hours at 0.50	150
Complete cost	910
Profit, 10 percent	91
	$1,001

Or, if your administrative overhead is based on a fixed percentage of the factory cost, a similar typical estimate sheet would be as follows:

Material	280
300 hours labor at 60 cents	180
Bare cost	460
Factory overhead, 300 hours at $1	300
Factory cost	760
Administrative expense, 20 percent	152
Complete cost	912
Profit, 10 percent	91
	$1,003

If this hypothetical plant had 300 contracts of $1,000 each, based on the above estimate, it would show a profit of $30,000 at the end of the year; and if all estimates were based on either of the above methods, whether it is made up of contracts varying from $500 to $5,000, they would find at the end of the year virtually the same results would be obtained.

Often the question is asked what percent is your overhead? If the amount of money expended for labor is $50,000 and your overhead is $50,000, then your overhead is 100 percent of your labor; or if your overhead is $100,000, your overhead is 200 percent of your labor; or if it is $150,000, it is 300 percent of your labor.

Your labor rate, therefore, affects your percent of overhead, and it should have no direct effect on your overhead, only inasmuch as the non-productive hours are involved in same. Therefore, the surer way of thinking of overhead is, what is the rate of overhead in respect to your productive hours; that is, instead of 100, 200 or 300 percent referred to above, refer to it as 50 cents an hour, $1 an hour or $1.50 an hour.

In your cost, this overhead should be divided into administrative and factory overhead. The factory overhead should be charged to the cost each month, dependent upon the number of productive hours expended that month upon the particular cost in question; that is, of course, assuming that you have a cost accounting system that gives you a profit and loss statement each month.

The administrative overhead should be charged to the number of productive hours involved in each cost that is charged up each particular month; or, as stated above, a fixed percent added to the factory cost. The work in process at the end of each month, or at the end of the year, should include in its value only the factory overhead and not the administrative overhead.

We believe that the principles involved in this paper are sound, and concerns that are operating upon a control cost system will agree in the principles of what has been presented, and we hope that those of our members who do not operate on some such basis will adopt some cost accounting method which will take care of the overhead in a proper manner.

STARR H. BARNUM, Chairman,
W. C. CONNELLY,
C. W. EDGERTON.

Chief Boiler Inspector Named for Delaware

Thomas R. Archer, formerly assistant chief boiler inspector of the State of Ohio, has been elected chief boiler inspector of the Delaware Board of Boiler Rules. Rules and Regulations issued by the board are now effective on users, insurance companies and boiler manufacturers, and copies of the rules can be obtained by applying to Mr. Archer, Public Building, Wilmington, Delaware.

Laying Out Locomotive Boilers—VIII*

Firebox tube, inside throat, outside throat and front tube sheet plate developments

By W. E. Joynes†

TAPERING backhead flange radius.—Fig. 29 shows the method of developing a backhead plate with a tapering flange radius as shown on boiler drawing Fig. 9. Fig. 30 shows the diagram of projections and dimension line *A* which locates the radii *C* and *B* is found by the same formula as given for *C* on Fig. 19.

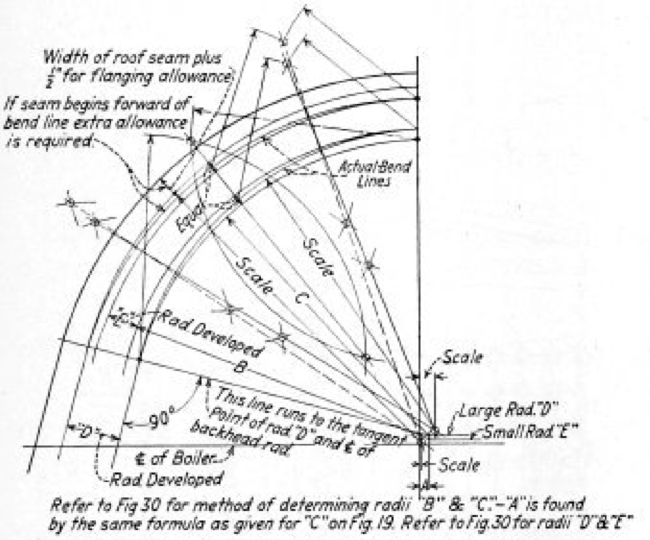


Fig. 29.—Tapering backhead flange radius

The development of a firebox tube sheet for non-combustion chamber boiler or an inside throat sheet for a combustion chamber boiler and all outside throat sheets will be found similar to the back flange sheets. They are, however, more difficult to unfold and to locate the staybolts.

Figs. 32 and 33 respectively are the developed shop drawings for the firebox tube and throat sheets as shown on boiler drawings Figs. 1 and 2.

Referring to Fig. 1 the two bends shown in the lower part of the tube sheet and the three bends in the throat sheet run straight across the sheets, parallel with the boiler center line or the base line. The bottom of the sheets is also a straight line as shown by the boiler cross section Fig. 2. The 2-inch flange radius shown below the boiler barrel, follows around the boiler near to the bottom of the throat seam when it dies out where the throat sheet becomes flat longitudinally.

Firebox Tube Sheet (Fig. 32).—To obtain the length of the plate, step off the bent part of the plate (from diagram) onto a straight line with the dividers. No allowance is added to the actual length of the tube sheet below the center line of the boiler, only to take care of the flange in bending around the corner radius. The method of finding this allowance for the corner is shown on the diagram Fig. 3. The

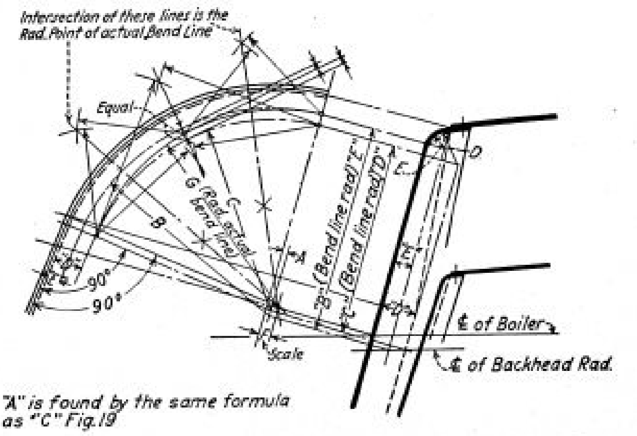


Fig. 30.—Method of finding backhead bend for tapering flange radius

plate is cut straight across from this allowance until after it is flanged and fitted to the boiler.

The transverse dimension giving the width of the sheet at the bend is scaled from the diagram (similar to the back sheets) at the lower tangent point of the bend radius.

The width of the sheet across the bottom is found in the same way as the firebox back sheet. Add ¼ inch beyond the actual width and to this 1 inch extra, carried up to the top corner as shown. This takes care of any thinning of the

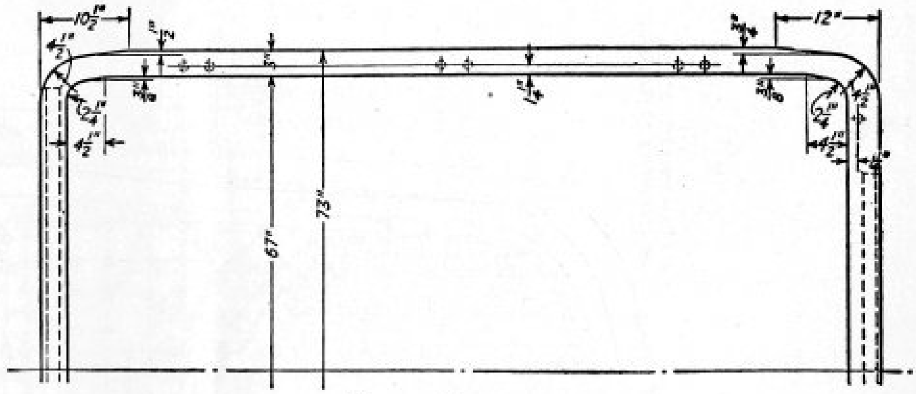


Fig. 31.—Firebox ring

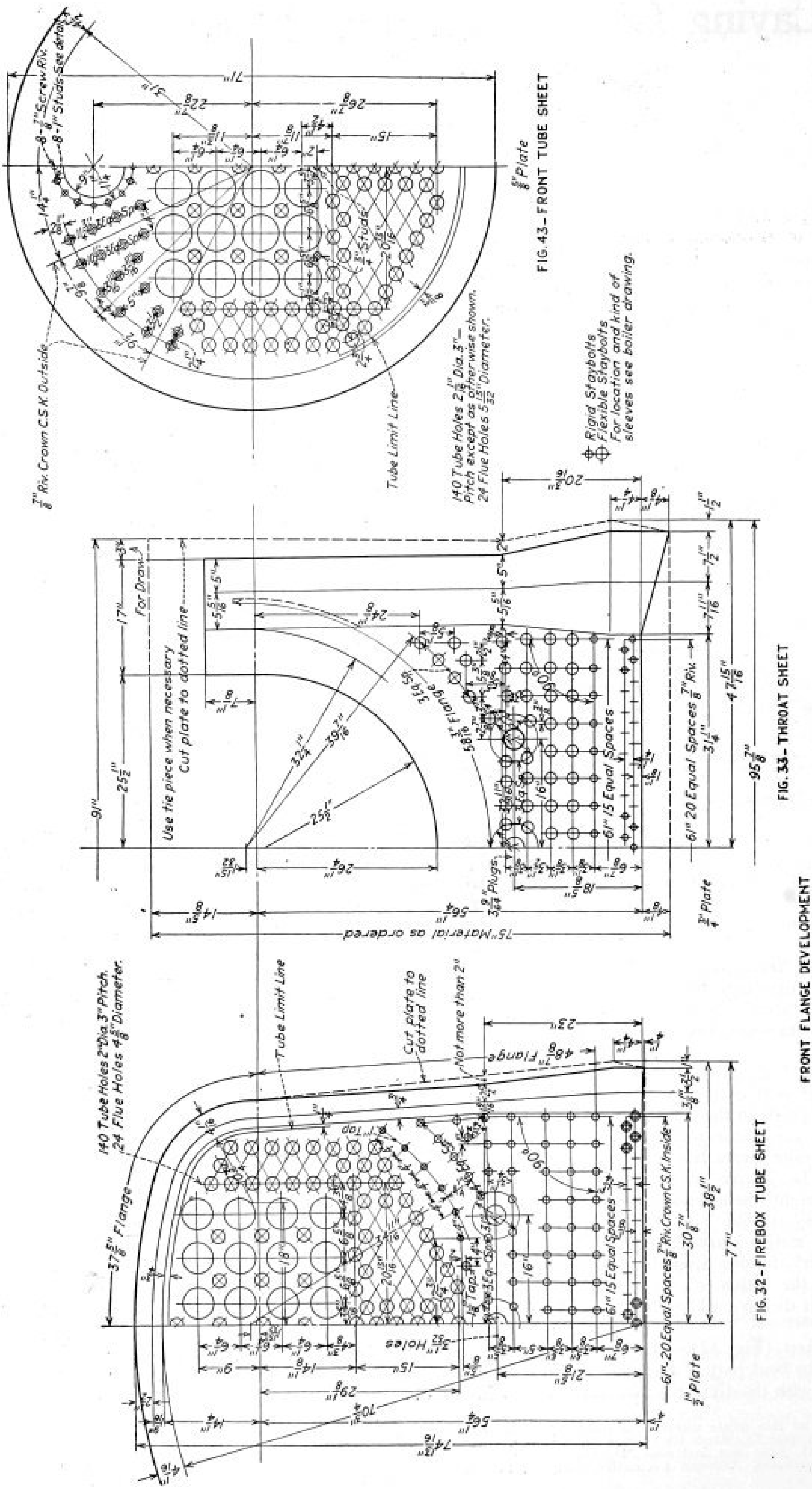
sheet opposite the bend radii, due to flanging these bends in the sheet. Refer to Figs. 34 and 35, which show similar allowances for the throat sheet.

The length of the sheet above the boiler center line is calculated from the dimensions given on the boiler drawing and with the use of the quarter circumference Table No. 2. To this length add ¼ inch for the flanging allowance, which runs around to the transverse bend line dimension.

The location dimensions for the tube sheet braces and stay-

*Previous installments of this article appeared on page 1, January issue; page 40, February issue; page 72, March issue; page 99, April issue; page 129, May issue; page 166, June issue, and page 235, August issue.

†Boiler Designing Department, American Locomotive Company, Schenectady, New York.



Figs. 32, 33 and 43.—Firebox tube sheet development, throat sheet and front tube sheet

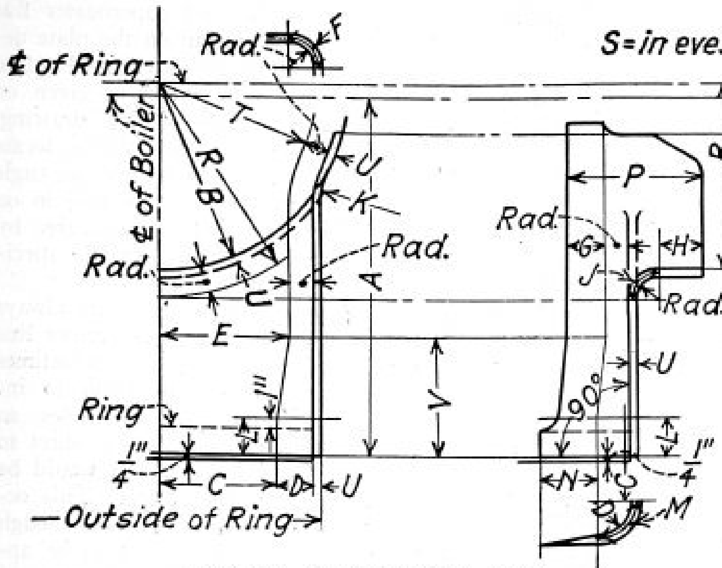


FIG. 36-FLANGED PLATE

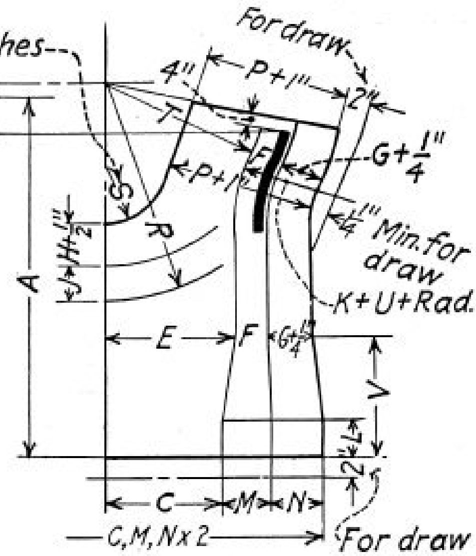


FIG. 37-DEVELOPED PLATE

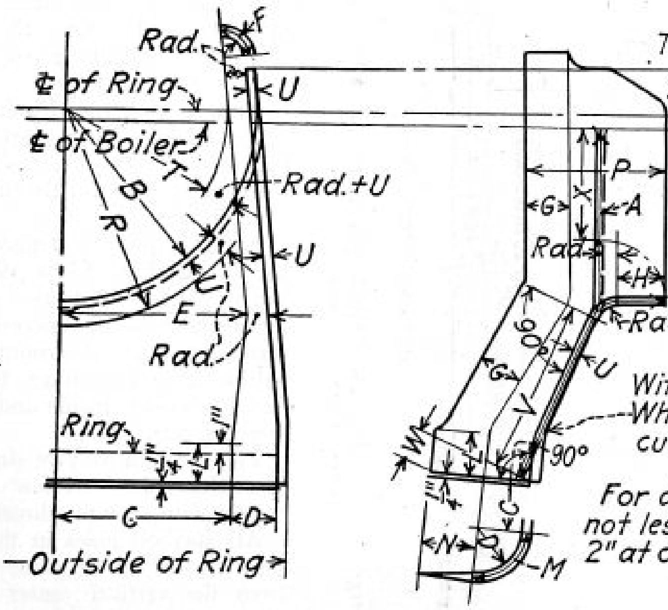


FIG.34-FLANGED PLATE

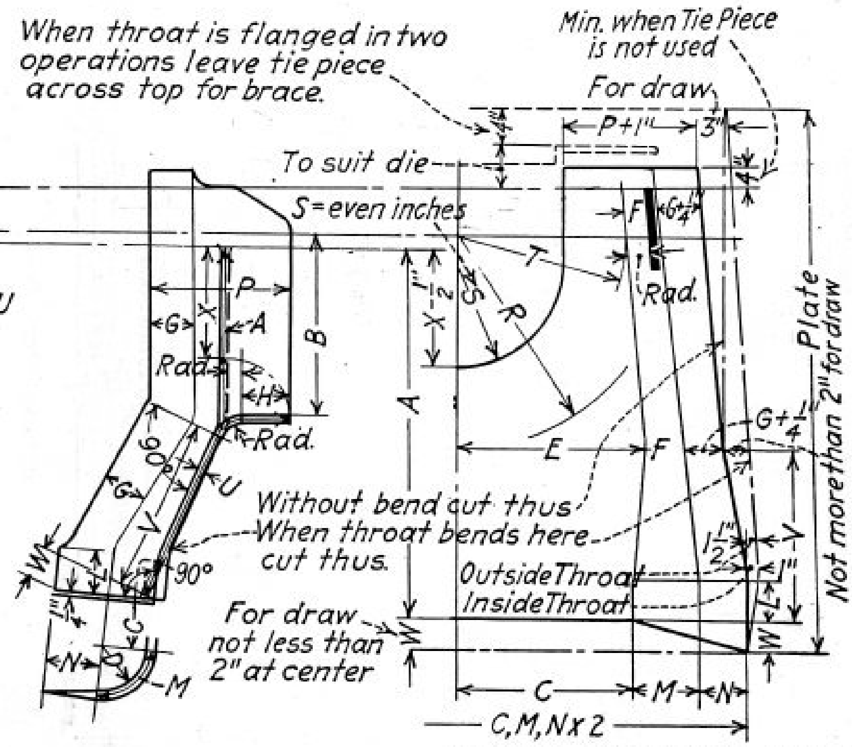


FIG. 35-DEVELOPED PLATE

Fig. 34.—Wide firebox throat sheet development. Fig. 35.— Sloping inside and outside throats. Fig. 36.—Narrow firebox throat sheet. Fig. 37.—Straight throats

bolts are taken from the boiler drawings. Any staybolts not located with a dimension can be located as explained for the back sheets.

It is important to know if all staybolts in the throat sheet have sufficient space between centers to allow for flexible staybolt sleeves and caps. The minimum preferred centers (on a flat surface) is 3 inches. This is best determined by laying the staybolt centers in on the diagram (or tracing the throat shape from the diagram on tracing paper) longitudinal section, per the spacing as fixed on the tube sheet. Draw through as near radially or 90 degrees to the tube sheet as good judgment will allow. It may be necessary for the staybolt to be tipped out of the radial or right angle position to obtain the 3-inch preferred centers, although 3-inch centers is not always enough when the staybolts angle together in a throat sheet bend.

If 3-inch centers cannot be obtained, or is not enough, look up the distance across the cap corners, then make the centers equal to the dimension across corners plus 1/4 inch which is a safety minimum allowance.

The vertical staybolt location dimensions for back tube sheets are laid out on the neutral line or flat plate. The dimensions for inside and outside throat sheets are laid out on the inside or fireside and waterside of the plates respectively. All holes in the throat sheets are laid out on the inside of the plate after flanging, because the plate is drawn up from the bottom around the center zone when the front flange is pushed out.

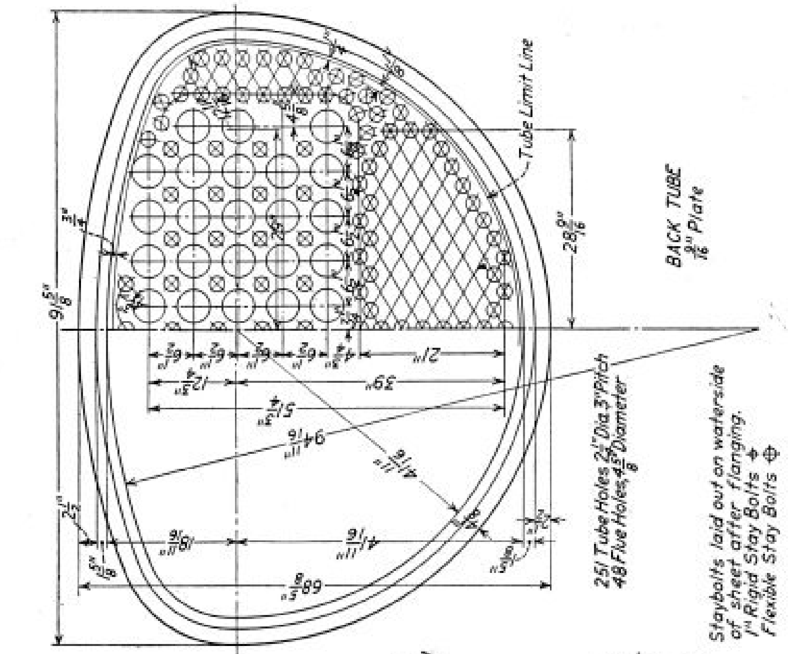


Fig. 44.—Combustion chamber, back tube sheet development

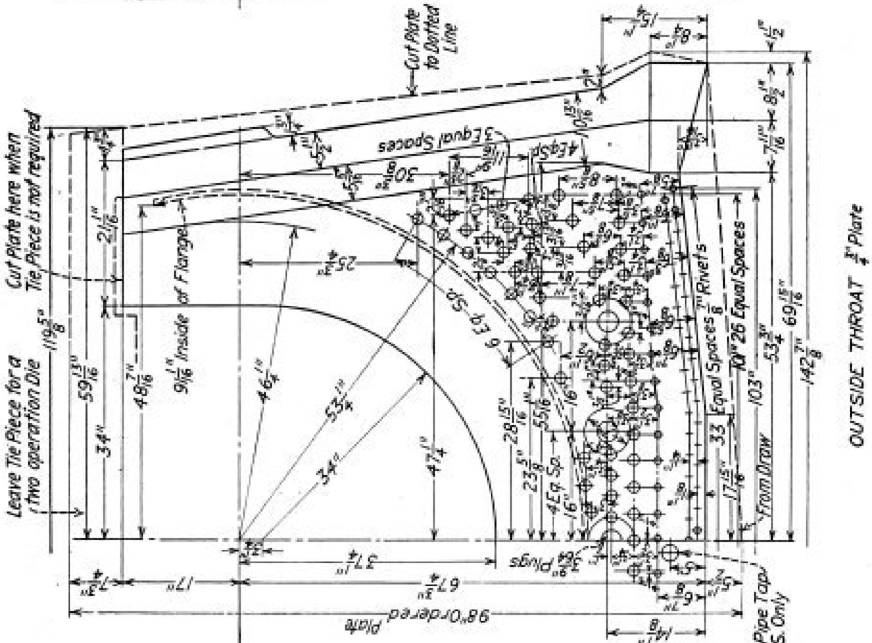


Fig. 39.—Outside throat sheet, basket design

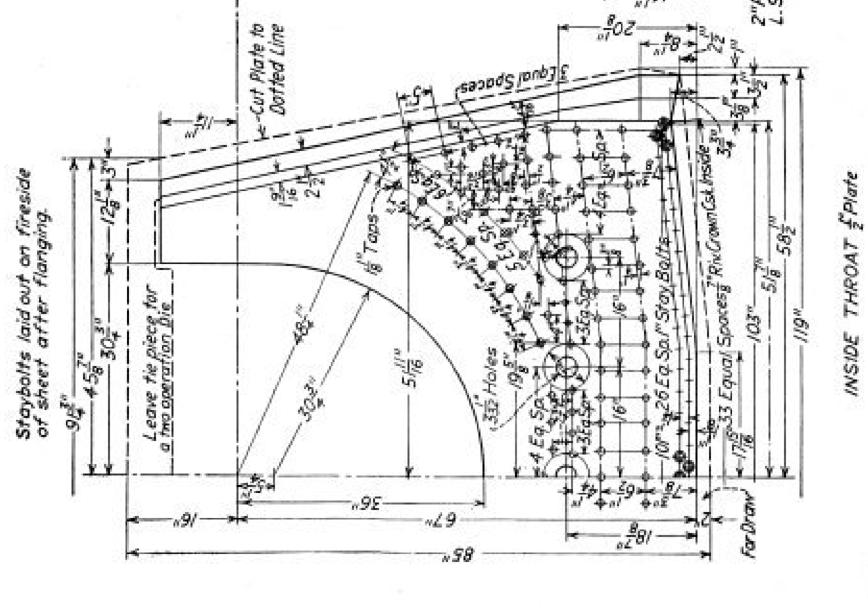


Fig. 38.—Inside throat sheet, basket design

The tube and superheater flue holes are laid out on the plate development with the same location and size dimensions as given on the boiler cross section drawing. The diagonal lines which locate the tube hole centers have an angle of 30 degrees and are laid in on the drawing with a 30-degree by 60-degree triangle per the specified tube pitch.

These diagonal lines are always 30 degrees to the boiler center line only, when they are sometimes changed in one direction to increase the pitch of the holes, so that tubes will brace the sheet to better advantage than it would be with the regular pitch. This occurs where there is not enough room for a brace foot to be applied, when the allowed space (6 inches) between the edge of the tubes and the inside of the plate flange is exceeded.

The horizontal distance from the vertical center line to any tube center can be taken from Table 4 or calculated from the trigonometrical formula given on that table.

Throat Sheet.—Finding the shape of the lower part of the throat sheet Fig. 33 is similar to the method given for the tube sheet Fig. 32.

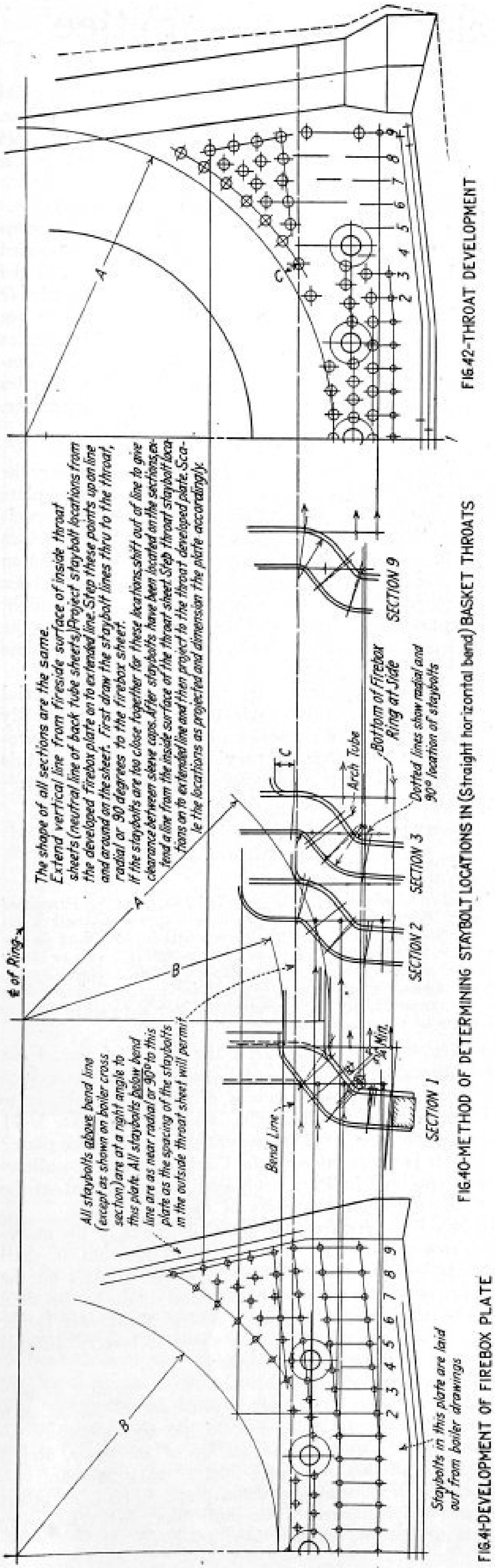
Fig. 34 shows a flanged throat sheet and Fig. 35 a developed throat plate. These two diagram figures give all the necessary information for determining the outline and allowances for wide firebox sloping, inside and outside throat sheets.

Figs. 36 and 37 give similar information for narrow firebox boilers with straight throat sheets.

All staybolt holes in the throat sheet should be the same distance from the vertical center line as those in the back tube sheet or inside throat sheet. Exceptions to this rule occur in the case of the staybolts at the top which are on a radius concentric with the boiler barrel. Refer to the boiler sections which show this arrangement clearly. Other staybolts may be set out of line for applying accessories, etc.

The brace or tie piece shown across the top of the throat sheet development Fig. 35 is necessary to keep the plate from drawing together at the top, when the plunger die performs the second operation in pushing down the front flange of the plate. The back flange is the first operation.

When a one-operation die is



Figs. 40, 41 and 42.—Throat sheet staybolt development

used for flanging a wide firebox throat sheet the tie piece is not required.

Figs. 38 and 39 are the shop drawings for the inside and outside throat sheets of the combustion chamber boiler Figs. 9 and 10.

The bottom edge of these plates shows what is known as the basket design of throat. The center part of the firebox ring and throat sheets are made lower than the sides, to gain more fire space between the top of the grates and the under side of the fire brick. Basket throats are designed for both combustion chamber and non-combustion chamber boilers; therefore, this design of sheet is generally found in back tube sheets.

This design sheet is presented to call special attention to the problem of laying out the staybolt hole locations.

It has already been stated in these instructions that the bends in the throat run straight across the boiler in a horizontal line. The staybolt holes follow the bottom or basket shape of the plates. Due to this fact each vertical line of staybolts will have a different location on the bends.

To find the location of the staybolt holes in the throat sheet a section of the throat leg through each line (depending on slope of throat and basket slope) of staybolts will be necessary. See sections Fig. 40, that were made for Figs. 38 and 39. Figs. 40, 41 and 42 show the layout method and the instruction for determining the staybolt locations.

The instructions and drawings presented above, relative to back tube and throat sheet developments, should be sufficient information for working out all problems in connection with various throat designs.

Front Tube Sheet.—The front tube sheet is a simple plate development. Fig. 43 is the shop drawing for the front tube for boiler Figs. 1 and 2. The diameter of the plate should not be more than the exact developed size. The plate stretches enough when it is flanged to allow for finishing the calking edge of the flange. The calking edge of this plate is machine turned. Too much allowance material is costly to machine off.

The tubes, longitudinal brace tee rivets and dry pipe hole arrangement are traced from the boiler sections. Scale the dimensions for locating the brace tee rivets.

Dimensions for the tubes and dry pipe hole arrangement are the same as on the boiler drawing.

Back Tube Sheet for Combustion Chamber Boiler.—Fig. 44 is the shop drawing of the back tube sheet for the combustion chamber boiler Figs. 9 and 10. This is a simple plate development with a ¼-inch allowance for flanging and trim. The tubes with dimensions are traced from the boiler drawing.

Rivet Holes in the Flange of Sheets.—The rivet holes in the flanges of the firebox back, tube and inside throat sheets are marked from the crown sheets, after the crown sheet has been rolled and the flanged sheets are fitted according to the boiler drawing dimensions.

The backhead and outside throat sheets are likewise marked from the roof sheet and the back shell ring of the boiler respectively.

The front tube sheet is laid out independently of the boiler shell, according to the number of rivets given on the boiler drawing.

The drawings for the backhead, firebox back, back tube, inside and outside throat sheets are viewed from the back end of the boiler. Therefore, the outside surface of the backhead, waterside surface of the firebox back and throat and the fireside surface of the back tube and inside throat sheets can be seen.

The front tube sheet is viewed from the front end of the boiler. In this case the smokebox surface of the sheet is visible.

(*To be continued*)

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

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

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

Below are given interpretations of the Committee in Cases Nos. 481, 484, 486, 491, 492, 494, 495, 496, and 497, as formulated at the meeting of June 5, 1925, all having been approved by the Council. In accordance with established practice, names of inquirers have been omitted.

Case No. 481. *Inquiry*: In calculating the strength of the rivets in shear in reinforcements for openings larger than 3-inch pipe size, under Par. P-261 of the Code, is it necessary to figure one-half of all the rivets in the reinforcement, or should the first two rivets on the horizontal center line be deducted and then one-half of the remainder figured?

Reply: It is the opinion of the Committee that the application of Par. P-261 to such a reinforcement as described will necessitate that the first two rivets on the horizontal center line must be deducted and that one-half of the remaining rivets shall be used for the calculation of the strength of rivets in shear.

Case No. 484 (Reopened). *Inquiry*: Is it permissible to connect a low-water signal or alarm of the whistle type to the water-column or water-gage connections of a boiler?

Reply: It is the opinion of the Committee that Par. P-295 of the Code does not permit the connection or attachment of any form of apparatus to the pipes connecting a water column to a boiler that may under any conditions allow steam to escape therefrom. This applies only to devices or attachments other than those enumerated in Par. P-295, and it is not to be construed that it will prohibit the use of feedwater regulators, damper regulators, or high- and low-water alarm devices in which there is no appreciable flow of steam from the connecting line.

Case No. 491. *Inquiry*: Is it permissible under Par. U-61 to transfer the stampings on steel plate without the authorization of an inspector for such transfer of markings under the power boiler rules?

Reply: It is the opinion of the Committee that the requirement of Par. U-61 regarding the transferring of stamps applies to the cutting of large sheets into smaller ones, as well as laying out. Attention is called, however, to the requirement in the last sentence of this paragraph that the form of stamping shall be such that it can be readily distinguished from the original plate-maker's stamping.

Case No. 492. *Inquiry*: Is the maximum unit working stress of 8,550 pounds per square inch for brazed vessels applicable in the formula for the calculation of dished heads, when such heads are brazed into the vessel? This would force the manufacturers to use heavier heads for brazed tanks than required for tanks of riveted construction.

Reply: Attention is called to the fact that the maximum unit working stress for brazed vessels as given in Par. U-94 is applicable for the determination of the stresses in the shell where affected by the brazed joint. For the original calculation of the dished head the stresses specified in Par. U-36 are applicable, and the requirement of Par. U-94 applies to the connection of the heads to the shell in the vessel.

Case No. 493.—(In the hands of the Committee.)

Case No. 494. *Inquiry*: Is it permissible in the construction of large riveted vessels for storage of compressed air, to use nozzles of cast-iron construction, riveted to the shell, for 6-inch, 8-inch and 10-inch pipe-size connections?

Reply: The Code for Unfired Pressure Vessels does not place any restrictions upon material required for nozzles or connections to such vessels. It is the opinion of the Committee that the use of properly designed cast-iron nozzles riveted to the shells of air tanks will constitute safe practice.

Use of Edge-Rolled Plate

Case No. 495. *Inquiry*: Is it permissible under the rules in the Code to use universal or edge-rolled boiler plate for butt straps in view of the tension-test requirements specified in Par. P-190? It was pointed out that in a previous interpretation of the Boiler Code Committee the application of this tension-test requirement in Par. P-190 had been made to apply to either dimension of the plate as might be desired, but that there is still some uncertainty as to the acceptability of the so-called universal or edge-rolled plate under the present revised edition of the Code.

Reply: There appears to be nothing in the Material Specifications Section of the Code that pertains specifically to universal or edge-rolled boiler plate. It has been proposed to revise the Code to provide for the use of this material for double butt straps by the addition of the following:

Make present Par. S-11 section *a* and change side head to read:

Bend Test for Sheared Plates

Add new section *b* to read:

Bend Test for Universal or Edge-Rolled Plates where Permitted for Double Butt Straps. b. The bent-test specimen shall withstand being bent cold through 180 degrees without cracking on the outside of the bent portion as follows: For material 1 inch or under in thickness, around a pin the diameter of which is equal to 1½ times the thickness of the specimen; and for material over 1 inch in thickness, around a pin the diameter of which is equal to 3 times the thickness of the specimen.

Case No. 496. *Inquiry*: Is it the intent of Par. U-68 that the allowable stress of 5,600 pounds per square inch shall refer to the normal thickness of the shell plate, or to the thickness at the welded joint, which under Par. U-71 is required to be from 20 to 50 percent thicker than the plate?

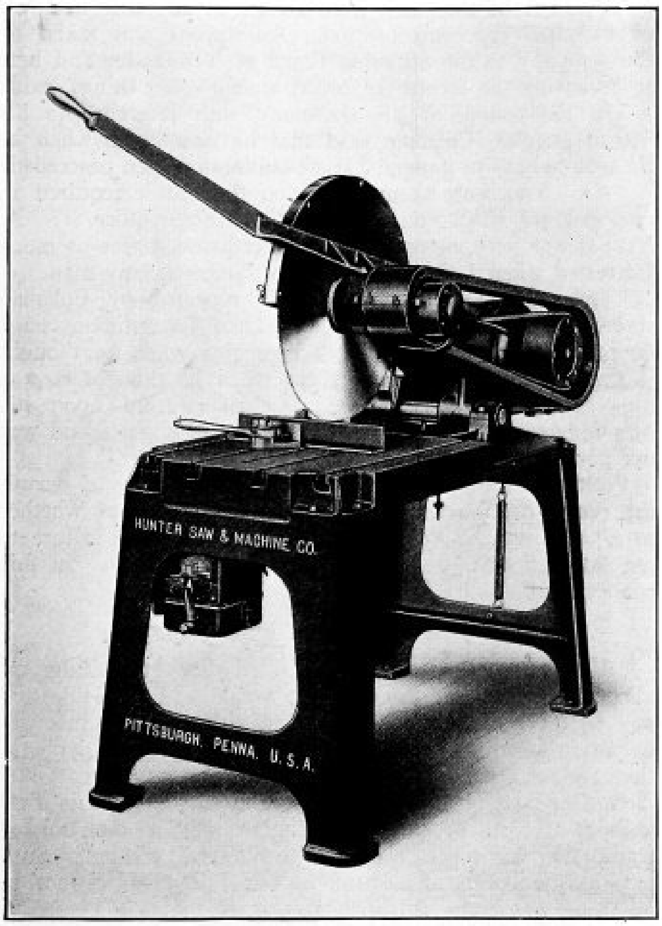
Reply: It is the opinion of the Committee that the allowable stress specified in Par. U-68 shall be calculated on the basis of the minimum thickness of the shell plate.

Case No. 497. *Inquiry*: Is it not the intent of the marking requirements in Par. U-66 of the Code that it shall be optional for the manufacturer to stamp directly on the shell plate, or solder a non-ferrous name plate to the shell plate, as is provided for in Par. P-332 of the Power Boiler Section? With tanks having thin shells it is very difficult to apply the marking by stamping.

Reply: It has been the intent of the Committee to provide for the marking of unfired pressure vessels along such lines as will conform in general to the corresponding requirement in the Power Boiler Section of the Code, and it is the opinion of the Committee that to mark pressure vessels by use of a non-ferrous name plate, brazed, or otherwise irremovably attached to the shell plate, will conform to the spirit of the requirement in Par. U-66.

High Speed Metal Cut-off Saw

THE machine illustrated below was designed by the Hunter Saw & Machine Company, Pittsburgh, Pa., to cut cold metal by means of a high rotative speed circular saw, particularly adapted for tubing and metal sections. The motor and saw blade are mounted on opposite ends of a tilting frame, the machine is driven by a belt from the motor and an idler pulley is located in the frame to give a maximum belt contact on the arbor pulley with a minimum tension. The saw arbor and idler pulley are equipped with S. K. F. self-alining ball bearings in oil-tight dust-proof housings. The belt and saw blades are fully protected by steel guards to conform with safety specifications. A pan is attached to the underside of the table enclosing the saw



Hunter saw for cutting metal cold

at its lowest point to catch cuttings. This pan can be dropped and the cuttings removed, which operation requires only a minimum of time.

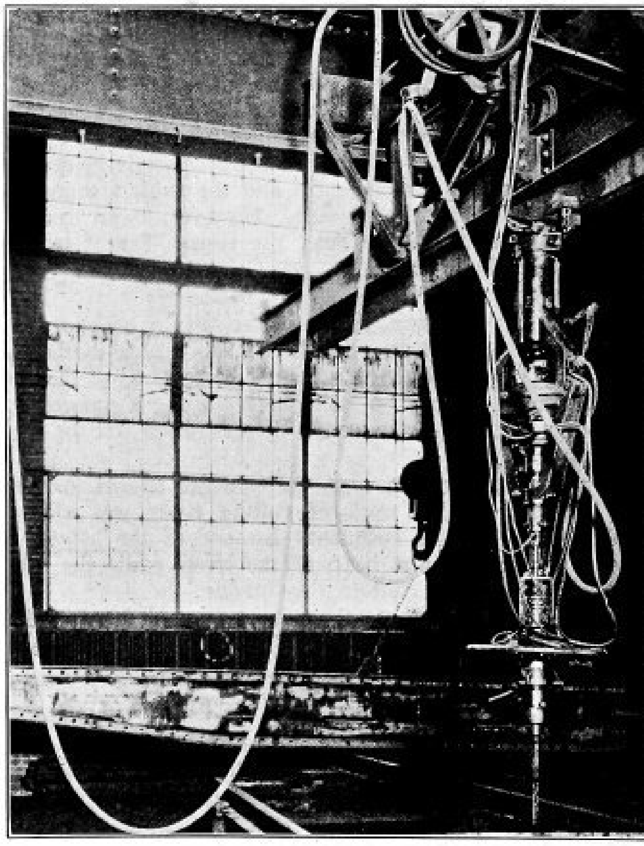
The motor support is provided with adjusting screws to give the belt the desired tension. The motor end of the tilting frame has a cushioned stop and is connected with a spiral spring to return the frame to the height necessary to clear the material being cut. The saw is fed down through the work by an offside hand lever attached to the forward end of the tilting frame. The work to be cut should be raised above the table on the clamping side with supporting strips furnished to prevent it from pinching the saw blade when passing through. For rapid production, the work should be located on the table so that the least section will be in contact with the saw blade throughout the cut. These conditions are readily obtained with this machine.

The table is provided with a graduated quadrant stop that can be set to any angle within the sweep of the saw blade used. This stop is held firmly in position on the table by a bolt moving through T-slots. The material is clamped by a quick-acting eccentric jaw. The machine has a capacity for tubes up to 4 inches in diameter. It is equipped to take care of a saw of 24-inch maximum overall section. It is driven by a 7½-horsepower motor with a speed of 1,750 revolutions per minute. The machine occupies a floor space of 31 inches by 24 inches and can be readily moved if desired.

Vertical and Horizontal Reaming Machine

THE American Car & Foundry Company, New York, has recently placed on the market a vertical and horizontal reaming machine developed and used as standard equipment at all the plants of this company.

The machine is controlled by a single operator, who becomes skilled in its use in 10 hours or less, and can then accurately ream holes as fast as he can find them. Mounted on a traveler which can be racked forward or backward by means of an electric motor controlled by a switch located on the hand-wheel, the longitudinal spacing of holes is limited only by the length of the traveler runway. The trolley which carries the machine has been built with ball bearings, so that a very light push on the hand-wheel will give horizontal con-



The weight of this machine feeds the reamer in holes up to 1⅝ inches without any exertion on the part of the operator

trol along the traveler bridge; here again the width of the work is limited only by the length of the traveler bridge.

The electric motor used for rotating the reamer bit has a break-test capacity of 6.9 horsepower, and will ream holes up to 1⅝ inch in diameter. Rotation of the armature is controlled by a contactor, which is operated automatically when the air cylinder, used for vertical control, is lowered or raised. The air valve used for controlling the air cylinder is operated by means of a clamp handle, located on the handwheel. A safety clutch is placed between the reamer bit and rotating armature shaft extension. This clutch is released as soon as the operator's hands are removed from the handwheel; and, when released, the reamer bit immediately stops rotating. Since the bit, and its extension if used, are the only exposed rotating parts, this clutch insures safety against accidents.

The machine has sufficient weight and rigidity to insure vertical reaming, and yet has a certain amount of flexibility, permitting the bit to enter holes not in the proper alinement.

Maintenance consists principally in the occasional renewal of motor brushes and lubrication. All parts are interchangeable, so that any part can be readily duplicated and all parts are readily accessible to inspection and repair. Breakage of reamer bits is practically eliminated, because the weight of the machine has been accurately determined as sufficient to drive the reamer through the hole without applying additional external force, and because of accurate central withdrawal from the hole by means of the air cylinder. Reamer bits can be changed as conveniently as a drill in any standard machine.

Necessity of Utilizing Safety Appliances

By Leslie Childs

By the weight of authority, the willful failure of an employee to use safety appliances, according to the rules of his employer, may result in a denial of compensation under workmen's compensation statutes if injury results. Of course each case of this kind must necessarily be decided in the light of its circumstances and the subject cannot be covered by a hard and fast rule. However, as an example of the application of the rule, the recent Tennessee case of Nashville, C. & St. L. Ry., vs. Coleman, 269 S.W. 919, is worthy of review.

In this case Coleman, the employee, was a boiler maker, and while cutting rivets off a boiler was struck in the eye with a rivet head which necessitated the removal of the eyeball. For the injury so suffered he brought proceedings under the Tennessee Workmen's Compensation Act for compensation.

Upon the trial of the case, the evidence tended to prove that Coleman in his work of cutting rivets was allowed two helpers. It was customary for one of the helpers to hold a broom over the head of the rivets while the other wielded the hammer and in this manner the danger to all concerned from flying rivet heads was avoided. In addition the company had a standing rule which provided:

Rule Required Goggles to be Worn

"Goggles must be worn by all workmen when chipping, using air motors, drilling, sledging of any kind, when using emery wheels, electric welders, or any work where their duties require that their eyes be protected from flying particles."

Upon the occasion of the accident, Coleman was cutting rivets with but one helper who was wielding the hammer and no one was holding a broom over the rivet heads. Furthermore it was shown that Coleman was not wearing goggles, though the company provided them for use on all work of this kind.

Coleman testified that he used goggles when he thought it proper and did not use them when he thought it unnecessary. The trial court found that he, Coleman, was familiar with the rule requiring the use of goggles on work of that kind. It was also in evidence that cutting rivets was a dangerous job if not carried on with safety appliances.

On this set of facts, the company took the position that Coleman's injury was the direct result of his willful failure to use the safety appliances provided, contending that in view of which he was not entitled to compensation under the Tennessee Act. The section of the Act relied upon by the company provided:

"That no compensation shall be allowed for an injury or death due to the employee's willful misconduct or intentional self-inflicted injury, or due to intoxication, or willful failure or refusal to use a safety appliance or perform a duty required by law."

Judgment Rendered for Employee

The trial of the cause resulted in a judgment in favor of Coleman for compensation. An appeal was taken by the company to the Supreme Court of Tennessee, and here in reviewing the record the court, among other things, said:

"In the course of his testimony with reference to his use of goggles, Coleman said that he wore them when he thought he was in danger. His examination then proceeded:

" 'Q. You wore them when you thought it required it, and did not when you thought it did not require it? A. Yes; it was very uncomfortable, nevertheless I was as much interested when I thought I was in danger as any man.'

"This statement in substance is repeated by Coleman several times in his brief. The effect of his testimony must be conceded to be that he used goggles when he thought it proper, and did not use them when he thought it was unnecessary. In other words, Coleman acted upon his own judgment customarily about the use of goggles and was not governed by the rule of the railway company."

Following the foregoing review of the evidence of record, the court directed its attention to the question of whether or not the acts of Coleman constituted a willful failure to use safety appliances that would bar his recovery. In this connection the court, in part, said:

What the Higher Court Decided

"When he (Coleman) substituted his own judgment about the matter for his employer's rule and set aside that rule in favor of his own notions, we think his conduct was willful disobedience. It involved both intent and deliberation and was not a casual, although voluntary, act. * * * According to Coleman's testimony the cutting of this rivet without the use of safety appliances was not an isolated transaction, but was of a piece with his usual conduct. Such habitual violation of a rule, in our judgment, cannot be anything else than willful and this is the case before us * * *."

In conclusion the court reversed the judgment rendered by the lower court in favor of Coleman and ordered the action dismissed. Holding, as outlined in the opinion, that under the evidence Coleman was not entitled to recover because of his willful failure to use the safety appliances provided by his employer.

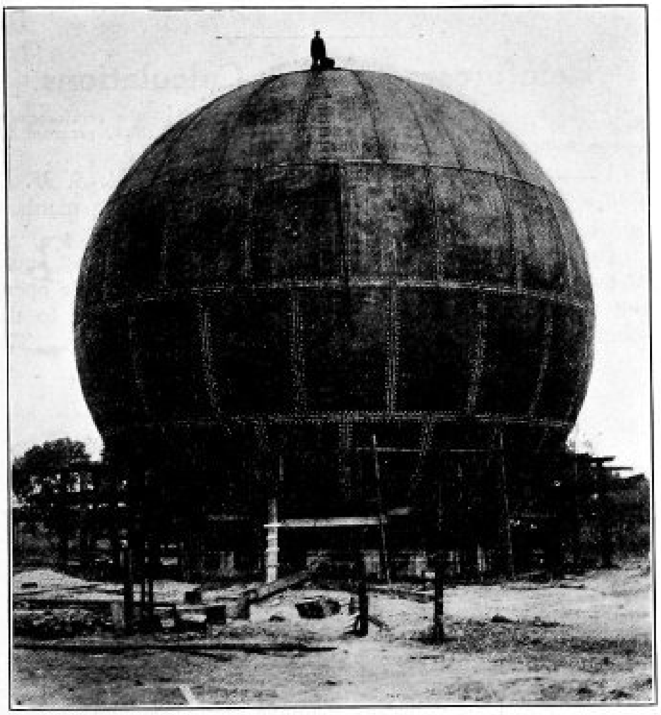
International Acetylene Association to Meet in Chicago

November 18, 19 and 20, 1925, have been set as tentative dates for the convention of the International Acetylene Association to be held in Chicago. The program committee, which has been appointed, consists of the following: E. E. Thum, Linde Air Products Company, New York, chairman; H. S. Smith, Prest-O-Lite Company, New York; Stuart Plumley, Acetylene Journal, Chicago, Ill.;

R. A. Sossong, Air Reduction Company, New York; F. E. Rogers, Air Reduction Company, New York; H. S. Card, Welding Engineer, Chicago, Ill.; H. W. Cook, J. B. Colt Company, New York, and P. Kearney, K. G. Welding Company, New York. The committee on arrangements for the convention will be J. D. Swain, Union Carbide Company, Chicago, Ill., chairman; J. I. Banash, 168 North Michigan Avenue, Chicago, Ill.; Stuart Plumley, Acetylene Journal, Chicago, Ill.; B. N. Law, Air Reduction Company, Chicago, Ill.; E. L. Mills, Bastian-Blessing Company, Chicago, Ill., and H. W. Cook, J. B. Colt Company, New York.

Steel "Captive Balloon" Replaces Gas Holder

WHY does a toy balloon which you buy from a street vender assume a spherical shape when it is filled? If you know the answer to that one you can guess why the newest type of gas holder is a spherical steel tank. To relieve the suspense of those who have forgotten their geometry we will tell the answer. The balloon assumes a spherical shape because a sphere has a greater capacity for the same area of surface than any other body. That means that a spherical tank can be made to contain more gas per unit of cost than a tank of any other shape.



New type spherical gas tank

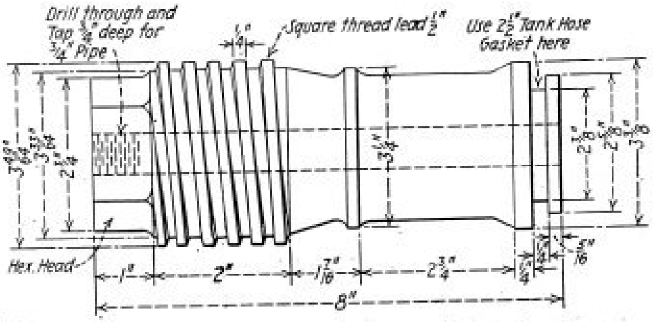
The accompanying picture shows the first one of these new tanks ever built. It is at Phoenix, Arizona, on the property of the Central Arizona Power & Light Company. It is 57 feet 6 inches in diameter and will contain 300,000 cubic feet of gas at a maximum pressure of fifty pounds per square inch.

This tank has been named the Hortonsphere in honor of George T. Horton of Chicago, who is its inventor.

The Hulson Grate Company, Inc., Keokuk, Iowa, which bought the Pechstein Iron Works, in Keokuk, last April, has recently placed the plant in operation. The machine and boiler shops have been discontinued and the foundry re-equipped.

Feedwater Heater Testing Nozzle

THE device shown in the sketch is used in testing locomotive feedwater heaters equipped with "Y" connections in the branch pipe for the purpose of washing out the feedwater heater. It has been the practice in recent years to equip feedwater heaters with these "Y" connections, particularly in territories having bad water. The fitting shown in the sketch may be used on either the condensate line where it returns to the tank, or on the feedwater pump supply pipe.



Nozzle for testing feedwater heaters of the closed type

It is the usual practice to test the feedwater heater at the time of the monthly inspection of the locomotive. This is done by closing the locomotive boiler check stop valve and opening the condensate valve. Water is pumped into the feedwater heater under pressure through a tapped hole in the end of the heater, which is plugged when not in use, or through a tapped hole located just above the flanged connection to the branch pipe. Water coming out of the condensate valve at the front of the tank or under the cab indicates a leak in the heater tubes. This procedure is also followed in cases where the heater has the condensate pipe returning to the feedwater pump supply line. In testing this type of equipment the locomotive tank valve is closed tight. Water from the condensate valve might indicate that there is a leak in the feedwater heater tubes or that water is passing by the feedwater pump valves and back through the supply pipe. However, if the fitting shown in the sketch is screwed into the connection of the branch pipe leading to the heater, water from the condensate valve will show that the leak is due to a bad feedwater heater tube.

In cases where the equipment has the condensate pipe returning to the supply pipe of the feedwater pump, with no "Y" connection in the branch pipe, the heater can be tested by blanking the branch pipe leading to the pump or breaking a joint of the condensate pipe between the heater and the supply pipe.

Air Reduction Sales Company Acquires Gas Tank Recharging Company

ON August 12, 1925, the Air Reduction Sales Company with executive offices at 342 Madison Avenue, New York City, purchased the assets and assumed the liabilities of the Gas Tank Recharging Company, incorporated in 1913. The Gas Tank Recharging Company owned and operated acetylene plants at Milwaukee, Wisconsin, and Bettendorf, Iowa; and a carbide plant at Keokuk, Iowa, where they manufactured Sun-Lite brand carbide.

The manufacture and distribution of Airco-National Carbide will be increased by the acquisition of the Keokuk plant, guaranteeing to consumers in the Mid-Western territories a carbide of as high quality as maintained by National Carbide produced at the Ivanhoe plant.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Jacketed Tank

Q.—Being a regular reader of your valuable paper THE BOILER MAKER I should be pleased if you can give me information on a few points regarding the design of some steam jacketed cylinders to the sketch below:

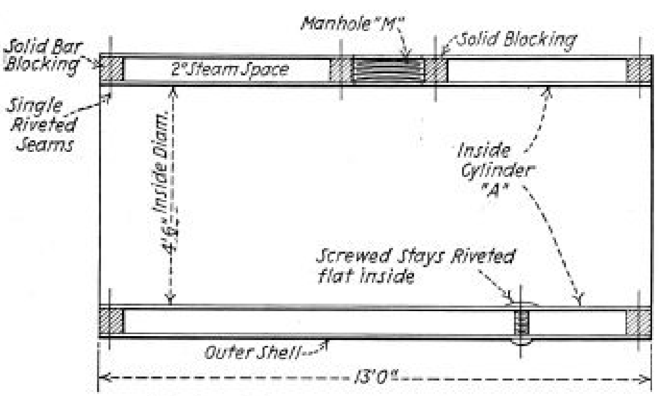
1. How may I determine the thickness of the inside cylinder *A*? This is to be in one piece, solid welded longitudinally. The welding is to be done by fire heat; can you give me the approximate efficiency of a fire welded joint?

2. I take it that the thickness of the outer shell may be found by the usual method, but, supposing this is made of thinner material than usual or than found by the general formula, how may I determine the number of screwed stays required, and their position? The stays would be run through both cylinders, through suitably screwed holes, and then heated and riveted over to form a cup head.

3. What allowance in thickness should be made if the manhole *M* is placed in as shown, 16-inch diameter?

4. Can you recommend any hints in the design of these cylinders?
L. J.

A.—To answer your question definitely it is necessary to know the pressure the cylinders will be subject to. The *A. S. M. E. Boiler Construction Code* gives the rules covering the construction of *unfired pressure vessels* and the formulas for determining the strength and size of the parts of such vessels. These rules do not apply to the following:



Design of a steam jacketed tank

(a) To boilers and other pressure vessels which are subject to Federal inspection and control; (b) to locomotives of all types; (c) to vessels containing only water under pressure for domestic use; (d) to vessels subject to temperatures above 750 degrees.

If your problem comes within the rules governing unfired pressure vessels, use the formula given in Par. U-20 for determining the thickness of plate for shells subject to bursting pressure, and the formula in Par. U-40 for stayed surfaces.

Par. U-55 states as follows on reinforcing manhole openings:

A manhole reinforcing ring, when used, shall be of rolled, forged or cast steel, shall be at least as thick as the shell plate, and shall have a net cross sectional area, or a line parallel to the axis of the shell, not less than the cross sectional area of shell plate removed on the same line.

Calculate the staying of the inner shell as a flat surface, and figure the location of the first row of stays at each end from the center line of rivets. If you will give full particulars on the problem, complete information can be given in this column of THE BOILER MAKER.

Reinforcement Ring Calculations

Q.—Please give the rule for figuring out the sizes of the reinforcement ring for an 11 by 15-inch manhole; shell plates ½-inch thick, pressure 125 pounds, using ⅞-inch rivets,—L. M. C.

A.—Paragraphs 258 to 261 inclusive of the *A. S. M. E. Boiler Code* cover the requirements of reinforcing manhole and hand hole openings.

The strength of a manhole frame shall be at least equal to the tensile strength of the material removed by the opening and rivet holes, measured on any line parallel to the longitudinal axis of the shell, through the opening. The

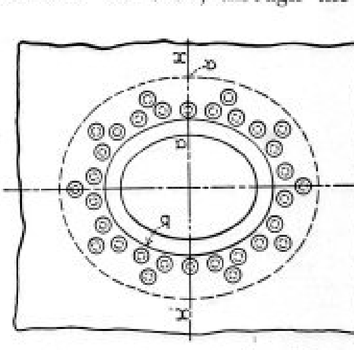


Fig. 1.—Calculating manhole reinforcements

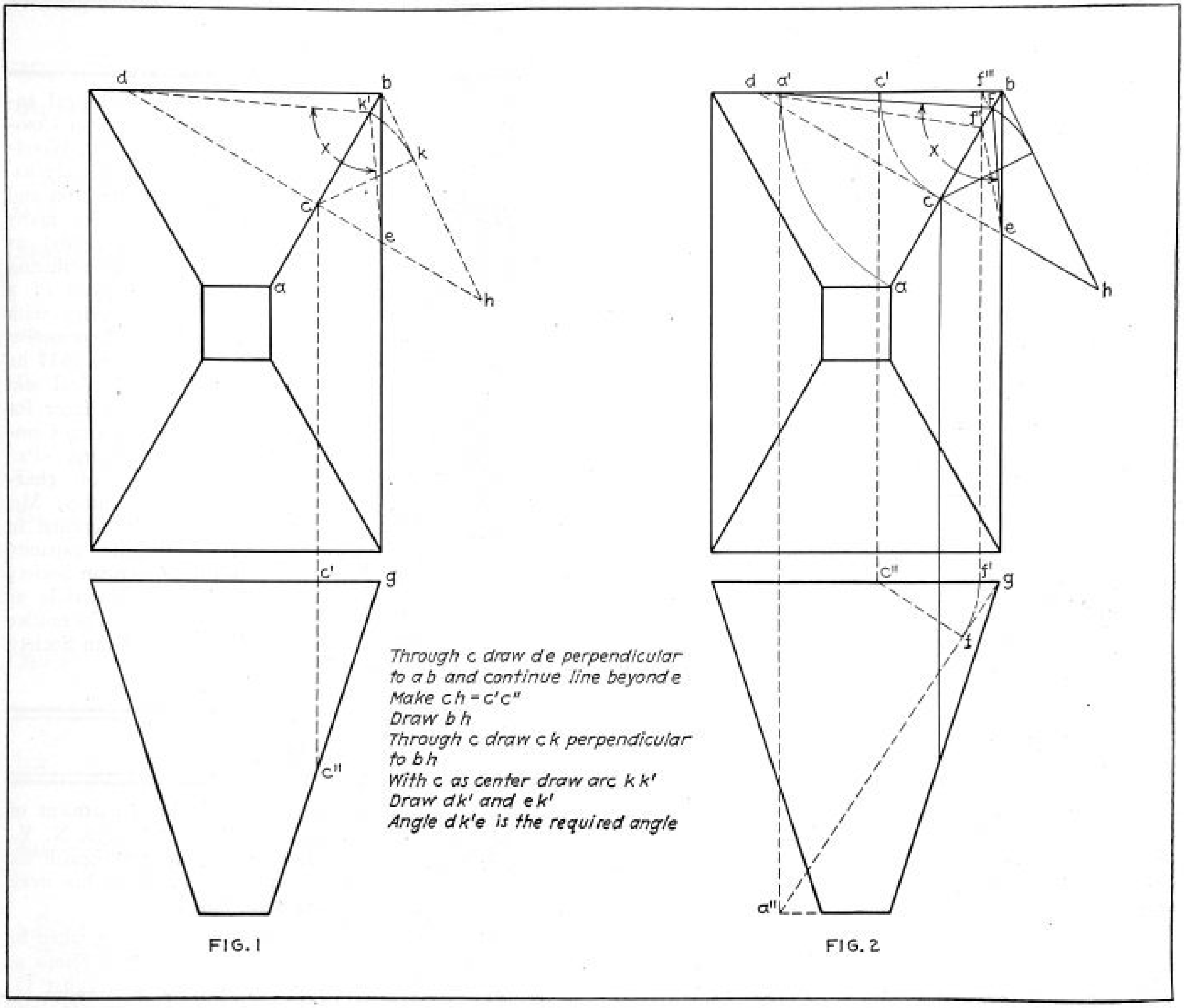
frames or reinforcing line on the shells must have the curvature of the shell. On boilers over 48 inches in diameter, the liners shall be riveted to the shell plate with two rows of rivets as shown in Fig. 1 and shall have a thickness at least equal to that of the shell plate.

The width of the ring through *a-a* shall have a strength equal at least to one-half of the shell plate removed on line *x-x*. The formula for finding this width for a double riveted ring is as follows:

$$W = \frac{l \times t}{2 \times t} + (2 \times d)$$

in which,

W = width of ring, inches
l = length of plate removed on line *x-x*, inches
t = thickness of shell plate, inches
d = diameter of rivet hole, inches.



Method of finding correct angle between hopper sides

Substitute the values of your example in the formula, then

$$W = \frac{11 \times \frac{1}{2}}{2 \times \frac{1}{2}} + (2 \times 0.9375) = 7\tfrac{3}{8} \text{ inches.}$$

The number of rivets on each side of line x-x should be sufficient, so that their combined resistance to shear equals at least the tensile strength of the shell plate removed on line x-x. However, it will be found necessary to use more rivets than the theoretical number, in order to have proper arrangement, and to prevent leakage around the calking edge b of the liner and shell.

The following formula may be used:

$$N = \frac{5.1 \times T \times a}{S \times d^2}$$

in which,

N = number of rivets required on each side x-x
T = tensile strength of plate, pounds per square inch
a = sectional area of liner one side of line x-x
d = diameter rivet holes.

The Dearborn Chemical Company contemplates the construction of a warehouse in Los Angeles, Cal., while the plant under construction in Chicago will be ready for occupancy on October 17.

Angle Between Sides of Hopper

Q.—The inclosed Fig. 1 indicates a method of determining the angle between the sides of a tapering hopper which is much simpler than the solution given in your July issue of THE BOILER MAKER in reply to the question of M. E. H.

Moreover your solution does not give the correct angle. The inclosed Fig. 2 indicates the additional construction necessary to obtain the correct angle by your method. For the purpose of comparison the construction by Fig. 1 method is added in red lines on Fig. 2.—W. F. F.

A.—Your solution is correct. The error in our construction is in the projection of the revolved length c''—f of the elevation to the plan, whereas this distance should be transferred by setting off c—f'' of the plan equal to c''—f of the elevation.

Boiler Calculations

Q.—Inclosed you will find rough sketch of a wagon top type boiler, which we are re-designing for use on a vessel that will navigate the waters of the east coast in and about New York harbor and Long Island Sound.

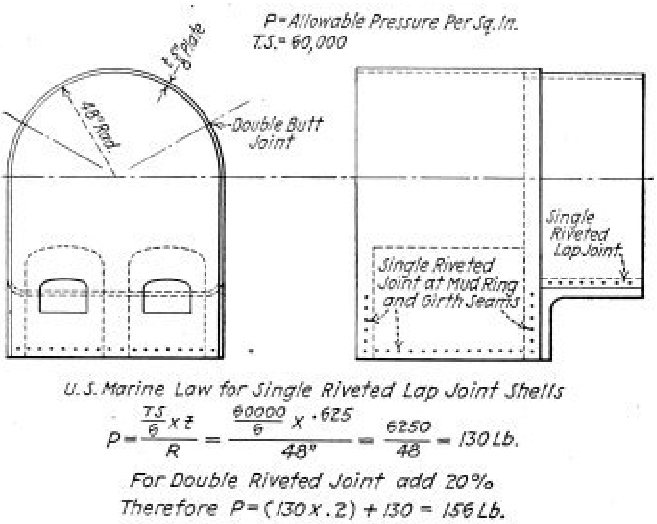
A question has arisen as to the proper method of figuring the allowable pressure on the wagon top.

Rule II, Section 2 of the Department of Commerce Steamboat Inspection Service (Ocean and Coastwise) reads as follows:

"The working steam pressure allowable on cylindrical shells of boilers constructed of plates inspected as required by these rules when single riveted, shall not produce a strain to exceed one-sixth of the tensile strength of the iron or steel plates of which such boilers are constructed; but where the longitudinal laps of the cylindrical parts of such boilers are double riveted, and the rivet holes for such boilers have been fairly drilled instead of punched, an addition of 20 percent to the working pressure provided for single riveting shall be allowed. The pressure for any dimension of boilers shall be ascertained by the following rule, viz.:

"Multiply one-sixth of the lowest tensile strength found stamped on the plates in the cylindrical shell by the thickness—expressed in inches or part of an inch—and divide by the radius of half diameter, also expressed in inches, and the result will be the pressure allowable per square inch of surface for single riveting, to which add 20 percent where the longitudinal laps of the cylindrical parts of such boiler are double riveted, when all the rivet holes of such boiler, including steam and mud drums, have been fairly drilled and no part of such holes has been punched. The pressure allowed shall be based on the plate whose tensile strength multiplied by its thickness gives the lowest product."

We naturally assume that this rule applies to our particular type boiler, but are in doubt as to just how. For instance, if we make the wagon top



Determining allowable working pressure

of one solid plate from mud ring to mud ring the allowable working pressure, as we interpret this rule, will figure out as follows:

$$P = \frac{\frac{TS}{6} \times t}{R} = \frac{\frac{60,000}{6} \times 0.625}{48} = \frac{6,250}{48} = 130 \text{ pounds}$$

But if a double butt joint is put in the steam space, as shown on sketch, the pressure can be increased 20 percent, therefore:

$$P = (130 \times 0.20) + 130 = 156 \text{ pounds.}$$

Our opinion is that a solid plate will withstand a greater pressure than one with a joint, but we can find no rule governing same.. We would therefore appreciate very much to know whether our interpretation of this law is correct or not.

Do you know of any rule governing wagon tops of solid plate? Thanking you in advance for any information, we remain.—H. J. S.

A.—We would advise you to consult the steam boiler inspector, located in the district where the boiler is to be operated.

The maximum allowable working pressure is figured from the strength of the weakest section of the boiler. The rule stated in the question applies to riveted joints and so far your interpretation is correct. However, the stayed surfaces, stays, their arrangement and proportions, strength of material, etc., must be also considered in calculating allowable pressure on the wagon top. A solid plate will withstand a greater pressure than one with a riveted joint, the ultimate strength of the solid plate is figured at 100 percent divided by the factor of safety. Riveted joints have an efficiency of from 50 to 94 percent of the solid plate section depending on the type of joint.

Your problem is one that requires an analysis of the strength of all boiler parts before the allowable pressure can be determined.

Owing to expansion of business during the past year, the Ingersoll-Rand Company will occupy the entire twelfth floor of the Bowling Green Building, 11 Broadway, New York.

PERSONAL

G. H. Woodroffe has been appointed metallurgical engineer, a newly created position, of the Reading Iron Company's boiler tube department at Reading, Pa. Mr. Woodroffe has been closely associated with the iron and steel industry for many years, having served as engineer of tests during the last five years of a nine years' service with the Baldwin Locomotive Works, and since 1917 he has been mechanical and metallurgical engineer for the Parkesburg Iron Company, Parkesburg, Pa., manufacturers of charcoal iron boiler tubes. Mr. Woodroffe is serving in an important capacity with the American Society for Testing Materials as secretary of Committee A-1 on Steel, and is also a member of the American Society of Mechanical Engineers.

G. H. Woodroffe

OBITUARY

Robert Joy, superintendent of the boiler department of the Kingsford Foundry & Machine Works, Oswego, N. Y., died on August 23, 1925. He had been in poor health for the past few months but continued to attend to his work until the last and was at the office daily.

John McKeown, who was until four years ago, when he retired, chief boiler inspector of the Erie Railroad Shops at Galion, Ohio, died at his home in that city on August 17. Mr. McKeown was born in County Antrim, Ireland, in March, 1847, and came to this country when very young. After completing his school course, he entered the Steubenville shops of the Steubenville & Indiana Railroad which are now part of the Pennsylvania Railroad System, as a boiler maker's helper. He later became an apprentice to the trade of boiler making and served his full time. In 1866 when the shop forces at Steubenville were transferred to the new Pennsylvania shops at Dennison, Ohio, Mr. McKeown accompanied them. He worked for the Pennsylvania company for 22 years. In 1888 he became connected with the Erie Railroad and was placed in charge of what was known as the N. Y. P. & O. boiler shops in Galion. He remained in charge of the boiler makers' force at this point for 22 years when he became chief boiler inspector. He held this position until his retirement.

John McKeown

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

Steamboat Inspection Service of the Department of Commerce

Supervising Inspector General—George Uhler, Washington, D. C.
Deputy Supervising Inspector General—D. N. Hoover, Jr., Washington, D. C.

American Uniform Boiler Law Society

Chairman of the Administrative Council—Charles E. Gorton, 253 Broadway, New York.

Boiler Code Committee of the American Society of Mechanical Engineers

Chairman—John A. Stevens, Lowell, Mass.
Vice-Chairman—D. S. Jacobus, New York.
Secretary—C. W. Obert, 29 West 39th Street, New York.

National Board of Boiler and Pressure Vessel Inspectors

Chairman—J. F. Scott, Trenton, N. J.
Secretary-Treasurer—C. O. Myers, State House, Columbus, Ohio.
Vice-Chairman—R. L. Hemingway, San Francisco, Cal.
Statistician—E. W. Farmer, Rhode Island.

International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

J. A. Franklin, International President, suite 522, Brotherhood Block, Kansas City, Kansas.
William Atkinson, Assistant International President, suite 522, Brotherhood Block, Kansas City, Kansas.
Joseph Flynn, International Secretary-Treasurer, suite 504, Brotherhood Block, Kansas City, Kansas.
James B. Casey, Editor-Manager of Journal, suite 524, Brotherhood Block, Kansas City, Kansas.
H. J. Norton, International Vice-President, Alcazar Hotel, San Francisco, Calif.
International Vice-Presidents—Thomas Nolan, 700 Court St., Portsmouth, Va.; John Coots, 344 North Spring St., St. Louis, Mo.; M. A. Maher, 2001-20th St., Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, 15 La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Ave., Chicago, Ill.; John F. Schmitt, 605 East 11th Ave., Columbus, Ohio.

Master Boiler Makers' Association

President—Thomas F. Powers, system general foreman, boiler department, Chicago & Northwestern.
First Vice President—J. F. Raps, general boiler inspector, Illinois Central.
Second Vice President—W. J. Murphy, general foreman boiler maker, Pennsylvania.
Third Vice President—L. M. Stewart, general boiler inspector, Atlantic Coast Line.
Fourth Vice President—S. M. Carroll, general master boiler maker, Chesapeake & Ohio.
Fifth Vice President—George B. Usherwood, supervisor of boilers, New York Central.
Secretary—Harry D. Vought, 26 Cortlandt street, New York.
Treasurer—W. H. Laughridge, general foreman boiler maker, Hocking Valley.
Executive Board—A. F. Stiglmeier, N. Y. C. R. R., Albany, N. Y., chairman; H. J. Raps, G. F. B. M., I. C. R. R., 7224 Woodlawn avenue, Chicago, Ill., secretary.

Boiler Makers' Supply Men's Association

President—F. H. McCabe, McCabe Manufacturing Company, Lawrence, Mass.
Vice President—J. W. Kelly, National Tube Company, Pittsburgh, Pa.
Treasurer—S. F. Sullivan, Ewald Iron Company, Chicago, Ill.
Secretary—W. H. Dangel, Lovejoy Tool Works, Chicago, Ill.

American Boiler Manufacturers' Association

President—G. W. Bach, Union Works, Erie Pa.
Vice President—A. R. Goldie, Goldie-McCulloch Company, Galt, Ont., Canada.
Secretary-Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.
Executive Committee—E. R. Fish, Heine Boiler Company, St. Louis, Mo.; G. S. Barnum, The Bigelow Company, New Haven, Conn.; W. C. Connelly, D. Connelly Boiler Company, Cleveland, O.; W. A. Drake, The Brownell Company, Dayton, O.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; J. F. Johnston, Johnston Brothers, Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Works, Kewanee, Ill.; A. G. Pratt, The Babcock & Wilcox Company, New York and J. H. Broderick, Broderick Boiler Company, Muncie, Ind.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

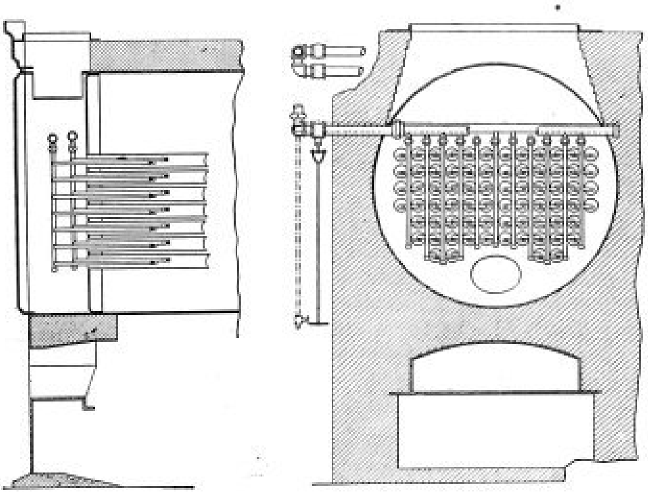
SELECTED BOILER PATENTS

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

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

1,533,873. APPARATUS AND METHOD FOR CLEANING BOILER TUBES. FREDERICK W. LINAKER AND THEODORE M. BRUBACK, OF DUBOIS, PENNSYLVANIA.

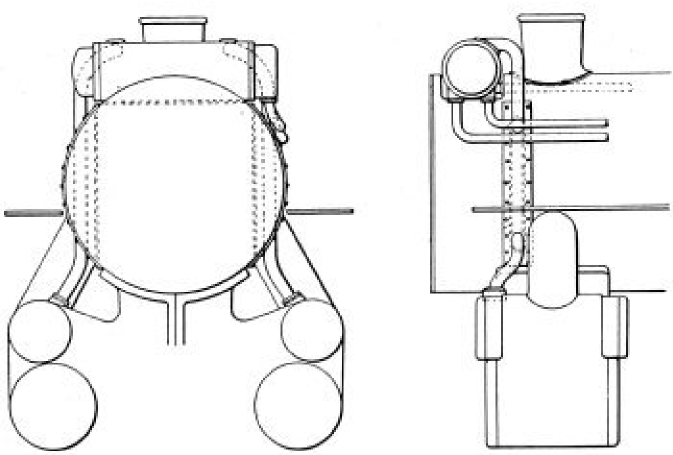
Claim 1.—A tube system having parallel tubes connected at their respective ends, and means for causing a normal draft through the tubes in one direction, said tubes divided into groups or series, with cleaning means comprising jet-projecting elements having accelerating nozzles located



within the tubes, the series of such elements in the tubes of one group discharging in a direction opposed to such normal draft, and the series in the tubes of another group discharging in a direction coinciding with the normal draft, and controlling valves, whereby on blowing both series of elements a circulation is caused in one direction through one group of tubes and in the reverse direction through the other group of tubes. Seventeen claims.

1,533,962. LOCOMOTIVE CONSTRUCTION. AUGUSTINE R. AYERS, OF CLEVELAND, OHIO.

Claim 1.—A locomotive construction including a steam chest, a feed water heater, a smoke box and a pipe connecting said steam chest to said heater, said smoke box being formed with a recess adapted to receive said pipe.

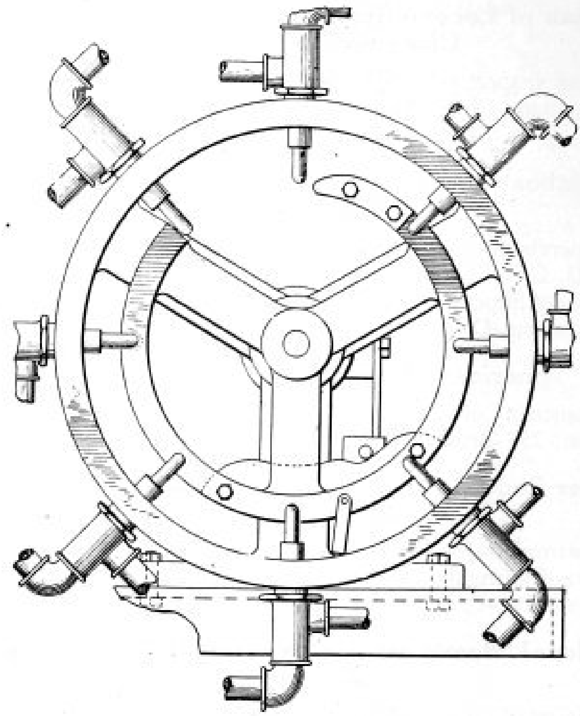


In a steam locomotive structure of the character described including a steam chest, a feed water heater, a smoke box and a pipe connecting said steam chest and feed water heater, said smoke box being provided with a recess adjacent one side thereof adapted to house said pipe, and a cover for closing the open side of said recess. Seven claims.

1,535,495. BOILER CLEANING. GRANT I. RAWSON, OF DETROIT, MICHIGAN, ASSIGNOR, BY MESNE ASSIGNMENTS, TO DIAMOND POWER SPECIALTY CORPORATION, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

Claim 1.—In a boiler cleaning system comprising a plurality of blower units, a header for delivering cleaning fluid to said units; a distributor for controlling the delivery of said fluid to said header; means operable by the stoker of the boiler for controlling the delivery of fluid to said header and a drain valve in said header operable through the pressure of the cleaning fluid in said header.

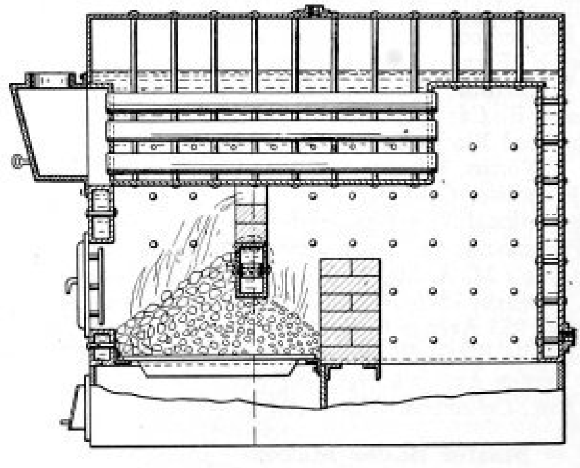
In a boiler cleaning system comprising a plurality of blower units, a header for delivering cleaning fluid to said units; means for controlling



the delivery of said fluid to said header; means for controlling the delivery of fluid to each of said units from said header; means for operating said control means of said header; means for successively operating said control means of said units; and means operable by the stoker of the boiler for operating said control means of said header and successively operating said control means for said units. Fifteen claims.

1,539,330. BOILER. JAMES A. ROSS, OF CHICAGO, ILLINOIS.

Claim 1.—The combination with the arch wall and the water compartment of a boiler, of a hollow arch support in open communication with said water compartment; means for re-inforcing the walls of said arch support; longitudinally extending bevelled plates removably mounted on said means in



said arch support intermediate the bottom and top thereof and having their adjacent ends in spaced relation with respect to each other, said plates being adapted to direct convecting currents through said arch support; and means permitting withdrawal of the bevelled plates from within said arch support. Four claims.

1,539,257. COMBUSTION CONTROL. GEORGE H. GIBSON, OF MONTCLAIR, NEW JERSEY.

Claim 1. The combination with a furnace comprising a grate on which solid fuel is burned and having its primary air inlet and its outlet for gaseous products of combustion connected, one to the atmosphere by a passage of constant flow resistance, and the other to a draft creating device, of fuel supply means automatically responsive to a force proportional to the difference betwen the resultant of the pressure in the furnace above the grate and the opposing pressure of the atmosphere over one area, and the resultant of the pressure in the furnace adjacent the draft creating device and the opposing pressure of the atmosphere over an area different from the first mentioned area, for supplying fuel to said grate as required to maintain a fuel bed of approximately constant resistance to gas flow therethrough. Four claims.

The Boiler Maker

Volume XXIV 25 | October, 1925 | Number 9 10

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

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Cable address: Urasigmec, London

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

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

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

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

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Group Plan of Wage Payment

Manufacturers throughout the country are continually striving for a method of wage payment that will be fair to workers, stimulate their interest and be relatively easy to compute and understand. That there is no cut and dried solution to this problem that can be universally applied to the general satisfaction of both workers and employers goes without saying. The problem is of long standing and with the growing complication of manufacturing processes is steadily becoming more difficult to solve. Of recent developments one of the most helpful is that of considering workers in groups rather than as individuals. The method of compensation based on the group makes for better cooperation, two advantages that are eminently desirable in any scheme of wage payment. In fact, payment by group is one of the livest developments in the theory and practice of compensation.

How the method of group payment has been successfully applied in various industries of widely different character is described in an instructive bulletin distributed by the Policyholders' Service Bureau of the Metropolitan Life Insurance Company. In some cases a group bonus plan is applied to all productive departments, in others a group premium system is used in only a few departments and in still others the diversity and nature of the operations involved in manufacturing the product do not permit of grouping for computation of earnings. In general it is found that the group system simplifies the computations for determining wages and costs as it is only necessary to keep track of the output of each individual. The advantage of individual initiative is maintained for the reason that the members of each group who have ideas or knowledge of methods that will increase the output of the group have every incentive to use their ideas themselves as well as to transmit them to their fellow workers.

If the group plan tends to increase the output of the manufacturing plant and at the same time gives the individual worker a better opportunity to capitalize his earning capacity, it is something that should receive careful consideration by the management.

Efficiency in Boiler Work

In boiler making as in any trade there are many ways of promoting efficiency that are overlooked for a time and then some progressive individual, after carefully studying his methods, discovers where time and labor can be saved by incorporating obvious changes in them. Too frequently such individuals are unwilling to give their fellow craftsmen the benefits derived from their discoveries. There are still others, however, who are not only willing but anxious to pass along any information that comes their way which will serve to aid others in the conduct of their own methods.

An example of this spirit is evidenced in the article "System of Laying Out Elbows," which appears in this issue of The Boiler Maker. The author finding that the repetition of elbow cut layouts day after day to obtain the rises for the spaces around an elbow required considerable time, decided that he could simplify the problem materially by developing a series of standard spacing charts. By the aid of these charts a layer out can determine the necessary lengths for his elbow on a piece of band iron and these lengths can then be transferred to the sheet on which he is working. The usual method of laying out an elbow necessitates the making of a series of sketches to determine the correct spacing of the cuts. Since each sketch involves about fifteen minutes work and the layer out usually has several to do in the course of the day, a material time saving can be accomplished by the use of the charts.

This example of what one of our readers is accomplishing in the way of improvement and simplifications should serve to stimulate others and we trust that further articles applying the principles of simplifications to other forms of boiler work will be made available to the trade through the medium of our pages.

Welded Joints Meet Supreme Test

DETAILS of a recent crown sheet failure on the Canadian Pacific Railway, as given on page 287 of this issue, add further proof of the efficiency of welded firebox seams when properly made. In this case the explosion, due to low water, carried away the entire crown sheet and parts of the side sheets, the boiler itself being torn from the engine and hurled clear of the track. Notwithstanding the force of the explosion, which tore the solid plate of both crown and side sheets in many directions, the welded joints connecting the crown and side sheets held fast, proving the strength and high efficiency of the welds as compared with the solid plate.

In this case at least the boiler explosion cannot be laid to the welded joints in the firebox. The executives of the Canadian Pacific are satisfied that the welding process they have adopted as standard practice meets all requirements. It has given satisfactory service under severe conditions of boiler operation for five years and now has met the supreme test of a destructive boiler explosion without failure.

The Largest Locomotive in Great Britain

WHAT is said to be the largest and most powerful locomotive ever built in Great Britain for domestic service is the new Garratt locomotive of the North Eastern Railway, illustrated and described on page 297 of this issue. It weighs 178¾ tons, has a tractive force of 72,940 pounds at 85 percent of the boiler pressure and develops its power in six cylinders. The boiler, which is said to be far larger than any hitherto in service on English railways, has a total heating surface of 3,640 square feet and a grate area of 56.4 square feet. The working steam pressure is 180 pounds per square inch. The boiler barrel is 13 feet long and has a maximum diameter of 7 feet. The firebox is of the round-top type with direct stays. As this locomotive is built for heavy freight service on a stretch of heavy grades it is interesting to compare it with some of the recent locomotives built for similar service in the United States.

A recent American locomotive of the Consolidation type having about the same tractive force as the British engine weighs over 220 tons, has a working steam pressure of 220 pounds per square inch, a total heating surface of 4,093 square feet and a grate area of 94.5 square feet. The largest American freight locomotive in service is the Mallet articulated compound locomotive built for the Virginian Railway by the American Locomotive Company. This has a tractive force (simple) of 176,600 pounds. Its total weight is 400 tons. The steam pressure is 215 pounds per square inch, the total equivalent heating surface 11,785 square feet and the grate area 108.7 square feet.

LETTERS TO THE EDITOR

Safety Appliances for Steam Boilers

To the Editor:

VARIOUS theories and views are expressed by inspectors and others having witnessed the results of boiler explosions regarding their actual cause. So wide apart are the theories of these men who have seen the after effects of such explosions and in so few cases are the causes made plain by actual eye witnesses, or of conditions existing previous to the explosion that the whole affair is made dark so far as determining the actual cause.

On September 5 by request of the State Department I inspected a boiler having exploded previous to this date. This explosion resulted in the death of the man who for ten years had fired and taken care of the boiler and who was undoubtedly a careful and an efficient man and who thought he knew the actual condition of the boiler. However, he might have been mistaken and did not know the strength of the boiler compared to the pressure he was carrying. Anyway this man did his best and some one or some source, rather than he, was actually responsible for his death.

Taking the above facts into consideration, it is reasonable to conclude that there might have been a fault in the safety appliances of this boiler. By the safety appliances I mean the steam gage, the safety valve, and other appliances to the water level such as water glass and tricox.

After examining the steam gage I found that the safety valve was destroyed so far as its accuracy was concerned, either by explosion or was not in working condition before. Not having found the safety valve I am unable to say if it was at fault. Also the water column was destroyed and lost by the explosion.

I looked over the boiler and found it was in poor condition, especially the front head. Other parts of the boiler would usually have stood one hundred pounds pressure, which it was supposed to be operated under as told to me by the owner of the boiler, whom I might say without a doubt is a man of honor.

The safety plug in the crown sheet was seemingly in good condition and not being burned out indicating it might not have been caused by low water. The crown sheet was in good condition.

Taking all these facts into consideration, there are but three feasible conclusions in determining the actual cause. The safety valve either failed to work, thus causing an enormous steam pressure to gather, or the boiler was made so weak by age and wear that it was unable to carry one hundred pounds pressure. Whatever fault might have been the actual cause of the fatal explosion, the accident could have been avoided.

In taking up this paragraph which I am going to devote to the remedy or prevention of similar explosions, I shall divide it into two parts, either one of which would tend to diminish the possibility of another accident by fifty percent, and both of which would discard all possibility of another, taking for granted all boilers are fired by efficient firemen or operators.

As we are all aware of the fact that our safety valve appliance would take care of the boiler's allowable pressure, can we not rest assured that if it is in good working condition the boiler is safe as well as the man who is operating it? Then why not require the application of two safety valves on each boiler, each of which will tend to increase the safety of the boiler. If one fails the other wont fail ordinarily.

Taking up the last and foremost precaution, should not every state have a law strictly enforced requiring each and every boiler and appliances to be inspected thoroughly internally by a competent boiler inspector each year, accompanied by a hydrostatic test of one and one-half times its allowable working pressure.

Only those men upon whom we depend in administering laws regarding boilers can remedy this fault and four words I believe will name the two duties (safety appliances and boiler inspection).

Franklin, Pa. R. L. Hamilton.

Why Do Boilers Explode?

To the Editor:

I HAVE been interested in the letters under the above heading, both from Mr. Schaphorst and Mr. Kirkland. Mr. Schaphorst, it would seem, was more interested in the question of which would explode with the greater violence, a watertube or a firetube boiler. Mr. Kirkland gives a number of reasons to account for the explosion of either kind of boiler, but does not go into the question at any length.

As there is a good deal of misconception among many men operating boilers on this subject, it may be of value to some of them to go a little more fully into the matter, and take the various causes given by Mr. Kirkland, analyzing them as far as may be.

In the first place, it must be conceded that whatever the primary cause, the explosion itself is caused by the sudden release of pressure due to an opening of large area allowing a sudden escape of steam. The initial opening may be due to a number of causes, but before any explosion takes place, the failure must occur. In simple words, the rupture always precedes the explosion. The explosion does not cause the rupture.

The rupture or opening being provided, the sudden drop of pressure causes the water contained in the boiler to flash into steam, the necessary latent heat for this being taken from the water itself. Steam at atmospheric pressure occupying a far greater volume than that at higher pressures, and all the energy contained in the water being available to remove any obstruction to expansion, a violent explosion occurs, the extent of the explosion being dependent on two things. The first is the extent of the initial rupture, and therefore the suddenness with which the pressure is relieved, and the second, the amount of water and the heat energy contained in it.

It is this latter factor which accounts for the fact that a boiler working at comparatively low pressure, such as a heating boiler, can do enormous damage if an explosion occurs. Between a boiler working at 150 pounds per square inch and one working at 15 pounds per square inch, the ratio of pressure is as 10 to 1. The ratio of explosive force is only about 1½ to 1 with the same water content.

Causes of Explosion

The first reason given by Mr. Kirkland for the explosion of a boiler is shortness of water. Let us see how far this reason may be taken as a cause of explosion. A little thought will show that it is in practically only one type of boiler that shortness of water is likely to cause an explosion. That is if we are considering the word explosion to mean a sudden and violent tearing apart, accompanied by general destruction. It is only in the locomotive type of boiler that shortness of water is liable to occasion an explosion of this sort. In this type of boiler, we have a plate, the crown sheet of the firebox, exposed to very intense heat and covered with a very small depth of water under normal conditions. If this plate becomes denuded of water, a very sudden rise of temperature occurs, and the plate becomes very rapidly unfit to withstand any stress. One of two things inevitably occurs. Either the staybolts become loose in the plate, allowing sufficient steam and water to escape to partially deaden the fire and draw the attendant's attention allowing fires to be damped or otherwise deadened, or else the plate tears between the staybolts. In the latter case, we have the sudden opening provided for the release of a large volume of steam, instantly, followed by the flashing into steam of most of the water in the boiler and the violent escape through the opening provided of the contents of the boiler. This usually results in the boiler being hurled violently from its position and a complete wreck, attended with loss of life or injury, and property damage.

In the other familiar types of boilers, shortage of water is not attended with such dire results.

Take the average watertube boiler, for example, one of the B. & W. type. Shortage of water in this boiler will usually result in leakage at a tube or at the most in the splitting of a tube. In this case the opening for the escape of the boiler contents is comparatively small and while the escape of steam may be termed an explosion, it is not so in the same sense as the explosion of the locomotive type just referred to. As a rule the only damage is to the tube itself, or there may be other tubes buckled. The explosion is not such as to move the boiler from its setting. Without going into details, the same may be said for nearly all types of watertube boilers.

The reason for this is that it is only the tubes that are exposed to violent heat, and the tubes that will first become dry, are those at the greatest distance from the fire. Instances of watertube boilers blowing up through shortness of water are not very common, in fact, I cannot recall any at the moment.

Internally fired boilers other than the locomotive boiler are not likely to explode from want of water. The marine boiler, of the Scotch type, if allowed to become short of water, does not explode. The first part affected is the crown sheet of the combustion chamber and this collapses allowing steam and water to escape into the furnace. The sides may be distorted and the tubes in the affected nest will leak, but a violent explosion involving the complete wreck of the boiler does not occur. The vertical firebox boiler will also usually develop sufficient leakage at the tubes, to put out the fire or relieve the pressure before any sudden and violent rupture can occur, as the water must go down a long way before the firebox crown sheet can be affected.

Our old friend the horizontal return tubular boiler will also give very clear indications at the tubes before the water can fall sufficiently low for the shell to become overheated to a dangerous extent due to shortness of water. Of course it is conceivable that if a horizontal return tubular boiler was allowed to evaporate the entire amount of water contained in it and the fire kept going, that the shell would open up. If no steam was being taken away during this time, the pressure generated might be sufficient to cause an explosion if the safety valves had not sufficient area to relieve the pressure. This could only occur if there were no one attending the boiler at the time. If steam was being continually drawn from the boiler and no water added and it were possible for the boiler to become dry below the fire level without sufficient leakage at the tubes to call attention to the fact, an explosion might occur. However, in the writer's humble opinion, the danger of an explosion through shortness of water on this type of boiler is not very great. Damage can ensue certainly, but hardly a violent explosion.

This covers the danger of explosion through shortness of water.

Defective Gages

Mr. Kirkland mentions defective steam gages. This has been the cause of explosions, but only in conjunction with defective safety valves. If the safety valves do not blow at the safe pressure set for the boiler, as shown by the gage, the cause is usually investigated. If both safety valves and steam gages are defective, pressure may accumulate until an explosion occurs. There was a case in England some years ago, where a disastrous explosion took place through this cause. The boiler has not been used for a long time and when lighted up, neither the steam gage nor the safety valve was examined. After firing for a considerable length of time, without much steam showing, the boiler suddenly blew up. The investigation later showed the steam gage to be broken and the safety valve stuck fast.

Defective safety valves must be accompanied by defective steam gages (unless there is no attendant) to be dangerous. Defective water gages, feed valves, choked watertubes, are all accounted for in the preceding part of this article, dealing with shortness of water.

PRESSURE TOO GREAT FOR CONSTRUCTION

This is no doubt a prolific cause for boiler explosions. When the stress that the metal of the boiler is subjected to becomes greater than the tensile stress of the metal, then a failure, accompanied by an explosion is inevitable. This particular cause is gradually becoming rare, through better construction and inspection methods. It still exists, however, and we have had several recent explosions in Canada that can be traced to this cause. Perhaps it is not quite correct to say that the failure was entirely due to construction, but in one case the failure might be initially charged up to faulty construction. The boiler in question was a horizontal return tubular boiler with a single riveted lap seam and while strong enough when new, the lap joint deteriorated through grooving and pitting until it failed with disastrous results. No inspection had been made for a number of years and needless to say no insurance was carried.

Lap jointed boilers, as is well known, are subject to this kind of deterioration and such construction in large diameter firetube boilers may well be described as faulty, in modern practice.

Another cause, not mentioned by your correspondent, is the indiscriminate use of the hydraulic test and for further information on this question, I might refer to an article on the "Value of Hydraulic Testing" which was printed in THE BOILER MAKER, from an article written by myself.

DEFECTIVE STOP VALVES

Unless accompanied by defective safety valves, explosion should not occur through this cause. I make exception, of course, to such an occurence as the bursting of a stop valve, the sudden release of steam provided by such an accident, being quite likely to cause an explosion; however, with the proper area of safety valve, the boiler should be relieved of all the steam it can generate with the stop valve closed, with only a slight increase above the working pressure.

COLLAPSE OF FURNACES

In the Scotch boiler the collapse of furnaces is not an uncommon accident, but this is practically never attended by explosion. In the vertical firebox boiler, explosions have occurred through the tearing of a firebox sheet, but hardly through the collapse in the strict sense. By collapse of a furnace is usually understood the closing in of a circular furnace such as is used in marine, Lancashire, or Cornish boilers and this usually results in nothing more than the local damage.

Failure of staybolts, if in sufficiently large numbers, in flat sheets may cause explosion. Grooving and pitting of plates to such an extent that the plate is weakened beyond its capability of withstanding the pressure, so that a sudden tearing over a large area takes place, can cause explosion. Any large rupture, however caused, will cause explosion. Shortage of water, except in the locomotive boiler, is not, in my opinion, likely to cause violent explosion, and neither is the old familiar reason, beloved of coroner's juries, of putting cold water on a hot plate. It was recently stated, in a technical paper, which is published for the operating engineer, that feeding cold water into an overheated boiler was the cause of many explosions. I wrote the editor of this paper, and asked him to give me an instance where such a case had been authenticated, or to explain how such an explosion would occur, but have so far had no reply.

The subject of boiler explosions is an interesting one to all who have anything to do with boilers, and the foregoing may be of value to some of your readers who have not studied the matter very deeply.

Toronto, Can. THOMAS H. FENNER.

Finding the Neutral Axis of Heavy Plate

TO THE EDITOR:

THE article in your August issue of THE BOILER MAKER by James Winthorpe, relative to the stretching of heavy boiler plate when bent, certainly calls for some fair comment. Technically, it is an established fact that the mean diameter of a cylinder multiplied by 3.1416 is the correct length of the plate on the flat, and the mean circumference of a cylinder multiplied by 0.3183 is the bore.

Mr. Winthorpe informs us that he marked off on both sides of the plate 24 inches and when the plate was bent the distance on the outside increased to 24⅞ inches and decreased on the inside to 23¼ inches. This was termed expanding and contracting, whereas, with the exception of ⅛ inch per 24 inches, it was the plate taking up its predetermined length.

To prove this: On a 42-inch bore drum 1½ inches thick, the circumference inside after bending would be 131.95 inches, and the circumference outside 141.37 inches, and the plate on the flat was 136.66 inches. As this shows a difference of approximately 5 inches, one would hardly call that expansion and contraction. However, the real trouble appears to be that for every 24 inches of 1½-inch thick plate, a stretching of ⅛ inch accrued and the theory offered is that the plate during the process of rolling is in compression inside and in tension outside. One can hardly visualize a plate passing through the rolls (a moving body) being in compression and tension at the same time, any more than the resultant of an irresistible force coming in contact with an immovable body.

The ⅛ inch per 24 inches found to be in excess, is a distortion due to the process of bending and should be allowed for as practice demands, but to set up a new formula for finding the mean diameter of a drum, or the length of a stretchout is ridiculous.

One can imagine the boiler maker erecting a perpendicular equal to 55,000 pounds, bisecting it and dividing it into ten equal parts, then erect another equal to 95,000 pounds and so on. Why anyone can get the length of a plate in a flash and if the machinery used distorts it why allow for it next time.

No mention was made of how the plates were bent, hot or cold, rolled horizontally, or squeezed in vertical rolls. In the latter method the plate is subjected to a terrific squeezing or crushing force and we expect it to lengthen a little in 12 feet.

Leeds, England. JOHN GORDON KIRKLAND.

Stephen F. Sullivan, vice-president of the Ewald Iron Company, with headquarters in Chicago, died in Benton Harbor, Mich., on September 6, after a short illness of heart trouble.

System of Laying Out Elbows

Method and charts by which the layer out can save fifteen minutes on each elbow plate

By Raymond Hackett*

THE average layer out makes about thirty-six hundred different kinds of elbow in a lifetime, without a repetition. The methods employed by all these men are very similar. The layer out finds the high point and low point by

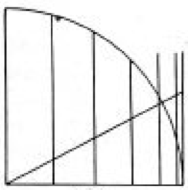

Fig. 1

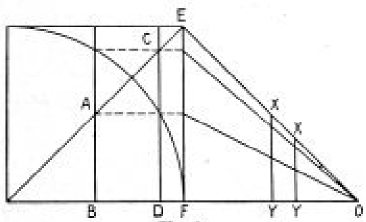

Fig. 2

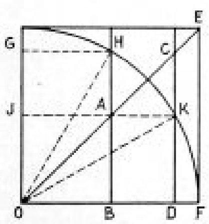

Fig. 3

Method of developing charts

means of trigonometry or a sketch. He then draws two parallel lines on his plate at a distance apart equal to the average between the high point and the low point, measures off the circumference, squares up the plate and then spaces each side of the plate off into a number of equal divisions. He then draws parallel lines through these points. To find the cut of the elbow, he subtracts the low point from the high point and divides the result by two or four as the case may be. For the high point he marks this cut on the outside of the parallel lines

* Foreman, The William B. Pollock Company, Youngstown, Ohio.

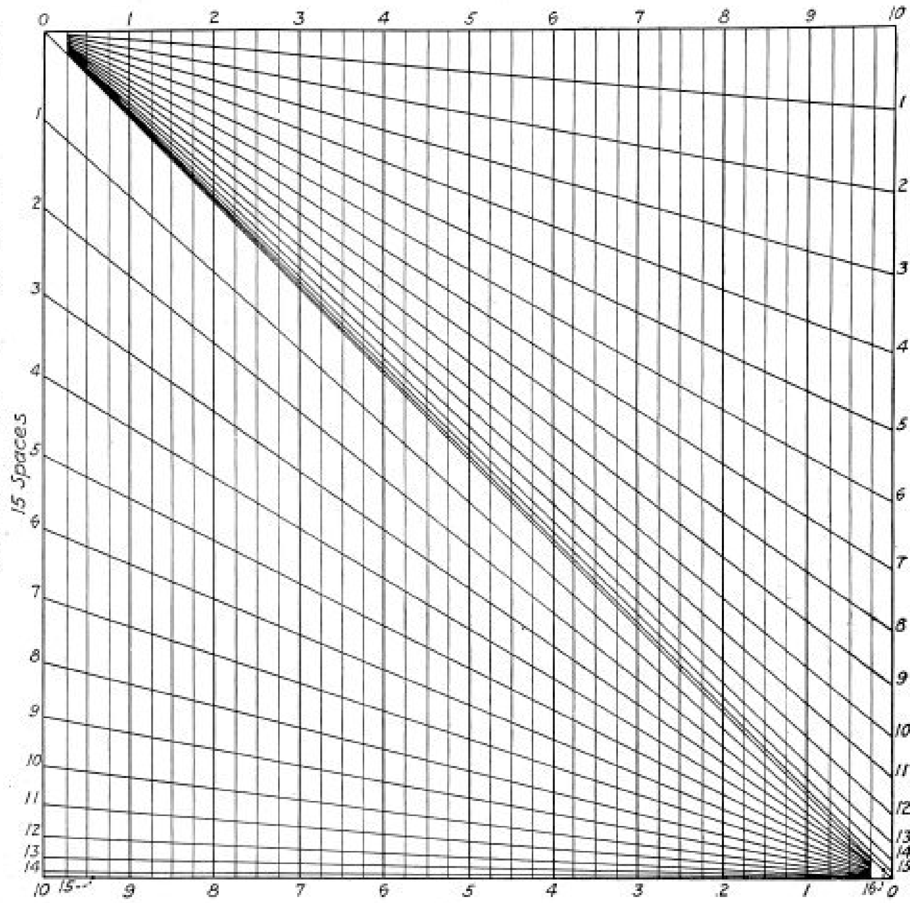

Fig. 4.

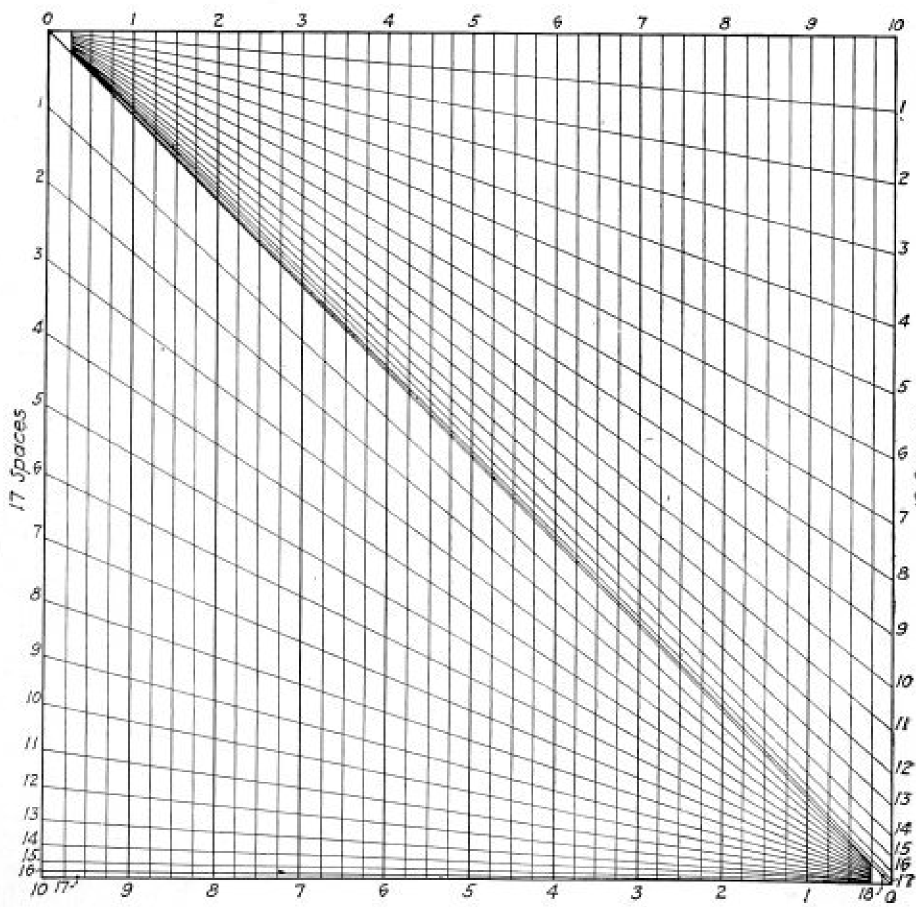

Fig. 5.

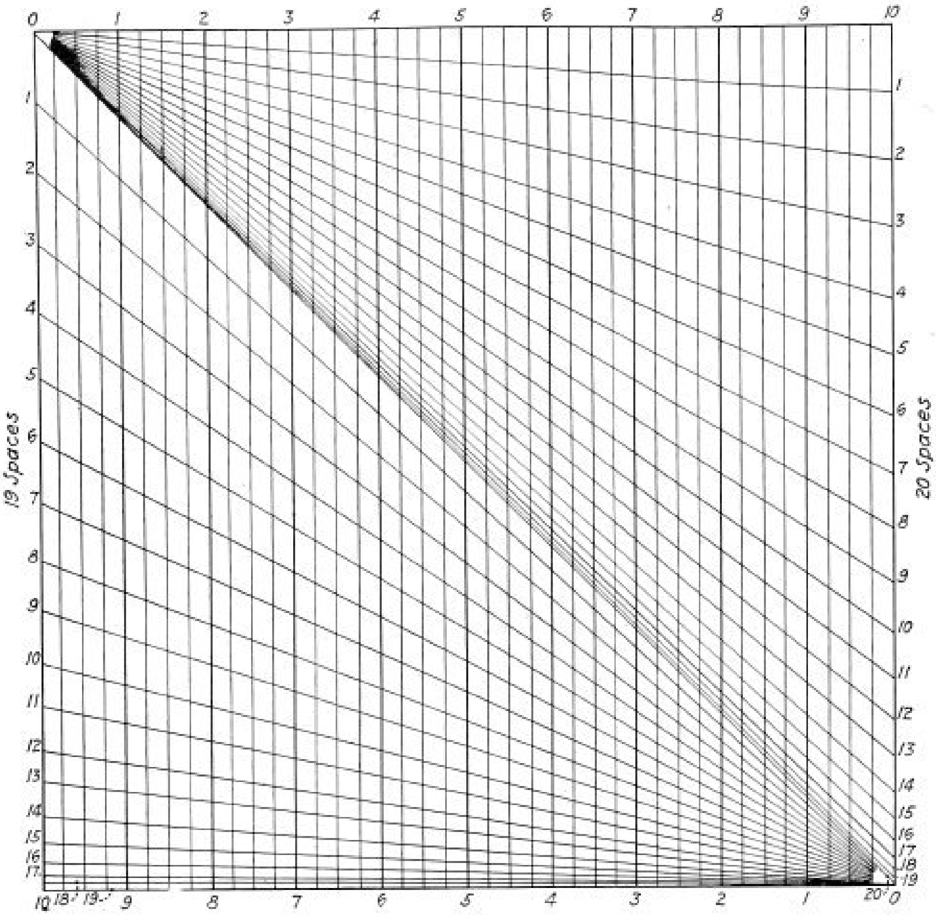

Fig. 6.

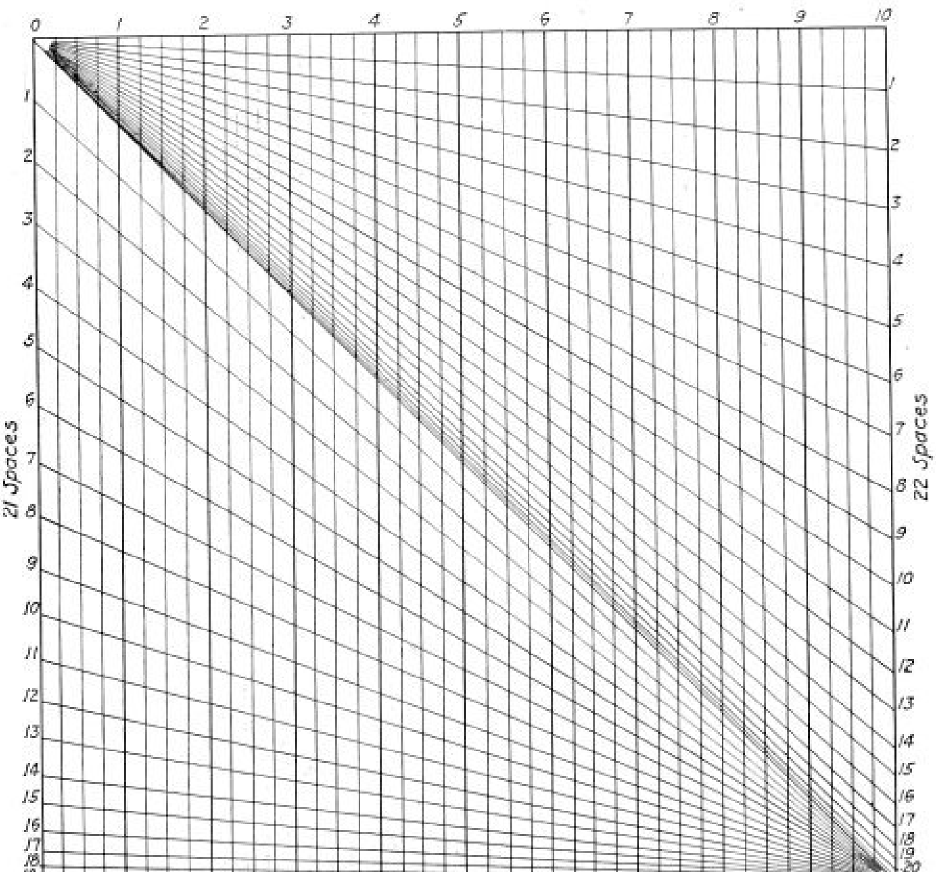

Fig. 7.

and for the low point on the inside. For the intermediate points he draws a sketch similar to Fig. 1. Then from this sketch he marks off the heights of the intermediate points on a piece of band iron, or pasteboard, and transfers them to his developed plate.

Spacing Out An Elbow

The spacing of an elbow that a layer out may be required to work on may vary from five spaces to thirty spaces to the quarter circle. This means about twenty-five different kinds of spacings. For each of these spacings his cut may vary from one inch to ten inches. If he were to use a difference of one-sixteenth of an inch in his work, he would have one hundred and forty-four sixteenths for each of the twenty-five different spacings, or thirty-six hundred different kinds of elbows.

It would be of little use to save his cuts from one job to another as one day he might lay out an elbow of one spacing, while the next day he might be on a different size of pipe with a different spacing. Or if he were on the same size of pipe he would probably have a different height of cut. This being the case, he could not use the piece of band iron or the sketch, but would have to construct a new sketch and mark off a new piece of band iron.

While each sketch requires only about fifteen minutes to draw up, if he were to lay out all of the thirty-six hundred different elbows, he would spend about nine hundred hours drawing up elbow cuts.

Laying Out An Elbow Without Drawing A Cut

The purpose of this article is to describe a method by which a layer out may lay out any elbow without drawing a single sketch, provided that he knows the high point and the low point. He would turn to the chart headed the correct number of spaces, place his piece of band iron on it and without moving the band iron again, proceed to mark off the height of the different spaces on it and then transfer these marks to the developed plate.

To illustrate how these charts were figured, refer to Fig. 2, using a cut equal in length to the radius of the circle. Now this would be a sketch for the cut of an elbow with three spaces to the quarter circle and lines *AB*, *CD* and *EF*, would be the heights for the three spaces. These lengths were then projected to line *EF*, and through the points on *EF* lines were drawn to point *O*, making *OF* equal *EF*. Now to take any cut from this sketch, move the band iron along parallel to line EF until the distance from a point X to a point Y is equal to the cut.

This sketch would give the heights for any cut of three spaces to the quarter circle. To make a complete set of charts, I constructed sixteen charts, from fifteen spaces to thirty spaces inclusive. Any spacing could be taken from these sixteen charts. To get a spacing of eight spaces to the quarter circle, we could use the chart for sixteen spaces and use every other line. To get a cut of more than thirty spaces to the quarter circle, we could use the chart having half the required number of rivet spaces.

To make the charts absolutely accurate, I figured all the charts out by trigonometry rather than rely on projection. To illustrate this, let us refer to Fig. 3, which is drawn similar to Fig. 2. AB and CD are the lengths that we would be required to figure. Taking AB first we find that it is equal to BO because line OE is drawn at an angle of 45 degrees to OF. Now BO is equal to GH, because HB is parallel to GO. To figure the length of GH, take the natural sine of thirty degrees and multiply it by the radius HO. To make this the more simple I used a radius of ten inches, then I could find the sine and move the decimal point one place to the right. To find the length of the line CD, proceed in the same manner. Line CD is equal to DO which is also equal to JK. To figure JK, take the natural sine of 60 de-

Table of Spacing for Charts

1 Space equals 5 degrees.	Ten times the sine of 5 degrees is	0.8716
2 Spaces equal 10 degrees.	Ten times the sine of 10 degrees is	1.7365
3 Spaces equal 15 degrees.	Ten times the sine of 15 degrees is	2.5882
4 Spaces equal 2 degrees.	Ten times the sine of 20 degrees is	3.4202
5 Spaces equal 25 degrees.	Ten times the sine of 25 degrees is	4.2262
6 Spaces equal 30 degrees.	Ten times the sine of 30 degrees is	5.0000
7 Spaces equal 35 degrees.	Ten times the size of 35 degrees is	5.7358
8 Spaces equal 40 degrees.	Ten times the sine of 40 degrees is	6.4278
9 Spaces equal 45 degrees.	Ten times the sine of 45 degrees is	7.071
10 Spaces equal 50 degrees.	Ten times the sine of 50 degrees is	7.6604
11 Spaces equal 55 degrees.	Ten times the sine of 55 degrees is	8.1915
12 Spaces equal 60 degrees.	Ten times the sine of 60 degrees is	8.6603
13 Spaces equal 65 degrees.	Ten times the sine of 65 degrees is	9.0631
14 Spaces equal 70 degrees.	Ten times the sine of 70 degrees is	9.3969
15 Spaces equal 75 degrees.	Ten times the sine of 75 degrees is	9.6593
16 Spaces equal 80 degrees.	Ten times the sine of 80 degrees is	9.8481
17 Spaces equal 85 degrees.	Ten times the sine of 85 degrees is	9.9619
18 Spaces equal 90 degrees.	Ten times the sine of 90 degrees is	10.0000

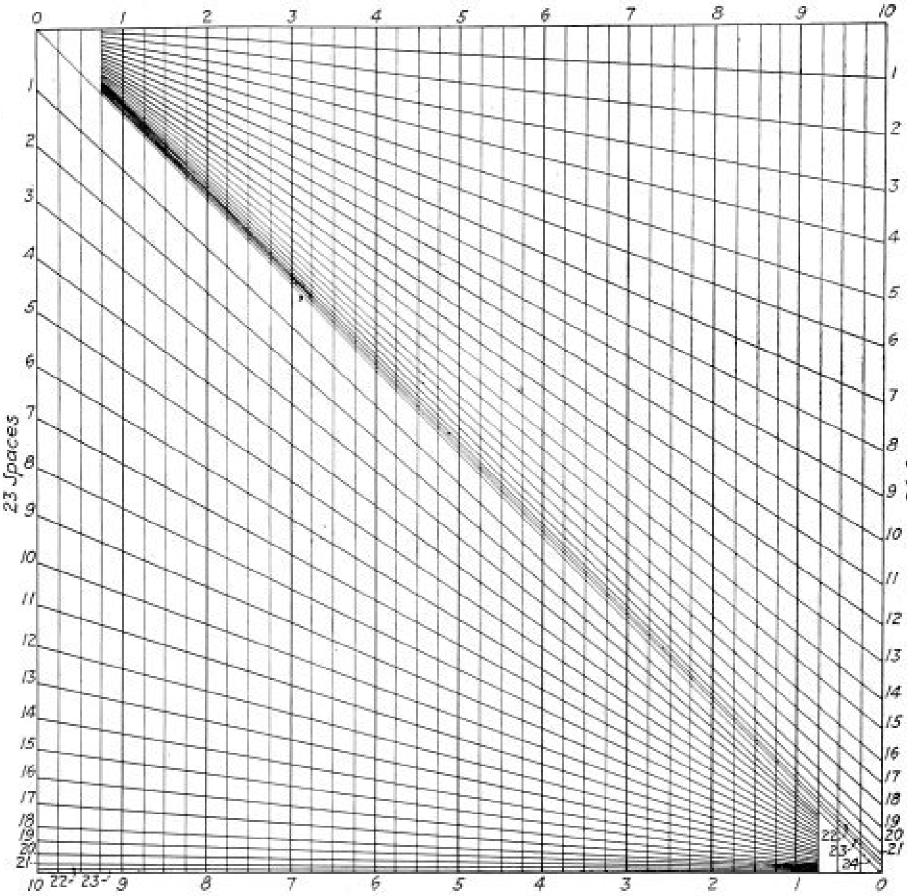

Fig. 8.

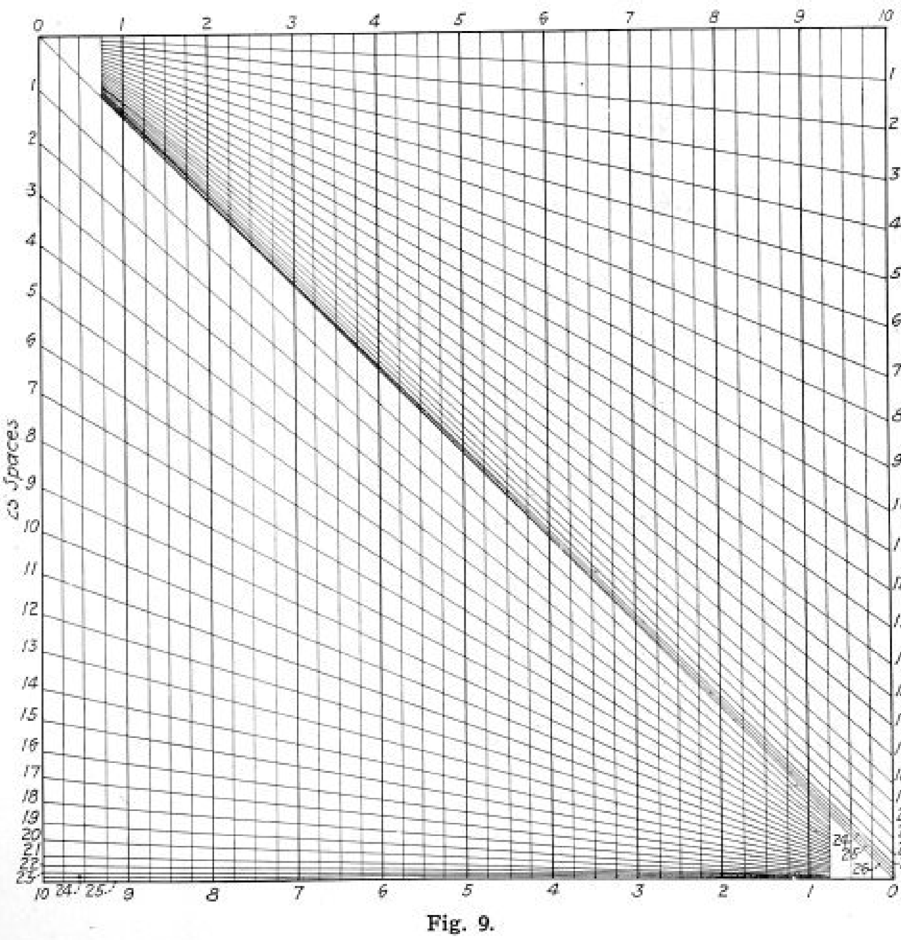

Fig. 9.

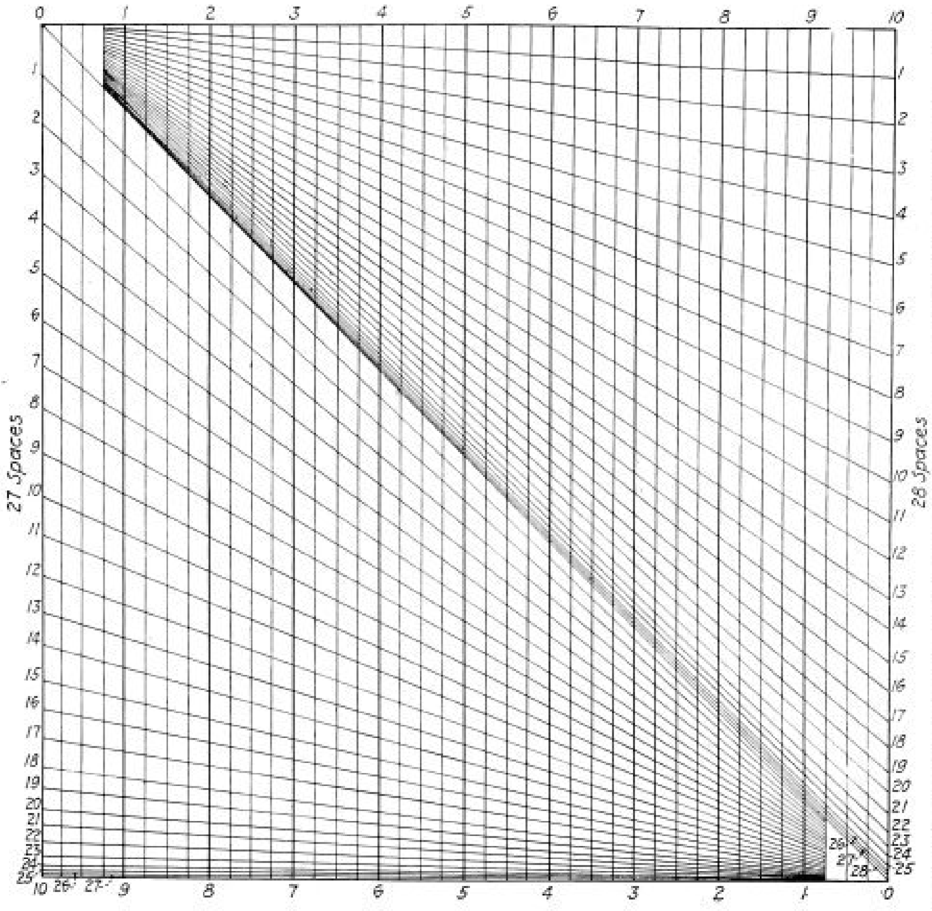

Fig. 10.

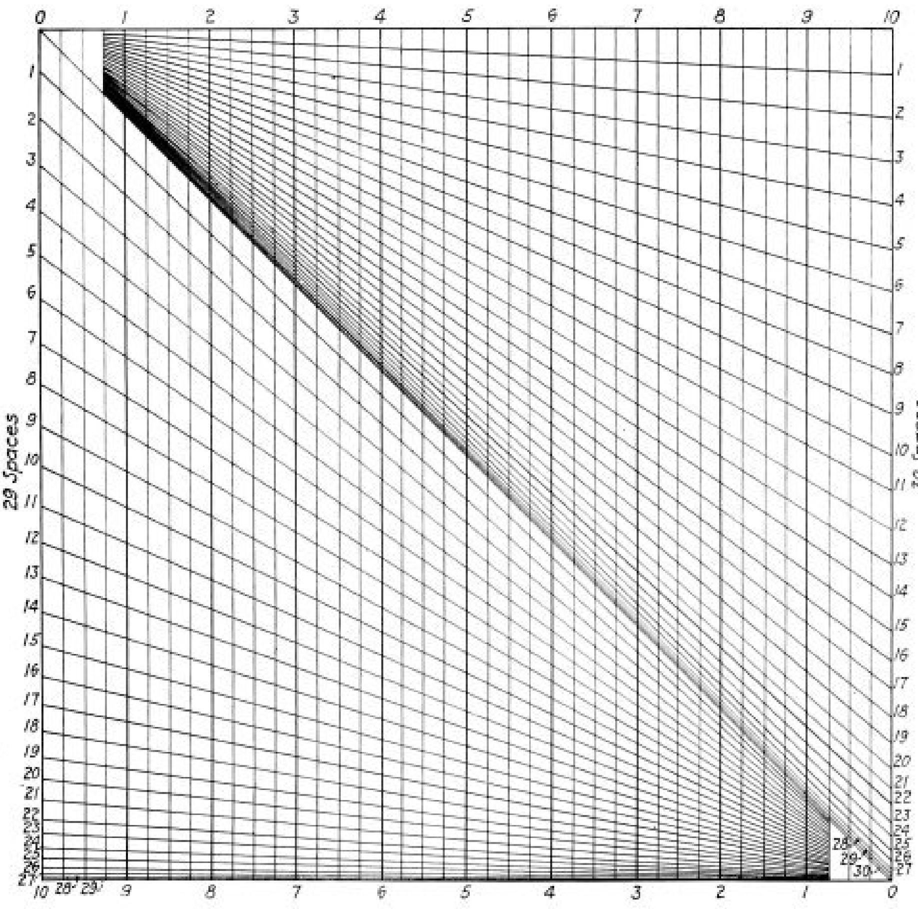

Fig. 11.

grees and move the decimal point one place to the right.

All the charts were figured in the same manner. The table, page 283, gives the figures on a cut of eighteen spaces to the quarter circle. This was easily figured as 90 degrees which is divisable by 18. A spacing like twenty-nine spaces to the quarter, was harder to figure out because I had to figure carefully, so that the total of the twenty-nine spaces was equal to 90 degrees.

The way for a layer out to use this method of laying out elbows, is to take this issue of THE BOILER-MAKER to the work bench. Then suppose that he wants to lay out a cut of 4¾ inches on an elbow with nineteen spaces to the quarter circle. He would take a piece of band iron about a foot long and put a mark on it 4¾ inches from one end. He would then turn to the chart marked nineteen spaces, and then move the band—along the parallel lines until the end of it coincided with the upper line of the chart, when the mark on the band iron coincided with the bottom line of the chart. Then where every diagonal line crosses the band iron he would put a mark on it and then transfer these marks to the developed plate.

Annual Meeting of American Society of Mechanical Engineers

NOVEMBER 30 through December 4 are the days when the Forty-sixth Annual Meeting of the Society will be held in New York City. Judging from the list of outstanding speakers and from the advance plans for technical sessions, the meeting will attract an attendance that will exceed the 1924 event, which was the largest the Society ever held with 2,174 registered. The Professional Divisions have been at work on their programs in cooperation with the Committee on Meetings and Program since April and efforts are being exerted to complete the program for early publication. About forty-five papers will be presented.

This phase of the program will be approached from many more angles than usual. Industrial furnaces will be dealt with exhaustively in one session. Industrial power will come in for thorough discussion centered about papers on higher steam pressures and industrial power costs. Power plant materials will furnish the topic for a strong session at which steel castings, bolt materials and boiler tube corrosion will be discussed.

Proportioning Boiler Flanges and Throat Seams

Tables of dimensions for flanges and throats with diagrams giving rivet spacing

By H. J. Blanton*

As a continuation of my article on "Boiler Seams" published in the January, 1925, issue of THE BOILER MAKER it may be that those interested will find the following tabulations of flange and throat seam proportions of value.

Fig. 1 shows the form that may be applied to either the backhead wrapper sheet seam or either of the inside firebox seams. Rivets for firebox seams are almost always ¾ inch in diameter and the last two lines will govern in any case, depending upon the knuckle radius which should be kept as large as possible.

Fig. 2 illustrates flange distances for the throat sheet and wrapper sheet. Since the thickness of the thinnest sheet determines the size of the rivet and the width of the seam, in this case we have two sets of values. Suppose we have a

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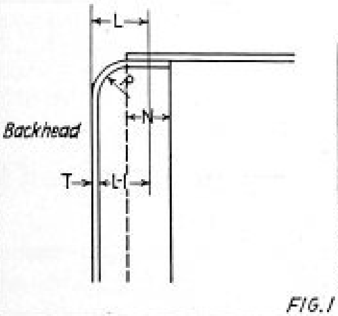
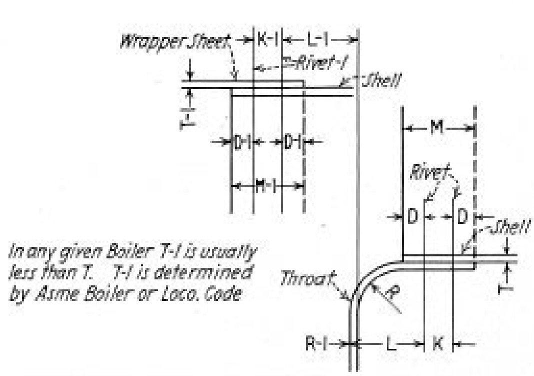


T	Rivet	N	R	L.	L-1
3/8"	3/4"	2 7/16"	1 3/4"	3 3/4"	
3/8"	3/4"	2 7/16"	2 1/2"	4"	
7/16"–1/2"	7/8"	2 15/16"	1 3/4"	3 3/4"	
7/16"–1/2"	7/8"	2 15/16"	2 1/2"	4 1/4"	
9/16"–5/8"	1"	3 5/16"	2 1/2"	4 1/2"	
11/16"	1 1/8"	3 5/16"	2 1/2"	4 3/4"	
5/16"–3/8" Crown	3/4"	2 7/16"	5/8"	–	1 7/8"
5/16"–3/8" Crown	3/4"	2 7/16"	1"	–	2 1/4"

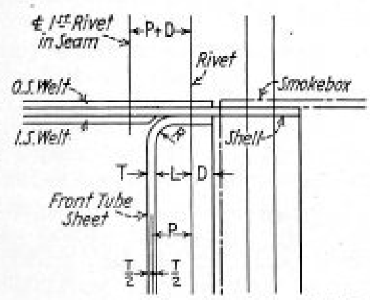
Inside Firebox Seams

FIG. 1



T	Rivet	M	D	K	R	L	T-1	Riv-1	M-1	D-1	K-1	L-1	R-1
11/32"–3/8"	3/4"	4 1/16"	1 7/32"	1 5/8"	1 3/4"	3 3/4"	11/32"–3/8"	3/4"	4 1/16"	1 7/32"	1 5/8"	3 3/4"	1 3/4"
11/32"–3/8"	3/4"	4 1/16"	1 7/32"	1 5/8"	2 1/2"	4"	11/32"–3/8"	3/4"	4 1/16"	1 7/32"	1 5/8"	4"	2 1/2"
13/32"–17/32"	7/8"	4 11/16"	1 13/32"	1 7/8"	1 3/4"	3 3/4"	13/32"–17/32"	7/8"	4 11/16"	1 13/32"	1 7/8"	3 3/4"	1 3/4"
13/32"–17/32"	7/8"	4 11/16"	1 13/32"	1 7/8"	2 1/2"	4 1/4"	13/32"–17/32"	7/8"	4 11/16"	1 13/32"	1 7/8"	4 1/4"	2 1/2"
9/16"–5/8"	1"	5 5/16"	1 19/32"	2 1/8"	2 1/2"	4 1/2"	9/16"–5/8"	1"	5 5/16"	1 19/32"	2 1/8"	4 1/2"	2 1/2"
21/32"–23/32"	1 1/8"	5 13/16"	1 25/32"	2 3/8"	2 1/2"	4 3/4"	21/32"–23/32"	1 1/8"	5 13/16"	1 25/32"	2 3/8"	4 3/4"	2 1/2"
3/4"–13/16"	1 1/4"	6 9/16"	1 31/32"	2 5/8"	2 1/2"	5"	3/4"–13/16"	1 1/4"	6 9/16"	1 31/32"	2 5/8"	5"	2 1/2"
7/8"	1 3/8"	7 3/16"	2 5/32"	2 7/8"	2 1/2"	5 1/4"							

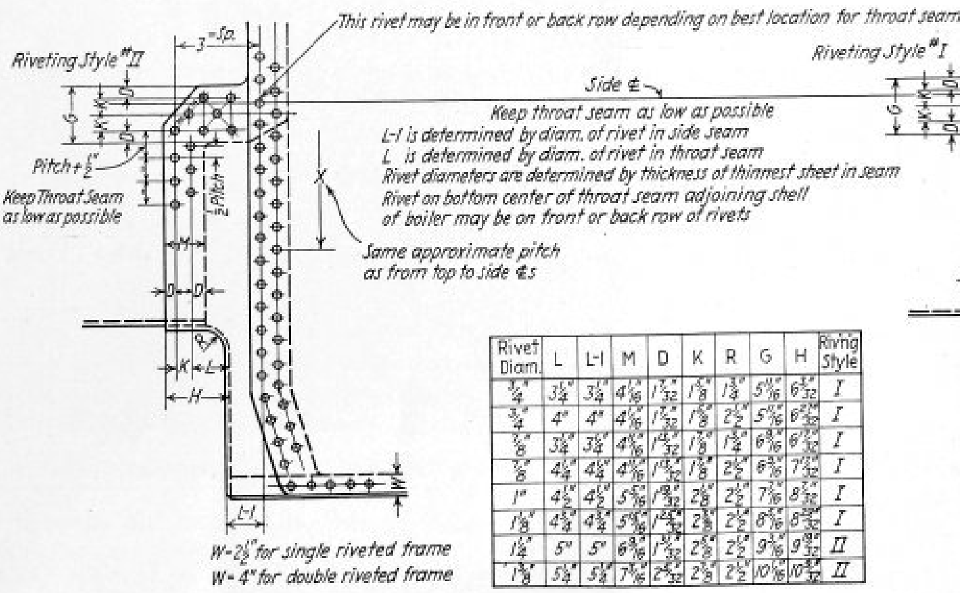
FIG. 3

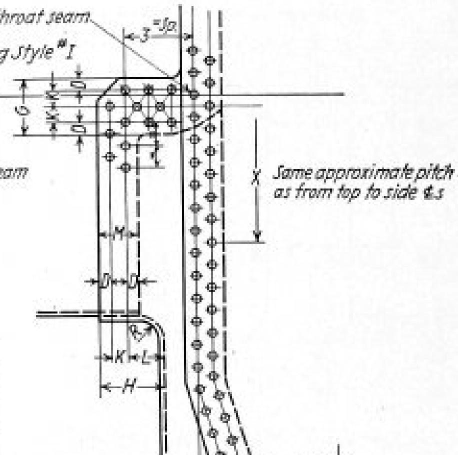


T	Rivet	R	L	D	P	P+D
3/8"	3/4"	5/8"	1 1/8"	1 7/32"	2 1/16"	3 9/32"
3/8"	3/4"	1"	2"	1 7/32"	2 1/16"	3 9/32"
7/16"	7/8"	5/8"	1 1/8"	1 15/32"	2 1/32"	3 1/2"
7/16"	7/8"	1"	2"	1 15/32"	2 5/32"	3 5/8"
1/2"	7/8"	1"	2"	1 15/32"	2 1/4"	3 23/32"
9/16"	1"	1"	2 1/4"	1 19/32"	2 17/32"	4 1/8"
5/8"	1"	1"	2 1/4"	1 19/32"	2 9/16"	4 5/32"

FIG. 3

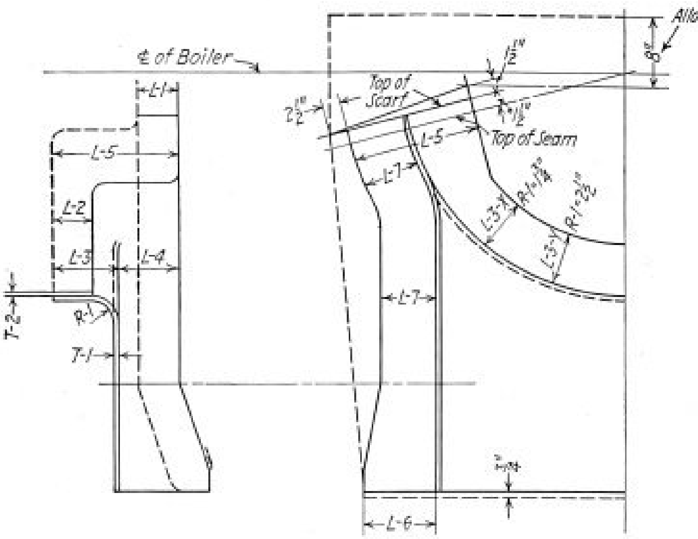
Fig. 1.—Forms for backhead wrapper sheet or firebox seams. Fig. 2.—Flange distances for throat sheet and wrapper sheet. Fig. 3.—Method of locating rivet distances for front tube sheet





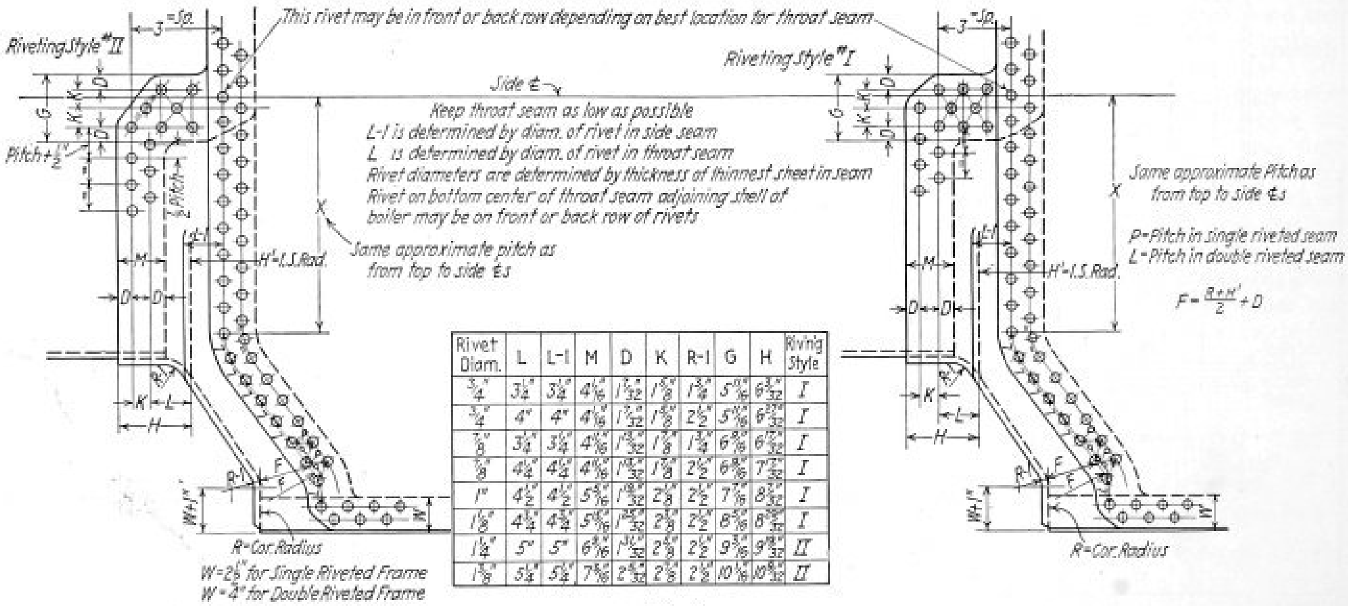
Rivet Diam.	L	L-1	M	D	K	R	G	H	Riv'ng Style
3/4"	3 1/4"	3 1/4"	4 1/16"	1 7/32"	1 5/8"	1 3/4"	5 11/16"	6 5/32"	I
3/4"	4"	4"	4 1/16"	1 7/32"	1 5/8"	2 1/2"	5 11/16"	6 23/32"	I
7/8"	3 3/4"	3 3/4"	4 11/16"	1 13/32"	1 7/8"	1 3/4"	6 5/16"	6 27/32"	I
7/8"	4 1/4"	4 1/4"	4 11/16"	1 13/32"	1 7/8"	2 1/2"	6 13/16"	7 3/32"	I
1"	4 1/2"	4 1/2"	5 5/16"	1 19/32"	2 1/8"	2 1/2"	7 5/16"	8 3/32"	I
1 1/8"	4 3/4"	4 3/4"	5 13/16"	1 25/32"	2 3/8"	2 1/2"	8 5/16"	8 23/32"	I
1 1/4"	5"	5"	6 9/16"	1 31/32"	2 5/8"	2 1/2"	9 3/16"	9 19/32"	II
1 3/8"	5 1/4"	5 1/4"	7 3/16"	2 5/32"	2 7/8"	2 1/2"	10 1/16"	10 17/32"	II

Fig. 4.—Throat and seam details



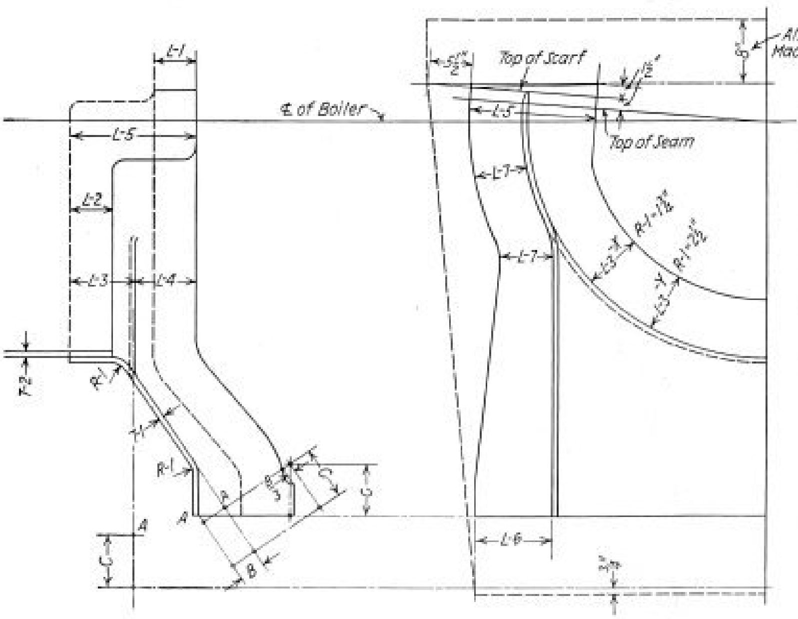
Rivet	Vert. Seams Single or Double Riveted	Max. L-1	Max. L-2	Max. T-1	Max. T-2	R-1	Max. X	Max. Y	L-3	L-4	L-5	L-6	L-7
3/4"	S.R.	2 7/16"	2 7/16"	7/16"	3/8"	1 3/4"	1/2"	–	4 15/32"	4 1/32"	8 1/2"	See Firebox Frame Corner	3 17/32"
3/4"	S.R.	2 7/16"	2 7/16"	7/16"	3/8"	2 1/2"	–	3/4"	5 7/32"	4 29/32"	10"	" "	4 1/32"
3/4"	D.R.	4 1/16"	4 1/16"	7/16"	3/8"	1 3/4"	1/2"	–	6 3/32"	5 21/32"	11 3/4"	" "	5 5/32"
3/4"	D.R.	4 1/16"	4 1/16"	7/16"	3/8"	2 1/2"	–	3/4"	6 27/32"	6 13/32"	13 1/4"	" "	5 21/32"
7/8"	D.R.	4 11/16"	4 11/16"	9/16"	1/2"	1 3/4"	1/2"	–	6 17/32"	5 31/32"	12 1/2"	" "	5 19/32"
7/8"	D.R.	4 11/16"	4 11/16"	9/16"	1/2"	2 1/2"	–	3/4"	7 17/32"	6 31/32"	14 1/2"	" "	6 7/32"
1"	D.R.	5 5/16"	5 5/16"	11/16"	5/8"	2 1/2"	–	7/8"	8 7/32"	7 17/32"	15 3/4"	" "	6 21/32"
1 1/8"	D.R.	5 15/16"	5 15/16"	3/4"	11/16"	2 1/2"	–	7/8"	8 29/32"	8 5/32"	17 1/16"	" "	7 9/32"
1 1/4"	D.R.	6 9/16"	6 9/16"	7/8"	13/16"	2 1/2"	–	1"	9 19/32"	8 23/32"	18 5/16"	" "	7 25/32"
1 3/8"	D.R.	7 3/16"	7 3/16"	15/16"	7/8"	2 1/2"	–	1"	10 9/32"	9 11/32"	19 5/8"	" "	8 11/32"

Fig. 5.



Rivet Diam.	L	L-1	M	D	K	R-1	G	H	Riving Style
3/4"	3 1/4"	3 1/4"	4 1/16"	1 7/32"	1 5/8"	1 3/4"	5 11/16"	6 3/32"	I
3/4"	4"	4"	4 1/16"	1 7/32"	1 5/8"	2 1/2"	5 11/16"	6 27/32"	I
7/8"	3 1/4"	3 1/4"	4 11/16"	1 13/32"	1 7/8"	1 3/4"	6 9/16"	6 17/32"	I
7/8"	4 1/4"	4 1/4"	4 11/16"	1 13/32"	1 7/8"	2 1/2"	6 9/16"	7 7/32"	I
1"	4 1/2"	4 1/2"	5 5/16"	1 19/32"	2 1/8"	2 1/2"	7 7/16"	8 7/32"	I
1 1/8"	4 3/4"	4 3/4"	5 15/16"	1 25/32"	2 3/8"	2 1/2"	8 5/16"	8 29/32"	I
1 1/4"	5"	5"	6 9/16"	1 31/32"	2 5/8"	2 1/2"	9 3/16"	9 19/32"	II
1 3/8"	5 1/4"	5 1/4"	7 3/16"	2 5/32"	2 7/8"	2 1/2"	10 1/16"	10 9/32"	II

Fig. 6.



Rivet	Vert. Seams Single or Double Riveted	Max. L-1	Max. L-2	Max. T-1	Max. T-2	R-1	Max. X	Max. Y	L-3	L-4	L-5	L-6	L-7
3/4"	S.R.	2 7/16"	2 7/16"	7/16"	3/8"	1 3/4"	1/2"	–	4 15/32"	4 1/32"	8 1/2"	See Firebox Frame Corner	3 17/32"
3/4"	S.R.	2 7/16"	2 7/16"	7/16"	3/8"	2 1/2"	–	3/4"	5 7/32"	4 29/32"	10"	" "	4 1/32"
3/4"	D.R.	4 1/16"	4 1/16"	7/16"	3/8"	1 3/4"	1/2"	–	6 3/32"	5 21/32"	11 3/4"	" "	5 5/32"
3/4"	D.R.	4 1/16"	4 1/16"	7/16"	3/8"	2 1/2"	–	3/4"	6 27/32"	6 13/32"	13 1/4"	" "	5 21/32"
7/8"	D.R.	4 11/16"	4 11/16"	9/16"	1/2"	1 3/4"	1/2"	–	6 17/32"	5 31/32"	12 1/2"	" "	5 19/32"
7/8"	D.R.	4 11/16"	4 11/16"	9/16"	1/2"	2 1/2"	–	3/4"	7 17/32"	6 31/32"	14 1/2"	" "	6 7/32"
1"	D.R.	5 5/16"	5 5/16"	11/16"	5/8"	2 1/2"	–	7/8"	8 7/32"	7 17/32"	15 3/4"	" "	6 21/32"
1 1/8"	D.R.	5 15/16"	5 15/16"	3/4"	11/16"	2 1/2"	–	7/8"	8 29/32"	8 5/32"	17 1/16"	" "	7 9/32"
1 1/4"	D.R.	6 9/16"	6 9/16"	7/8"	13/16"	2 1/2"	–	1"	9 19/32"	8 23/32"	18 5/16"	" "	7 25/32"
1 3/8"	D.R.	7 3/16"	7 3/16"	15/16"	7/8"	2 1/2"	–	1"	10 9/32"	9 11/32"	19 5/8"	" "	8 11/32"

Fig. 7.

Figs. 5, 6 and 7.—Throat seam details and method of finding sheet size

¾-inch shell plate and ⅝-inch wagon top sheet, then the rivet distance for the throat sheet seam will be 5 inches from the inside of the throat sheet and the rivet distance for the wrapper sheet seam will be 4½ inches from the outside of the throat sheet, assuming of course that the inside and outside radii of the throat sheet, the one merging into the boiler shell contour and the other into the wrapper sheet, are the same at corresponding points.

Fig. 3 is self explanatory and gives a simple and standard method of locating the rivet distance for the front tube sheet and also the first rivets in the longitudinal seam of the first course.

Figs. 4 to 7 inclusive give both the throat seam details and the methods for obtaining the proper size of the required sheet. It will be noticed that the wagon top seam is offset at its lower extremity. The amount of this offset is determined by the radius of the firebox frame corners. These illustrations are all self explanatory and the required development work becomes an easy operation with a little practice. The drawing room will find the method illustrated of great value in making up bills of material.

Comments on this material are invited from all interested.

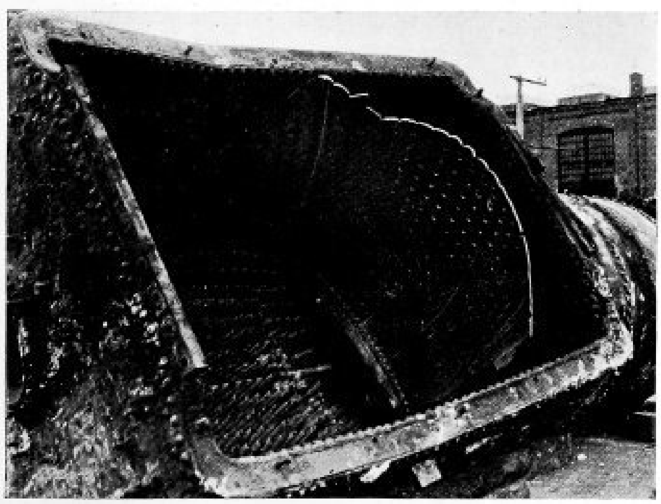
The Supreme Test of Welded Joints

By "Maple Leaf"

The illustrations on this page show a serious crown sheet failure which occurred on the Canadian Pacific Railway in Western Canada.

The inspection of the firebox brought to light the fact that the crown sheet, tube sheet and door sheets had been extremely hot for about eight inches below the highest portion of the firebox. The crown sheet was three inches higher at the front than elsewhere. It separated from its entire staybolting, consisting of about 436 radials and in carrying away tore portions of both side sheets from 175 staybolts with it, as well as bending down the door sheet and back tube sheets.

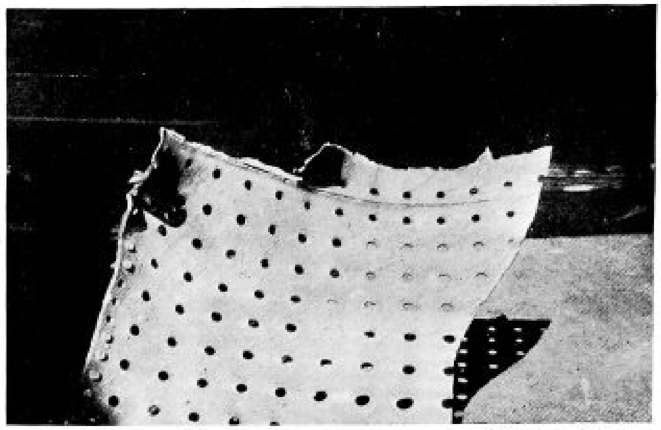
The explosion was so serious that the boiler left the engine as the result of shearing away from the frame bracings and separating from the cylinders, where it fractured the neck of the casting about half way of its distance. Thus the top portion went with the boiler, clear of the track and the



Welds remained intact while solid plate tore

balance remained with the machinery which continued for several car lengths without derailment.

The movement of the boiler was not noticed when the separation occurred, but it is assumed that it turned a complete somersault in order to fracture the cylinders and land in the ditch clear of the track.



Section cut from torn sheet

The demarcation line on the crown, tube and door sheets was very pronounced, leaving no question as to how low the water was in the boiler at the time of the failure. There were no broken or defective staybolts and no contributory causes to assist in greater injury.

The welded joints connecting the side sheets and crown sheet are proof of the strength and high efficiency of the "weld and process of forming the same," compared with the major plate. The major plate can be seen quite plainly from the pictures as having torn in many and various directions, whereas the welds stood the "supreme test by proving an efficiency in excess of the major plate, which is very well illustrated in both pictures.

Ordinary welded joints are the subject of much criticism, because of their behavior when a boiler is subject to water shortage and are frequently blamed for contributing to the extent of the injury to the boiler, as well as the personal injury to the crew.

The executives of the Canadian Pacific Railway are satisfied that the welding process, which they have in use has met these objections. They have adopted it as standard practice, because it exceeds the value of the major plates.

With five years of satisfactory service the "weld and process of forming the same" employed on the Canadian Pacific Railway has stood up without failure, operating with the hardest water on the continent of America, as well as under most severe frosty conditions during the winter.

The two photographs were necessary because the torch was used to burn off the portion of the crown sheet extending below the mud ring, so as the boiler could be conveniently loaded on a flat car. The cutting of the piece away with the torch exposes on the large picture the extent of the tufting which developed before the separation.

Annual Convention of International Acetylene Association

The International Acetylene Association will hold its convention this year at the Congress Hotel, Chicago, Ill., on Wednesday, November 18, Thursday, November 19, and Friday, November 20.

Probably the most important matters requiring consideration this year are: extending the use of welding and cutting equipment in new fields; producing engineering standards for accomplishing specific work, popularly known as Procedure Controls; fostering and encouraging greater education and better training of welders; and in the lighting field the highway traffic signal offers a fertile field for development. These matters are important to every individual, who is in any way connected or affiliated with the industry.

Power and Heating for Small Manufacturing Plants*

Where the exhaust steam can be utilized for heating or process work, the fuel cost of power becomes the cheapest in the world

By David Moffat Myers†

THE greatest element of cost in the generation of energy by steam is the fuel cost. In a plant where all the exhaust steam from turbines, engines and pumps can be utilized for heating or process work, the fuel cost of power is far less than that of the largest and most modern of our carbo-electric generating stations. Even in small manufacturing plants having maximum power demands of 100 to 500 kilowatts, the above statement holds true; and the majority of our factory plants require a load demand of 500 kilowatts or less.

This condition of economy even in the small plant, arises from the fact that when the exhaust steam is used practically all of the heat of the steam is conserved. Whereas, where it is not utilized or where the prime movers are run condensing, all of the latent heat of the steam is lost. Thus in the small plant with prime movers having water rates ranging from 16 to 60 pounds of steam per indicated horse-

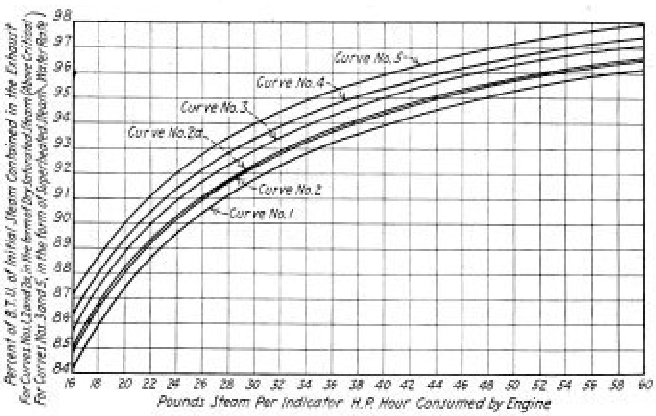


Fig. 1

power, 84 to 96 percent of the initial heat remains in the exhaust after passing through the engine or turbine. When this heat can be utilized to replace live steam from the boilers, the latent heat is conserved which results in an overall efficiency several times greater than can be secured in any steam plant whose duty is the generation of power alone.

Even in our great central steam stations, where a kilowatt-hour produced for 18,000 British thermal units is considered a very fine record, only 19 percent of the heat of the coal is made available as a useful product in the form of electrical energy.

Percentage of Heat Left in Exhaust Steam From Prime Movers

In a paper on the Heating Value of Exhaust Steam, presented at the 1915 annual meeting of the American Society of Heating and Ventilating Engineers, I deduced a formula for determining the percentage of heat left in the exhaust steam after passing through and performing work in any type of prime mover. The percentages given refer to the heat in the dry portion of the exhaust steam. These values are shown on the curves herewith presented and are accurate within ½ to 2 percent, this being the general range of radiation loss through prime movers.

It may be interesting to state that the formula and the curves here presented were later confirmed throughout by the tests made by Professor Lockwood at Yale University, for the sole purpose of determining by actual experiment the same values which were the object of my theoretical deductions.

Fig. 1 gives graphically the heat values of exhaust steam under various conditions of pressure and water rate.

Fig. 2 gives the percentage of moisture content or superheat in exhaust steam under a similar range of conditions.

A very simple example will serve to illustrate the advan-

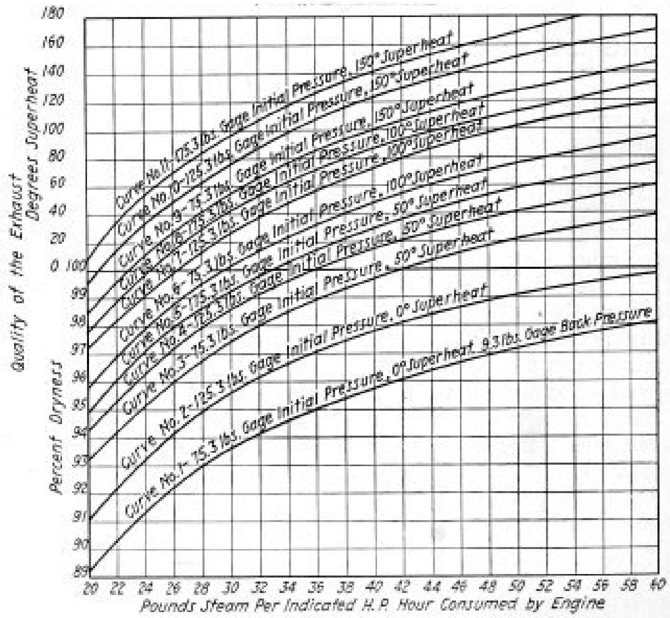


Fig. 2

tage of the small plant using its exhaust steam, over the central station from the standpoint of fuel economy.

A central station of 50,000 kilowatts capacity working on 18,000 British thermal units of coal per kilowatt-hour developed would have a coal consumption (with coal at 13,500 British thermal units per pound) of 1⅓ pounds per kilowatt-hour, very fine efficiency.

A small factory plant of 100 kilowatts capacity with an evaporation of 8 pounds of steam per pound of coal, and an engine-generator set using 34 pounds of steam per kilowatt-hour would take 4¼ pounds of coal per kilowatt-hour. Now if all of the exhaust is utilized for heating and process work, the exhaust so furnished will take the equal place of about 89 percent of the total initial steam fed to the engine. Thus only 11 percent of 4¼ pounds or 0.4675 pound of coal, less than ½ pound, has been used to generate a kilowatt-hour as against 1⅓ pounds required by the superpower station which later must suffer a further and very material loss in transmitting the current to the point of consumption.

*Paper presented at the annual convention of the American Boiler Manufacturers' Association on June 2, 1925, at Watkins, New York.

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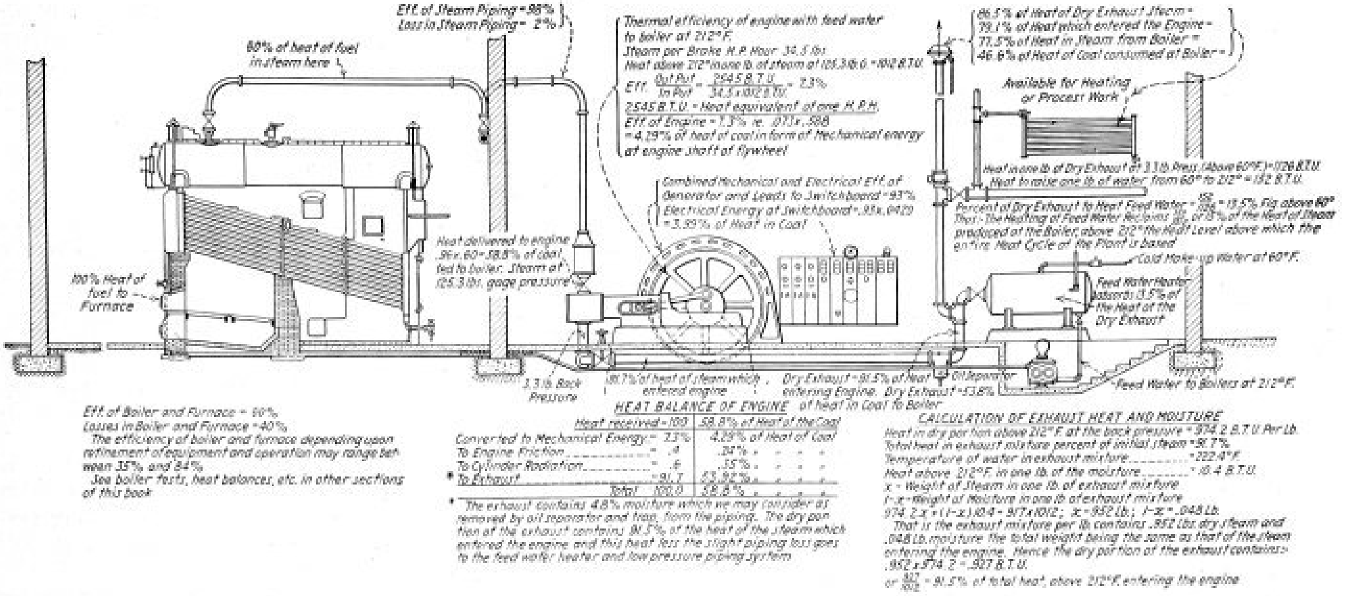


Fig. 3

Heat Balance of Small Factory Power Plant

For the purpose of presenting a real picture of the heat balance in a typical small factory power plant, I have included Fig. 3 which is a graphic analysis I prepared a few years ago to assist the small plant owner and others interested in gaining a grasp of this problem. The layout and values shown are quite typical of the size of plant (500 kilowatts and less) we are considering today. The chief points to be noted are:

1. In the dry part of the exhaust there remains 91.7 percent of the heat entering the engine throttle. Some of this heat in the diagram is used to heat the feed water and saves about 13 percent of the coal which, without the feed water heater, would be required.
2. This portion of the heat of the steam is available for heating and process work after it has generated the full quota of electrical energy.
3. The engine has acted virtually as a reducing valve but has developed useful energy while performing this function. The power is practically a by-product of the heating and process work if all the exhaust is applied to these purposes.

If we have a boiler plant developing 100 boiler horsepower for low pressure heating and process work we can install an engine between the boiler and the heating system, and get 100 horsepower from the engine plus 90 boiler horsepower for the heating system without one cent per year for extra fuel.

As a matter of operating record such plants have been run with less fuel with the engine running than when shut down with live steam to the heating system alone. This of course does not mean that there is as much heat in exhaust as in live steam for this is not true; but there are good reasons for the explanation of this fact. And in actual practice for approximate computations exhaust steam is frequently figured as equal to live steam in heating value.

Figs. 4, 5 and 6 are taken from Engineering Bulletin No. 2 issued by the U. S. Fuel Administration in collaboration with the U. S. Bureau of Mines. It is one of a series I had prepared and published during the war and the diagrams were made by an engineer connected with our staff. They show very clearly representative heat cycles in four types of plant.

Fig. 4 illustrates an efficient condensing plant such as would mark good practice of this sort in a fair sized industry. There is no heating considered. Power alone is developed. Delivered at the switchboard in electric energy we have 11 percent of the heat in the fuel consumed.

Figs. 5 and 6 apply to small factory plants of the capacities we are considering, 500 kilowatts and less in power demand.

Fig. 5 presents again a case of no heating requirements and shows a net efficiency of 5.6 percent and 8 percent for non-condensing and condensing plants respectively. Note the huge waste of fuel in the exhaust steam both for condensing and for atmospheric exhaust.

Fig. 6 indicates the cycle with a simple non-condensing engine whose exhaust is completely utilized for heating and

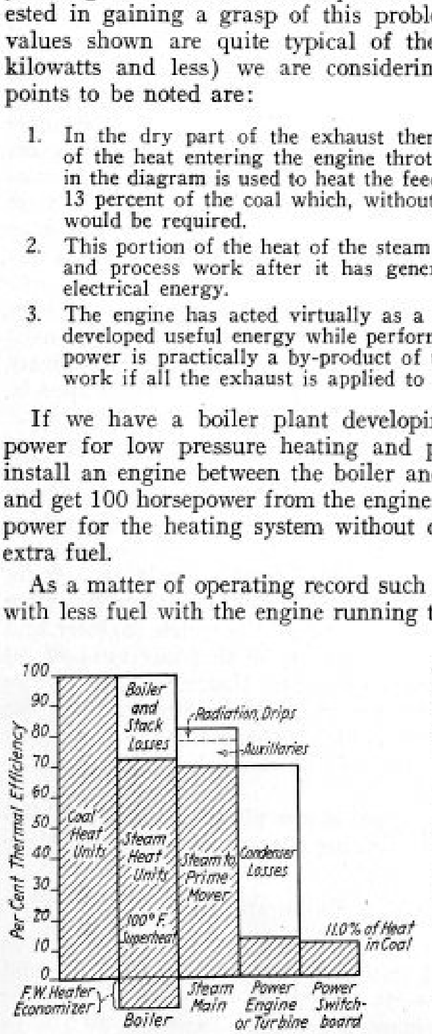


Fig. 4

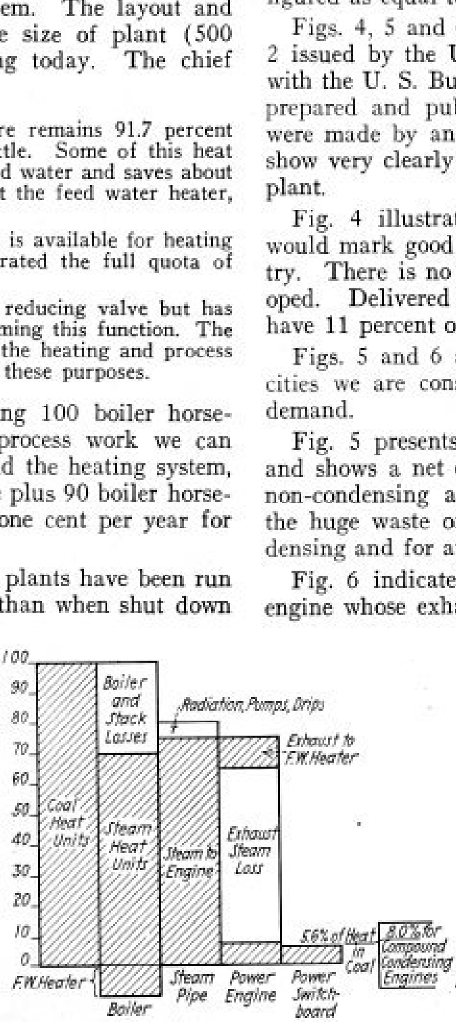


Fig. 5

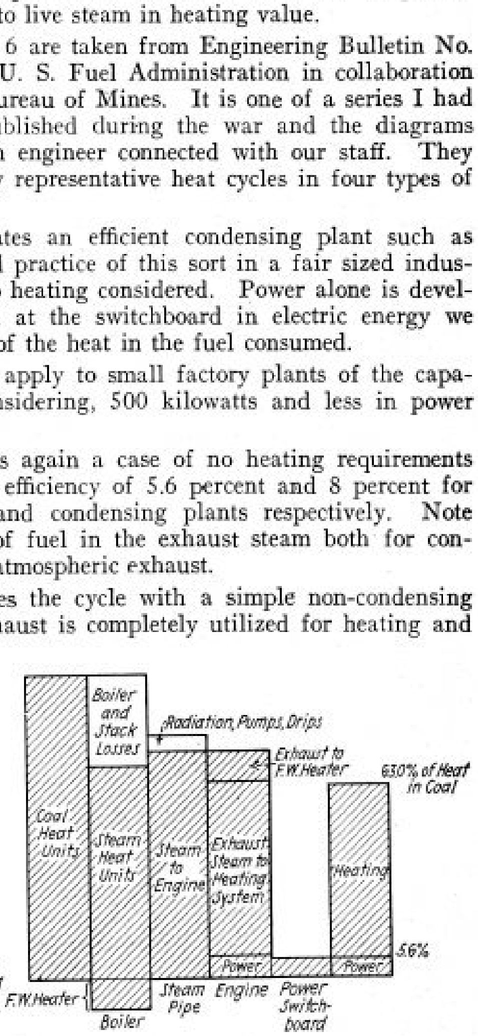


Fig. 6

process work and shows a heat and fuel efficiency of 63 percent.

This is directly comparable with the 19 percent efficiency of the highly organized central steam station previously mentioned.

The heat cycle may be computed for a proportion of utilizable exhaust and, as a matter of fact, each case must be considered separately on its merits.

As the use for exhaust steam (in the small non-condensing plant) decreases, a certain point will be reached where the same coal consumption would obtain for the generation of power by the central steam station making power alone. This point may be termed the critical point. Thus for example, if the central station has a coal rate of 3 pounds per kilowatt-hour and the private plant 6 pounds, the critical point will be reached when 1 minus 3/6 or one-half of the exhaust or coal is needed for heating, and the same total coal will be consumed whether the power is purchased or the engine operated. Based on the fact that the proportion of exhaust required for heating represents almost the same proportion of coal which will have to be burned for direct steam heating if the engine is replaced by purchased power.

Take another example assuming that current can be supplied at the purchasers switchboard for 2 pounds of coal and that the small plant produces it for 5 pounds. Then, if 1 minus 2/5 equals 3/5 of the coal or exhaust is needed for heating, no change in coal consumption will occur if current is purchased, the engine shut down and the boilers operated for heating only. If more than 3/5 of the coal or exhaust is needed for heating, coal would be saved (to the country) by operating the private plant. These formulative figures apply to the non-condensing private plant.

Is It Cheaper to Buy Power and Generate Steam for Heating?

Plant owners often propound this question: "Is it not cheaper to buy our power and light from the central station and generate steam at low pressure for heating?" The answer is: It might be in a small plant if the heating requirements are small and variable in comparison with the power requirements. If on the other hand the heating portion of the total requirements is large it will pay to install an engine and let the exhaust steam do the heating. The power then becomes virtually a by-product of the heating cost in which case, by comparison, purchased power becomes a large and unnecessary expense.

But factory owners sometimes believe that it costs very much less to generate low pressure steam as compared to high pressure steam. The answer to this, as every engineer knows, is that they have been misinformed.

To generate a given amount of heat in steam whether at high or low pressure with boiler-and-furnace efficiencies equal requires precisely the same amount of fuel. Steam at 149.3 pounds gage contains 1,195 British thermal units against 1,152 British thermal units at 1.3 pounds gage, a difference of only 3.7 percent. To make the lower pressure steam requires 43 British thermal units per pound less than the higher pressure but more pounds of it must be made so that to gain the same heating effect the same amount of heat from the fuel must be supplied to the boiler.

By lowering the boiler pressure it is true that a lower flue gas temperature can be maintained which reduces the chimney loss a certain amount, depending upon conditions. Five or 6 percent would be a generous allowance for this gain in efficiency.

Cost of Power

We have now discussed the salient features of the steam and fuel aspects of our problem and it remains to touch upon the chief factors of cost, in dollars and cents.

The cost of power may be divided into overhead and operating expenses. I have before me the complete operating cost records of a factory power plant where the maximum demand is 500 kilowatts, the steam pressure at the throttle 150 pounds and where there is a small requirement for 110 150 pound steam for ovens in addition to the demand for low pressure steam for building heating. This plant operates condensing and is so designed that exhaust steam in the quantity needed can be applied to building heating which, of course, is a seasonal and variable demand. Thus a proper steam balance is secured at all times. There are many ways in which such a steam balance can be obtained in the design of a plant, either with turbines or with engines, with direct and indirect steam heating or with a hot water system. Upon the engineering solution of this problem of design depends the degree of economy that will be possible. Each individual problem requires separate study and treatment.

In this case mentioned, the exhaust from the engines is divided between the condenser and the heaters which warm the water which is then circulated through the heating system, the vacuum on the condenser being regulated to suit the weather conditions.

In this plant the total operating cost for the last year for power, heat and light, was $42,652. If the boilers had been operated for building heating only with all power units shut down and current purchased for power and light, the coal requirements would have cost $17,016. This is based on similar buildings for this locality of equal cubic contents.

The actual coal consumed for all purposes including power was $22,268. The ratio therefore of heating coal to total

$$\text{coal was } \frac{17{,}016}{22{,}268} \text{ or 80 percent.}$$

Now, in general, most of the charges for power and heat are in proportion to the heating-fuel and power-fuel requirements, with some small and variable exceptions. The extra fuel in this case needed for power was 20 units as compared to 80 units which would be needed if the engines were shut down. For approximate comparison then we may charge 20 percent of the operating costs against power in this example.

The chief engineer's services could not be eliminated even if power were purchased as it is usual for him to spend most of his time as master mechanic in charge of all machinery and appliances throughout the factory. The firemen must be retained, and repairmen for all equipment, except prime movers. The electrician must certainly be kept so that this extra charge against power may be considered nothing. The only exceptions in this case are the watch engineer (who could be dropped) and the material portion of the engine room repairs and supplies.

The 100 percent charges which would remain on account of the chief engineer, the firemen and electrician would more than offset the saving in cutting off the watch engineer and engine room supplies and repairs, so that our ratio of 80 to 20 would remain a very safe one. Hence the approximate operating charge against power would be 20 percent of the total of $42,652 or $8,512 which includes the live steam used for baking purposes. Let this be charged against power to be further conservative.

The total electrical output of the plant was 914,425 kilowatt-hours so that the operating charges against power alone

$$\text{are } \frac{\$8{,}512}{\$914{,}425} = \$0.0093 \text{ per kilowatt-hour.}$$

The cost of central station current for the same demand and energy requirements would have been $30,400 or $0.0253 per kilowatt-hour, a gross difference of $0.016 in favor of making versus buying, equal to $14,600 per year.

We will now see what the addition of overhead means in this instance. The power unit with piping, foundation and auxiliaries with allowance for space or land value would not cost at present over $25,000. If we allow 13 percent for interest and depreciation we have $3,250 per year or $0.0035 per kilowatt-hour, which, added to the operating cost, gives a total cost of $0.0129 for generating versus $0.0253 for buying power. This difference of $0.0124 would amount to $11,340 per year in favor of making the power.

Actually the power investment would pay for itself in about two years after which there would be a clean saving of $14,600 per year.

I might quote another case where the plant in question was making a part of its power with a compound condensing engine, buying the balance of its requirements and using direct steam from the boilers at reduced pressure for heating and process. I installed a non-condensing Corliss engine generator set to act as a reducing valve between the boilers and the heating. Purchased current was cut out. The fuel consumption and cost did not perceptibly increase. The only charge against the saving was the overhead on the investment plus an inconsiderable item for engine supplies. These charges amounted to about one-half cent per kilowatt hour against 2½ cents formerly paid for purchased power. A steam balance, that is the elimination of exhaust steam waste during non-heating months, was effected by dividing the electric load between the condensing and non-condensing engines so that just the required amount of exhaust steam was developed at all times.

Another way to produce the steam balance is to employ as we have done in many cases, the use of a bleeder type of turbo-generator set from which exhaust steam in the required amount is automatically drawn for heating and process. The balance of steam not so needed passes on through the low pressure stages of the turbine and to the condenser, thus developing more power or decreasing the throttle flow.

In localities where condensing facilities are not available and where all the exhaust can not be utilized all the time, its waste can be reduced to a minimum by high economy engines, such as the uniflow type. Superheat also assists in this direction.

One more example which demonstrated the value of exhaust steam where all of it was used all of the time for process, water heating and building warming. I shut down all the engines one Sunday but kept all the heating in regular operation with temperatures carefully controlled. The same amount of fuel was burned with the engines shut down as when they were in operation.

These examples are merely by way of illustration. No two cases are alike. Purchased power has a very broad and proper field where its use spells economy to the plant owner. In the small plant where little or no heating is needed and where the electric rates are reasonable, it fills a valuable need. But where a large proportion of low pressure steam can be used, the small plant can make power cheaper than it can be bought in most instances, and there are hundreds of such plants throughout the country.

Purchased power often fills a need even when making power in the factory is cheaper. Although the private power plant may be capable of showing a good profit as an investment it sometimes happens that the owner's capital is limited and that a quicker turnover for the same money can be secured by enlarging the production side of the factory. I could recount instances of this kind also.

But the fact remains that where the exhaust steam can be utilized the by-product power, thus made possible, is the cheapest in the world.

The Kuhlman Electric Company, Bay City, Mich., has appointed the D. H. Braymer Equipment Company, Omaha, Neb., its representative in Iowa and Nebraska.

Cooperation in Establishing the Boiler Code*

By Fred R. Low†

Much thought has, during the past year, been given to the introduction of the 1924 edition of the Boiler Code, as well as of several new sections of the code, such as the "Low Pressure Heating Boiler Section" and the "Unfired Pressure Vessel Section." The chief inspectors of several states and municipalities have been in communication with the writer of late in the endeavor to obtain information necessary to properly place these codes before their authorities. Such cooperation is invited and the boiler code committee volunteers every possible assistance to the state inspectors for this purpose.

Six months has rolled around and the National Board has gathered for another meeting. What is it going to do?

When you adjourn and go home and the report of your doings goes out to your constituents and the public what will that report contain that warrants the time and expense of this meeting? What will it contain to justify the Board in the eyes of those who are watching it with continued hope but as yet unestablished confidence? What is the National Board going to do with their accomplishment and outlook for usefulness, to attract to it the allegiance and the active interests of all the official boiler inspection departments of America and to establish in the minds of the public, the Boiler Code Committee, conviction that here is an institution founded upon an industrial and social economic need, competent to carry out its purposes upon a high, impersonal and disinterested plane? What assurance will it carry that the Board is bound to endure and preserve the integrity and continuity of its records through all the changes of political preferment and appointment, the jealousies of place and power and resentment of those who have felt its restraining hand?

The opportunities of the National Board are so great, so possible of early realization. The service that it can render is one of the dominant factors in the sensible and orderly impressment of engineering knowledge and judgment and experience upon the administration of this phase of the safety movement. We who are interested in its development would deplore any letting down in the effort to develop its higher possibilities. We want to make it more than a filing system and registration bureau, an exponent of all that is best in the governmental supervision of vessels under steam or other pressure.

The Boiler Code Committee supplies you with a standard in accordance with which boilers should be built to be reasonably safe, but no matter how well a boiler may be built it may explode by ignorant or careless installation and operation. It is yours to see that these boilers, safe when new, are so installed and operated as not to menace their surroundings. Have there been any explosions of boilers under the jurisdiction of any member of the Board during the past year? If not, this meeting should proclaim that fact as a demonstration of effectiveness of the kind of supervision that it exercises. What an argument it would be for friend Gorton, what an inspiration it would be to wake up other states to the desirability and justification of such legislation. What a picture to put before the public of the service that this Board and the inspectors have rendered. If there have been such explosions, this is the place to hold the post-mortem on them. What were the causes? How did they happen? How could they have been prevented? Have you on file in your secretary's office a list of boiler and pressure vessel explosions as they occur and machinery

*Abstract of paper presented at meeting of National Board of Boiler and Pressure Vessel Inspectors, at Milwaukee, May 18, 19, 20, 1925.
† Editor of *Power*.

for collecting knowledge of them? Does this board know what is the dominant cause of explosions today? What causes more explosions in the United States than elsewhere? Because they have routed it out and in that way bring a systematic, orderly procedure on causes of boiler explosions and bring about their gradual rejection. The office of your secretary ought to be the official headquarters for information of that kind.

Condemned Boilers

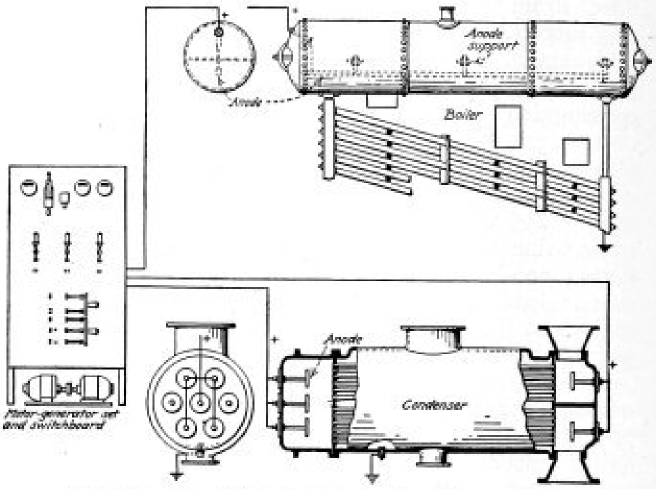
I am told that there has been a wholesale condemnation of twenty-four 500 horsepower boilers in one lot by one of the state inspectors. That is a fact. It is the most tremendous condemnation that has ever taken place to my knowledge and probably in fact. If it is not justified it will be very derogatory to the inspector in question and can be quoted and applied by the opponents of the legislative supervision of boilers. If it is a fact, we ought to know about it and we ought to be able to publicly justify it and to tell why they were condemned. Does this board know about it? What a subject that would be to prepare and present to a Board meeting of this kind and have this Board make a thorough study of that and other technical questions of that kind. It is a logical question for you rather than the Boiler Code Committee to investigate. To my mind it should be the function of the boiler code committee to furnish a standard for safety design and construction of boilers and other pressure vessels. It is your function to see that only these safe vessels are installed in the future and that those already installed that do not measure up to these standards may be allowed to work out their terms of remaining usefulness under such conditions as to be compatible with public safety. These are administrative and executive functions requiring for their intelligent performance, it is true, the expert, intimate, detailed, practical engineering knowledge of the supervisor and the inspector, the application of engineering experience involving construction and design with which the boiler committee deals or forthcoming suggestions which were discussed yesterday afternoon on the boiler code committee for the care of boilers in service is very advantageous in the carrying out of this work. I want to see the Code divested of those features which will properly demonstrate to this Board that the Boiler Code Committee ought to make the rules, regulations and standards rather than the handling merely of demonstrative and executive matters which do not deal with the design and construction but with the application of the law. We eliminate a lot of such things when we get rid of the code for existing installations.

When the National Board shall have become sufficiently established to warrant confidence in its stability, its confidence to inaugurate, to maintain uniformity in said particulars, I hope to see it take over all of these administrative functions. Notwithstanding all that has been said about the economical factor this country is absolutely without reliable statistics with regard to its functionalities. We cannot find anybody anywhere who can give you the number of boilers installed in the United States and the number of manufacturers in the United States. It has been my hope that as the different states get organized machinery would be established whereby we might have an absolute record of the number of boilers that are installed and a complete record of the casualties which occur to these boilers, their causes and extent. I am very glad to see the move that has been taken in that direction and the report that Mr. Farmer has presented. I hope that will be carried out more completely and that every state and city department will make it a part of its duty to keep these records and to furnish them to headquarters either through the secretary or the committee so that the country may have the benefit of such statistics.

Electrolytic System of Protection for Boilers

THE electrolytic system of preventing corrosion and scale formation in boilers and condensers has been quite extensively used in the marine service. Recent developments along this line, made by the Kirkaldy Engineering Corp., 52 Vanderbilt Ave., New York City, have brought out a system especially adapted to stationary plant practice.

The system embodies the principle of maintaining a constant supply of electricity at low voltage to a number of anodes placed at suitable locations in the boiler, condenser or other vessel to be protected, the boiler surface, condenser tubes, etc., forming the cathode of the circuit. At the anode



Arrangement of anodes in boiler and condenser

or anodes, due to electrochemical action, combinations take place between the iron of the anodes and the oxygen or acid radical of the impurities in the boiler or condenser circulating water. In this way the anodes eliminate the constituents of the water that would otherwise cause destructive corrosion of the boiler shell or boiler tubes.

The general arrangement of the anodes in a boiler and condenser is shown in the illustration. In a horizontal watertube boiler the anodes are suspended below the water line as shown in the upper view. In a surface condenser they are arranged at suitable points in the circulating water passes at each end of the condenser as shown.

The electrode for boilers is constructed with a distance piece of metal and is insulated from the boiler shell and current bar with a minimum of exposed insulation within the boiler. The electrode for condensers has the conductor and its insulation completely incased within a metal tube forming a single unit.

For supplying the current to the anodes, a motor-driven direct-current generator set and complete control board is provided as shown at the left of the illustration. The amount of current supplied to any particular boiler or condenser is varied and controlled by adjustable resistances.

As it is essential that no reversal of current or polarity of the poles of the circuit take place while the system is in operation, a reverse-current relay is inserted in the main circuit to open it automatically should the direction of the current be accidentally reversed.

The system, in addition to protecting the boiler or other vessels from corrosion, is claimed to prevent the formation of hard adherent scale. This protection is brought about by the film of hydrogen produced electrolytically over the surface of the boiler or condenser tube, thereby preventing the adhesion of scale and other impurities to these surfaces.
—*Power.*

Laying Out Locomotive Boilers—IX*

Finding the developed size of a plain ring course—Laying out the dome course

By W. E. Joynes†

FINDING the developed size of a plain ring or cylinder course is a simple work in comparison to developing the firebox plates. The work should be carefully carried out, as mistakes in the seam, waist and guide yoke angle location and other details will be found costly and troublesome.

Fig. 45 is the shop drawing for the first or front ring of the boiler Fig. 1. The order of development is as follows:

Refer to the boiler drawing; obtain neutral diameter 65-21/32 inches, longitudinal plate length 73-5/8 inches and the location of the seam. Make sure whether the seam is on the left or right side of the boiler. Sometimes it will be found on the top center, seldom on the side center and never below the side center. The plate is developed with the outside surface of the plate out and looking toward the front end of the boiler.

Refer to the circumference table and obtain the circumference of the neutral diameter (middle of plate thickness) of the ring 65-21/32 inches to the nearest sixteenth of an inch.

The exact circumference in decimals is found to be 206.262 inches. The nearest fraction of an inch not smaller than a sixteenth of an inch to this dimension is 206¼ inches. Divide 206¼ inches by 4 to obtain the length of each quarter of the circumference; this dimension is found to be 51-9/16 inches.

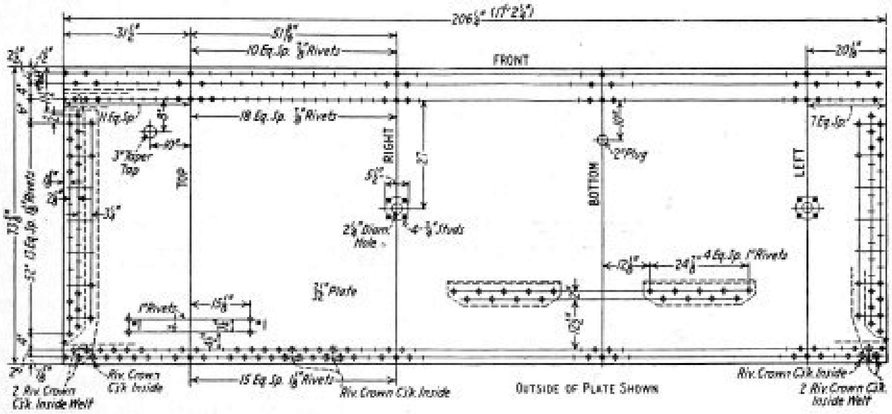


Fig. 45.—First ring development

When the circumference of the diameter of a ring is found to end in sixteenths, this will make the quarter circumference of the ring end in sixty-fourths of an inch. A dimension ending in sixteenths of an inch is the smallest fraction of an inch required for the developed total plate length.

No allowance is made—and each joining ring is made to the nearest sixteenth of an inch of the exact developed circumferential length. When assembling the rings the end of the largest ring is heated and expanded enough to allow the smaller ring to slip in up to the width of the circumferential seam.

Begin to lay out the plate from the top center—looking toward the front end. If the seam is on the left side (as shown in Fig. 45) only that part of the plate from the top center down to the seam will be shown to the left of the top center. The remaining part of the quarter and the three full quarters of the circumference will be shown to the right of the top center.

The location of the seam as designated "a number of spaces up" on the boiler drawing refers to the rivet spaces or pitch of the rivets in the front circumferential seam of the plate, for all rings except the front ring. The "number of spaces up" for the front or first ring has reference to the rivets in the front tube sheet.

Divide the length of the quarter circumference by the number of rivet spaces in the quarter which will give the pitch; multiply the pitch by the "number of spaces up," which will give the seam location. Make this dimension to the nearest sixty-fourth of an inch.

Now that the outline and the four center lines are laid down, the rivet lines for the circumferential seams and the tube sheet rivet line should be laid in. Space off the rivets in one quarter, front and back. With the divider as set for the quarter spacings continue to space off the rivets down to the seam on both sides of the plate.

Lay in the rivets for the longitudinal seam according to the seam drawing given on the boiler.

The injector check hole with studs, washout plug, guide yoke angle rivets, etc., are located on the plate as dimensioned on the boiler drawing and reference drawings. The difference in the circumferential rivet dimension on the surface of an angle and the neutral axis of the shell is to be allowed for.

The location of the longitudinal brace feet rivet holes, as located from the top or side center, is radial with the tee irons in the front tube sheet (when the tee is radial to the boiler center line) except when set out of the radial line to clear the inside welt strip of the longitudinal seam or other obstructions. When the tee iron is not radial to the boiler center line the brace feet are to be located half way between a line struck radial with the boiler center (through the center of the rod as shown on the boiler cross section) and the extended center line of the tee at the neutral line of the boiler shell.

When the brace tees in the front tube sheet are radial to the boiler center line the location dimensions for the brace feet on the boiler shell will be proportional to the circumferential dimensions locating the tees on the front tube plate drawing.

It is clearly seen that in rolling this plate with the surface as shown outside, the seam will come on the left side of the boiler as required by the boiler drawing. It is also obvious if the plate should be rolled with the surface as shown on the inside, the seam would come on the right side of the boiler and all holes in the plate that are not right and left would be on the wrong or opposite side of the boiler than what was intended or shown by the boiler drawing.

In locating the brace feet on a conical course sheet a section is made through the cone between the brace foot rivets. This

* Previous installments of this article appeared on page 1, January issue; page 40, February issue; page 72, March issue; page 99, April issue; page 129, May issue; page 166, June issue, page 235, August issue and page 263 of the September issue.

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section is a neutral radius line of the cone at the foot and is described on the front tube sheet of the boiler layout drawing. Scale the location of the foot as projected onto this line. The foot is radial to the shell, from the pin location on the projected tee center line or half way center line when the tee is not radial.

When the seam is on the right side of the boiler the top center line of the plate development will be at the right hand side of the drawing or in other words the plate layout will be vice versa from plate Fig. 45.

When the longitudinal seam is on the top center line it is only necessary to show one half of the plate. Various holes, etc., in the plate that are not right and left should be marked R.S. (right side) only, or L.S. (left side) only. Those that are right and left should not be marked R. and L. (right and left), as this will be clearly understood without the R. and L. marking.

There *will not* be a rivet on the longitudinal seam center line in the back circumferential seam unless the back circumferential seam contains the same number of rivets as the front circumferential seam of the plate, see Fig. 46. The rivets in the back circumferential seam are not shifted off the regular spacing and may come close to the edge of the plate (center line of longitudinal seam) as may be seen by referring to Fig. 45. The above applies to all back circumferential seams and the smokebox circumferential seam for first rings.

Care should be taken to countersink rivets in the circumferential seam to clear the brace rods when found to be necessary.

Tapped holes for the hand rail post studs, runboard and other bracket studs and other accessories requiring studs in the boiler are located, drilled and tapped after the boiler has been sent to the erecting shop.

Dome Course

Fig. 46 is a cylindrical ring course similar to Fig. 45, only it has a large opening in the top of the plate for admitting steam to the dome and is commonly referred to as the "dome course" because of the fact that the steam dome is located on it.

The opening is a true circle in the flat plate and is reinforced by a round liner for which the riveting is shown on the plate.

Locating the Rivet Holes in the Dome Liner.—Find the center of the liner and describe the same size opening circle as given for the plate. The hole is punched or burnt out; send the liner to the rolls and have it rolled to fit the inside of the "dome course." Clamp the liner to the inside of the "dome course" and mark off the rivet holes. Re-roll the liner flat and punch the rivet holes.

When more than one boiler is to be built use the liner as a template for marking off the other liners.

The boiler shown by Fig. 9 (for which Fig. 46 is the 3rd ring) is for a Mallet compound locomotive. The liner shown at the bottom of the plate is for re-enforcing the plate for attaching the high pressure cylinder saddle. The riveting as shown, for holding the liner, is on the flat plate. The liner is rolled to fit the outside of the shell, clamped on the shell and the riveting marked off similar to the dome liner.

The liner is pointed or diamond shaped for reason of the rivet distribution. This arrangement puts the least number of rivets in a straight line, thereby keeping the plate at a high efficiency to conform to the seam efficiency.

Mark off the liner margin (as dimensioned on the boiler drawing) from the center line of the rivet holes to the edge of the plate.

All liner rivet holes (whether the liner is on the inside or outside of the boiler shell) are located on the liner by the method of rolling up the liner to fit the shell, marking through the shell holes onto the liner. Re-roll the liner flat, punch holes and use as a template, when more than one boiler is to be built.

Do not try to lay out large liners other than as described above. The rivet dimensions given on the plate are shell dimensions only. The liner dimensions for the same holes, for an outside liner, will be greater, and for an inside liner will be smaller. This difference is proportionately calculated and should not be forgotten when determining the circumferential length of a liner.

The dome rivet holes are not laid out on the shell plate. The dome is clamped on the boiler and the rivet holes are drilled directly through the shell from the rivet holes in the dome base.

Inside liners are rolled to a radius slightly larger than the shell and outside liners to a radius slightly smaller than the shell. This allows the liner to draw against the shell tightly for marking off.

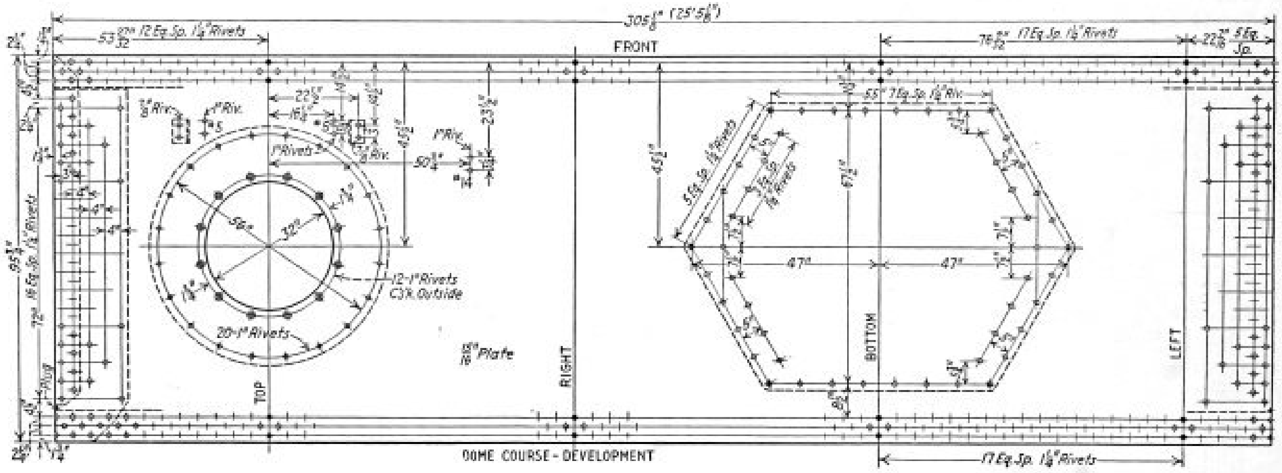

Fig. 46.—Development of dome course

Locating the Rivet Holes in the Seam Welt Strips

Outside Welt Strip.—The longitudinal pitch of the rivet holes for an outside welt strip is marked on a metal strip from the rivet spacing as laid out on the plate. Transfer this spacing as marked on the gage strip to the welt strip. The inside welt strip for sextuple seams is also marked from this same gage strip. Inside welt strips wider than sextuple riveted are rolled up and marked from the shell.

The longitudinal center lines for the rivet holes are laid out directly on the welt strips, but the distance from the seam center line to the first row, and between the rows, will be proportionately greater than the shell for the outside welt and smaller for the inside welt, also the circumferential seam holes in the front end of the outside welt and the back end of the inside welt are measured from the shell and a proportional allowance made for the welts.

After one welt strip has been marked off, use it as a gage for drilling the remaining welt strips, when more than one boiler is to be built.

The term "clamp" does not refer to the "screw clamp" where used in connection with holding the welt strips or liners in place for marking off the rivet holes, etc., from the shell plates. What is actually done is to locate and drill four of the seam holes, two at each end and near the longitudinal center line of the welt strip, or liner, for bolting the same tight against the shell.

(*To be continued*)

Boiler Manufacturers Recognize Value of National Board*

By E. R. Fish†

I AM glad to come before you again and tell you briefly how some of the problems with which we are both concerned look from the manufacturer's point of view. I come not so much as an officer and employee of the Heine Boiler Company but as a representative of the American Boiler Manufacturers' Association of which I have the honor and pleasure of being president.

We builders of boilers have with much interest watched the growth of your organization, for we have been very desirous of its success in order to simplify and lessen to the greatest possible degree the clerical work necessary to satisfy the requirements of the times. Any one who has been connected with the boiler manufacturing industry for any considerable period realizes how many more records it is necessary to keep than it was only a comparatively few years ago. There are good and sufficient reasons for these records, the principal one being the safeguard which it is thus possible to throw around the material and manufacture of boilers. However, at the same time, it considerably increases the overhead cost of doing business, and to that extent inevitably adds to the cost of the product. Any means which will contribute to minimizing the amount of clerical labor necessary to keep the proper records, make out the various forms, etc., is highly desirable.

One of the chief causes for complaint when the various states began adopting the A. S. M. E. Code and requiring boilers to be stamped with their state numbers, was the great multiplicity of stamping required on boilers built for stock and therefore likely to go into any state. Probably all of you recall boilers which were almost literally covered with stampings of various states.

Even when it was not known exactly where a boiler was to go when it was built, there was still much complication due to the necessity of keeping separate lists for each state, which involved the possibility of mistakes.

Then again came the insurance men's viewpoint. The necessity of having the inspectors located at different points in the country qualified to make inspections for all states was a source of great inconvenience and expense, due to the necessity of having to send the inspectors to the different states to be examined and their competency determined. It is self-evident that if some central agency could issue the certificates of competency, and which would be honored by all the states, it would effect a very great saving in time and money.

It is to the credit of both the manufacturers and insurance companies that they practically, without exception, have tried conscientiously to follow out and comply with the various state requirements.

Inasmuch as the code committee does not and will not pass on specific designs, it seems necessary in order to carry out the idea of uniformity, which was tremendously helped by the A. S. M. E. Code, to have some generally recognized body that can pass upon such designs so that there may be some assurance that what is acceptable in one place is also acceptable in another. It is obvious that when decisions are made entirely independently by different men such decisions must inevitably be different, even to the extent at times of being diametrically opposed. To have problems of this sort considered and solved by a central agency, the decisions of which are accepted by all who are identified with that agency, contributes again to uniformity of practice and simplicity of operation.

It seems to me to be beyond controversy that the opinion of a majority of a body of qualified men is better in the long run than the judgment of any one man, and further that it is very greatly to the advantage of every one who has to make decisions, to have a consensus of opinion to accept as the proper guide, even though any such decisions are not absolutely binding on each individual. If any controversies arise one is in an exceedingly strong position to be able to cite an opinion which is that of a number of competent men instead of having to defend his own individual judgment. It is this feature that gives such strength to the boiler code and has contributed to its very general adoption.

All of the above arguments point to the one conclusion that an organization such as yours is fully justified and is well worth while, and the manufacturers are thankful that it has come into being, and has really arrived at the point where it functions continuously and smoothly, and they are, so far as my information goes, without exception, back of you.

I cannot pass without giving expression to some words of commendation and appreciation of the efforts of your secretary-treasurer, Mr. Myers, who, I believe, initiated the idea of the National Board and who has persistently and conscientiously nursed it through its infancy and brought it to its present state of being, and I am thoroughly of the opinion that the end is not yet.

Should I attempt to name others who have been prominently connected with the movement it would most likely result in overlooking some since there has been quite a number of such. In order, therefore, to avoid hurting any one's feelings I will not attempt to be too definite in that particular.

The A. S. M. E. Boiler Code is primarily an instrument for the safe construction of boilers. In a great many particulars it is quite specific, and yet in many of those particulars the safety of the structure probably is not absolutely dependent upon the literal compliance with the requirements. We manufacturers, as in any other line of activity, are in it to make a profit if possible. In so doing we are giving lucrative employment to a large number of men, and unless we can continue to operate at a profit must inevitably shut down and in doing that, deprive many of their means of livelihood, at least temporarily.

Most boiler makers are desirous of turning out a good article built as perfectly as possible. It is always a source of regret if anything happens to a boiler after it is put into operation, and practically all manufacturers would not knowingly let a boiler go out of the shop that contained any defect, either in material or workmanship that would

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*Abstract of address made at National Board of Boiler and Pressure Vessel Inspectors' meeting, held at Milwaukee, May 18, 19 and 20.

† President of the American Boiler Manufacturers' Association.

by any possibility result in a rupture that would cause injury, loss of life or property.

It is largely up to you inspectors to determine whether any little minor departures from the exact wording of the Code requirements should or should not cause the rejection of that part or possibly of the structure as a whole. Really a great responsibility lies with you in this respect, for the arbitrary insistence upon compliance with some little more or less immaterial and unimportant feature may cause a considerable and unnecessary financial loss to the company, for as you all know, it is impossible to hold the workmen for the mistakes that are made, and the great majority of mistakes are made by them, and not through any fault of the designer or draftsman. All losses, therefore, fall upon the company whose only recourse on the maker of the mistake is to fire him, which is a thing that employers generally hesitate to do, particularly if it is a good man or in the case of shortage of labor.

You will understand, therefore, that in my estimation, one of the functions of the inspector is to exercise his good judgment in dealing with these human frailties.

I venture to suggest the above not with the idea that anything should ever be passed of a really doubtful nature, but merely to call attention to the needlessness of working unnecessary hardships.

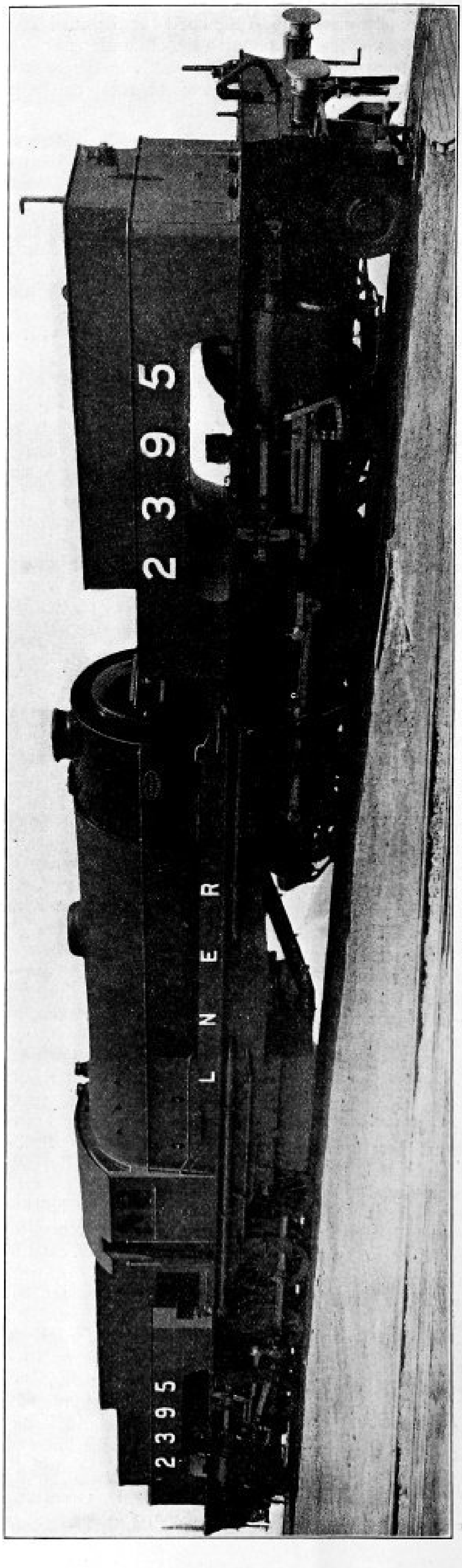
In conclusion I want to again reiterate the appreciation of the manufacturers of the function which the National Board is fulfilling, and to express the hope that the usefulness and importance of the Board will continue to grow to our mutual benefit.

Standardization of Color Markings for Compressed-Gas Cylinders

The Industrial Accident Commission of California recently requested the American Engineering Standards Committee to undertake the standardization of color markings for the identification of compressed-gas cylinders. It has been proposed that this suggestion, together with the proposal of the War Department for the standardization of valve threads for compressed-gas cylinders, be the subject of a general conference of all interested groups to decide what action, if any, should be taken. In view of representations to the Committee by representatives of the Compressed Gas Manufacturers' Association and the International Acetylene Association that the producers were not at present prepared to enter into such an undertaking, the A.E.S.C. decided not to assemble such a conference at the present time. This action is in accordance with the general policy of the A.E.S.C. that it is not itself an initiating body and that work is undertaken under its auspices only when the attitude of industry is sufficiently favorable to make it reasonably certain that national standardization, that is, a real national consensus, can be brought about. For this, the active cooperation of the producer groups is manifestly necessary.

Locomotives Inspected

During August 6,604 locomotives were inspected by the Bureau of Locomotive Inspection of the Interstate Commerce Commission, according to its monthly report to the President on the condition of railroad equipment. Of these 2,689, or 40 percent were found defective and 275 were ordered out of service. During the month 17 cases, involving 32 violations of the safety appliance acts, were transmitted to various United States attorneys for prosecution and the imposition of penalties provided by law.



Garratt locomotive for L. N. E. R. service

Developments in British Locomotives

Garratt type locomotive has largest boiler ever placed in service in Great Britain

By G. P. Blackall

TWO locomotives of extraordinary interest, inasmuch as they both introduce new types into English locomotive practice, are shortly to be placed in service by the London and North Eastern Railway, one of the "big four" of the British railway world. One of these is of the Garratt type and the other is a "Mikado."

Although the Garratt type of locomotive construction is not entirely new to Great Britain, it has not hitherto been utilized under actual railroad conditions, the only previous example of the type being restricted to working in the yards of an industrial concern in South Wales, where it has proved quite successful under difficult conditions of service.

Apart from the system upon which it was constructed, the new Garratt locomotive of the London and North Eastern Railway is remarkable on account of having six cylinders, an exceptionally large boiler, with a maximum diameter of 7 feet, a total heating surface of 3,640 square feet, and grate area of 56.4 square feet. It is easily the largest, heaviest, and most powerful engine ever built in the United Kingdom for domestic service.

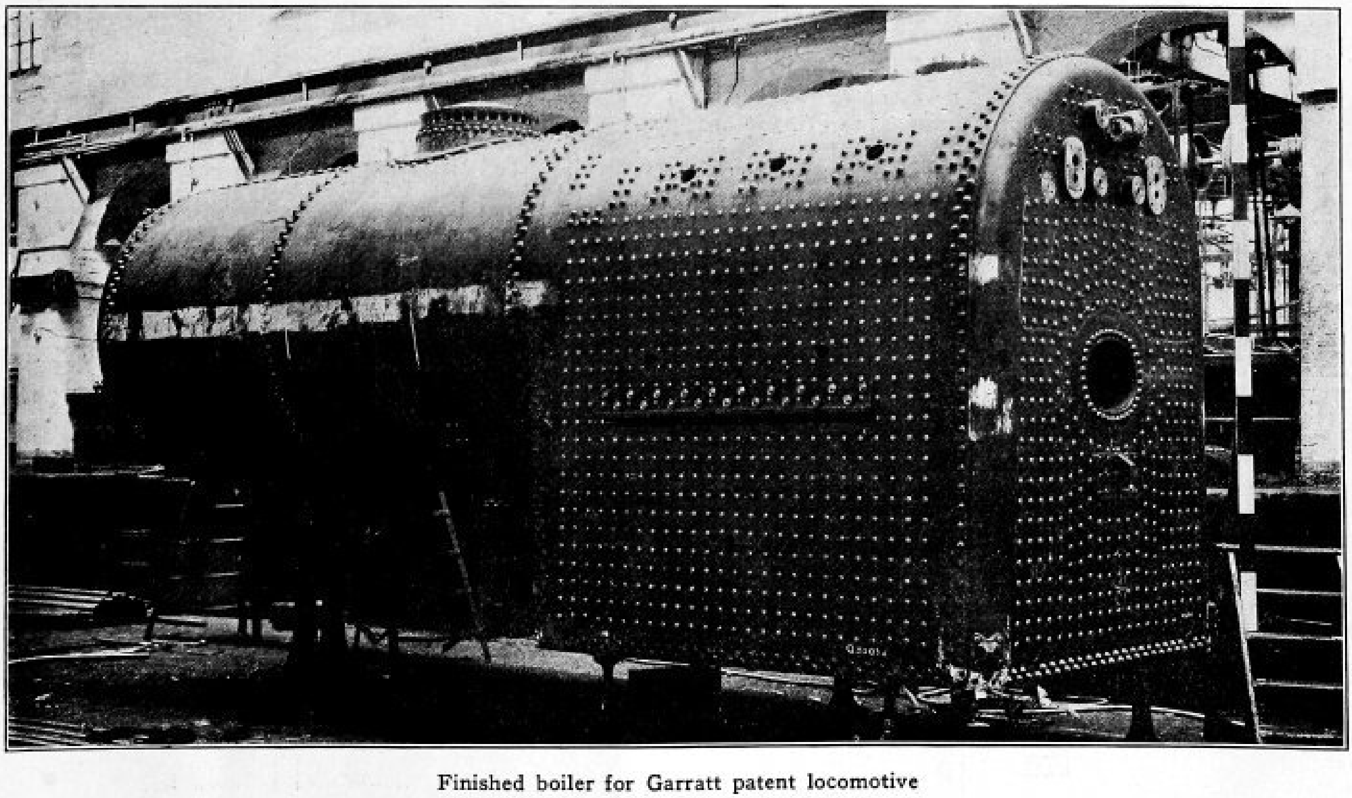
The engine develops a tractive force of 72,940 pounds at 85 percent of the boiler pressure and equals in power capacity two of the 3-cylinder, eight-wheeled coupled engines of the 3499 class much used by the same railway. The cylinders, valve motion, etc., are all interchangeable with the corresponding parts of these locomotives, and wherever possible the engine details are interchangeable with that class. The boiler is far larger than any hitherto in service on English railways or even possible with engines of the usual type.

Each group of coupled wheels is arranged on a base of 17 feet 10 inches, and the total wheelbase of the engine is 79 feet 1 inch. The boiler barrel is 13 feet long, and, as previously stated, has a maximum diameter of 7 feet. It contains 275 fire-tubes each 2 inches in diameter, and 45 superheater flues, 5¼-inch diameter outside. The heating surfaces are:

Tubes	2,757 square feet
Firebox	237 square feet
Total	2,994 square feet
Superheater	646 square feet
Total	3,640 square feet

The firebox is of the round-topped type with direct stays. It carries a working pressure of 180 pounds per square inch. The boiler contains a Robinson superheater, the element tubes having a diameter of 1⅜ inches outside. The boiler center is placed 8 feet 6 inches above the level of the rails. The maximum height of the engine is 12 feet 10 inches. The following are additional particulars:

Cylinders (6), diameter	18½ inches
Cylinders, piston stroke	26 inches
Wheels, coupled diameter	4 feet 8 inches
Total water capacity	5,000 gallons
Coal capacity	7 tons (long)
Ratio of tractive force (85 percent) to adhesive weight (tanks full)	1 to 4.37



Finished boiler for Garratt patent locomotive

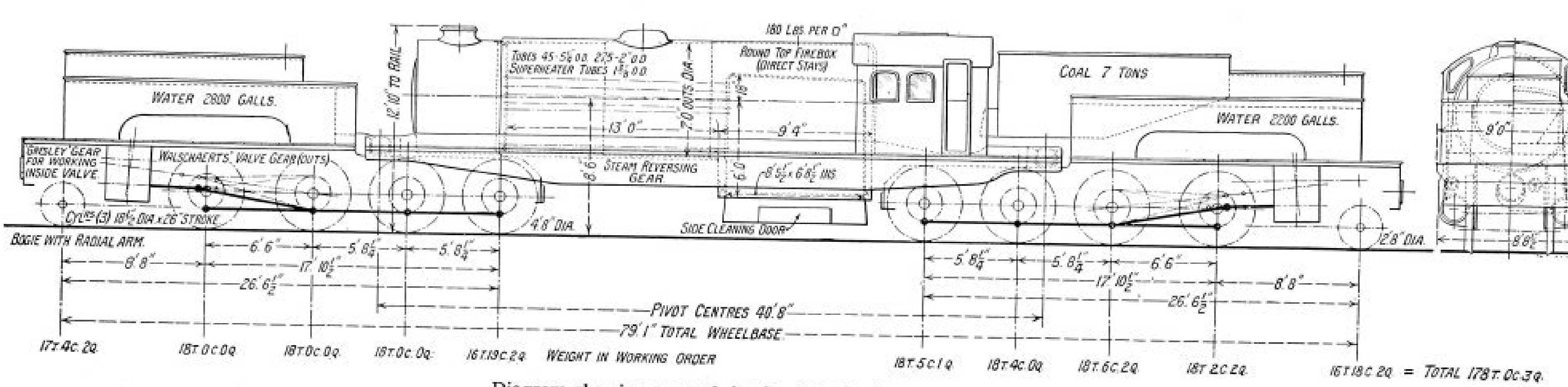
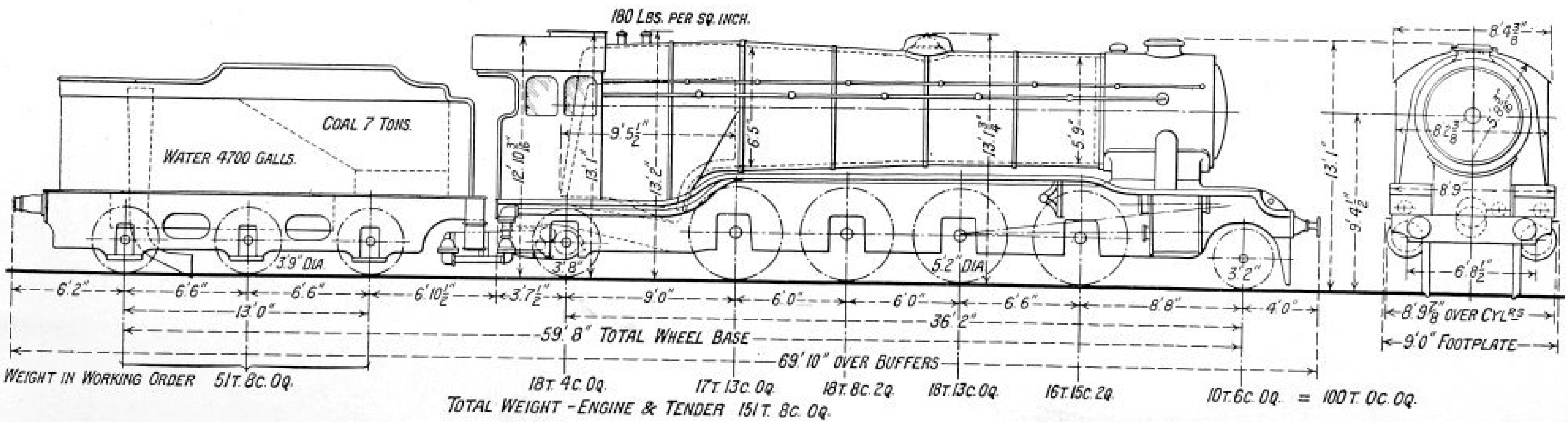


Diagram showing general details of L. N. E. R. Garratt locomotive



Principal dimensions of L. N. E. R. 2-8-2 Type freight engine

Steam brakes are fitted to all the coupled wheels, with handscrew brake to the coupled wheels at the firebox end only, vacuum brake appliances being fitted for the train. Steam sanding is applied to the front and rear of each group of coupled wheels. The equipment also includes mechanical axle-box lubricators, and an exhaust steam injector.

Undoubtedly this locomotive constitutes a great advance, as a single-engine unit, on any hitherto built in Great Britain. Although its total weight, viz., 178¾ tons (long), is considerably in excess of former standards, it must be remembered that this weight is distributed over a considerable length of wheelbase. The weight per foot run of wheelbase is approximately 2¼ tons, owing to the principle on which the engine is built—the grouping of wheels and articulation of the main units. There is, notwithstanding the engine's great length, no fear for the track under any of the circumstances in which the engine can be used.

It is to be employed as a banking engine for banking heavy coal trains between Wath and Penistone, a distance of 7 miles all on a rising gradient, of which two miles are up 1 in 40. The weight of these trains is approximately 1,000 tons, and they are at present worked by two train engines in front and two or three banking engines in the rear. It is intended that the Garratt engine will replace all of the latter.

Mikado Type in Service

The "Mikado," or 2-8-2 type locomotive, is a development of the 3-cylinder, 2-8-0 coal engine which Mr. Gresley some time ago introduced in the Peterborough-London freight service. Many of the parts of the "Pacific" express engine have been embodied in its design, including the boiler, cylinders, piston valve, valve motion, etc., all of which are interchangeable with those of the "Pacific" locomotives.

The "Mikado" engines are to work the heaviest coal trains between Peterborough and London consisting of 100 trucks, the weight of the train being approximately 1,600 long tons, exclusive of engine and tender. The existing 2-8-0 engines take 80 wagons of an approximate weight of 1,280 tons. The coupled wheels of the new "Mikado" are 5 feet 2 inches diameter instead of 4 feet 8 inches, the object being to get faster working with this class of train than is possible with existing engines. A booster has been added to the engine to enable it to start quickly and to take the trains up the long gradients of 1 in 200.

Apart from tank-engine construction, the 2-8-2 wheel arrangement has never hitherto been adopted in Britain. In the form in which this "Mikado" locomotive has been built it is of special interest, owing to the utilization of three high-pressure cylinders, a very large boiler, and a booster engine, and in such circumstances it constitutes a very important advance on previous freight locomotive practice in the United Kingdom.

The boiler's maximum diameter is 6 feet 5 inches, and length 19 feet. Superheating apparatus of the Robinson type is employed, there being 32 elements. Two "pop" safety valves are mounted upon the firebox. Steam distribution is by piston valves actuated by Walschaerts gearing, Gresley's arrangement for actuating the inside valve being employed. The maximum travel of the valves is 5½ inches, steam lap 1¼ inch, exhaust lap ⅛ inch, and cut-off in full gear 75 percent. The valves are 8 inches diameter.

Following are some of the leading particulars:

Cylinders (3), diameter	20 inches
Cylinders, piston stroke	26 inches
Wheels, coupled, diameter	5 feet 2 inches
Wheels, leading, diameter	3 feet 2 inches
Wheels, trailing, diameter	3 feet 8 inches
Wheelbase, coupled	18 feet 6 inches
Wheelbase, total engine	36 feet 2 inches
Wheelbase, total engine and tender	59 feet 8 inches
Boiler, maximum diameter	6 feet 5 inches
Boiler, height of center above rails	9 feet 4½ inches
Heating Surface:	
Tubes, small	1,880 square feet
Flues	835 square feet
Firebox	215 square feet
Total Evaporative	2,930 square feet
Superheater	525 square feet
Total	3,455 square feet
Grate area	41.25 square feet
Working pressure	180 pounds per square inch
Weight of engine in working order	100 tons
Weight of tender in working order	51 tons 8 hundred weight
Coal capacity	7 tons
Water capacity	4,700 gallons

The tender is of the new pattern and is equipped with water pick-up apparatus. The booster engine has two cylinders measuring 10 inches diameter by 12-inch stroke. Its tractive effort is 8,500 pounds. The ratio of adhesive weight to tractive effort is 4:79. The tractive effort of the main cylinders, at 85 percent of the boiler pressure, is 38,500 pounds, and ratio of adhesive weight to tractive effort 4:16. The boiler horsepower of the engine is 1,815.

Fusible Plugs Approved During July, 1925

Following is a list of fusible plugs approved during the month of July, 1925, by the United States Steamboat Inspection Service. The names of the manufacturers, with their addresses, and the heat numbers of fusible plugs are given:

American Injector Company, Detroit, Mich.; heat 91.

The Atlantic Works, East Boston, Mass.; heat 15.

Crane Company, Chicago, Ill.; heats 395 to 403, inclusive.

W. T. Garratt & Co., San Francisco, Calif.; heat 209.

Glasgow Iron Works & Supply Company, New York, N. Y.; heat 251.

Mason Engineering Works, New York, N. Y.; heat 6.

The William Powell Company, Cincinnati, Ohio; heat 6.

The following fusible plugs were approved during the month of May, 1925:

The Farnan Brass Works Company, Cleveland, Ohio; heat 198.

Hills-McCanna Company, Chicago, Ill.; heat 112.

Good Health Profitable All Around

Doctor M. R. Taylor (quoted at the National Safety Council convention at Cleveland) in discussing the stimulation of production, said: "The modern employer has come to realize that the human machine pays a far larger return on the investment in its upkeep than any piece of iron or steel ever can or will. Physical health is man's greatest asset; and as this is true individually, it must be true collectively; therefore, the capitalizing of it should become a consequential factor in all industries. A well-organized industrial medical department should be as beneficial to the employer as to the employee."

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Spiral Riveted Pipe

Q.—I am the owner of one of your books, namely "Laying Out for Boiler Makers" and there is one problem that perplexes me and that is the layout of a spiral seamed pipe. You state that, not taking plate thickness into consideration, it is a very simple problem; I find it the opposite. Now I would like to have it fully explained to me how to start to develop a spiral seamed pipe with sheet metal, say 28 gage material or 24 gage. I would sincerely appreciate it if you would send me a drawing and explain fully how it is done. Hoping you will be able to comply with the request and thanking you in advance, I beg to remain.—R. G. B.

A.—Refer to page 337, The Boiler Maker, November issue, 1920. Therein is given the development of a spiral riveted pipe. If you do not have this copy we will give the solution again.

Allowable Pressure on Corroded Stays

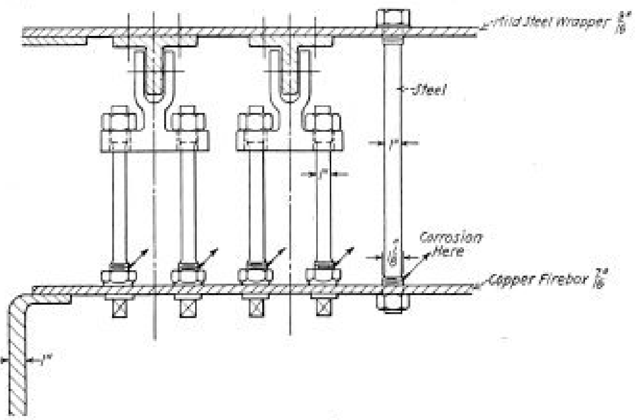
Q.—I have to thank you for the help you have given me from time to time through the columns of The Boiler Maker and because of your ever ready help it gives me great confidence to again put another question for insertion in your valuable paper.

The majority of locomotives in India, or shall I say on Indian railways, are fitted with Belpaire type boilers with direct stays as per sketch attached.

The trouble with these stays is that they corrode around the root of the stay just above crown sheet, as I have indicated in the diagram. The question is when this wasting away of the stay is found, what would be safe working thickness? When new, the stays are 1⅛ inches over the thread. That is, the stays corrode down to an average thickness of ½ inch, and the administration on one of the railways here consider them to be quite safe.

Is it possible to apply the formula for staying flat surfaces or is there any other method? Personally, as a boiler foreman, I consider that once stays begin to eat away or corrode at the root even to a small margin they should be attended to and the trouble eliminated.—J. K.

A.—When boiler plate, stays and other parts have wasted away, the material has weakened. Such parts should be repaired to maintain if possible the allowable working pressure. A boiler should not be operated at a pressure greater than the weakest section can carry, figured from a safety factor of at least 5.



Points where corrosion attacks stays

The following formula may be used in determining the maximum pressure allowed on plate that has wasted away:

$$P = \frac{t' \times p}{t}$$

in which,

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

t' = thickness of wasted plate, inches.

p = original maximum allowable working pressure, pounds per square inch.

t = original thickness of plate, inches.

Example.—The original plate thickness of a boiler was ½ inch, due to corrosion the thickness wasted away to ⅜ inch along the seam. The original pressure allowed, 150 pounds per square inch. Determine the maximum allowable pressure.

Solution.—Substitute the given values of the example in the formula, then,

$$P = \frac{\frac{3}{8} \times 150}{\frac{1}{2}} = 112\tfrac{1}{2} \text{ pounds per square inch.}$$

This formula may be used also in the case of stays, substituting for t' the diameter of the corroded stays and for t the original diameter of the stay measured through the weakest cross sectional area.

Blast Pipe and Screw Conveyor Problem

Q.—I would like to know how to develop a screw conveyor. I would also like to know how to develop the cone plate and pipe for the top of a blast furnace.—C. K.

A.—The plan and elevation of the blast furnace section, Fig. 1, should be drawn to the neutral axis of the plate: In this development it is essential to produce the opening in the plan view of the cone, as obtained by passing the cylinder through the cone. For this purpose divide the profile of the cylinder in both views in equal parts and draw projectors through the points parallel with the axis of the cylinder. Consider the lines of the cylinder in the elevation as traces of planes. Where these planes pass through the cone, the sections of the cones are either ellipses, parabolas or hyperbolas, depending on the inclination of the planes with the axis of the cone.

The plan view shows sections of the cones, which are obtained by finding the intersection of the projectors of the cylinder and elements of the cone as shown at *1-2-3*, *4-5-6*, etc. The intersection of the projectors of the cylinder plan view with the conical sections fixes points on the miter, as s, t, u, v and w.

Having determined the miter line, lay off the pattern, Fig. 2, of the cylinder and Fig. 3, which is a section of the conical pattern.

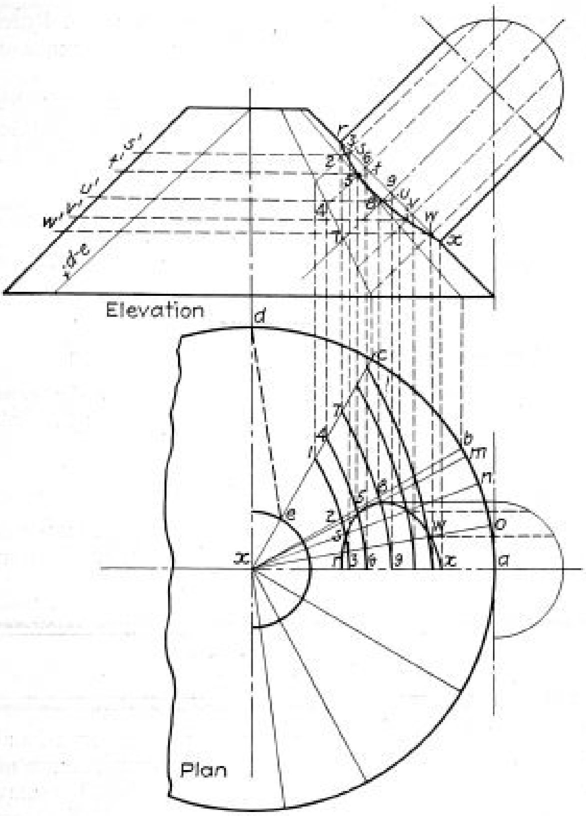


FIG. 1

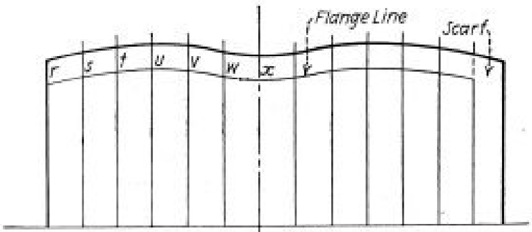


FIG. 2

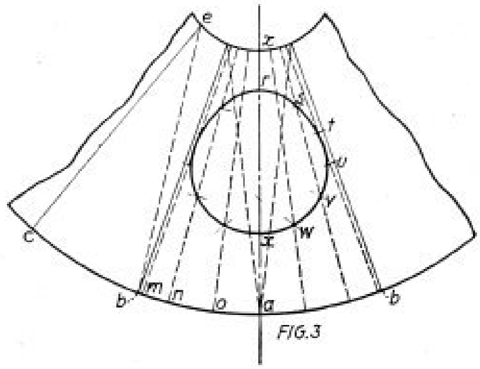


FIG. 3

Plan and elevation of blast furnace section

Fig. 3 is developed by triangulation as the cone section has such a small taper, thus making it difficult to draw the stretchout with a radius equal to the slant height of the cone.

To develop the opening in the conical pattern, first find where the points on the miter are located at their true distance above the base of the frustum. This may be done by projecting the points *s*, *t*, *u*, *v* and *w* of the elevation, parallel with the base of the cone to the outer element as at *s'*, *t'*, *u'*. An allowance must be made for the plate section required inside of the opening in the pattern, Fig. 3. This may be measured as called for on your original drawing.

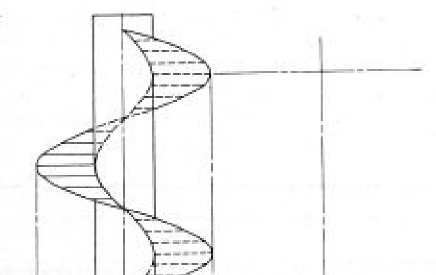


Fig. 4.—Method of developing helical conveyor

Helical Conveyor Layout

Fig. 4 shows a method for constructing the pattern for a helical conveyor. Lay off the pitch for one complete turn of the helix; also draw a semicircle for the inside and outside edges of the conveyor in the plan. Divide the semicircle into a number of equal parts and the pitch of the helix into twice the same number of parts. Vertical projectors are drawn from the points of the plan to intersect the corresponding horizontal lines of the elevation. The intersection of these projectors establishes the points on the helix as at *1-2-3*, etc., in the elevation. The lines *2-2*, *3-3*, etc., of the elevation are all equal in length to line *1-1*. The length of the diagonal *c* plan view is found by constructing a right angled triangle, using *c* for the base and a height equal to the vertical distance between the parallel lines *1-1* and *2-2*. The hypotenuse of this triangle is used in developing the pattern for a section of the conveyor.

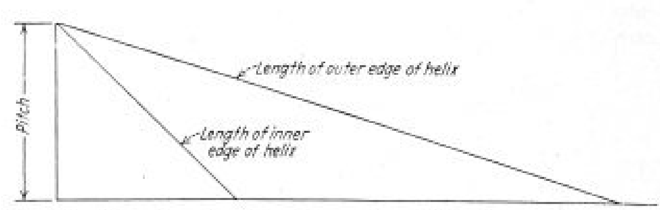


Fig. 5.—True lengths of inside and outside edges of conveyor

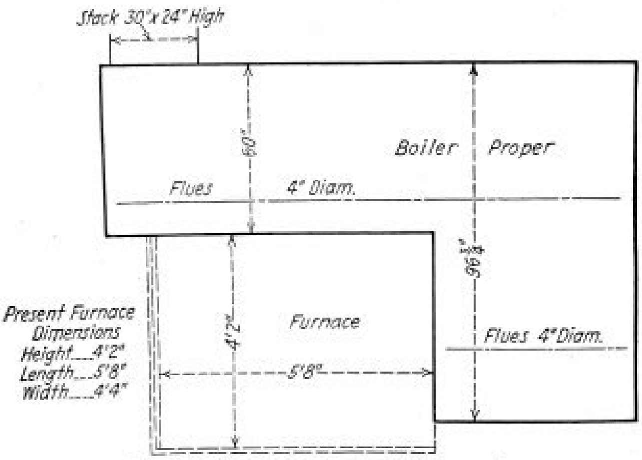
With the length *1-1*, the true length of the diagonal *C* and the arc lengths on the inside and outside edges of the helix, the pattern may be developed as shown in Fig. 4. The true arc lengths on the inside and outside edges must be determined, which may be done by laying off as shown in Fig. 5 a right angled triangle for each edge of the helix, making the bases equal respectively to the circumference of their diameters and the height equal to the pitch of the helix. Divide the hypotenuse into the same number of equal parts as contained in the pitch, Fig. 4.

Since the lengths of respective helices are equal to the hypotenuses of the triangles explained above, the pattern section may be very closely approximated by describing concentric circles with radii that would give a circumference equal to the length of each helix.

Boiler Furnace and Stack Proportions

Q.—It is my desire to obtain your views regarding the proper furnace and dimensions capable of taking care of an economic boiler built by the Erie City Boiler Works with the following dimensions: Working pressure, 125 pounds; heating surface, 1,040 square feet; stack dimensions: diameter 30 inches, length 24 feet; shell, 60 inches diameter. The present furnace whose dimensions I have given does not seem large enough or at least capable of taking care of the present load. There is also a possibility of the stack being too small. They have 3 low pressure gas burners to fire this boiler. If you are able to publish your conclusion in regard to the matter, let me know, if not your personal views given to me by mail will be as good. If you are unable to do this, kindly let me know through what source I can obtain the desired information.—R. L. H.

A.—To give you definite information it is essential to know the quantity of steam required or load the boiler must take care of. The approximate horsepower of this type of



Problem to determine size of stack

boiler figured on a basis of 10 square feet of heating surface equals $1,040 \div 10 = 104$ horsepower. The actual boiler horsepower is the evaporation of 34.5 pounds of water per hour from and at 212 degrees F. and the power of any boiler is calculated by dividing the equivalent evaporation from and at 212 degrees F. by 34.5.

If you will give us the number of horsepower the plant requires, also the number of cubic feet of gas burned per hour and the nature of the gas used, we can assist you.

Various Boiler Questions

Q.—Would you please tell me how you get the area of a segment and brace same? Also how to compute the working pressure of an arch tube?

Is there a hand book giving mensuration of surface and strength of boilers for boiler makers? Is there any standard for patch bolts, rivets or plugs for every day use in the shop? Spacing for same?

Scranton's method for computing the collapsing pressure of a 4-inch seamless tube is $P = 95{,}520 =$ etc. I understand in the examination for government inspector that such values are not allowed. If this is correct, how would they be allowed?

Could you give me an idea of the questions in passing this examination? Especially on air and where I could find answers for same? Is there any course for government inspectors?

I am inclosing another problem also in which the question seems to be incomplete. Any of these questions which you will answer will be greatly appreciated.—C. L. H.

A.—Write to the Department of Commerce for General Rules and Regulations prescribed by the Board of Supervising Inspectors. These rules cover some of the problems you require information upon, and also data that you should thoroughly understand, if you intend to apply for examination as a government inspector in the ocean and coastwise division. If you are interested in locomotive inspection, write to the Interstate Commerce Commission, Division of Locomotive Inspection, Washington, D. C., for Laws and Rules and Instructions for Inspection and Testing of Locomotives, Tenders and Their Appurtenances.

Kent's handbook on Engineering will be of value also; this book you can obtain through the office of The Boiler Maker. Procure also the A. S. M. E. Boiler Code Rules on Locomotives.

The nature of your questions covers such a wide scope, therefore we cannot answer them all in detail.

In August issue, 1922, a complete solution is given on the staying of a segment of a boiler head.

Reinforcing Ring Calculation

Q.—How many rivets ⅞-inch driven diameter for a single reinforcing ring ½-inch thick and 4 inches wide? Tensile strength of ring = 60,000; rivet shearing strength = 38,000; ring to be single riveted. Answer given:

$$N = \frac{4 \times 60.000 \times 1.56}{38 \times (⅞^2) \times 0.7854}$$

Is this example given correctly?—C. L. H.

A.—Please advise under what rules the above example is given. Refer to "Reinforcement Ring Calculations" given in September issue of The Boiler Maker.

BUSINESS NOTES

The C. H. Hollup Corporation, formerly the International Welding Engineering Corporation, Chicago, manufacturer of welding wire and supplies, has purchased 15,000 square foot of land on South Turner avenue and West 48th place, upon which it will construct a factory building.

The Independent Pneumatic Tool Company, manufacturers of Thor pneumatic tools and electric tools, has opened a branch office at Milwaukee, Wis., in charge of G. H. Du Sell, who has represented the company in this territory for a number of years. The new office will be located at 288 East Water street.

Joseph V. Miller, western sales representative of the Prime Manufacturing Company, Milwaukee, Wis., has resigned to go to the Chicago, Milwaukee & St. Paul as assistant general storekeeper. C. Arthur Dunn, eastern sales representative of the Prime Manufacturing Company, with headquarters at Philadelphia, has been promoted to sales manager, railway division, with headquarters at Milwaukee.

TRADE PUBLICATIONS

Regulators.—The Alexander Milburn Company, Baltimore, Md., has issued an eight-page brochure descriptive of its standard regulators for oxygen, acetylene and other gases. The rear opening of the Milburn regulator is only 1⅛ inch diameter, which enables the cap to be unscrewed and the seat and nozzle to be immediately reached without undoing any other part.

Feedwater Heaters.—Instructions for the operation and maintenance of the Elesco locomotive feedwater heater are contained in a 74-page handbook recently issued by the Superheater Company, New York. After a brief description of the principle used in its design, the Elesco heater and its parts are described. The succeeding chapters deal with the operation, maintenance, inspection and test of the equipment, how it is cleaned, heater and pump repairs, and questions and answers regarding operation. Charts show in colors the various passages of live and exhaust steam, hot and cold water through a locomotive equipped with the Elesco heater and the passages of steam and water through various parts of the heater itself.

ASSOCIATIONS

Bureau of Locomotive Inspection of the Interstate Commerce Commission

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

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Vice-Chairman—R. L. Hemingway, San Francisco, Cal.

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

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

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

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

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

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

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

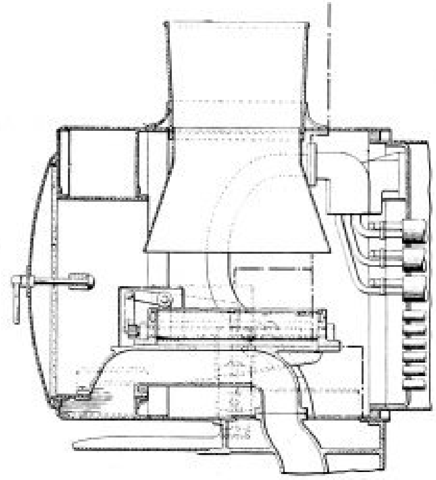
SELECTED BOILER PATENTS

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

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

1,539,125. LOCOMOTIVE DRAFT APPLIANCE. DAVID M. LEWIS, OF CHICAGO, ILLINOIS, ASSIGNOR TO LEWIS DRAFT APPLIANCE COMPANY, A CORPORATION OF ILLINOIS.

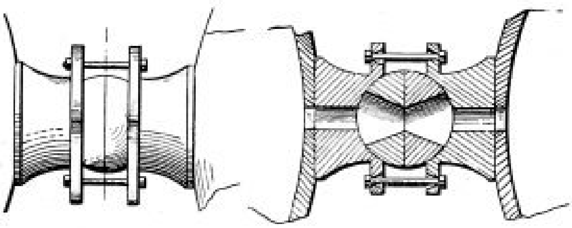
Claim 1.—In a locomotive draft appliance, the combination of an elongated nozzle having its major axis longitudinal of the smoke box, a similarly



shaped and disposed stack, and a volume chamber. In a locomotive draft appliance, the combination of an elongated nozzle having its major axis longitudinal of the smoke box, a similarly shaped and disposed stack, and a volume chamber in series with the nozzle. Eight claims.

1,544,664. BOILER FITTING OR CONNECTION. ALVA ARTHUR LINDLEY, OF SPOKANE, WASHINGTON.

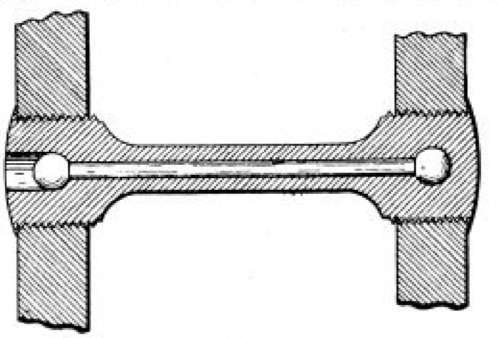
Claim 1. In a device of the character described, a pair of coupling members, having axial openings and seats, a ball consisting of semi-spherical sections having a ground joint between their contacting faces, the sections of



the ball being received on the seats of the coupling members and ground joint being provided between the sections of the ball and the seats of the couplings, the sections of the ball having communicating openings therein, coupling flanges carried by the coupling members and bolts coacting with said coupling members and bolts coacting with said coupling flanges for securing the coupling members and ball in assembly. 3 claims.

1,544,731. METHOD OF MAKING STAY BOLTS. GEORGE H. EMERSON, OF BALTIMORE, MARYLAND.

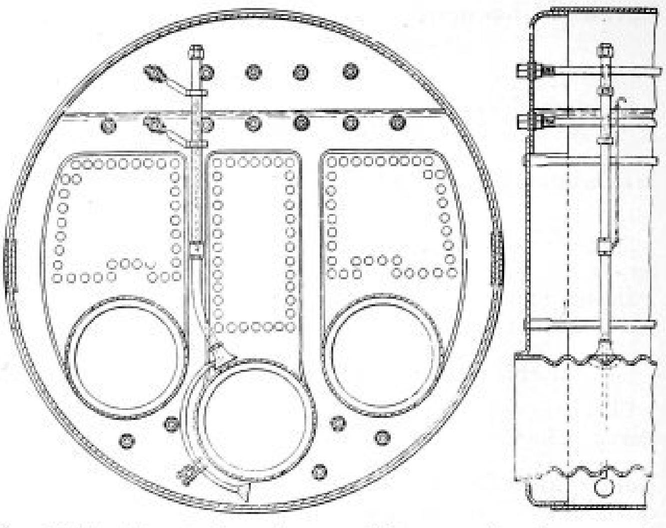
Claim 1. The herein described method of forming bolts having high tensile strength and low transverse stiffness which consists in drilling a



hole partly through a blank of metal, then introducing within said hole a strengthening member comprising a shank and enlargements on the end of said shank larger in cross section than the cross section of said shank, and then swaging said blank between said enlargements until the walls of said hole are compressed against said shank. 3 claims.

1,545,303. APPARATUS FOR PROMOTING THE CIRCULATION OF WATER IN STEAM BOILERS. ROBERT BROWN, OF GLASGOW, SCOTLAND.

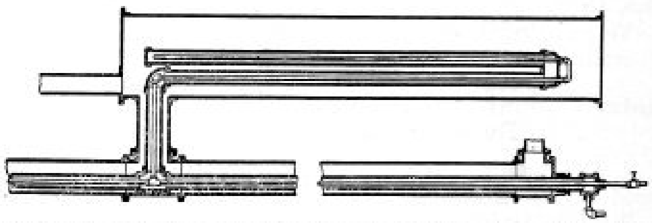
Claim 1. Water circulating apparatus for a steam boiler which is contained wholly within the boiler and is operated without the use of means external thereto, comprising a circulator tube having an open end located



immediately adjacent and opening toward the crown of a furnace at the point of maximum initial heat, the upper end of the circulator tube extending into the steam space of the boiler and being closed, a branch from the circulator tube opening into the steam space, and a dip pipe extending from the dead water space of the boiler into the open end of the circulator tube and being of less diameter than such open end of the tube. 7 claims.

1,545,957. HEATING APPARATUS. LESLIE B. GRAHAM, OF EAST CHICAGO, INDIANA, ASSIGNOR TO NATIONAL BOILER WASHING COMPANY, OF ILLINOIS, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

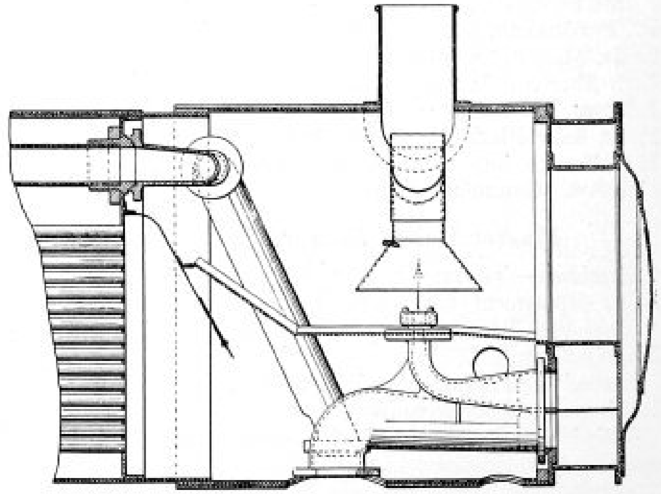
Claim 1. A heater comprising an elongated radiator and a steam pipe extending through said radiator to a remote portion thereof, and there



constructed to discharge steam into the space between the conduit and the wall of the radiator; said radiator having means for withdrawing both vapor and water of condensation from said space. 3 claims.

1,545,434. APPARATUS FOR DRAFTING LOCOMOTIVES. DAVID M. LEWIS, OF TOPEKA, KANSAS, ASSIGNOR, BY DIRECT AND MESNE ASSIGNMENTS, TO LEWIS DRAFT APPLIANCE CO., OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

Claim 1. In a locomotive draft appliance, the combination of an expansion chamber located exteriorly of the front end or smoke box, means for conducting exhaust steam from the cylinders thereto, and means for



conducting the steam therefrom to the stack. In a locomotive draft appliance, the combination of an expansion chamber, located exteriorly of the front end or smoke box, means for conducting exhaust steam from the cylinders thereto, and means for conducting the steam therefrom to the stack, said last means extending into the smoke box and discharging upwardly. 7 claims.

The Boiler Maker

Volume XXIV 25 | November, 1925 | Number 11

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

Edward A. Simmons, *Pres.*
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San Francisco: 74 New Montgomery St.
London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London

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

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

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

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CONTENTS

Cracks in Tube Sheet Flanges

THE methods for repairing cracked knuckles in flue sheet flanges, which were suggested in a report presented at the annual 1925 meeting of the Master Boiler Makers' Association, are published elsewhere in this issue. The manner of making flange repairs under existing operating conditions is of course of prime importance, but the object of the designer and the shop staff should be along the lines of developing a type flue sheet that will avoid this widespread weakness. The discussion following the report touched briefly on the repair of cracks. The constructive side of the problem was also considered from the angle of determining how such cracks might be prevented.

J. A. Doarnberger of the Norfolk and Western Railroad reported a series of tests that were made on this road to determine the exact conditions under which cracks formed at the flanges and offered a solution in the form of reinforcing plates which were intended to act as stiffeners at this point.

The Canadian National Railways has also given the subject considerable attention and the tube sheet design developed to prevent the failure of knuckles was demonstrated by T. W. Lowe. The Boiler Maker is fortunate in being able to publish on Page 320 of this issue, a complete description of this compression resisting, diaphragm flange of the Canadian National Railways. As stated in the article, the flange is still in the experimental stage, but the mechanical officials of the road believe that it will solve the problem of cracked flange knuckles satisfactorily.

This specific case may be considered as an outstanding example of the efforts, not only of the Association as a body, but of individual members, towards the elimination of defects in the locomotives coming under their care. Each year certain phases of boiler work keep recurring at the meetings of the Association and although the effects of the discussion may not be immediately apparent, a steady and sure improvement in all lines can be measured over a period of several years. In this particular instance of cracks in flange knuckles, the 1926 meeting will undoubtedly bring out further developments along the same line and eventually the difficulty will be entirely rectified.

Welding Shop Equipment

IN a recent issue of The Boiler Maker an article was published outlining the principles of procedure control in oxy-acetylene welding as applied to the construction of storage tanks. The elements entering into this new method of solving welding problems are scientifically correct from the standpoint of production and so can be utilized in any welding shop no matter how small or how great the job may be. The article referred to considered the building of storage tanks on a large scale, thus exemplifying procedure control where large numbers of similar units were involved.

Procedure control on a limited scale, and a very practical one, is demonstrated in the article in this issue, "Methods for Making Welding Trucks." Wherever gas cylinders have to be handled, which means in practically every shop, welding trucks are tremendously useful pieces of equipment. With this detailed account of how such trucks can be made in the shop at a low cost there is no reason why a full quota of such trucks should not be made to meet service requirements.

That these trucks should be correct in design, material selected, workmanship and inspection to insure the safe handling of gas cylinders goes without saying. The only way in which security can be realized is in the close observance of a definite set of specifications and method of procedure.

A careful study of the principles involved in making welding trucks will indicate to our readers where similar methods can advantageously be applied in doing many other special jobs of welding.

Boiler and Tank Shops

THE New York metropolitan district, with its tremendous industrial and domestic development, offers a broad market for many of the steel plate products of the boiler shop other than boilers. The list of necessary equipment includes tanks of many types, uptakes, conveyors, chutes, and the like. There are actually comparatively few modern shops in the vicinity of New York arranged to handle work of this nature and so a great deal of the equipment has to be brought from distant points.

A few concerns, such as the Cole-Duncan Boiler Works, described in this number, early recognized the possibility of developing a lucrative business in this direction in New York and have built up a stable and efficient production of steel plate work. It is rather remarkable that a shop of the size and with the machine installation of the Cole-Duncan Works has been able to handle the volume and variety of products that goes through the shop. This has only been possible through the organizing ability of the management and the cooperation of the shop staff as well as the good-will that has grown up among users of the equipment made here. General excellence in its products and service have been the basis of this good-will since the foundation of the company in 1906.

Readers have expressed their interest in descriptive articles on boiler and plate shops and their work and the editors of THE BOILER MAKER will be pleased to consider for publication similar articles describing other shops. In fact, this may be considered a specific request for material of this nature from any of our readers who feel that their shop offers any special features for comment either in the management, arrangement or method of handling work.

Machine Tool Equipment

THE mechanical department of an eastern railroad has just completed the installation of new machine tools and equipment in nine of its shops. The past record of this road bears out the statement of the department head that "the procurement of this new equipment is in line with the well established practice of this road to retire equipment as it becomes inefficient and obsolete, and to replace it with modern, up-to-date equipment."

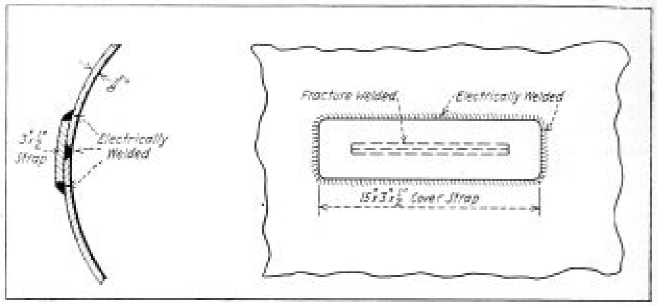
Proper and adequate records of the production of all machine tools will show when a tool is failing to meet requirements. To keep a machine tool in service that retards shop production or with which it is impossible to do the right kind of work is an expensive investment for any road. It pays to know what your machine tools are doing.

LETTERS TO THE EDITOR

Design for a Locomotive Boiler Patch

TO THE EDITOR:

The design for a locomotive boiler barrel patch, given by Mr. Wilson in the September issue of THE BOILER MAKER is constructionally correct. I think, however, that the dimension of the inside strap, which is given as 1½ inches, is an error as this was intended by Mr. Wilson as ½ inch. Aside from this, however, the method of repairing is lengthy and laborious and belongs to the "Stone Age." Survey it a moment and you will discover that the manhole or dome



Repairing boiler barrel fracture by electric welding

cover would have to be removed, also a certain number of tubes to give access to the holder up and the inside cover strap, the marking, studding, drilling, bending, assembling, riveting and calking, besides refixing the tubes and manhole cover, would be a job for a squad of boiler makers for 3 days, including a steam test.

ELECTRIC WELDING THE FRACTURE

For comparison, we will take an alternative design or method of repairing the same fracture by electric welding. The sketch submitted will give the reader a general idea of the method, and the time and process are given step by step as follows:

Cutting a vee in the barrel by pneumatic tool, 1 man 1 hour. Welding 12 inches of ⅝-inch plate butt weld, 1 man 1 hour. Making a 15-inch by 3-inch by ½-inch cover strap, 2 men 1 hour. Welding cover over butt weld (see sketch); 36 inches of fillet weld, 1 man 2 hours. Chipping and fullering with rough tool, 1 man 2 hours. Steam test, 2 men 3 hours. We now have a total of 14 one-man hours as compared with 72 one-man hours on the riveted patch.

Furthermore, by the welding process we have not risked damaging the tubes by removing them; for it is often found that tubes are weak behind the tube plate and buckle up while being driven out. Also we have 100 percent solid plate by sealing the fracture as compared with 84 percent solid plate and the fracture still open. In addition, we have 9 cubic inches of electric welding, sealing the cover or compensating plate to the barrel and the job has been done at one-fifth the wage cost of riveting.

Electric welding for reclaiming boiler pitting and grooving and repairing fractures is recognized by insurance companies in Britain and this is certainly an example where the process can be rapidly, effectively and economically applied. With the advance of welding in the boiler making world, riveting retreats in disgrace; for it must be borne in mind that a riveted vessel is like a postage stamp, i.e., weakest at the perforations.

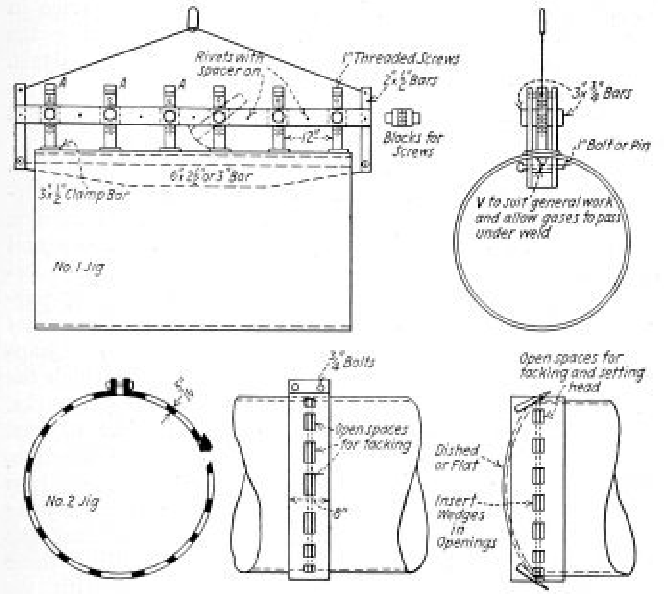
Leeds, England. JOHN GORDON KIRKLAND.

Welding Storage Tanks

To the Editor:

In reading your article in the September issue, *re* welding storage tanks, it struck me that some of our friends might be interested in a few jigs that I used while welding a batch of gasoline storage tanks in our small shop in Montreal, Canada. These jigs were very successful and economical as regards price and labor while erecting and welding.

After the plates were prepared for welding and rolled to shape, they were put into position for welding on No. 1 jig,



Jigs to aid in welding tanks

or longitudinal joint welder, with a *friction* release, to handle the contraction and also keep the portion already welded hot so that the weld was hot from start to finish of the operation, eliminating as much stress as possible on the weld. As you will see from the construction of the jig, shown herewith, it was hung in a handy position on a chain block with enough strain on the chain block to take the weight from the course to be welded and raised or lowered to suit, so as to hold the course round. The clamps marked *A* were in turned blocks so as to be freely moved away from the seam when required by the welder, who also adjusted them to obtain the required amount of friction to allow the seam to come together as required, or to hold apart, by tightening on the screw to increase the friction. After passing one of the clamps, it was allowed to drop back in position and slightly tightened to hold the work on the jig. The V in the block carries the heat backward over the portion already welded, and is made large enough to give ample clearance, for the class of work engaged upon, and to clear the weld.

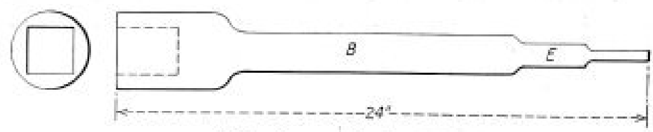
The jig No. 2 was made in three or four sizes, also to suit the diameter of the different tanks and was used to tack the circumferential seams and heads in position, at the same time lining up the tank. It was about 8 inches wide so that it had a good bearing on both courses. As for tacking, we used the usual procedure of tacking on the quarters first, then on the eighths, etc. On the application of a head, the ones we were using being flat disks, slightly dished convex—the No. 2 jig was used again with a few wedges inserted into the tack spaces to bring the plates into position for welding. These heads were sheared just large enough, say 1/16 to ⅛ inch larger than the inside diameter of the tank, so as not to enter. A few liners for the head to rest upon in the jig were used to line up the work. The buckles or flanges for pipe connections were put on in the usual manner, except in light tanks, where the buckles would be brought to a red heat and held in position by a helper until tacked, this being done on account of the difference in thickness of the buckle and the plate requiring different amounts of heat to bring them to the welding point.

Olean, N. Y. Alex M. McKay.

Removing Flexible Staybolt Caps

To the Editor:

In the February issue of The Boiler Maker T. P. Tulin, in discussing the various aspects of the removal of caps from the flush or flat type of flexible staybolts gave us a description of a socket wrench used in conjunction with a small air hammer. The accompanying sketch shows a wrench made to his description, with the exception of a slight change in the shank. As shown in the sketch, the section of shank marked *B* is 1¼ inches square and a closed square wrench is used. When necessary to change the position of the wrench,



A handy staybolt tool

slide the wrench back to the section marked *E,* which is turned down to 1 inch diameter. The remainder of the shank is made to fit the air hammer.

This tool gives good results. Where the caps are very obstinate and it is found necessary to use the acetylene torch, they are sometimes cooled off with a stream of water. This method, in my estimation, is open to objection so far as its effects on the metal and threads are concerned. Better results are obtained by heating and allowing the caps to cool slowly.

Lorain, Ohio. Joseph Smith.

The Safe Slope of Crown Sheets

To the Editor:

Much has been said and written concerning the safe slope of crown sheets and as I see it, very little if any benefit derived from any of the various reasons given for the existing slope. The main contention seems to be that if the rear portion of a firebox is not lower than the forward end, it would become uncovered when passing over grades and making stops.

I am curious to know what would happen, or rather, what the results would be, if the present height of the rear end of the crown sheet were maintained and the forward end lowered, so as to eliminate forward crown and back flue sheet defects. Lowering the forward end of the crown sheet would add more water where the heat is the most intense, which in turn should cause an equal expansion and contraction throughout sheets. Of course, it would mean the elimination of the top row of flues and the lowering of the flue sheet, with a decrease in heating surface. Yet, I recall instances years ago before the advent of the autogenous weld, where it was necessary to remove the top row of flues and to blank the holes with sunflowers in order to apply a patch to a defective sheet and the engine did not fail for steam. If the removal of flues as mentioned, should affect steaming, syphons could be applied to replace the heating surface removed.

Something should be done to eliminate the forward crown and back flue sheet defects, which have been a menace to boilers for years. Quoting Elbert Hubbard, "where there is an existing error, there is a corrective measure if properly applied."

Hagerstown, Md. M. B. ERICKSON.

Explosion of a Small Boiler Causes Much Damage

SMALL gas-heated boilers or tanks are commonly used in barber shops for supplying hot water. There is nothing particularly impressive about their appearance, and few persons would be likely to consider them capable of causing any great amount of trouble. Nevertheless, one of these small boilers exploded recently, and damage seemingly out of all proportion to the size of the boiler resulted. Fortunately, the shop was closed at the time of the explosion and no one was injured. The proprietor, apparently, had failed to shut off the gas under the boiler, when leaving the shop, and steam was consequently generated by the continued application of heat. As the tank was not designed to withstand any considerable pressure, nor provided with appropriate safety devices, it burst.

The tank was 20 inches high, 12½ inches in diameter, and set vertically. The longitudinal joint was single riveted, and the upper head was single riveted to the shell. We cannot say, positively, how the lower head was secured, because it was torn entirely free from the shell, and had not been found at the time of the investigation. The shell plate was approximately ⅛ of an inch in thickness, and the upper head was 3/16 of an inch thick. The inlet and outlet pipes were tapped into the upper head.

The barber shop is about 30 feet long and 12 feet wide. The tank and heater were set just above the floor level at about the middle of the length of the shop and close to one of the side walls. The walls are composed of 2-inch by 6-inch studs, with ½-inch sheathing on both sides.

When the tank exploded, an opening about 10 feet square was torn in the wall back of the tank, and a similar opening was made in the wall on the opposite side of the room. The boiler passed through a metal ceiling and the flooring directly overhead, through a room above the barber shop, and through another ceiling and flooring. In the room above the tank were two heavy chairs. One of them was thrown to the ceiling and demolished. The plate glass in the barber shop was broken, and considerable other damage was done in two adjoining stores. Glass and various objects were also blown through the windows of an automobile parked in front of the shop; and windows in the buildings on the opposite side of the street were broken by flying material. The total damage was estimated at from $3,000 to $4,000.

This explosion again emphasizes the importance of providing safety devices even on small hot water tanks. Every tank of this kind should have a relief valve of suitable size, which should be kept in good working order. It would also be advisable to install an automatic device to turn off the gas when the water reaches the desired temperature. This would almost entirely eliminate the possibility of leaving the gas burning until pressure had been generated.

Another important lesson taught by this explosion is that even the smallest of pressure vessels is capable of producing serious damage, and should be operated with care. In this connection it is well to keep in mind a saying that has come down through the ages, "Behold, how great a matter of a little fire kindleth"! With slight modification this may be aptly applied to the case under discussion.—*The Travelers Standard.*

BOOK REVIEWS

TESTS FOR RAILWAY MATERIAL AND EQUIPMENT. *By Henry Knauer, 257 pages, illustrated, 4¾ in. by 7½ in. Published by the Simmons-Boardman Publishing Co., 30 Church Street, New York.*

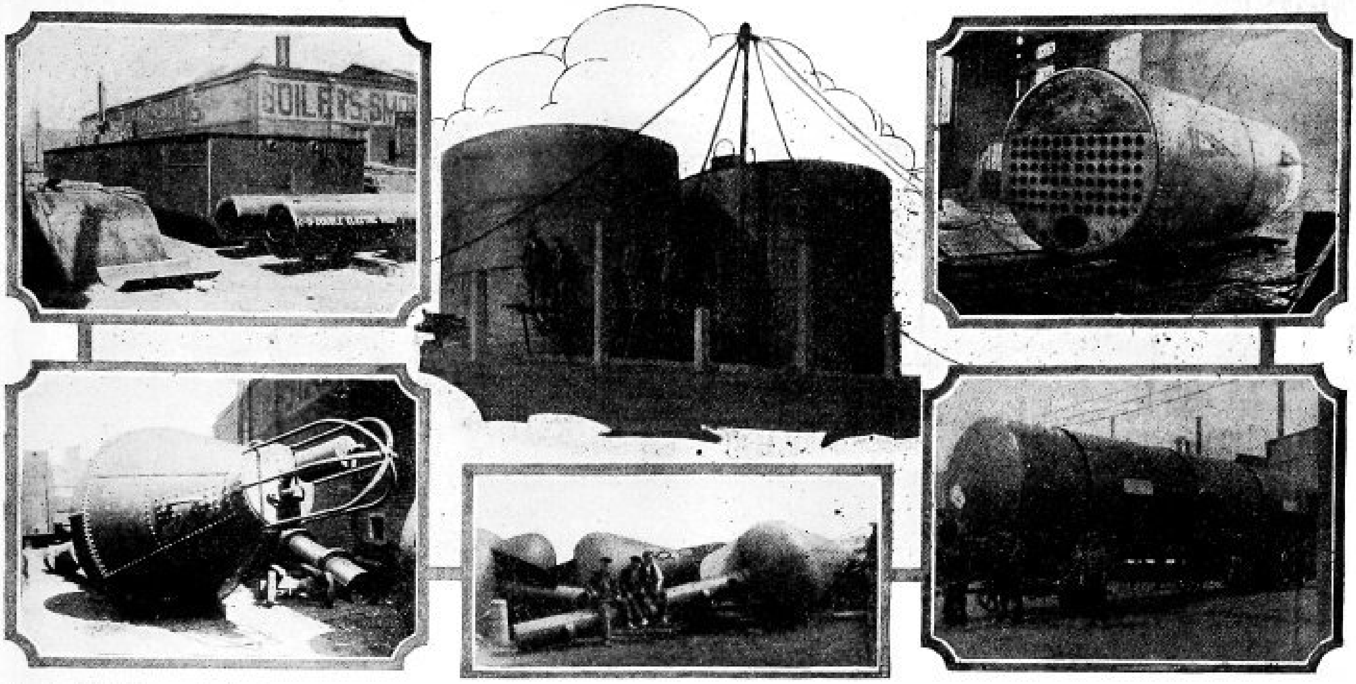
The material contained in this volume is elementary in its scope and is intended for those taking up testing work in the laboratory and for those in the shops aspiring to engage in inspection of railway materials in the field. The tests are explained in such a clear, concise manner that a novice in this work should experience no trouble in grasping the fundamentals necessary for a successful laboratory analysis. The phraseology is such that all calculations and arithmetical substitutions are readily comprehended without recourse to chemistry or higher mathematics.

The first two chapters are devoted to the explanation of the nature of a test and with the methods and importance of recording the results of the findings. The next two chapters go into a detailed explanation of water and the treatment of the various mineral and organic compounds which may be found in it to cause trouble, particularly in a locomotive boiler. For a necessarily brief treatment, this particular subject is well handled. Chapter X contains a list of nine mechanical materials which the author quickly passed over with a few elementary remarks. Chapter XIV contains four pages on the subject of cast iron. Considerably more space could have been devoted to this important subject. The chapters on wrought iron and steel products are well done and the chapters dealing with tension, hardness, fuel heat value tests and flue gas analysis are well worth reading for those handling these tests in the laboratory. The chapters dealing with the quality of steam and steam boiler tests and the methods of determining indicated and brake horsepower contain elementary information for novices interested in these tests. The last four chapters touch briefly on the subjects of the calculation of the test results of a steam engine, power reverse gear, locomotive road tests and tonnage rating tests.

The author omitted from his book any information pertaining to the testing of tender and car wheels, locomotive wheel centers and tires, glass, copper bearing steel, sheet metal, creosote for wood preserving, lumber and the testing of electric light bulbs and wire. These are essential railway materials and to make the book comprehensive should have received the same consideration as those actually covered.

PRINCIPLES OF LOCOMOTIVE OPERATION, *by Arthur Julius Wood, professor of mechanical engineering, the Pennsylvania State College. 315 pages, illustrated, 6 inches by 9¼ inches. Bound in cloth. Published by the McGraw-Hill Book Co., Inc., New York.*

The first edition of this book, which was published under the title of the "Principles of Locomotive Operation and Train Control," has been used quite extensively as a text book in technical schools and as a reference book by many railway mechanical department officers. This, the second edition, is a worthy successor of its predecessor for the author has included in its revision the most recent developments, both theoretical and practical, in the design and construction of the steam locomotive. Prof. Wood has shown the locomotive as a power plant in which the maximum possible amount of energy in the fuel should be available at the drawbar. The application of the laws of mechanics and thermodynamics are brought out by a number of practical examples which point the way to a solution of the more involved problems in proportioning and design.



Group of Cole-Duncan products

Facilities of the Cole-Duncan Boiler Works

Long Island City plant turns out nearly four thousand tons of miscellaneous boiler and plate work annually

By C. B. Lindstrom*

THE Cole-Duncan Boiler Works, Inc., was organized in 1906 for the handling of general boiler, tank, stack, breeching, repair and construction work. At this time no attempt was made to accomplish things on a large scale but the company established a reputation which called for expansion. In 1916 the concern was incorporated under the laws of the State of New York. Mr. Cole, one of the founders of the organization, now deceased, was an efficient and practical boiler maker who established a wide acquaintance of high standing in the building trades of New York city and the surrounding territory. In later years the business expanded into a greater field due to the efforts of A. M. Duncan, president. At the present time an average of 60 to 75 men is maintained in the shop staff, 5 are engaged in clerical and office work and 10 to 12 men are kept busy on erection in the field.

Plant and Equipment

The Works are situated at 379 to 381 Borden avenue, Long Island City, New York, covering an area of 175 feet by 195 feet deep. The shop is a modern building of steel construction 40 feet wide and 195 feet long. The railroad siding and store yard, the plate and structural steel mill are located at the rear of the plant; the floor layout of the plant and storage yard, shown herewith, gives a good idea of the arrangement of machinery, handling facilities and the like.

To facilitate the handling of material in the plate storage yard, a 2-ton boom crane is fixed to the end-column of the building. This crane has a wide range, swinging in an arc of 270 degrees. A 2-ton jib crane is also attached to this column. This crane is used to pick up plate and other material for placement on the laying out table. The shop is equipped with 6 overhead traveling cranes that handle the shifting of material and finished work without delays. The outside yard is used for fabricating some of the larger work and for this purpose the yard is served by an 8-ton boom, stiff-legged derrick and six 2-ton jib cranes each 25 feet long. The use of the derrick in combination with the jibs furnishes a ready means for fitting up and loading work.

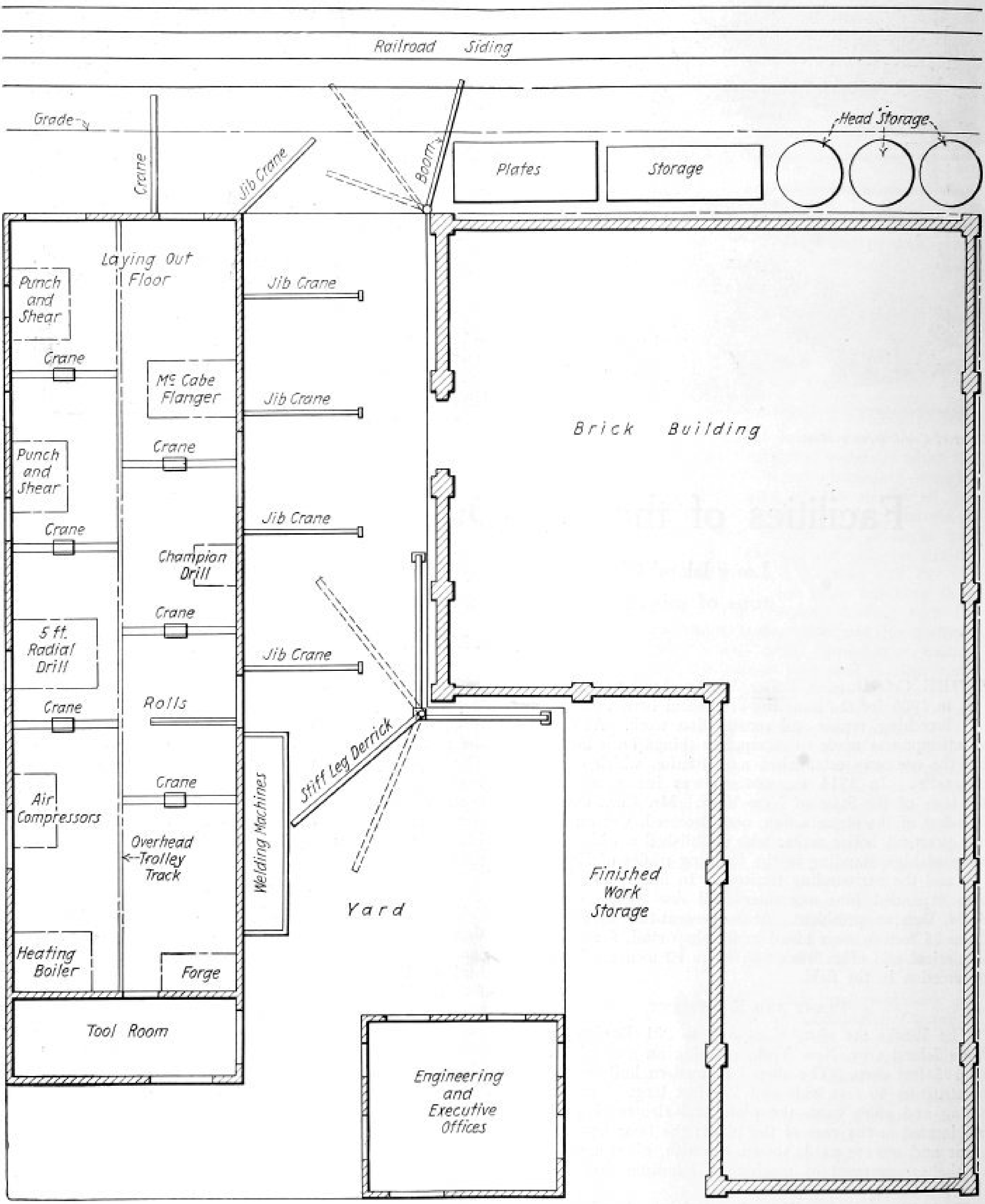
Shop Machines

The shop is equipped with one Hilles & Jones combination punch and shears having a 36-inch throat; one Cleveland punch and shears with a 36-inch gap; one 10-foot horizontal plate bending roll; one McCabe flange; one 5-foot American radial drill of the full universal type; one Champion drill; one open-end power punch; three American air compressors; four 200-ampere direct current Lincoln electric welders; one 300-ampere direct current U.S.L. electric welder; one 200-ampere U. S. L. portable gasoline-driven electric welder; Purox, K. and G., Oxweld and Milburn burning and welding outfits; as well as a miscellaneous equipment of air motors, hammers, grinding machines, etc.

Cole-Duncan specializes in both riveted and welded construction for building both high and low pressure boilers. The low pressure heating boilers are of welded construction throughout. Both welding and riveting are also used in the construction of stacks, breeching, chutes, tanks and miscellaneous plate work from 1/8 inch to 1 inch in thickness.

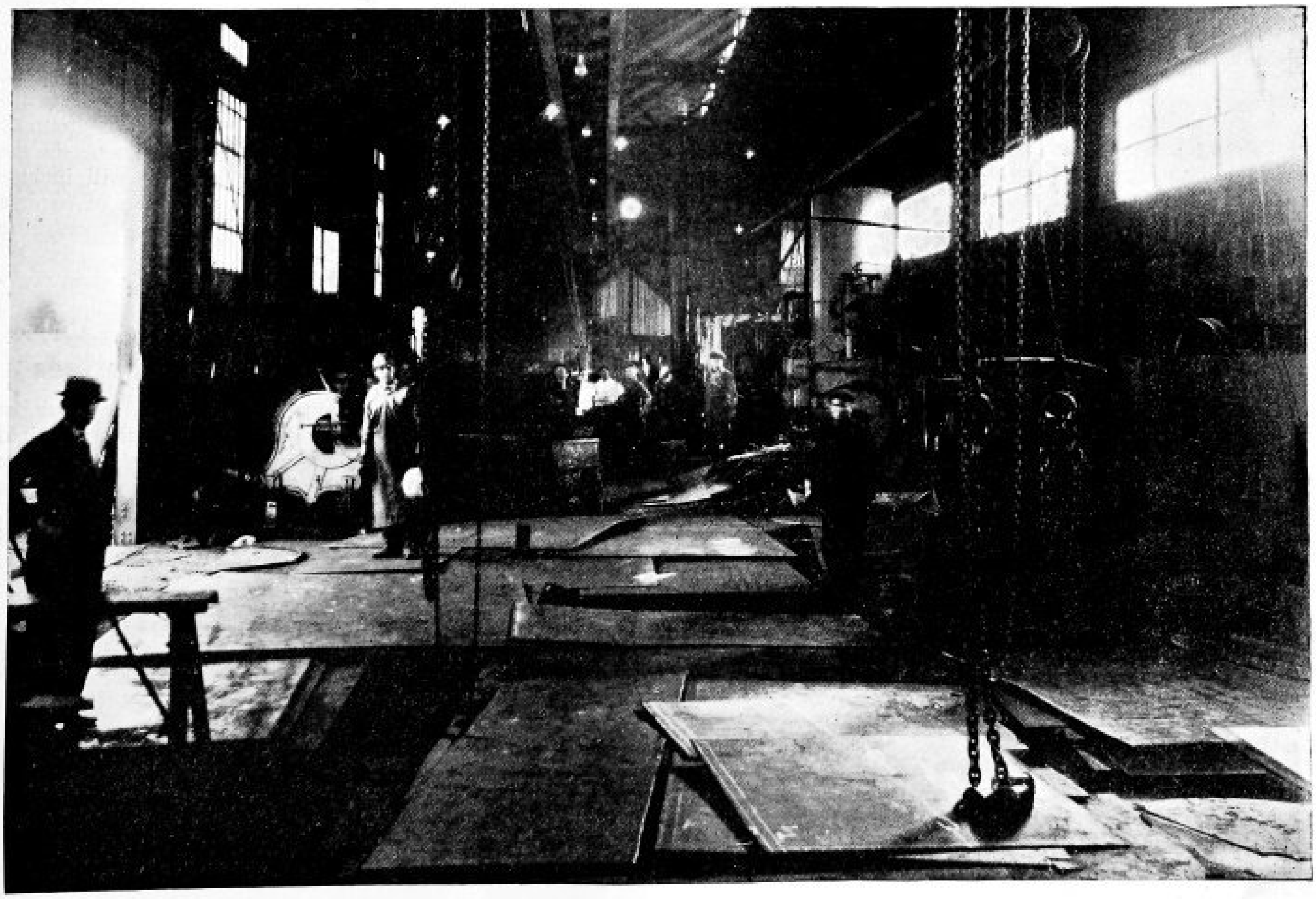
While most of the work is for domestic use in the United States, this company also exports its products to Canada,

*Vice-president of the Cole-Duncan Boiler Works, Inc., Long Island City, New York.



Shop layout and storage yard facilities of Cole-Duncan Boiler Works

Fabrication of large work is carried on outside the plant



View on the production floor of the Cole-Duncan works

Elbow, chute and tank erected in field

Cuba and South America. The annual production at present is from 3,000 to 4,000 tons. At the present time the shop has work on hand sufficient to keep the plant running to capacity for four months.

Management

A. M. Duncan supervises the general office, estimating and contract departments while the plant and its operation are under the supervision of the writer. The shop foreman handles the fabrication, plant employees and maintenance of equipment. He is assisted by a master mechanic.

The shop has a safety organization for the purpose of eliminating injuries to employees. The Safety Committee consists of the foreman, the master mechanic and the vice president. This committee works very closely with the state inspector and liability insurance company. The general condition of the shop, machinery, tools and the like are kept under careful observation and recommendations made for the care and safeguarding of the employees against accidents.

Exposition of Power and Mechanical Engineering

THE Fourth National Exposition of Power and Mechanical Engineering will open at 2 p.m. on Monday, November 30, 1925, at the Grand Central Palace, New York City. It will extend through the week, ending December 5, opening each day at noon.

The basic purpose of the Exposition is to bring together showings of manufacturers of power and mechanical equipment so that engineers and industrial executives may have an opportunity for comparative study of the outstanding developments in the field. The manner in which the Power Exposition has developed during the past three years is convincing proof that it is filling a useful place in the tremendous development in power generating and power using devices.

Devices to increase the effectiveness and economy of combustion will be presented at the Show in distinguished array. Air preheaters, pulverized fuel equipment of all types, stokers, water-cooled boiler furnace walls, soot blowers and draft apparatus will be shown. One of the features of this group of exhibits will be the showings of recent developments in the more economical use of pulverized fuel. This will include new designs of boiler furnaces, several new types of burners for pulverizing fuel and the latest achievements in crushing and drying coal.

Machine tools and equipment used in machine shop practice will form a large and important group of exhibits.

October Shipments of Locomotives

THE Department of Commerce announces that October shipments of railroad locomotives, from the principal manufacturing plants, based on reports received from the individual establishments, totaled 79 locomotives, as compared with 94 in September and 96 in October, 1924.

The following table gives the shipments and unfilled orders of locomotives for the first ten months of the past year:

RAILROAD LOCOMOTIVES

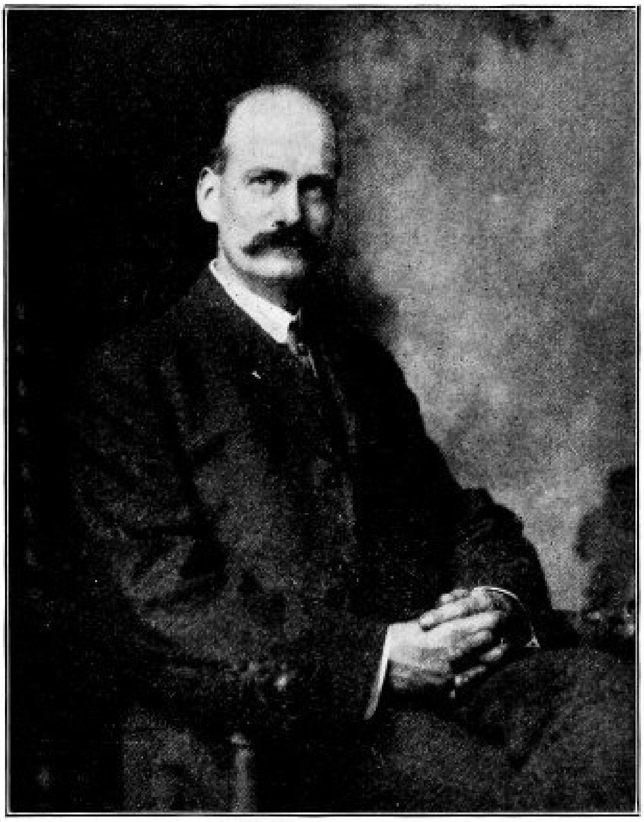
	Shipments			Unfilled orders end of month		
	Total	Domestic	Foreign	Total	Domestic	Foreign
January	90	45	45	407	351	56
February	85	73	12	397	343	54
March	109	93	16	447	351	96
April	92	82	10	477	362	115
May	96	68	28	467	353	114
June	110	61	49	397	300	97
July	66	58	8	378	283	95
August	104	91	13	309	225	84
September	94	50	44	363	296	67
October	79	54	25	497	397	100
Total (10 mos.)	925	675	250	...	...	...

George M. Basford Dies Suddenly

Enthusiastic advocate of better signaling, improved locomotive design and utilization, and more effective training of workers

GEORGE M. BASFORD, head of the G. M. Basford Company, New York, dropped dead in the Jerome avenue subway station in New York, on Monday evening, October 26.

Mr. Basford exerted a constructive leadership in several important phases of railway activity. That he was able to accomplish so much was due to his tireless energy and the rare faculty of discarding unessential details and going to the very heart of a problem. Early in his railway career—and he has always been identified with the railway industry—he became interested in the development of signaling. He soon realized the possibilities of closer contacts between the men engaged in this work on the different railroads and was largely instrumental in starting the Railway Signal Association; indeed, he was familiarly known as the "father" of that organization. While he realized the great possibilities of safety in improved signaling, he had a keen appreciation also of its effect in increasing the capacity of a railroad, thus making possible more efficient and economical operation and he became a most forceful advocate in promoting an interest in the study of the economics of signaling.



George M. Basford

Mr. Basford, from his boyhood, was especially interested in locomotive design and operation. His editorial work made it possible for him to broaden his studies in that direction and as far back as a quarter of a century ago he was recognized for his far-reaching vision concerning the possibilities of improvement in the steam locomotive, as well as a greater utilization of the locomotive. He was one of the first to recognize many of what are now considered to be the most important improvements in locomotive design, and their adoption was greatly hastened in many cases by the enthusiastic and tireless way in which he promoted them. The railroads are in a large degree indebted to him for the steam locomotive as we have it today.

While Mr. Basford will always be recognized as an outstanding engineer, he was at the same time intensely human. Not many years ago mechanical engineers, or engineers of any sort, rather assumed that matters relating to management and men and the human element were more or less outside their profession and placed an undue stress on materials and methods. George Basford was always impatient over such a narrow interpretation of engineering. While he recognized the technical side of the engineering profession, he was equally insistent that proper attention must be given to the human element. He was deeply concerned about the providing of leaders to meet the larger problems of the future and to this end insisted that greater care be taken in selecting the men entering the railway field, and in seeing that they were properly placed and were given adequate training.

His paper before the 1905 convention of the American Railway Master Mechanics' Association, entitled, "The Technical Education of Railway Employees — The Men of the Future," was regarded by many as a masterpiece. It was not only directly responsible for the introduction of modern apprenticeship methods in the mechanical department on American railroads, but it had a distinct influence in getting many railroad officers to think through this question in relation to their own departments. More than this, however, Mr. Basford was constantly on the look-out throughout his life for promising young men, who by words of encouragement and otherwise, could be made to recognize the possibilities in the railway field and to fit themselves for real places of leadership. It is fitting that his last address, made only ten days before his death, was in connection with the "Younger Men's Night" of the New York Railroad Club. Because of his intense interest in the welfare of the young men and the fact that no sacrifice was too great for him to make if he could help them, he was requested by the Subjects Committee of the club to express appreciation at the close of the program to the seven young men who took part in it. This he did in his characteristic way; it was, indeed, a rare benediction, greatly appreciated especially by the young men. Mr. Basford was loved for his willingness and ability to help others. Many men occupying high positions—secured, often, with his help—in times of stress have turned to him for guidance.

After leaving editorial work his experience for several years was more along the lines of publicity and salesmanship, so that when he finally entered the field of technical advertising, he was rich in experiences which enabled him to make constructive and unique contributions to that field, which helped to place it upon its present high standard.

Mr. Basford was born in Boston in 1865, where he attended the public schools. He was graduated from the Massachusetts Institute of Technology in 1889, after which he entered the Charlestown shops of the Boston & Maine, later going to the Chicago, Burlington & Quincy as a draftsman at Aurora, Ill. He left the Burlington to take a position in the motive power department of the Union Pacific, and was connected with the test department of that road for some time, after which he entered the service of the Chicago, Milwaukee & St. Paul as signal engineer. Later he was superintendent of construction of the Johnson Railway Signal Company, was with the Union Switch & Signal Company for a short time, and then became signal engineer of the Hall Signal Company. In 1895 he became mechanical department editor of the Railway and Engineering Review, and in 1897 was made editor of the American Engineer and Railroad Journal, now the Railway Mechanical Engineer. In September, 1905, he was made assistant to the president of the American Locomotive Company. It was during this period that for a number of months he was called upon to give part of his time in helping to start the Railway Business Association, rendering exceedingly effectual and much appreciated service. In March, 1913, he became chief engineer of the railroad department of Joseph T. Ryerson & Son. Mr. Basford organized the G. M. Basford Company to handle technical advertising in March, 1916. At about this time he was also made president of the newly organized Locomotive Feedwater Heater Company and headed it for several years until it was taken over by the Superheater Company. He was also consulting engineer of the Lima Locomotive Works, Inc.

Mr. Basford always took a keen interest in railroad associations and clubs. He has given much time in assisting the officers and subjects committees of many of these organizations and has presented numerous papers before them, every one of which was prepared with the utmost care and thought, each word being properly measured and evaluated.

Are Welded Pressure Tanks Safe?

By John S. Spicer*

FOR some time the Department of Labor and Industry of Pennsylvania has felt the necessity of formulating regulations regarding the manufacture and use of unfired pressure vessels. The Pennsylvania Boiler Code covers the construction of fired pressure vessels; and it has been generally accepted throughout the country by both manufacturers and dealers.

Many failures of air receivers during the last few years, and particularly during the past few months, have convinced the officials of the Department of Labor and Industry that some regulations are necessary for the construction of other types of containers which are subjected to pressure. In many cases the pressures are equal to those found in boiler installations, but the construction of these vessels has never been given the attention that their use requires.

A few months ago an accident occurred which was caused by the rupture of an air receiver which was being used at the rear of the Capitol in Harrisburg. The contractor was doing some construction work. The end of the welded tank or air receiver was blown several hundred feet and through one of the windows of the Capitol, causing considerable damage to the interior of the room. Fortunately, the persons in the room were not injured and the employee who was in charge of the compressor was only slightly injured.

An examination of the ruptured tank showed that the end which had been welded to the body of the tank was held in some places by only a scant eighth of an inch or less of metal. The cause of the explosion that ruptured this tank was not definitely determined, but it was evident that in some way an excessive pressure had developed in the tank and the tank ruptured at the weak joint.

Less than three months later in another part of the state, a similarly constructed tank exploded because of excessive pressure, and an examination of the head and the body of the tank, where the head had been welded to the tank, showed places where the weld was not more than one-eighth of an inch in thickness.

One month later, a larger tank than either of the two previously mentioned, but which was used as an air receiver for an air compressor, exploded and an examination of this tank showed conditions similar to the other two. Both of these latter accidents caused the death of an employee.

In the time intervening between the occurrences of these three accidents, two other tanks which were used for compressed air exploded and in each case an employee was killed. These tanks were used in connection with kerosene torches and were of welded construction. Kerosene was poured into the tank. A hand pump was then used and 15 to 25 pounds of air pressure was applied. In the one case, however, this air was obtained from an air line and not by means of a hand pump. Both of these tanks had welded bottoms. The welding gave way and the resultant explosion and scattering of flaming kerosene was responsible for the death of two employees.

The rupturing of welded tanks while under pressure has conclusively demonstrated that unfired pressure vessels require regulations such as are required for fired pressure vessels in accordance with the rulings as outlined in the Safety Standards of the Department of Labor and Industry.

Difficulty of Inspection

There is no doubt that a welded tank, if properly constructed, will stand up under pressure. The great difficulty is, however, that it is impossible to determine by inspection that the workmanship of the weld has been properly performed, and that an abundance of metal to make the weld has been used. Unless a hydrostatic test, made in excess of the working pressure which is to be used on the particular tank, has been made, it is not safe to use a welded tank under pressure.

Within recent years the Department of Labor and Industry has not heard of the failure of a riveted tank when used for similar purposes under similar conditions.

The question, therefore, uppermost in the minds of the officials of the Department of Labor and Industry at the present time is whether a welded tank is suitable where pressure is applied to it. If so, what regulations should cover its construction and use.

Any constructive criticism upon this matter will be welcome, and any interested persons are invited to send such criticisms to Richard H. Lansburgh, Secretary of Labor and Industry, Harrisburg, Pennsylvania. In this way the Department will have the full benefit of the experience and information of all persons concerned; and the regulations which are now being considered will be based upon authoritative information of both manufacturer and user.

*Chief of the accident investigation section, Bureau of Inspection, Pennsylvania Department of Labor and Industry.

The Premier Staybolt Company, Pittsburgh, Pa., has appointed the American Railway Appliances Company, Borden building, New York, as its eastern representative, effective at once. The eastern territory includes all railroads tributary to New York.

Practical Methods for Making Welding Trucks*

Several alternative designs and a procedure control for welding a handy piece of equipment for the boiler shop

FOR best results procedure control is as necessary in the small welding jobs as in large engineering projects. Good workmanship, correct design, and adequate inspection will result in economy and satisfaction when making a small piece of plant equipment (such as described in the following pages) just the same as when carrying out work of greater proportions.

The truth is often forgotten. Many small matters are given hasty consideration, or none at all—merely left to the ingenuity of the workman. If the workman is a careful and competent journeyman, he will supply the necessary thought and consideration and an acceptable device will probably be produced. But in the large majority of cases, a makeshift affair, an eyesore, expensive of labor, wasteful of material and doubtful in strength will be the final result.

As an illustration of *method* in the construction of plant equipment, the procedure control for a welding truck is submitted. A cursory examination indicates that the same

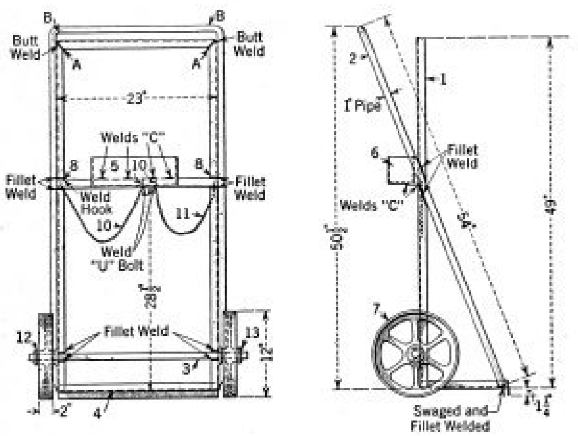
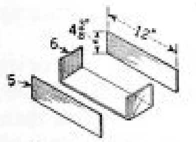


Fig. 1.—Layout for small-wheel truck for 2 cylinders



DETAIL OF TOOL BOX

method outlined herein is equally applicable to the manufacture, either singly or in quantity, of such things as shelving, racks, tote boxes, "boats," guards—the list might be extended indefinitely. The *method* is merely this: provide a skilled workman with adequate instructions, a well thought out plan, and sufficient good material and equipment for the job, and a moderate amount of supervision will then insure the result which will pass inspection and serve its intended purpose excellently. The *method* is derived from the same principle underlying the art of production engineering.

To develop this idea in a tangible way, some specific piece of equipment must evidently be selected for description. The two-wheel truck for a complete welding or cutting unit has therefore been chosen. Many of these are in use. When a job has to be done which cannot be taken to the central welding shop, it is usually an emergency one. Valuable time has too often been lost in making three trips from the welding shop to the job while carting the individual cylinders and apparatus. With a two-wheel truck, the apparatus may be quickly and easily moved to the desired point in one operation. Several designs are submitted with the idea of covering in a general way the variance in construction due to the difference in the conditions of its use. It is not the intention to imply that such a truck can always be built at a lower price than it can be bought from an equipment house, but as noted above, it is described as an illustration of the best way to construct special plant equipment of metal.

Check of the Welders

Welders who have had experience in steel welding, and preferably on steel pipe, may be used for this application.

Design and Selection of Material

1. *General.*—The design of a two-wheel truck for the transportation of a complete welding or cutting unit is determined by the conditions of its use. Therefore several designs have been submitted.

Fig. 1 illustrates a truck which is in very common usage. The cost of fabrication is very low, due to the small wheels

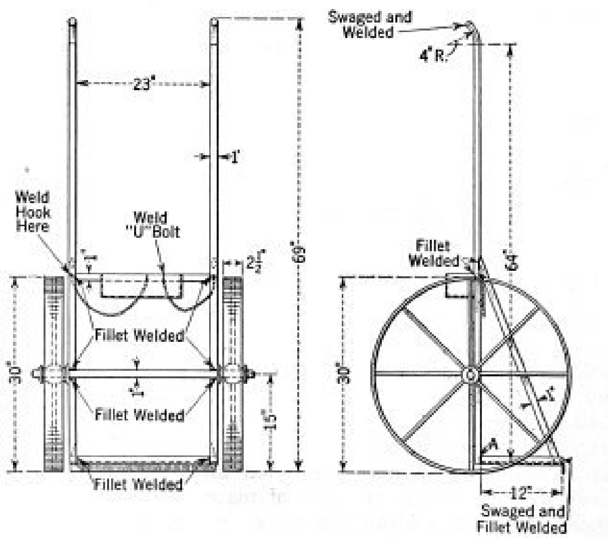


Fig. 2.—Large-wheel truck for 2 cylinders—better for rough ground

used, and it is particularly adaptable for use within buildings on cement or wooden floors. The small wheels provide another advantage in the comparative ease with which this type may be swung into position for rolling, but on the other hand make it difficult to wheel over rough surfaces.

The truck shown in Fig. 2 is designed principally for outdoor use or where rough rolling surfaces are encountered. The use of the large wheels permits application of force more in line with the center of rotation and thus facilitates the movement of the truck. The construction cost of this truck is necessarily greater than that of the first type, as fabricated steel wheels must be used to obtain the required diameter. Furthermore, because of the larger wheels, this truck cannot be swung as easily from the upright to the rolling position.

Another design in which one cylinder is located on each

* Published through the courtesy of *Oxy-Acetylene Tips*, Linde Air Products, N. Y.

side of the axle is shown in Fig. 3. The principal advantage of this design lies in its ability to traverse narrow passages. The truck is also very stable when in an upright position provided the supporting braces have been moved into position, and it may be very easily swung from the upright to the rolling position. The disadvantages in this design are due to the necessity of lifting the oxygen cylinder 6 inches from the ground to place it on the truck and the difficulty of taking off or putting on the oxygen regulator with the cylinder in position on the truck.

In plants where the acetylene is piped from a generator, the necessity arises for the transportation of a single cylinder of oxygen at a time. Fig. 4 illustrates the design of a two-wheel truck for this purpose. In the using of this truck the weight is distributed on both arms of the operator by gripping the cylinder cap with one hand and the handle with the other. The design offers a very simple and cheap construction and one which will give ease of operation and manipulation.

2. *Bottom Plate.*—The bottom plate, or bottom plates as shown in Fig. 3, should be constructed of 10-gage metal.

3. *Frame.*—The truck frame may be constructed of angle iron or pipe. The amount and size of the angle iron required for the truck frame shown in Fig. 1 are given in the bill of material on this page. The design shown in Fig. 3 is especially suited to pipe frame construction but the material from which the frame is constructed may be transposed in every design shown, the amount of material necessary being determined by scaling the print of the design determined upon.

Where the bottom plate is bent as shown in Fig. 1, the supporting frame about it will be eliminated.

4. *Handle.*—The handle should be constructed of 1-inch pipe. The necessary bending and closing of the ends of the pipe may be accomplished with the aid of the welding and cutting blowpipes as subsequently described. Two handle designs are illustrated in Figs. 1 and 2.

5. *Wheels.*—Cast iron wheels should be used where practical because of their cheapness. It has been found that the factors of weight and strength make it impractical to use cast iron wheels in larger sizes than 18-inch diameter. On larger diameters, fabricated steel wheels are therefore recommended.

6. *Tool Box.*—The tool box should be made from three pieces of 14-gage sheet metal, one piece forming the bottom and two sides and the other two pieces the remaining sides. The dimensions of the sheet metal necessary are given in the bill of material on this page.

7. *Miscellaneous Material.*—The other required material is given in the same bill of material and is the same for all the designs described.

Design and Layout of Welded Joints

1. The design of the weld, its position and length, are designated on the attached sketches.

2. On butt welds the penetration should extend to the inside wall of the piece and the weld should have a width equal to 2½ times the thickness of the wall metal.

3. Fillet welds should be fused thoroughly with the abutting edges of the base metal and should be built up flush with the outside edges of the intersecting pieces.

4. Welds marked "C" should have the following dimensions: length ¾ inch, width 2½ times the plate thickness, reinforcement equal to the plate thickness.

Preparation of the Piece for Welding

1. *Cleaning.*—Where scrap pipe, plate or angle iron is used in truck construction, oxide and scale should be removed from all sections where welds are to be made.

2. *Bending.* The amount of welding required may be reduced somewhat if the angle iron and pipe can be secured in sufficient lengths to permit bends rather than joints to be made.

Where angle iron is used, a triangle should be cut from the lower leg, so that a 90-degree angle is formed at the intersection of the two cut edges. The angle iron can then be bent through 90 degrees by heating the upper leg at the

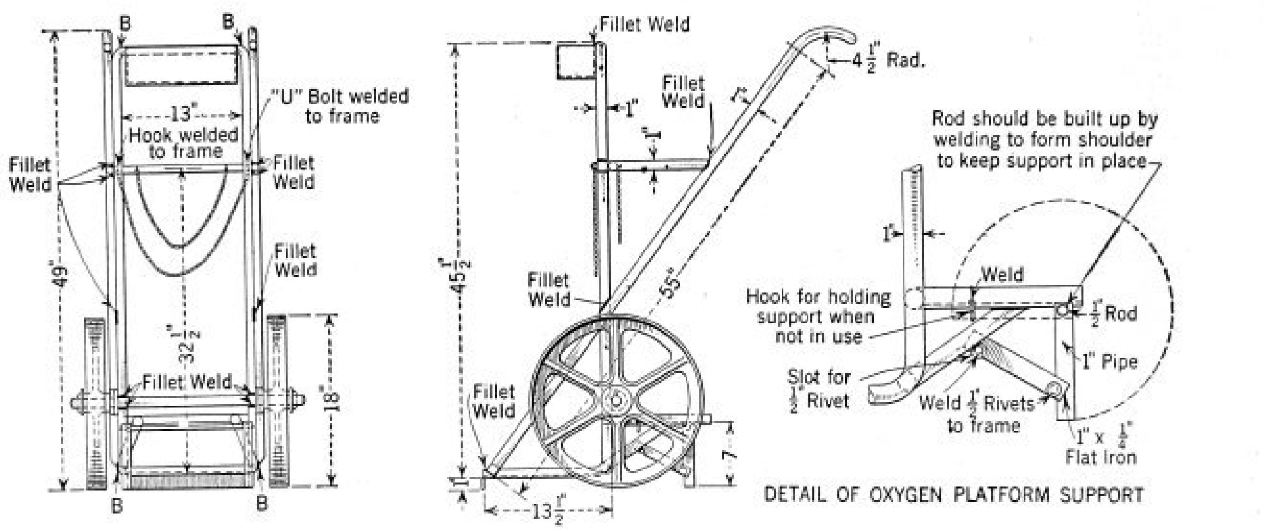


Fig. 3.—Layout for narrow-gage 2 cylinder truck

List of Material Required for One Truck
Assembled

Part No.	No. Req'd	Name	Material
1	1	Frame	3/16"x1¼"x1¼"x144" Long Angle Iron
2	1	Handle	1" Standard Pipe 133" Long
3	1	Axle	1" Standard Pipe 31" Long
4	1	Bottom Plate	24½"x14¼" No. 10 U.S.S. Gage
5	2	Tool Box—Straight Plate	No. 14 U.S.S. Gage 4⅜"x12"
6	1	Tool Box—Bent Plate	No. 14 U.S.S. Gage 4⅜"x20¾"
7	2	Wheels	12" Cast Iron
8	2	Hooks	⅜"
9	2	"U" Bolts	⅜"
10	1	Chain	36" No. 4 American Coil Chain
11	1	Chain	28½" No. 4 American Coil Chain
12	4	Washers	1¼" Standard Washer
13	2	Cotter Pin	¼"x2½" Long Cotter

point where the cut has been made. This practice eliminates 50 percent of the welding on angle iron joints.

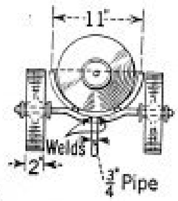
Where pipe is used, the bending may be accomplished as follows:

The pipe should be filled completely with sand, rammed tightly. After heating the section with an oxy-acetylene blowpipe where the bend is to be made, the pipe can be bent in a vise or around drift pins set in a surface table.

If sand is not employed as suggested above, the bent section will be somewhat flattened. This flattening will, however, affect only the appearance of the piece.

Bending may replace welding at all points marked "A" for angle iron, and "B" for pipe on the attached sketches.

The bends required in the preparation of the bottom plate and tool box may be accomplished in an angle brake or by placing the plate between two pieces of angle iron in a vise. The plate should then be heated along the desired line of bend and hammered over to the required angle. The piece may also be bent cold by the above method or by clamping it on a cast iron table and



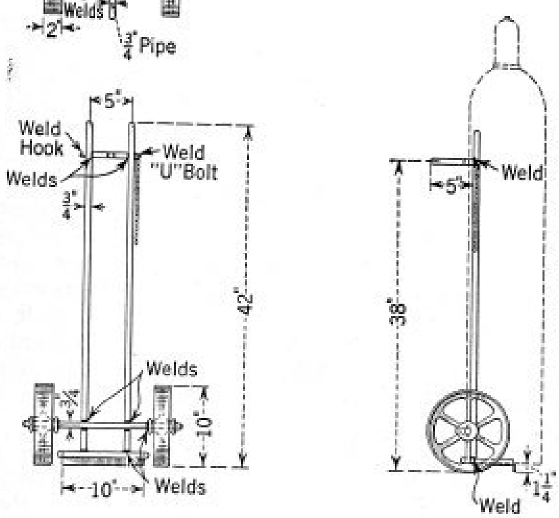


Fig. 4.—Layout for oxygen cylinder truck

sledging it over to the required angle.

3. *Miscellaneous Heating Operations.*—Where the handle joins the angle iron bottom plate support, the pipe should be flattened as shown in Fig. 2. The oxy-acetylene blowpipe may be used for this operation.

The handle design shown in Figs. 2, 3 and 4 requires the capping of the handle ends. This may be accomplished by heating the ends with the blowpipe and peening them over to a point. The end may then be welded to form the cap.

4. *Lining Up the Frame.*—The frame should preferably be lined up and clamped on a surface table before the welds are made. If facilities for clamping the frame are not available it may be straightened, if necessary, after welding.

Welding Technique

The sequence of the truck fabrication should be as follows:

1. The angle iron or pipe comprising the frame should first be welded together. Care must be taken to aline the frame accurately before welding. In general, the supporting frame for the bottom plate may be welded in one piece, the cylinder supporting frame welded next, the various braces attached by welding, and the cylinder supporting or upright frame then welded to the bottom plate supporting frame.

2. The handles should next be welded to the frame, the ends being flattened and peened over as required.

3. The bottom plate should then be welded to the bottom plate supporting frame.

4. The pipe used for the axle should next be welded to the frame, holes having been drilled in the pipe ends for the insertion of cotter pins.

5. The tool box should then be welded together and attached to the frame. As previously pointed out, the tool box should be made from three pieces of plate. The two sides should first be tacked to the third piece comprising the bottom and the other two sides, the tacks being made at the four corners of each side. Welds should first be made along the bottom seams and then continued from the bottom seams up the four sides.

6. Washers should be used on both sides of the wheels, and cotter pins inserted through the axle to prevent the wheels from working off.

7. The truck design shown in Fig. 3 requires the use of a swinging supporting brace. Where this design is used, a piece of 1/2-inch rod should be welded to the rear bottom plate supporting frame and two sections of 1-inch pipe, in which 5/8-inch holes have been drilled, attached to the rod as shown.

Inspection

The welding foreman should be responsible for the quality of the work.

He should see that thorough penetration and fusion are obtained and that the dimensions of the welds conform to the requirements as set forth in above.

He should see that the requirements for cleaning, bending and lining up the pieces are carried out.

D. Connelly Boiler Company Celebrates Fiftieth Anniversary

When employees of the Daniel Connelly Boiler Company of Cleveland, Ohio, recently lined up in front of the Connelly plant for a group photograph which was to be part of the exercise in observation of the fiftieth anniversary of the founding of this concern, an unusual record of continuous employment was disclosed.

Three members of the group were found to have spent a quarter of a century in the service of the company, another had been forty-seven years with the Connelly company, another forty-nine years and a third fifty years.

After the workers were assembled, C. E. Shafer, superintendent of the factory, with a record of forty-nine years in the company's service, paid tribute to the memory of Daniel Connelly, founder of the business and to his sons, William C. and Lawrence E. Connelly, who succeeded their father in the ownership and management of the concern.

A gold loving cup was presented to the Connelly brothers by the workers and a basket of flowers placed upon the grave of the founder.

Indicative of the spirit of harmony and good will existing between workers and owners of the Connelly company was the presentation of life insurance premiums to each employee last January which will be maintained by the company at no cost to the worker.

The first product of the company consisted of 25 horsepower boilers for the oil industry. The production of return tubular boilers of from 20 to 150 horsepower began ten years later and Scotch marine boilers ranging up to 250 horsepower in size were built shortly after. The principal product today is a patented watertube boiler of from 200 to 3,000 horsepower and for steam pressures up to 400 pounds per square inch.

The Harnischfeger Corporation, Milwaukee, Wis., plans the construction of an addition to its plant at 38th street and National avenue.

Cracked Bridges

(a) Application of flue sheet patches not extending to joint between crown or side sheets

Cracks in Flange Knuckle Vertical and Transverse. How Cared for

(a) Application of flue sheet patches extending to and including joint making a joint with crown and side sheets

THE committee has written to several superintendents of motive power of different railroads; also has visited several railroad shops, and has gathered the following information which is submitted to the convention for discussion and approval.

CRACKED BRIDGES AND THE REPAIRING OF SAME

Cracked bridges can be repaired by the electric welding process or they can be plugged. If electric welded the flues on either side of the cracked bridge must be removed and the crack V'd out from fire side to a 45-degree angle, then holes expanded with either expander or pin so as to take care of contraction. The expander or pin should be allowed to remain until the weld has slightly cooled. Proper care

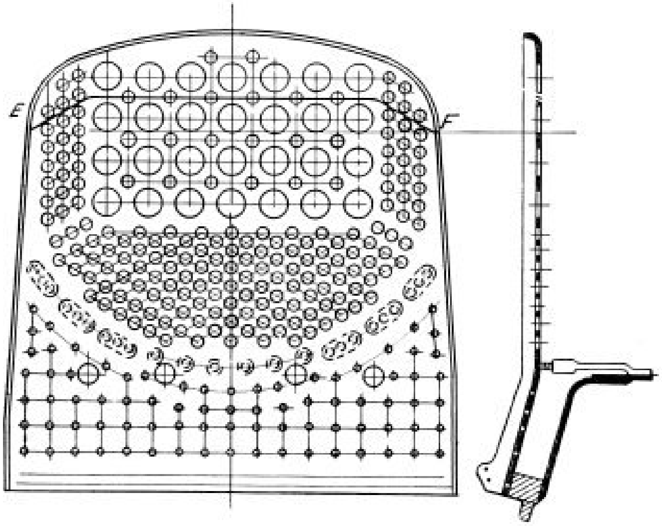


Fig. 1

must be given to see that portion to be welded is properly cleaned (sand blast preferred), before any welding is done.

If plugs are used and flues are electric welded, the weld may be cut out sufficiently to permit the application of plugs. The plugs should be of sufficient size to take care of the entire area of bridge or crack, the plugs to be tapered so a tight fit will be assured. After the plugs are applied and worked down flush with sheet, the boiler should be filled with water above the zone where plugs are applied before the weld is restored to the flue bead in order to prevent loosening of plugs in sheet due to expansion and contraction at time of rewelding flues.

If flues are not electric welded would recommend the following practice: Chip off beads, apply plugs, work plugs down flush with the sheet and then remove the flues and apply new flues.

If there are more than two adjacent, or a total of 10 cracked bridges in the entire sheet a patch may be applied.

* Report presented at annual meeting of Master Boiler Makers' Association, held in Chicago May 19 to 22.

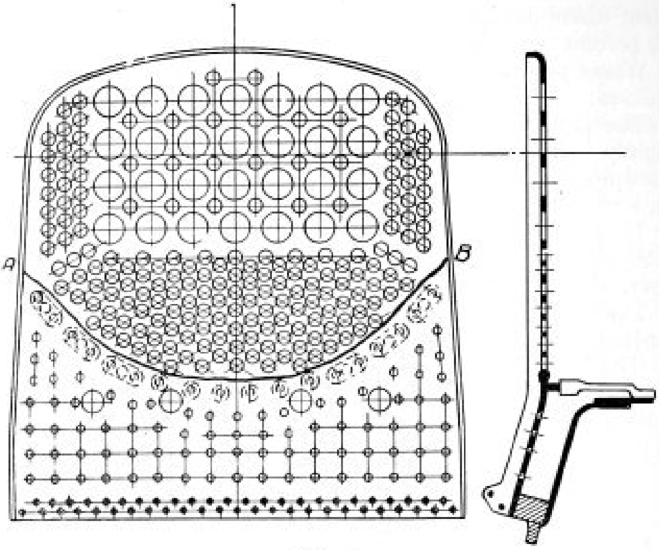


Fig. 2

Remove flues in defective portion by cutting through center of bridges and remove the defective part. Apply new piece in the following manner: drill all holes in patch, bevel patch and sheet to 45-degree angle. Great care must be exercised in fitting patch and sheet. If acetylene welding is used dish patch one-half inch; if electric welding is used, dishing is unnecessary. See Fig. 4.

Class repairs when all flues are removed. Flue sheet in good condition, flue holes true to size, flue holes not worn from working of flues. When there are five or less cracked bridges in entire flue area, but not adjacent, cracks may be V'd from both water and fire side to 45-degree angle and electric welded. Each weld should be allowed to cool entirely before proceeding with welding. A welt as heavy as possible should remain at the weld, so it does not interfere with the application of flues. See Fig. 4.

If five or less cracked bridges, flue holes true to size, sheet not worn from the working of flues, bridges may be plugged in the following manner: Plugs or flue ends should be temporarily applied as short as possible to flue holes on each side of the cracked bridge in order to keep drill from running into flue hole, plugs to have taper to assure a good tight fit and hammered down flush from both sides of sheet. When flues are applied, the boiler must be filled with water over plugs before they are welded so there will not be any expansion or contraction. For applying plugs, see Fig. 4.

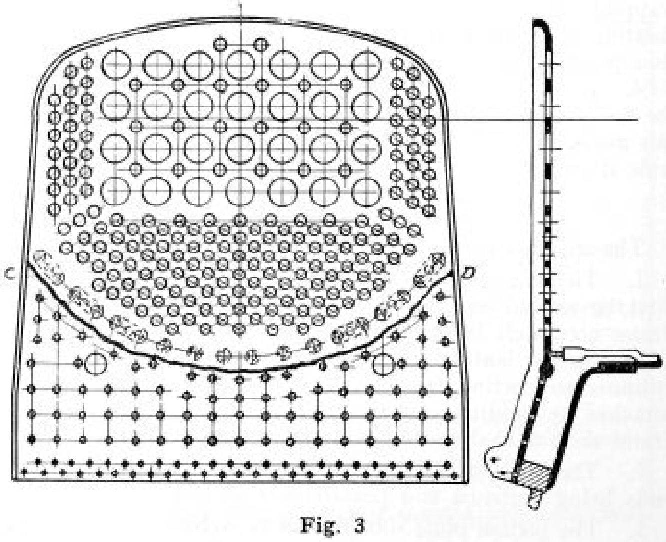
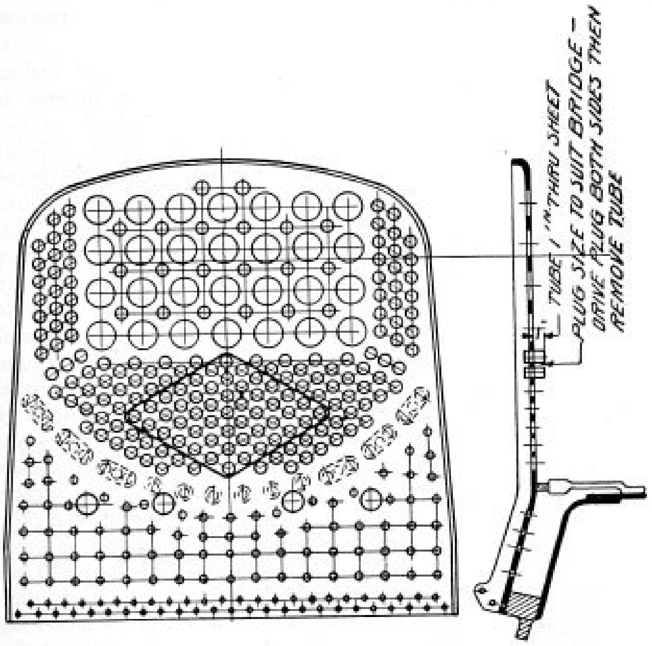


Fig. 3

When part or all of flue holes are not true to size, sheets worn from working of flues, sheets not straight, and flue sheet good in stayed surface; the part in flue area should be removed and a new portion applied. Care must be taken to properly fit up for welding and sheet V'd from both water and fire side to 45-degree angle. The welt over weld to be 3/16-inch. See Figs. 2 and 3.

Cracks in Flange Knuckle, Vertical and Transverse. How Cared For

If a crack develops in knuckle of flue sheet vertical or transverse, when flue sheet is riveted to crown sheet (repairs being made in engine house) the crack should be repaired in the following manner: If electric welding process is used,



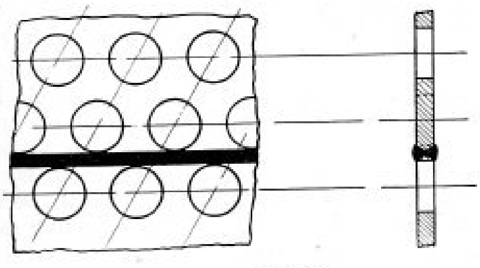


Fig. 4

the crack should be V'd out to 45-degree angle on water and fire side of sheet and properly cleaned before welding (sand blast preferred), and if crack extends into rivet or flue hole, the rivet or flue must be removed so that the weld can extend the full length of the crack. If the crack is 12 inches or more in length running transverse, a patch should be applied as shown in Fig. 1. If patch is riveted on it will not be necessary to extend below the top row of flues.

Class repairs all flues removed, flue sheet cracked at knuckle, vertical and transverse, flue holes true to size, sheet in good condition, except knuckle. Defective portion at knuckle may be removed and patch applied extending at least 12 inches below fire line. See Fig. 1.

Class repairs all flues removed, cracks in knuckle of flue sheet, vertical or transverse, flue hole not true to size, stayed portion of sheet in good condition; the flue portion of sheet may be removed and new part applied. See Figs. 2 and 3.

Before any electric welding is started the surface to be welded must be *cleaned.*

This report was prepared by a committee composed of L. W. Steeves, G. B. F., B. & O. R. R., Danville, Ill., chairman; John F. Raps, H. V. Stevens.

Discussion

J. A. Doarnberger: We have on the Norfolk and Western quite an epidemic of bad flue cracks, transverse through the knuckle. In our seventy-eight inch combustion chambers we do not have quite as many as we have in the thirty-eight inch. It matters not whether they are riveted in or lapped over and electrically welded in, they crack just the same, and about nineteen or twenty months is the life of them. Of course, we do quite a bit of welding on the water side, by putting on a band we probably get about six or seven months more out of them; maybe, not that long. They break through and we weld again, and then we resort to a patch, and that patch put in gives us as long a life as there is in the sheet, and we make three or four renewals that justify in removing the entire sheet. We know there is a movement there. We have experimented both on engines that had the four rows, transverse, rows, of the expansion type flexible bolts and also engines that had the four rows of complete rigid bolts.

We went so far as to take screw jacks, and by welding and balancing them out an inch and a quarter with screw jacks between each line of rigid bolts. We left them in. We took measurements, and those jacks would fall out. We have never been able to say whether the roof sheet moved or whether the crown sheet moved.

We went so far as to put braces across the boiler. We thought we could probably find out in that way. In order to prolong the life of our sheets, we took the knuckle out. We simply sheared a sheet and set it in the wrapper sheet and electrically welded that sheet on both fire and water side. We prolonged the life of the sheets, but we found after about twenty-four or twenty-six months, we got from four to five months out of what we calculated, and we did the flange knuckle sheet, and then the crown sheet commenced to crack, transversely, on the back end of the welding, what we call the fire side. Then, we were sacrificing crown sheets for flue sheet knuckles.

A little later on, we went further than that. We got up a series of riveting. What we had done by the rib was done on the set-in electrically welded sheet. We got a rib and ran it back about half inch below the first row of rigid bolts adjacent to the flue sheet and let that rib come down over the flue sheet, and welded it to that. That has been in service, I think, since October, 1922, and we have about forty-five or sixty engines, and it has given entire satisfaction.

When we first started this rib, we got a big punch up and punched them out of ⅝-inch plate. For four or five months we kept making internal inspections and we found in the seventy-five, 3 of those ribs broken right straight down through. The rib is about two and one quarter inches at the breaking point. In another engine, we found four, and another, two, and we stopped that when we made a reinforcing and brought it down.

L. M. Stewart (Atlantic Coast Lines): Speaking of cracked bridges and cracks in flange knuckles, we take the bridge as it cracks, "V" it out, warm it slightly, put the chisel in and crimp it and build it up and if you reinforce it from the inside you will find that it helps. You won't have to bother rolling the adjacent side. Warm your bridge, push it in, and weld it from both sides. That also works well in any place that you work to take care of contraction by crimping.

We have quite a lot of trouble with cracked knuckles on flue sheets. We apply the patch just the same as shown in Fig. 1. Recently, we have taken the third patch off of one engine and put it back with the same results, so we put in a new sheet, as shown in Fig. 1. We have quite a lot of trouble with cracked front flue sheets. In order to get away when a crack shows up, we chip out much farther than the crack shows and then reinforce the knuckle with electric welding, and that will keep it from cracking out later on, from time to time, if you will reinforce the knuckle in the front flue sheet.

MR. NICHOLS (Omaha): I would like to ask as a point of information, if there is any one here who has had experience with the old type shrink bars in our late type engines, to see whether that would have any effect or not. In my studying of this cracking (and we have had considerable), we found that it is due to the differential radius we have between our roof sheet and crown sheet. That is, boilers being in a "u" shape are becoming like a Burden tube in a steam gage, and that is giving a crushing strain down on our crown sheet.

I have been thinking of doing away with the expansion stay across there and supporting it with the shrink bar, and then supporting the roof sheet from the shrink bar.

W. M. WILSON (Rock Island): I just want to say a word for the information of all the members. We just removed the flue sheets from a Mikado type locomotive, a combustion chamber about thirty-eight inches deep.

The engine was put in service in 1921, and I made an examination of the interior of the boiler with the flues removed just before I came to the convention. I really expected to find a certain amount of cracking or indication of cracking in the combustion chamber flue sheet, but we did not find any occasion of cracking at all. There wasn't even a starting of a crack.

I just thought I would mention that in view of the fact that some of our members seem to have a great deal of trouble in 12, 17 or 18 months with cracked flue sheets. The engine is of a heavy type, modern, Mikado locomotive. The flues are seventeen feet, eight inches long.

Compression Resisting and Diaphragm Flange for Locomotive Firebox Tube Sheets

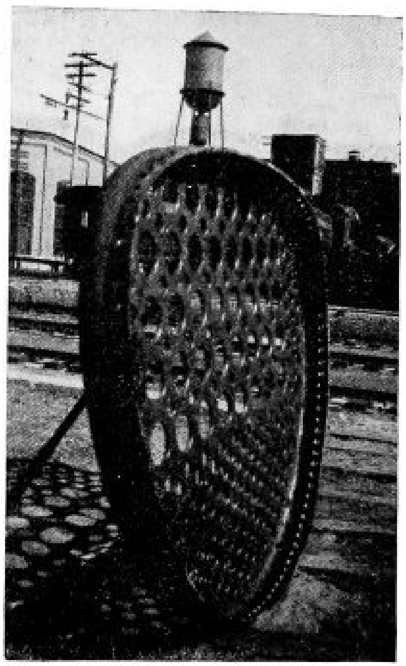
By "Maple Leaf"

WITH the introduction of the round top, outside and inside firebox boiler to locomotive practice, the cracking in the root of the back tube sheet flanges at the top increased to such an extent that many alterations have been experimented with in an endeavor to overcome the difficulty. Chief among these methods was the increase in the radius of the flange which helped to reduce the trouble. The application of transverse stays to the outside firebox immediately above the highest part of the inside firebox was another application which actually did arrest the cracking. The cure, however, was worse than the disease because it transferred the transverse cracking from the top root of the back tube sheet flange to longitudinal cracking immediately bordering the top joint of the side sheets, connecting with the crown sheets when they were riveted. This caused the value of welding joints at this location to be very much in doubt because of the frequency of the failures due to cracking.

This latter cracking extended the full length of the top side sheet joints which would amount to about 18 feet of cracking if both joints were affected, compared with 36 to 48 inches when a back tube sheet failed where transverse stays were not used.

The exhaustive tests and measurements taken of a round top locomotive boiler to obtain a reading comparing the movement of the outside firebox and boiler resulting from the difference in expansion between the inside and outside firebox brought about the transverse stay application. The lesson derived from these tests and measurements as well as the experiment with the transverse stays is a good illustration of what we must expect to follow any endeavor to increase rigidity as a means of compensating for the differential movement between the inside and outside firebox. What we need is material for outside firebox construction which will be more susceptible to expansion and contraction than that employed for inside firebox work.

The manufacturer who discovers a process to make material which will meet this requirement will accomplish a wonderful achievement in that its use would eliminate many of the inherited faults and defects which have been with us from the beginning of boiler construction. It will also be a complete cure for the breakage of the staybolts which support the inside and outside firebox plates, because the hinge motion which now causes the breakage would entirely disappear.



A flange designed to prevent cracks in the knuckle

The increased radius of firebox flanges is acknowledged as being the most helpful method to prevent cracking that has been tested out, although it has not accomplished all we would wish. Inside firebox flanges and particularly the tube sheets are subjected to many conditions of distortion. For example, the flange should be strong enough between the edge of the tube holes and the flange to resist compression, thus preventing cracking from the tube holes outwards which is a common defect. Again, the tools employed to apply flues and tubes set up a movement of the sheet which travels into the root of the flange. Further the expansion and contraction of the inside firebox plates because of temperature differentials are continually acting as a breathing movement in the flanges.

DEVELOPMENT OF FLANGE

The foregoing conditions were so serious with the combustion chamber firebox that the writer developed a combined compression resisting and diaphragm flange for locomotive firebox tube sheets which is illustrated herewith.

This form of flange is expected to provide rigidity to resist compression, as well as greater strength from the tube holes outwards and at the same time function with a diaphragm motion to accommodate service stresses and work performed on flues and tubes.

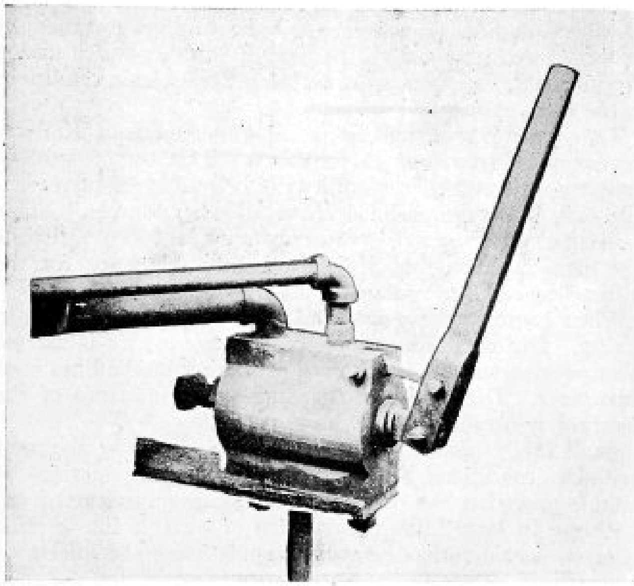
The experimental stage of this development has not yet passed, but the appearance of the job and the results so far obtained in service are quite promising. This form of flange need not be restricted to use in combustion chamber fireboxes alone, because it is adaptable to all flanges as a cure for distortion stresses.

The flanging of this particular sheet was very easily accomplished cold in a McCabe flanging machine but the want of such a machine need not discourage others from manufacturing it.

Seven-Ton Hydraulic Crane

By H. J. Raps*

ALTHOUGH for a number of years the Burnside Shops have had the reputation of being one of the best equipped shops in the country, the policy of the Illinois Central Railroad Company to discard old fashioned, inefficient machines for modern machines to increase the



Valve for hydraulic crane

efficiency of the shops and the quality of work performed, is still being maintained.

* General boiler foreman, Illinois Central Railroad.

One of the latest additions is the crane shown in the illustration. It was designed to serve the flange fire and flange press. Two more are under construction. One will be used on new firebox work and back ends; the other on tender trucks.

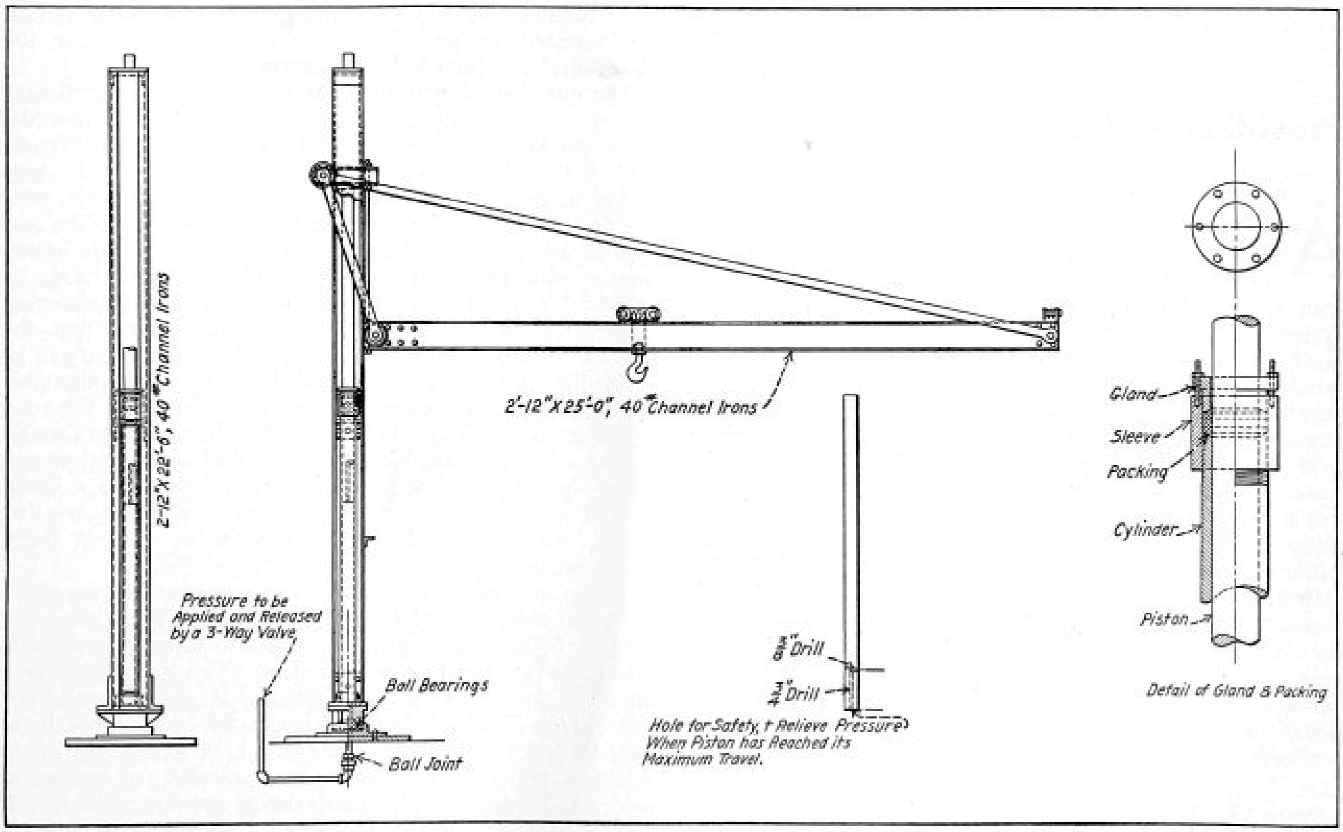
The cylinder is a 5¼-inch inside diameter tube, 7/16-inch thick; the piston is 4½ inches diameter. The upper end of the post and the carriage sheaves have roller bearings. The bottom end of the post has ball bearings. The pressure maintained is from 1,000 pounds to 1,200 pounds per square inch. The three way valve chamber is a one piece forging.

An improvement over cranes of the same general design is the manner of raising the boom. As a rule the boom is extended between the post members, the piston coming in direct contact with the boom. On the boom illustrated the point of contact is opposite the upper sheaves, increasing the available lift.

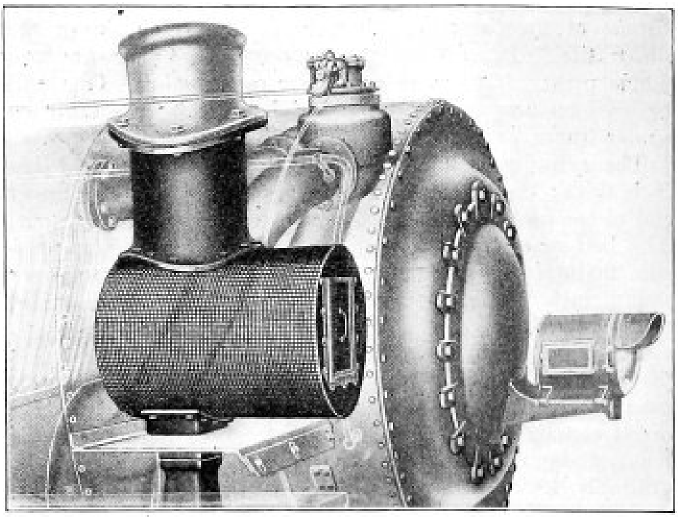
The details were worked out by Joe Millray, assistant boiler foreman, and Frank Cummings, machine shop foreman, under the supervision of Frank P. Nash, general foreman.

Security Unit Locomotive Spark Arrester

A DEVICE designed to prevent the emission of sparks from locomotives and reduce the cost of front-end inspection and maintenance work has been placed on the market recently by Mudge & Company, Chicago. It is called the Mudge Security Unit locomotive spark arrester. Special features of the design are the increased netting area which permits a larger exhaust nozzle, thereby reducing back pressure, possibility of complete inspection without removal, easy removal and reapplication when necessary, and the elimi-



Principal details of hydraulic type jib crane for the boiler shop



Phantom view, showing construction and application of Mudge security unit spark arrester

nation of patching joints, always a potential source of trouble.

The new spark arrester, shown in the illustrations, is built as a unit, welded together and bolted to an angle iron frame apart from the front end. It is installed through the smokebox front door as a unit without difficulty. The general construction of the spark arrester is evident from the illustration. It is built in the shape of a cylinder small enough to pass through the front end-door. The front and rear ends and seam of the spark arrester are reinforced by suitable angles bolted to the netting. The bottom of the arrester is bolted through a liner to the saddle casting, the top being bolted with a liner to the stack extension.

All patching of joints is eliminated in the Mudge Security Unit spark arrester as it is entirely independent of any other part of the front-end. There is no interference with superheater or front-end throttle and it permits of complete front-end inspection without removal.

Providing a Railroad's Water Supply*

By R. C. Bardwell†

AMONG the many phases of development on American railroads during the past few years, the general improvement and attention given the problems connected with water supply has shown considerable progress and has apparently rewarded the efforts and expenditures made with resulting economies. It is interesting to note in the monthly tabulations appearing in the *Railway Age*, showing the comparative operating statistics from the Class I railroads, that among the regular leaders in improved performance are those roads where attention and improvement have been given the water service.

The estimated annual consumption of water by locomotives alone on the railroads of the United States is 350,000,000,000 gallons. The cost of furnishing this water, not including maintenance, interest and depreciation of water stations is over $20,000,000.00 per year. The total water consumption for all purposes is in excess of 500,000,000,000 gallons per year, with a total expense for all water, including maintenance, interest and depreciation on plants, of over $50,000,-000.00 per year.

Check of statistics indicates that there are more than 16,000 water stations in service to supply the water required for our large tonnage and passenger movement. This would indicate that present cost for replacement of these facilities is in the neighborhood of $320,000,000.

Tests indicate that in heavy freight service locomotives will use from 200 to 250 gallons per engine mile for the Mikado and consolidation types, and between 350 and 400 for the large simple Mallets. The water used per 1,000 gross ton miles will vary from 100 to 200 gallons. Passenger engines will require from 50 to 125 gallons for each mile in service. The consumption of water should be largely governed by business conditions and the perusal of monthly water station reports is a fairly good index of the general traffic conditions on the road.

The general recommendation of the American Railway Engineering Association is that "When water of suitable quality and in sufficient quantity can be purchased at reasonable cost, it is recommended above all other sources." This is in line with the spirit of cooperation between railroads and municipalities, but it is frequently necessary for the railroad to make provision for its own supply.

When streams are used, there is considerable fluctuation in quality. During flood season, considerable matter is carried in suspension and the problem of protecting intake lines is of importance. During low water stages, the influence of the dissolved minerals is much more severe.

Small lakes, ponds, and reservoirs, usually offer the most favorable conditions for establishing pumping stations if suitable provision has been made to tide over protracted dry weather. In large lakes the question of suitable intake must be given consideration to avoid trouble from the effects of currents and storms.

WATER STATION FACILITIES

The most noticeable development in water station facilities during the past 20 years has been in tank construction. It is now a rare instance where a tank of less than 50,000 gallon storage capacity is installed and several have been built lately holding over 500,000 gallons of available water. With the increased cost and shortage of suitable tank timber, the use of steel has been largely augmented.

The question of satisfactory water quality is of particular economic interest to railway managements. In 1914, the American Railway Engineering Association presented figures to show that the cost of each pound of incrusting matter permitted to enter the locomotive boiler was seven cents, considering only the effect on fuel consumption, boiler and roundhouse repairs, and engine time for same. This figure, transposed to present day prices, is thirteen cents. Study by a special committee of the American Railway Engineering Association for the past four years has found that the statistics which have been gathered indicate this figure to be decidedly conservative. In addition the large intangible benefits, such as elimination of engine failures on the road and reduction in delays to traffic and train movement usually far outweigh the tangible savings in fuel consumption and boiler repairs. It is no longer a question whether a railroad can afford the necessary expenditure for water treating plants, but whether they can afford to be without them, where needed.

There are various methods of water treatment being practiced, the oldest and probably best advertised being the addition of boiler compound or chemicals, such as soda ash, direct into the engine tanks or boilers. This process has been improved and cases where the material is added in solidified form which dissolves slowly, either in the boiler through the washout holes or in engine tanks, and, in some cases in the roadside tanks, have shown good results on waters of moderate hardness. The disadvantage appears to be largely

(*Continued on page 328*)

*Abstract of paper read at a recent meeting of the St. Louis Railway Club, St. Louis, Mo.

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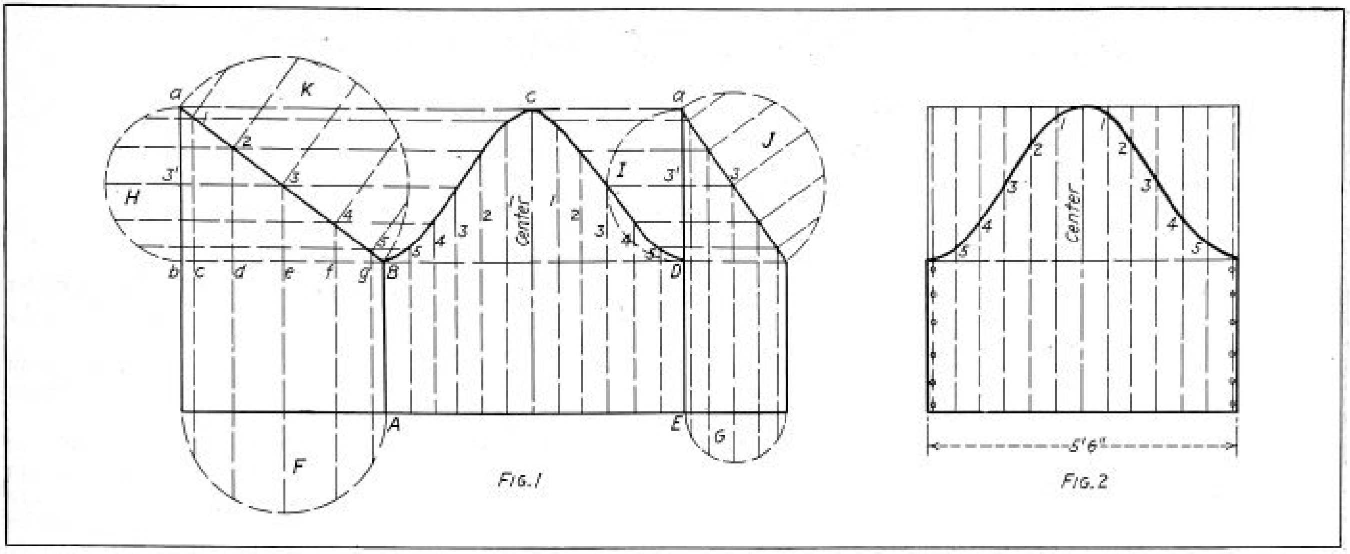

Layout of a beveled cylinder

Method of Developing a Beveled Cylinder

By O. H. Tomlin

THIS will introduce a method for problems where one or both ends of the cylinder are cut to a bevel, which will save considerable time in the process of development, it being unnecessary to know anything more about the pipe than the circumference and the height of the bevel or back set required, no compass being necessary. It will be seen that there is no need to strike out a circle; in fact, no drawing is used beyond the lines which are laid on the developed cylinder giving the developed bevel.

Process of Development

Let it be required to give the line of bevel on a given developed cylinder, say a pipe, when the pipe is 5 feet 6 inches circumference, and the greatest height of bevel is 12 inches. Divide the length of the circumference into 12 equal parts, which gives 5½ inches as the width of each division. It will be observed in this that the width of the developed pipe in feet equals the width of each space in inches.

Now refer to Fig. 1 to prove the method. It will be observed in this figure that *A B C D E* is the development of a cylinder which is divided into 12 equal parts and suppose the greatest height or back set is 12 inches. There is also a side view of two cylinders, *F* and *G*, showing the lines used in the ordinary way to obtain the development, neither of these cylinders having any relation in size to the development; the only thing of any importance in either or both of them is that they are of the same height of back set—12 inches.

Usual Method Followed

By the usual method, a half circle has been described at the base of each pipe at *F* and *G*, and the six divisions marked off on each. These divisions are then projected along the pipes until they cut the miter line; now if lines be drawn from the point *3* at right angles to the center lines of pipes, they will cross the sides of the pipes at *3'* *3'*; from the points *3'* with *3'a*, as a radius semicircles may be drawn as *H* and *I*, and both of them may be divided off into the usual six parts each and the points projected on to the miter lines. It will now be seen that these points meet those obtained from the base semicircles *F* and *G*. Then again semicircles may be drawn on the miter lines as *J* and *K*, and the same treatment as with the semicircles *H* and *I* will also give those same points on the miter line.

The object of this figure is to show, first, that it is not necessary to project always from the base; secondly, that the divisions obtained on the diameter lines of each semicircle are proportionate in the same ratio as the diameters are to each other; thirdly, that if a standard be known, any development may be obtained by proportion; and finally, the circles are not required. Now notice that *ab* is the full amount of back set; *3e* one half; *4f* is a quarter and *5g* is 13/16 of an inch when *ab* the full amount is 12 inches; or 1/16 of an inch for every inch of back set, with an extra 1/16 for every 12 inches or 13/16 for every 12 inches. This is not absolutely correct but it is proved to be 0.00865 of an inch out in 12 inches or 1/116 part of an inch.

Completing the Layout

Then the miter line works out in the following manner: Refer to Fig. 2. Having the plate ready to lay out, strike a line on the plate and make another one parallel to it equal to the height of the back set; divide these two lines into 12 equal parts, which is 5½ inches in the example given, at right angles to the lines and join the corresponding points. For convenience we will say they are numbered from the center line (which will be the longest line) both sides as center 1, 2, 3, 4, 5 side. Now we know the center is right and the sides are right; now mark on each line 3 one-halfs of the height of the back set; on each line next number 3 mark ¼ of back set, measuring for number 2 from top line and for number 4 from bottom line; this will give, so far, center 12 inches; number 2, 9 inches; number 3, 6 inches; number 4, 3 inches high. We now require numbers 1 and 5. It is said these will be 13/16 of an inch for 12 inches back set or the height of bevel, therefore, set off 13/16 of an inch, 1 inch from the top line on number 1 and set off 13/16 of an inch, 1 inch from the bottom line on number 5; draw a fair curve through the points obtained and the miter line of the elbow is marked.

Laying Out Locomotive Boilers—X*

Smokebox shell development—Laying out fire-holes—Method of locating flexible staybolts

By W. E. Joynes†

THE developed length of the cylindrical smokebox shell, shown on the boiler Fig. 1, is calculated at the neutral diameter of the plate, to the nearest sixteenth (1/16) of an inch, the same as the plain ring development Fig. 45.

Due to the shell being only air tight instead of steam tight the seam is of a simple, single welt, single riveted design and is located on the top center line. Omitting the welt strip and making a butt welded connection of the plate is becoming a popular standard.

Due to not having to locate any longitudinal brace feet, side seam location, etc., it has not been found necessary to make a developed plate drawing of the smokebox shell.

Sufficient detailed information is given on the boiler drawings, for laying out the plate in the shop, without a developed plate drawing.

This information includes a detail of the seam riveting and welt strip, diameter of the cut-out for the smoke stack, diameter and location of hand holes, with rivets; blower pipe elbow tap and location, location and size of the cut-outs, for the cylinder steam pipes. Also a detail of the size and riveting of the smokebox liner with the cut-out, through the shell and the liner, for the cylinder exhaust bosses are given. The cylinder bolt holes are drilled direct from the cylinder in the erecting shop.

The length of the liner is sheared, to fit between the smokebox ring and the first boiler course, as dimensioned on the boiler drawing. Roll the liner to the required shape, clamp same in the smokebox and mark off the rivet holes and cylinder cut-out. Refer to the instruction for laying out liners given in connection with Fig. 46.

The smokebox arrangement, which includes the deflecting plate, cinder netting screen and angle supports for same; superheater header supports, damper cylinder supports, etc., does not come under the heading of boiler making, or boiler layout work. This work is laid out and fitted up in the erecting shop.

Boiler Figs. 9 and 10 show a smokebox with a flanged plate flat bottom. The flat bottom design is made necessary for low pressure cylinder clearance on Mallet compound type locomotives and is also to be found on the three cylinder design locomotives.

The bottom plate is flanged to shape before it is laid out for size or any holes are put in it. After the plate has been flanged, clamp it to the boiler and mark off the length and girth to suit the top plate of the smokebox, also mark off the circumferential seam and smokebox ring rivets.

Layout the rivet holes for the liner and cut-out for the exhaust as shown on the boiler drawing. The longitudinal spacing of the seam rivet holes are squared down on the bottom plate, in line with the seam rivet holes in the top plate.

The liner for a "flat bottom smokebox" is either rolled or flanged to shape and then marked from the smokebox shell the same as for a cylindrical smokebox liner.

The contour of the firebox tube sheet is determined by the number of tubes and flues required. This gives the height of the front end of the crown sheet above the boiler center line. With this height determined the crown is sloped ½ inch in 12 inches.

The width of the water legs at the firebox ring varies from 3 inches to 5 inches at the back and sides and from 4 inches to 6 inches at the front or throat.

In order to have a rapid water circulation and a free passage for the formation and rising of the steam to the steam space above the top of the crown sheet, the water legs are made tapered. The firebox back and crown-sides should be tapered to have these legs 1½ inches more at the boiler center line than at the firebox ring. The front leg is made parallel above the bend in the tube and throat sheets and should be 1 inch more in the parallel space than at the firebox ring, for rings 4½ inches wide and under. One-half (½) inch more for rings 5 inches wide and equal in width to the firebox ring when the width of ring is more than 5 inches.

The above dimensions for increasing the width of the water legs at the boiler center line are the preferred ratios but may vary, more or less, to use flanging dies that have already been made.

The top bend in the back tube sheet and the throat begins ½ inch or more below the bottom of the lowest fire-tube. This allows for rolling and beading of the tube on the flat sheet.

The bends in the tube and throat sheets run straight across the sheets, parallel with the boiler center line and not radial with the boiler course. The bends just above the firebox ring are also straight across the sheet. When the firebox ring is made basket shaped to gain fire-space above the grates, these bends are also parallel with the boiler center line except in a few special cases where the bends have sloped with the firebox ring.

This sloped construction is not standard and has seldom been used except on a few boilers with short throats where it has been difficult to obtain a good angle in the tube sheet or inside throat sheet for applying the outer firebrick tubes. Also, this construction serves to facilitate the staybolt spacing in the outside throat sheet.

When this sloped throat construction is used the same is shown on the longitudinal view of the boiler drawing and will appear similar to Fig. 47.

In the cross-section of the boiler the backhead contour radius is made equal to one-half the outside diameter of the back ring except when it is found necessary to reduce the same to gain cab room or reduce the weight of the boiler.

When the backhead contour radius is made smaller than one-half the diameter of the back ring the form of the roof changes from a cylindrical to a cone shape.

The crown will also be coned to keep the back water leg approximately the same width as the front water leg. A cone or taper shaped roof or crown sheet is more difficult to develop than the cylindrical form as will be learned from the developments later on.

The width of the firebox at the bottom is the same front and back or rectangular in shape.

The required size of the firebox for various capacity boilers, number of tubes and flues required, heating surface, evaporation, horsepower, boiler pressure required, etc., will not be gone into here as the purpose of these remarks is to bring

*Previous installments of this article appeared on page 1, January issue; page 40, February issue; page 72, March issue; page 99, April issue; page 129, May issue; page 166, June issue; page 235, August issue; page 263 of the September issue, and page 293 of the October issue.

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out some of the features of the construction of a boiler after this information has been furnished.

Fireholes.—Fireholes are made in various types and sizes depending on the type the railroad company uses or prefers. Some mechanical stokers also enter into the design and location of the firehole. The most simple and used design of firehole is shown on boiler drawing Fig. 1. The connection between the backhead and the firebox back sheet is made by flanging the backhead and the firebox sheet into the water leg. These two flanges are then connected by a simple riveted lap seam with ¾-inch diameter, patched bolts, 2-inch pitch and countersunk heads or welded with a butt joint or ½-inch lap welded joint. A ¾-inch radius is used for the backhead flange. The firebox sheet flange radius should be more than ¾ inch when the width of the water leg will permit a larger

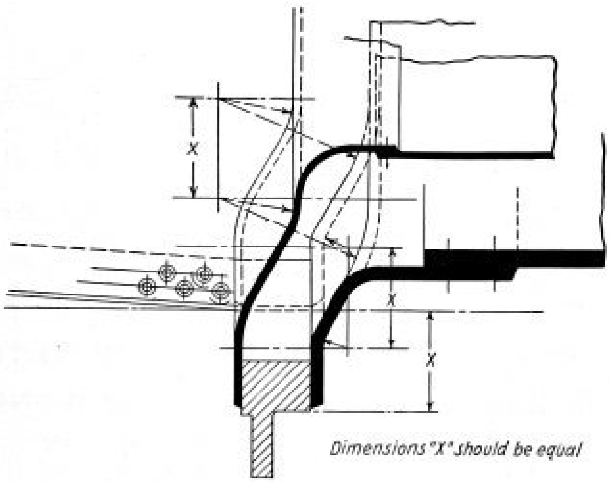


Fig. 47.—Sloping bend construction of throat

one to be used, which is most always possible with the welded type of flange. The larger radius serves to relieve the sheet from cracking or springing a leak at the connection.

When the firedoor is opened or closed the firebox sheet is subject to considerable expansion and contraction. This trouble is eliminated when the boiler is operated with a mechanical stoker. However, the large flange radius should be used for various causes of expansion and contraction.

The firebox and the outside shell are riveted to a solid bar at the bottom called the firebox ring. This ring is usually made with four pieces welded together—the sides are forged iron and the ends cast steel. The ring is 3½ inches to 4 inches thick, double riveted with ⅞-inch swell neck, through rivets about 3 inches pitch and 1¼ inches between the rivet lines. The ring should be ¼ inch below the bottom edge of the sheets. The front and back edge of the firebox ring at the back end and at the throat should be parallel, for application of the ring in the firebox.

The firebox and the outside shell above the firebox ring are stayed together to resist the steam pressure. The stays in the water legs are called "staybolts." The stays supporting the crown sheet to the roof sheet are called "radial stays" for reason of being radial to the crown sheet. The roof sheet is self-supporting because of its circular shape. The extent of the radial stays is at some point on the crown corner radius where the space between the inside surface of the crown sheet and the outside surface of the roof sheet is not less than 8 inches.

Radial stays have upset ends and when the distance over sheets is less than 8 inches it is not practical to make the upsets. As a rule all radial stays are rigid and have straight threads in the roof sheet end. From six to ten center longitudinal rows of radial stays have taper threaded ends in the crown sheet end. The top of the crown being subject to more intense heat, the taper end type of stay supports the sheet and keeps tight better than the straight end stay. The center rows or taper end stays are also referred to as "crown stays" and the straight threaded stays, or those outside of the taper end stays only, as "radial stays."

Rigid staybolts are made of round iron, threaded full length and vary in diameter from ⅞ inch to 1 inch, 1⅛ inches in special cases. All rigid staybolts and radial stays are headed over on the firebox and outside shell sheets. The head is low and slightly cone shaped. The stays should be made of hollow iron or have tell-tale holes about 3/16 inch diameter, drilled in the outer end to a depth beyond the inner surface of the shell sheet.

The above information relative to the kind of heads on the firebox end of crown stays refers to steel crown sheets only.

Crown stays for copper crown sheets have button heads or nuts on the crown sheet end.

Expansion Stays.—From two to four transverse rows of flexible stays are used at the front of the crown. The stays are called "expansion stays" and they relieve the firebox from severe strain—most of which occurs at the top-front of the firebox.

The calculation for the roof sheet thickness is based on the efficiency of the plate for rigid crown stays. The sleeve for expansion stays requires a larger hole in the sheet than rigid stays, therefore the efficiency of the roof sheet through the rows of expansion stays is reduced. This deficiency is corrected by the use of a liner on the inside of the roof sheet, when more than two transverse rows of expansion stays are used. The number of transverse rows of expansion stays used is based on the diameter of the back-boiler course. The longitudinal rows are usually carried around as far as the last radial stay row.

Location of Flexible Staybolts.—The staybolts in the firebox subject to the most strain should be flexible staybolts. A good sample for the location of flexible staybolts is shown by the two boiler drawings Figs. 1, 2, 9 and 10. The flexible staybolts are located in what is called the breaking zone and to describe this zone more clearly the staybolts should be located about as follows: Firebox sides—all the staybolts in the first three or four top rows—two rows up—front and back—beginning at the second row from the bottom and angled off to the top rows about as shown on Fig. 1. Backhead: Two outside rows—bottom row excepted. Throat: All staybolts except bottom row. Combustion chamber: The latest practice is to have all staybolts flexible instead of the six top rows as shown by the combustion chamber sections Fig. 10.

Type of Flexible Staybolt.—The type of flexible staybolt most commonly used is designed in three pieces, viz., bolt, sleeve and cap. The sleeves are of two types, viz., threaded and welded sleeves. The first type of sleeve requires the outside firebox or shell to be threaded for receiving the sleeves and the latter a hole through the shell without threads. The welding is around the sleeve and to the outer surface of the shell.

It is necessary to make a taper end flexible stay in four pieces, viz., bolt, ball nut, sleeve and cap. Taper end flexible stays are not recommended, having one more piece than the straight end flexible stay the manufactured cost is greater and it is not believed the taper end on a flexible stay adds much value to supporting the crown sheet. However, the same number rows of expansion stays as the taper end crown stays are made taper end when requested.

The cap for a welded sleeve, flexible staybolt projects about 1¼ inches beyond the outer surface of the shell, when the sleeve is approximately 90 degrees to the shell. A threaded sleeve cap projects about 1¾ inches beyond the shell, when the sleeve is at a right angle to the shell. A flush sleeve requires a larger hole in the shell than any other kind of sleeve.

(To be continued)

Tests of Dished Heads for Boilers

THE reported results of tests of dished heads for boilers made at the Materials Testing Laboratory of the Technischen Hochschule of Stuttgart, at the instance of the Wasserrohrkessel-Verbandes (Watertube Boiler Manufacturers' Association) are reviewed in brief by Dr. C. Bach in the *Zeitschrift des Vereines Deutscher Ingenieure* for March 21.

Three types of head were tested—those of the usual form, those having an elliptical cross section and those designed by an engineer by the name of Klöpper.

The three forms with the contours used for thicknesses of 15 millimeters and 25 millimeters are shown in Figs. 1 and 2 respectively.

The greatest distortion occurred in all cases at the heel or portion near the flange and manifested itself by the cracking off of the mill scale, an indication that the yield point of the material had been reached or passed.

The pressures under which this occurred are given for various thickness of material as follows:

Form	Thickness, Mm.	Thickness, In.	Pressure, Ats.	Pressure, Lb. Per Sq. In.
Elliptical	15.6	0.98	42.5	624.6
	19.6	0.77	64	940.6
	24.9	0.98	83+	1,220.1+
Klöpper	16.6	0.65	27.5	404.2
	25.7	1.01	43.5	639.3
Ordinary	14.9	0.59	11	161.7
	20.3	0.79	23.5	345.4
	24.4	0.96	28	411.5

Two samples of each type were tested and the pressure given is the average of the two. With the apparatus available it was impossible to increase the pressure to over 83 atmospheres, and in the case of the elliptical section of 24.9 millimeters thickness the mill scale had not commenced to spring off at that pressure.

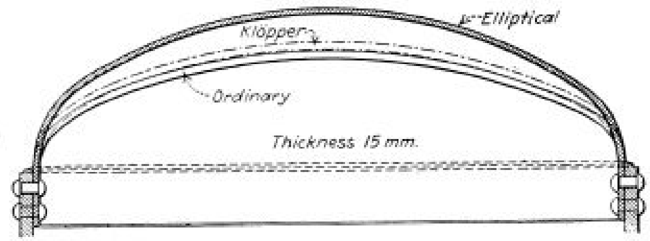


Fig. 1.—Sections of head tested. Thickness 15 mm. or 0.59 inch

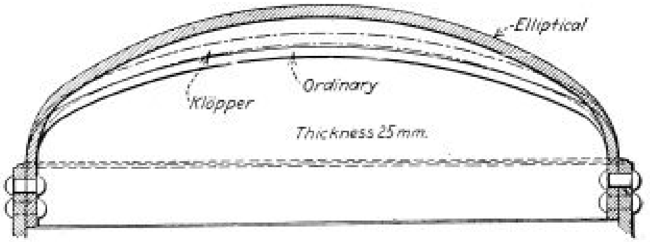


Fig. 2.—Sections of head tested. Thickness 25 mm. or 0.98 inch

In all cases the cracking off of the mill scale commenced at the heel of the flange. In the case of the usual and of the Klöpper types the distortion remained concentrated there. In the case of the elliptical section the scaling not only began later, but soon commenced to expand into wider zones.

In Fig. 3 the pressure under which the yield point occurs is plotted against the thickness of the material, showing not only that the elliptical section sustains a much greater pressure without distortion but the much steeper trend.

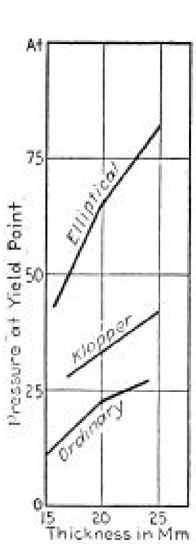


Fig. 3

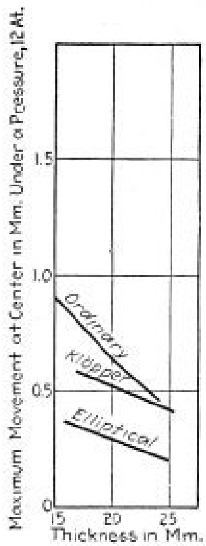


Fig. 4

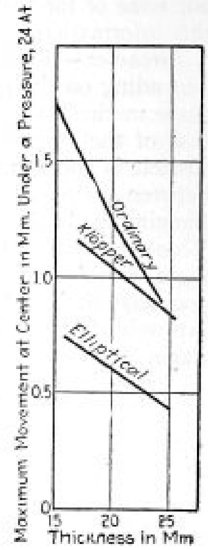


Fig. 5

In Figs. 4 and 5 the distortion or movement at the center of the head under pressure of 12 and 24 atmospheres respectively is plotted against the thickness of the material.

The diameter of the cylinder into which the heads were riveted was 1,300 millimeters (51 inches) and the radius of the curves at the centers of the heads was of approximately the same length.

The heads were unstayed and of uniform section, without openings.—*Power.*

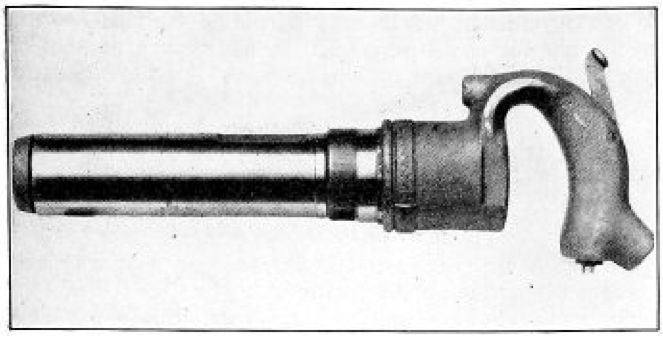
Thor Pneumatic Riveting Hammer

A PNEUMATIC hammer, known as the Thor riveting hammer, and embodying several important improvements, has been developed and placed on the market recently by the Independent Pneumatic Tool Company, Chicago.

The handle of this hammer is drop forged to shape from special alloy steel, particular care having been taken to leave plenty of stock at the bend and at the nipple lug. The handle opening has sufficient room for a large gloved hand and is shaped for a natural grip. The trigger is designed to have correct tension and is located to fit the hand grip. The throttle valve of this hammer is self-feeding, of the balanced type with spiral openings insuring accurate graduation for starting and control. The throttle valve stem, of hardened steel, operates in a bronze bushing. The handle is screwed on the barrel, large V-threads being used and the thread connection being exceptionally long. The handle lock is of the positive ratchet type held by an octagon milled on the barrel. The octagon gives eight positions for each tooth so the teeth always mesh tightly.

The main valve is a hollow substantial sleeve without any portholes. The walls are of even thickness. The inside of the lower end of the valve is ground with a slight taper, eliminating danger of the piston striking the valve squarely. The valve has large and long surfaces, insuring long life, precision of timing and high speed. The exhaust and inlet are widely separated, thus tending to prevent leakage and loss of power. The valve is hardened and ground all over.

The valve block also is hardened and ground all over, portholes being laid out in straight lines, assuring direct passage of the air in its natural flow and eliminating any effect of wire drawing. The barrel is of selected alloy steel, heat treated, with the piston bore hardened, ground



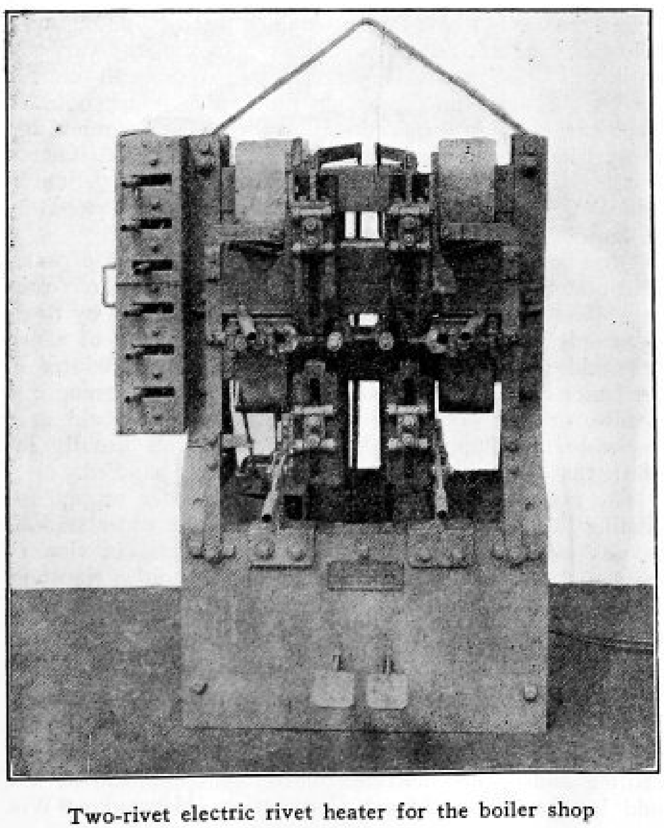
Improved Thor riveting hammer

and lapped. The nozzle bore is hardened and ground. The exhaust at the upper end of the barrel is diverted at any angle which may be desired by the operator by turning a deflector. The throttle is designed with a special view to securing one which will stay tight in service.

The hammer is symmetrical in shape, devoid of any projections or irregularities, and carefully balanced like the Thor chipping hammer. It is designed to have accurate balance and regulation, delivering exceptionally rapid and powerful blows with no back kick.

Electric Rivet Heater for the Boiler Shop

THREE models of electric rivet heaters, all of which operate on alternating current of any voltage, have been placed on the market by the American Hoist & Derrick Company, St. Paul, Minn. Model A is a two-rivet machine with a 40-foot super-service table, and weighs approximately 1,100 pounds. Model B is a four-rivet stationary type which weighs approximately 1,900 pounds. These models are primarily designed for heating rivets for structural work. Model C is a two-rivet machine, especially designed for heating rivets for boiler work. It weighs approximately 2,500 pounds.



Two-rivet electric rivet heater for the boiler shop

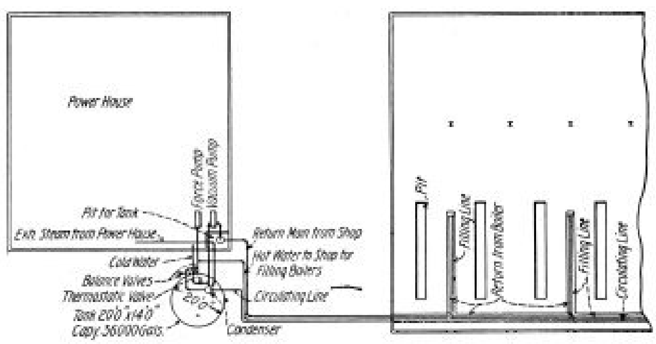
Model C is equipped with special adjustable side contacts so arranged that the temperature in any part of the rivet may be regulated by the operator. This arrangement enables the operator to heat the grip of the rivet to a white heat, while the end and head are kept at the proper temperature for driving, thus insuring that the rivet completely fills the holes.

The sliding jaws and the E element are of solid cast copper throughout and have thirty times the current carrying capacity of a 1-inch rivet, making it impossible to overheat the machine to a dangerous degree. They are so designed that the rivets up to and including 9 inches in length can be placed in the jaws without any adjustment and with no fear of mushrooming. The sliding jaw permits the E element to be constructed in such a manner as to tightly hug the laminated iron case—its source of power—on three sides, thus practically eliminating magnetic losses and reducing current consumption to a minimum.

All three types are equipped with interlocking heat control, conveniently located at the operator's left hand, which provides instant control of the current.

Locomotive Hot Water Hydrostatic Testing Plant

THE accompanying illustration shows a hot water testing plant for back shops or boiler shops where a number of locomotive boilers are tested daily. This work is generally done by filling the boiler with a hot water injector which takes live steam and a good deal of it. One boiler is



Piping arrangement of the National automatic, hot water hydrostatic testing plant for locomotives

often tested several times making a large waste of hot water, and as this water runs into a pit it produces a great deal of vapor in the shop. The plant shown has a large receiving and supply tank and a high pressure pump on the discharge line. The discharge line is run below the floor with a connection to each pit. At the far end of the discharge line a circulating line returns to the tank. The pump moves constantly, just enough to keep up the circulation. As soon as the locomotive boiler is connected to the main and the valve is opened, the pump goes to work and will flow any amount required, usually between 300 and 400 gallons per minute so that the boiler is rapidly filled with water at a predetermined temperature. The pump may be so set that it will furnish the required pressure and when it gets to that point it will slow down, or the boiler can be filled and the pressure put on with a hand pump. As soon as the defects have been chalked the boiler is disconnected from the discharge line and connected to the return line.

The return line is also below the floor with a connection to each pit. Near the far end it runs through a small regulating tank and from there through a vacuum pump to the main reservoir. The pump is governed by an outfloat on the regulating tank. When a boiler is connected this tank fills up and, through the float, opens the steam line to the pump. When the boiler is empty the pump lowers the water in the regulating tank and shuts off the steam, stopping the pump. The whole arrangement is automatic. A supply of hot water at a fixed temperature is always available. The temperature of the main tank and the height of the water is automatically governed.

This equipment is built by the National Boiler Washing Company, Chicago.

A New Scale Absorber

By G. P. Blackall

RECENT research in the use of organic colloids in boiler feedwater has produced some very interesting results. A successful commercial application of this discovery is embodied in a new British invention known as a "filtrator." The process is essentially non-chemical, and consists in the generation of a suitable colloid in a digester by the action of steam on ordinary uncrusted linseed.

The apparatus itself consists of a castiron cylinder, or digester, in which is supported a perforated container holding a charge of linseed. Live steam enters the cylinder at the top and acts directly on the linseed container, the steam permeating the linseed and extracting from it not oil but a mucilage. This forms an emulsion with the water condensed in the apparatus, and passes by gravity directly into the boiler through two pipes which lead from the base of the apparatus.

No chemical action whatsoever takes place in the water, the scale-forming salts being absorbed by the emulsion and prevented from coalescing and forming hard scale. The emulsion also exhibits the peculiarity of a mechanical action on existing scale, pushing it off when the emulsion has permeated through cracks in the scale and reaches the skin of the boiler.

The question as to whether oil is extracted from linseed in the process employed in the filtrator has been the subject of careful investigation by many analytical chemists, including the wellknown authority, Dr. W. R. Ormandy, D. Sc., F. I. C., F. C. S. It has been repeatedly demonstrated that the amount of linseed oil contained in a charge both before and after use does not vary more than one-tenth of one percent. The reason why practically no oil is emitted from the grains under steam treatment is due to the fact that the oil content is encased in a hard and impervious envelope which in turn is surrounded by a layer of resinous matter in a permeable envelope forming the outer surface of the seed. It is the outer envelope which parts with its contents, the inner envelope being left untouched.

The advantages which accrue by the use of such an apparatus are the saving in coal through prevention of scale and the elimination of expense and loss of service involved in scaling. The only cleaning required when this process is in use can be speedily effected with a wire brush and a hose pipe.

Variation in the hardness of the water does not affect the efficiency of the colloidal emulsion as a scale preventive, as there is normally an excess of colloid present amply sufficient to meet such conditions. Sea water can be used as make-up without the employment of an evaporator should it be desired to dispense with fresh water for reasons of loading or other cause.

A number of installations of filtrators have been made on all classes of merchant tonnage in Great Britain, and the French Government has recently purchased the rights to use the filtrator for naval purposes. In addition, a number of important British power stations have installed the apparatus on land.

Providing a Railroad's Water Supply

(*Continued from page 322*)

in the lack of dependable system for checking regularity and properly proportioning the treatment.

The least expensive systematic treatment from a first cost standpoint is the addition of soda ash to water in the roadside tanks so that all of the sulphate or hard scale-forming matter is softened. This system is practiced extensively on the Wabash, Chicago and Alton, Frisco, and, to some extent, on many other roads. With careful supervision and close and systematic check, it can be made to give satisfactory results, but it has the disadvantage of producing such acute foaming conditions where the concentration in the boiler is not maintained within workable limits by frequent blowing down, that it is held in bad repute in many localities.

Some experimenting with Zeolite softening is being done at the present time on the western coast. This system provides for running the water through a filtering medium which has an interchangeable base. That is, the filter absorbs the scale-forming elements and replaces them with non-scale forming alkali salts. At specified periods the filter is regenerated by soaking in strong salt brine solution. The experience with this system in this section has not been satisfactory due to excessive alkalinity produced with resultant foaming, and the cost for pre-filtration and the salt regeneration was excessive.

The standard and usual method of water softening consists of the use of lime and soda ash added to the water in predetermined amounts at wayside settling tanks. Its object is not only to soften the water but to remove the precipitated sludge with other mud or suspended matter so as to deliver water to the boilers not only soft but clean. Common lime and soda ash are used for the reason that they are the lowest priced chemicals which can be obtained that will do the work efficiently and economically. The types of plants vary not only with the patented proportioning equipment, on the market, but also with the designs prepared to best handle the local and individual conditions. With proper attention and supervision, experience has shown that decidedly satisfactory results can be secured in the way of scale and pitting elimination and that the economies effected usually far exceed the estimate.

One complaint which occurs with nearly all types of water treatment to a greater or less extent, is the question of foaming. The foaming tendency of a water is affected by treatment only in an approximate ratio to the amount of alkali salts added by soda ash treatment or the sludge produced in the boiler through incomplete treatment. Without going into details, we can say that such situations can be held at a workable minimum and that such complaints usually indicate that the situation is not being properly handled.

The range of the problem of railroad water supply, including the installation and operation of the water stations as well as the quality corrections, is wide and in view of the actual costs involved, as well as the effect upon transportation and train movement, well warrants the special study which is being given on many roads.

Joseph T. Ryerson & Son, Chicago, has acquired full rights covering the manufacture and sale of the horizontal drilling and boring machines heretofore manufactured and sold by the Harnischfeger Corporation, Milwaukee, Wis.

Questions and Answers for Boiler Makers

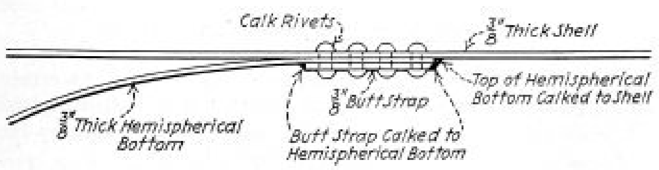
Information for Those Who Design, Construct, Erect, Inspect and Repair Boilers—Practical Boiler Shop Problems

Conducted by C. B. Lindstrom

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

Formula for Plate Thickness

Q.—Being a subscriber to THE BOILER MAKER and very much interested in the design and fabrication of various kinds of steel plate construction, we would very much appreciate it if you would kindly give us the following information: What is the formula for calculating the thickness of plates and for the style of riveted joint for the hemispherical bottom of an elevated tower tank for holding water? The calculation must be governed by a factor of safety of 5. We would very much appreciate your compliance to this request.—D. E. S.



Problem to determine shell plate sizes

A.—The formula for finding the plate thickness of a hemispherical head, if there are no joints in the head, is as follows:

$$t = \frac{Lfr}{2ts} \qquad (1)$$

in which, t = plate thickness, inches
L = load, pounds per square inch
f = factor of safety
r = radius of disk
ts = tensile strength of plate, pounds per square inch
E = efficiency of joint, percentage where a joint is used

$$t = \frac{Lfr}{2tsE} \qquad (2)$$

The minimum number of rivets in the transverse joint may be found from the following formula:

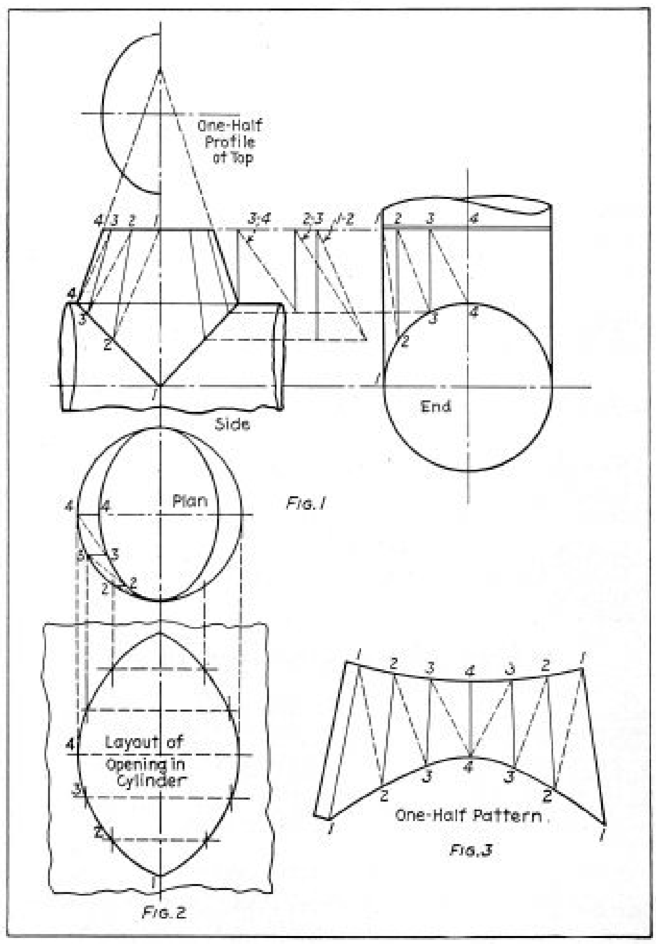
$$N = \frac{Lf}{aS}$$

in which, N = minimum number of rivets
L = total load in pounds on seam
f = factor of safety
a = area of rivet hole
S = shearing strength of rivets in pounds per square inch.

Transition Piece Intersecting Pipe

Q.—Will you kindly show development of a pipe connection as shown on inclosed sketch.—N. J. C.

A.—The solution is shown in Figs. 1, 2 and 3. Lay off a plan and elevations, showing in the plan the profile of the upper end, which in this case is an ellipse; the intersection of the transition piece and pipe is also an ellipse. Triangulation is used to lay off the pattern. Before the pattern can be laid out it is necessary to develop the opening in the pattern of the cylinder as shown in Fig. 2; then find the true length of the diagonal lines *3-4*, *2-3* and *1-2*.



Development of transition piece and pipe intersection

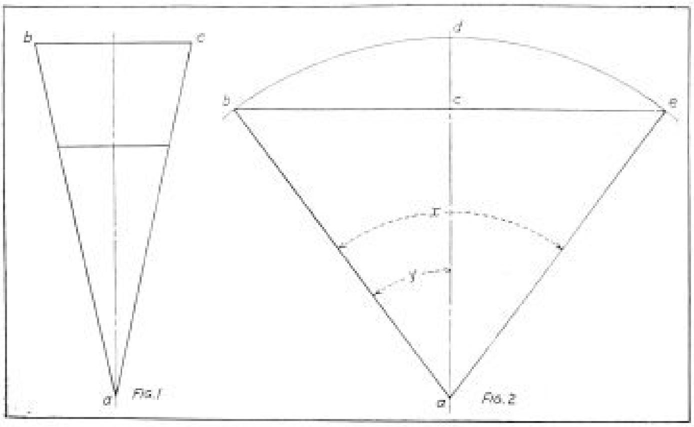
In Fig. 3 is given the pattern construction and, as all construction lines are numbered, the method should be readily understood.

If further details are required by any of our readers, additional information will be published later.

Camber and Versed Sine

Q.—Being a regular reader of your valuable paper THE BOILER MAKER, I should be pleased if you could give me a formula for figuring the drop or the camber in a cone or in a conical pipe. I am using the steel square method at the present time, for getting the drop in a piece of pipe. If I am not mistaken I think that there is a method for figuring it out.—J. K.

A.—To determine the camber in the pattern of a conical section, when the radius is so great that the arc cannot be conveniently drawn, the following method



Method of laying out a camber

may be used: Fig. 1 shows a cone of the following dimensions *a-b* equals 70 inches and *b-c* equals 30 inches. Fig. 2 is a diagram indicating the camber stretchout *b, d, e.* The length of this arc is to the circumference of the circle of which it is a part, as the number of degrees in the angle x is to 360 degrees. Therefore,

$$\text{Angle } x = \frac{360 \times 30 \times 3.1416}{70 \times 2 \times 3.1416} = 73 \text{ degrees approximately.}$$

$$\text{Angle } y = \frac{73 \text{ degrees}}{2} = 36 \text{ degrees } 30 \text{ minutes.}$$

Sine 30 degrees 30 minutes = 0.5948.
Length of $b\text{-}c = ab \times$ sine angle $y =$
$70 \times 0.5948 = 41.64$ inches
Length $a\text{-}c = \sqrt{70^2 - 41.64^2} = 56.27$ inches.
Versed sine equals $c\text{-}d = 70 - 56.27 = 13.73$ inches.
With these data the camber line *c, d, e* may be laid off.

Use of Copper Ferrules

Q.—I work on the I. C. R. R. and since I came here they have had me putting tin or copper shims in the front flue sheet around the bottom flues when new ones are put in. The shim sticks in the side, that is the water side, one inch. They say this is so that the chemical will not eat the flue as they have trouble with them pitting next to the sheet. Do you think this would prevent the chemical from eating the iron? If it is that strong it would also eat the boiler steel. I laughed at them but they still have me doing this work. I would like to get your opinion of this work. Would the copper shim prevent pitting next to the front flue sheet just inside?—O. R. B.

A.—Evidently there must be some good reason for applying the copper ferrules as you state; possibly for experimental purposes. You no doubt are aware that copper is soft, and when the tube is expanded, the ferrule is worked into the tube sheet crevices and, because of its greater expansion, aids in keeping a tight joint between the tube and tube hole. The ferrule would also aid in preventing pitting of the tube at the tube sheet.

Atlantic Coast Line Officials

Q.—Will you please obtain for me where or in which city the Atlantic Coast Line R. R. has their repair shop, and the name of the superintendent of motive power and his address. Also the name of the superintendent of motive power and his address of the Seaboard Air Line R. R.—A. W. T.

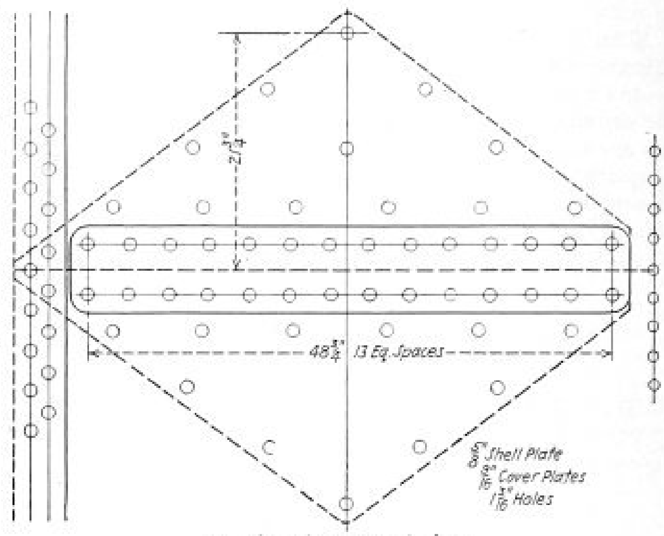
A.—Write to L. M. Stewart, general boiler inspector, Atlantic Coast Lines, Waycross, Ga.

Diagonal Seam

Q.—Will you please publish the formula for a diamond butt strap joint as used on locomotive boilers, a sketch of which is inclosed. A SUBSCRIBER.

A.—Diagonal seams have an effective efficiency in excess of a longitudinal seam of the same proportions. The increased efficiency is dependent upon the angle the seam makes with the girth seam. The nearer the diagonal seam approaches the girth seam, that is, the smaller the angle the diagonal seam makes with the girth seam, the greater is the effective efficiency.

To determine the efficiency of a diagonal seam, first cal-



Problem in seam design

culate the efficiency as a longitudinal joints; then ascertain the angle the joint makes with the girth seam. Multiply the efficiency of the seam as found for a longtitudinal joint by the factor obtained from the following formula:

$$\frac{2}{\sqrt{\text{sine of angle}^2 \times 3 + 1}}$$

Angle degrees	Factor
30	1.51
35	1.42
40	1.34
45	1.27
50	1.20
55	1.15
60	1.11
65	1.08

The efficiency of a single riveted longitudinal seam ranges approximately from 40 to 50 percent; and longitudinal butt and double strap from 70 to 90 percent.

Example.—The calculated efficiency of a longitudinal seam is 74 percent, what is the efficiency of the joint placed diagonally at an angle of 50 degrees with the girth seam?

Solution.—Refer to the table given; for 50 degrees the factor equals 1.20, then $74 \times 1.20 = 88.8$ percent.

Speed in Shop Operations

Q.—The writer is desirous of securing some information, if possible, relative to production speeds of different operations in a boiler shop, more particularly I would like to know at the present time what would be considered good boiler shop practice in the number of holes that could be punched per hour in ¾ inch plate, 13/16 inch holes, and the number of rivets that could be driven on a hydraulic riveter of the same plate, using ¾-inch rivets.—L. M. W.

A.—The speed in shop operations depends on shop conditions, such as equipment, methods of handling material and the qualifications of the men handling the work. For single punch machines, an average of 250 holes per hour is good, and from 600 to 800 bull driven rivets per day.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo	Parkersburg, W. Va.	Seattle, Wash.

SELECTED BOILER PATENTS

Compiled by

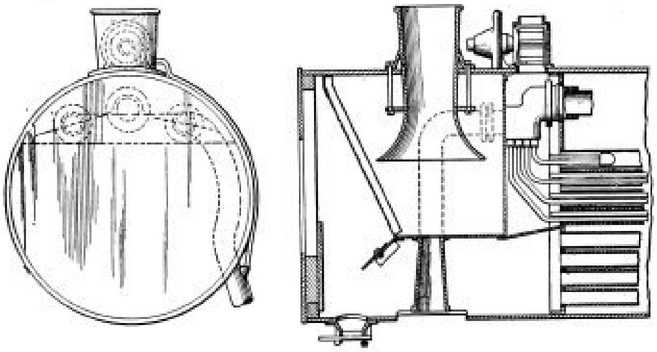
DWIGHT B. GALT, Patent Attorney,

Washington Loan and Trust Building
Washington, D. C.

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

1,553,578. JAMES TROTTER, OF CHICAGO, ILLINOIS. MECHANICAL DRAFT-PRODUCING DEVICE FOR LOCOMOTIVE ENGINES.

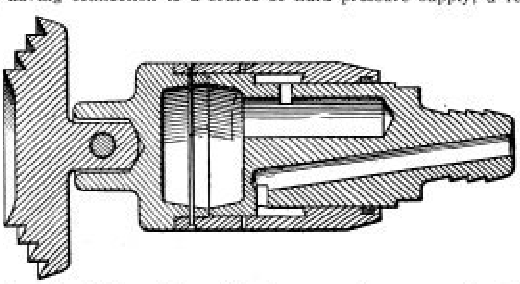
Claim 1. A mechanical draft producing device for locomotive engines embodying in combination, a chamber in the smoke box, said chamber being constantly out of communication with the interior of the smoke box but having communication with only some of the flues of the boiler, and a



mechanical suction creating device exterior of the smoke box and chamber and having communication with the chamber for creating suction only through those flues that have communication with the said chamber, said device co-operating with the exhaust steam for creating a draft over the entire area of the fire box grate. Two claims.

1,554,512. ARTHUR LOWY, OF NEWARK, NEW JERSEY, ASSIGNOR TO NEW YORK ENGINEERING COMPANY, A CORPORATION OF NEW YORK. BOILER-TUBE CLEANER.

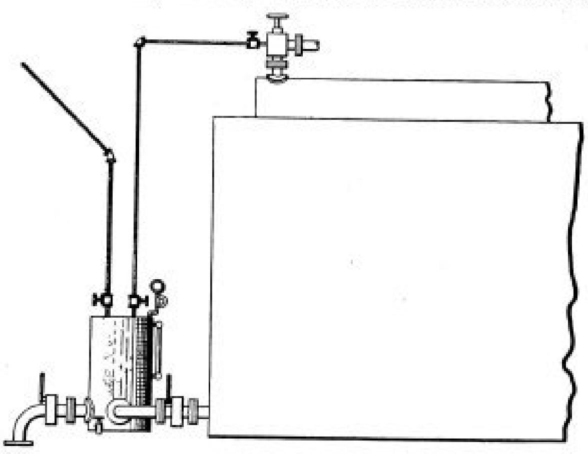
Claim 1. A fluid pressure percussion tool comprising a stationary ported member, having connection to a source of fluid pressure supply, a reciprocat-



ing member adapted to rotate and having an exhaust port for the escape of the motive fluid disposed non-radially to cause rotation, and tool attaching means carried by said reciprocating member. Six claims.

1,547,708. METHOD OF BLOWING OFF BOILERS. WYLIE G. WILSON, OF ELIZABETH, NEW JERSEY, ASSIGNOR TO LOOSE SEAT VALVE COMPANY, A CORPORATION OF DELAWARE.

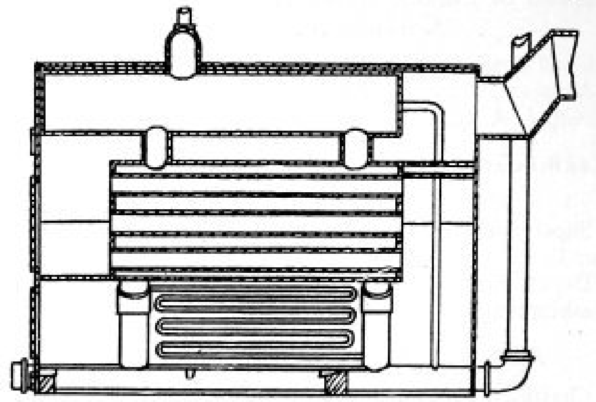
Claim 1. The method or system of boiler blow-off which consists in releasing the water under pressure against a gaseous cushion confined within a



suitable container, then cutting off such supply of water, and venting the container of gaseous fluid, then drawing off the fluid from the container for purposes of observation, test and discharge. 12 claims.

1,554,177. THOMAS F. REID, OF VANCOUVER, BRITISH COLUMBIA, CANADA. BOILER.

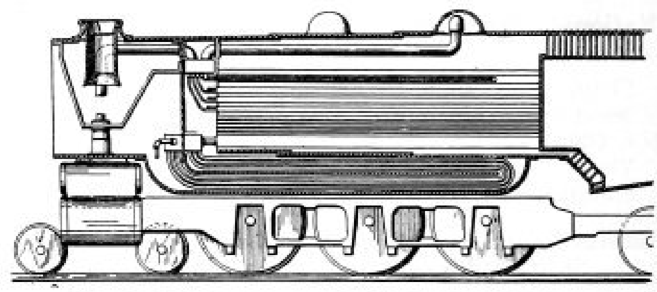
Claim 1. A boiler comprising front, rear, and side plates enclosing a furnace, a pair of pipes extending longitudinally on each side of the furnace adjacent the outer and lower edges of the front and rear plates and projecting through the same their front ends being capped and their rear ends elbowed, a cylindrical water chamber intermediate the height of



said front and rear plates shorter than the distance between them whereby a smoke box and a combustion chamber are formed at the front and rear ends respectively of said water chamber, plates forming the bottom and top of the said smoke box and combustion chamber respectively, smoke tubes extending through the said water chamber connecting the combustion chamber.

1,552,289. JAY S. FOSKY, OF SANDUSKY, OHIO. FEED-WATER HEATER.

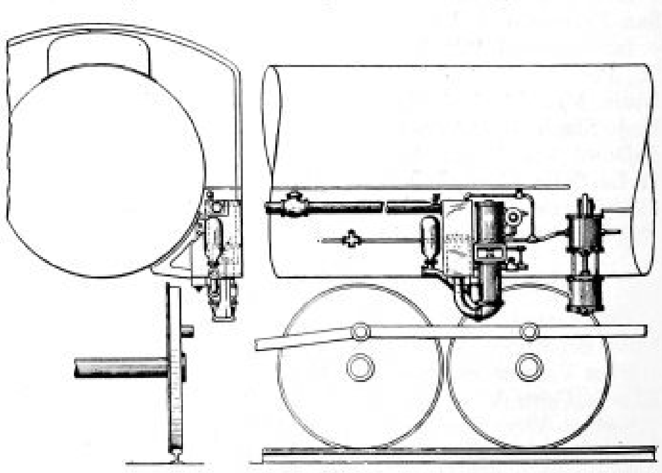
Claim 1. In a steam boiler, a substantially vertical baffle plate arranged in the smoke box, an intake header and an outlet header arranged on opposite sides of said baffle plate, a series of pipes connected to each of



said headers and extending beneath the water compartment of the boiler, and a substantially horizontal baffle plate extending from the lower end of said vertical baffle plate and arranged adjacent said pipes whereby the products of combustion are forced to flow under said horizontal baffle plate and around said pipes. Two claims.

1,551,727. EDMUND H. BLUNT, OF BROOKLYN, NEW YORK. LOCOMOTIVE-FEED-WATER HEATER AND PURIFIER.

Claim 1. In a locomotive open type feed water heater, a heater vessel, a pump cylinder, a single piston reciprocating in said cylinder for forcing a definite volume of cold water into said heater vessel at each upward stroke of the piston and withdrawing a definite but larger volume of hot



water from said vessel into the bottom of said cylinder at the same time, means for conducting steam to said heater vessel to be condensed by and mingled with the water therein, the volumetric displacement of the upper cold water end of the piston being less than the volumetric displacement of the lower hot water end of the piston by an amount determined by the cross-sectional area of the piston rod and the difference in the displacement between the cold and hot water sides of the piston being substantially equal to the normal volume of the condensate formed in the heater vessel.

Twenty-four claims.

The Boiler Maker

Volume XXIV 25 December, 1925 Number 12

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

Edward A. Simmons, *Pres.*
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London, England: 34 Victoria St. Westminster, S. W. 1.
Cable address: Urasigmec, London

H. H. Brown, Editor
L. S. Blodgett, Associate Editor

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

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

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

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CONTENTS

Annual Index

THE annual index of The Boiler Maker for the year 1925 will be published separately from the magazine at the end of the year. As the complete index will be useful only to those of our subscribers who have kept a complete file of the magazine for the year, only a sufficient number of copies will be printed to meet the requirements of those who notify us at once of their desire for a copy. A copy of the annual index will be mailed without cost to each subscriber whose request for it is received at our New York office on or before January 15.

A.S.M.E. Honors John A. Stevens

JOHN A. STEVENS, chairman of the American Society of Mechanical Engineers' Boiler Code Committee from August 11, 1911, to September 18, 1925, was made honorary chairman of the committee at a council meeting of the society held on November 30. At this time a certificate was presented to him notifying him of the action of the council. The Boiler Code Committee has taken this means of expressing the appreciation that the entire society holds for the great work which Mr. Stevens has done in promoting the cause of boiler safety. As honorary chairman, Mr. Stevens will continue to give his assistance to the work of the committee without having to carry the burden of the active chairmanship which he so ably and faithfully filled for nearly fifteen years.

Industrial Census

THE Honorable Herbert Hoover, Secretary of Commerce of the United States, has requested the early support of all industries in making their returns for the annual industrial census. The Bureau of Census of the Department of Commerce in Washington has enlisted the support of The Boiler Maker in calling the attention of all boiler manufacturers to the requirements of this census as outlined in the following statement:

"The Bureau of the Census is making plans for the next biennial census of manufacturers, which will cover the year 1925, as provided in the Act of Congress approved March 3, 1919.

"In deciding upon the items to be covered by the census, the bureau has consulted with the representatives of various manufacturers' associations with a view to securing, as far as practicable and without making the schedule too elaborate, information which will be of value to the representatives of the several industries concerned and at the same time furnish a record of the progress of manufactures generally throughout the United States.

"The blank forms upon which reports should be made will be mailed by the bureau to all manufacturers about January 1, and a report will be required from each manufacturer whose gross products are valued at $5,000 or more for the year 1925. It is to be hoped that every manufacturer concerned will have his records in such shape that he can fill out the schedule within a few days after its receipt, as the tabulation of each industry will not be made by the Bureau of the Census until reports are received from all manufacturers engaged in it. We therefore urge all boiler manufacturers to furnish this information, soon after January 1 in order that we may have, as early as possible in 1926, the statistics which will show the condition and record of their industry for the year 1925."

Pan American Business

STATESMEN and business leaders from the United States and Latin American countries and the Dominion of Canada will meet in New York on December 14 to 17 for the fifth annual convention of the Pan American Commercial Congress. Boiler manufacturers will be included among the delegates to this convention and an opportunity will be given for practical consideration of the problems involved in Pan American trade and commerce. In the Latin American countries lie immense possibilities for industrial development. With improved American transportation facilities and more direct business contacts between these countries and ours the Pan American market for products manufactured in the United States will steadily widen. This is an opportunity which boiler manufacturers cannot afford to overlook. Boilers built to the A. S. M. E. boiler code should have a special appeal to boiler users in South and Central America.

The Locomotive of the Future

THE development of the steam locomotive has practically reached its limit along conventional lines because of the physical restrictions of height, width and length. Since Stevenson's day the railroad engineering fraternity has concentrated on obtaining the greatest possible efficiency without altering the fundamental principles of design of the boiler or the mechanical features.

It does not require any great degree of foresight to realize that another generation will, because of mechanical problems, be dissatisfied with what we consider a high order of development today. Great changes in general develop slowly, but once in so often an individual steps from the ranks of the engineers of an industry and presents ideas that tend to speed up the developments that must inevitably take place. Not that his suggestions can be taken bodily and incorporated in plans that will revolutionize things over night, but they do serve to open a new line of thought which eventually wins the support of the industry.

An example of this is demonstrated in the article in this issue by William A. Newman, mechanical engineer of the Canadian-Pacific Railroad. After careful consideration over a long period of the problems that enter into present locomotive design and the limitations now imposed, Mr. Newman has developed in a formative way a type of steam locomotive that is now presented to the industry at large for consideration. As he states, the ideas are general rather than specific but should serve to open up the discussion of a vitally important matter. The problem is too broad for any one railroad or locomotive builder to experiment with. It is a matter, however, that deserves the consideration of the entire industry. The changes from conventional design suggested are radical but seem to offer no great difficulties mechanically or thermally; at the same time, they appear to solve many of the points of inefficiency existing in present-day designs.

THE BOILER MAKER considers it a great privilege to be able to present this material to its readers for comment and will be interested to receive their reactions on this "locomotive of the future."

LETTERS TO THE EDITOR

Prepared Graphite as Boiler Scale Remover

TO THE EDITOR:

Although the so-called remedies for scale are innumerable, none of the ordinary remedies is more than partly successful. Undoubtedly they do some good, but they certainly do not remove all the scale. Of late many boiler users in Great Britain have reported favorable results from the use of specially prepared graphite. The action of graphite is not chemical. It does not attack the metal, nor is it affected by acid contained in the water or the heat which is generated in the boiler.

The function of this material is to work through the fissures existing in the old scale and gradually penetrate between the scale and the metal. The scale thus loosened may be rapped off or removed with the ordinary cleaning tools. It must, of course, be understood that if the scale is very hard or thick as long as three or four months may pass before the graphite has any apparent effect. Even then the scale will not simply fall off, but the creeping action of the graphite loosens its hold on the boiler metal. In other cases a prepared graphite paint has been used to coat boiler interiors with excellent results. It has been asserted that such a coating will act as a heat insulator, but this is not the case and is one of the chief reasons why graphite crucibles are used for melting metals.

The graphite used for loosening scale is a finely-ground flake substance of good quality, as experience has shown that flake graphite is more evenly distributed over the surfaces of the shell and the tubes and becomes more permanently attached to the metal than the amorphous graphite. The quantities of graphite employed are, roughly, one-fifth of a pint per 50 horsepower per day of twelve hours for each boiler. A boiler of 100 horsepower, for example, will consume two-fifths of a pint per day of twelve hours, while a boiler of 500 horsepower will require two pints. One pint of the flake graphite is, roughly, equal to one-half pound.

London, England. G. P. BLACKALL.

Boiler Repairs vs. New Installations

TO THE EDITOR:

Subsequent and relative to the article which you published for me in the October number of the BOILER MAKER on "Safety Appliances for Steam Boilers" permit me to say I do not feel alone in endeavoring to be a factor in establishing means of reducing the fatal accidents and loss of life due to boiler explosions.

The mere fact that you are publishing articles on boiler and safety appliances and precautions along that line, should tend to create among the readers a more enthusiastic effort to aid you and the only means of aid that I can conceive of is for all to thoroughly study the article on safety appliances, the supposed and possible cause of explosions. In case the reader is an active boiler maker, inspector, foreman and possible foreman over a boiler plant, or in an operating boiler room, he should carry out the suggestions relating to the safe operation or safe repairs as he interprets them. His work is a duty and a large margin of his duty should be given to the aid of safe working conditions.

After reading the helpful articles written in the October number of THE BOILER MAKER by Mr. Fenner and coinciding with Mr. Kirkland's article along the same line, we find all causes of boiler explosions thoroughly discussed and scientific reasons established and given for such accidents accompanied with the peculiar picture of the boiler after the explosion. These articles alone from reliable sources and subject to the readers' viewpoint should tend to create more activity among all boiler inspectors, owners, builders, in establishing a system of study and research along this line.

We inspectors are not alone in the field of boiler difficulties but I believe we can speak regarding the obstinate facts that prevail in this broad line of duty.

Certainly we meet with all makes of boilers, good and poor, 90 percent perfect boilers and 10 percent bad. In other words, the boiler is either safe or not safe, and the line that separates the safe and the unsafe boiler in many instances is not an easy one to find. To me it is even more difficult to find this line that might lean towards the safety side than it was to build a standard boiler without a diagram because of the numerous points of prevalent weakness not easily detected in old boilers.

Along with the proper suggestions as to repairs of these faults, which is part of the inspector's duty, naturally arises the question, and always, a very important question indeed, to the boiler owner, "Is the boiler actually worth the cost of such repairs that might make it safe for a reasonable length of time?"

In various districts where saw mill drilling and private refinery boilers are distant from repair shops it is a question indeed that requires intense thought when elaborate repairs are necessary. Regardless of high cost of repairs if the owner continues to operate his plant with steam power, it is necessary to resort either to suggested repairs by the inspector or a new installation, either of which means some expenditure and by all means a most careful decision on the part of the owner.

I hope later to publish an article in which I shall endeavor to actually point out to the boiler owner and to other inspectors the boiler that should be junked and the boiler that can be repaired, thereby economically renewing its safety.

Franklin, Pa. R. L. HAMILTON.

Boiler Explosions

TO THE EDITOR:

I am glad to see that such a vital matter as boiler explosions and their causes is being taken up in the detailed manner the subject deserves. The safety of the public depends on such knowledge becoming the common property of the men who make boilers, and those who attend them, rather than the secret wisdom of the engineer, inspector, and technical men generally. How many boiler makers and riveters are there in the trade who could calculate the strength or efficiency of the riveted seams they are working on day by day? Oftentimes a squad of men is sent out to repair a fracture and beyond sticking a plate on and riveting and calking it they are lost. Fortunately most boilers are insured and consequently the repair must be to the satisfaction of the company's inspector.

Probably the man least aware of the huge responsibility thrust into his hands, is the stoker or fireman. With the exception of the Navy stoker and the locomotive firemen, stokers are drawn from the laboring classes (i.e., the man not skilled in a trade) and generally one who can do hard physical work being the most suitable for the job of throwing coal into the fire and drawing out clinkers. I remember asking a fireman who was attending a boiler at a factory in Young street, Toronto, what pressure he worked at, and he replied "100 and over, I guess." He really was guessing for the steam gage was graduated to 200 pounds and the insurance report allowed 90 pounds for a further 3 months. The same man had his coal rake hanging on to the end of the lever of the lever safety valve. The lever hung over the front end of the boiler and slightly to one side, and was beyond doubt a very handy place to hang the coal rake, but the thought of adding a further 30 pounds per square inch on to the adjusted load on the valve was beyond his comprehension.

However, these experiences are daily affairs in the work of an inspector and need not be dwelt upon other than to show that scientific design, high class materials and best workmanship are all in vain if a boiler is in the hands of an incompetent. Very often where there is a battery of two or more boilers, an engineer is in charge, but it is the single boiler, probably bought second hand and installed and operated in a crude way, where damage has occurred and loss of life.

The last essay on this subject was given by our friend Mr. Fenner in the October issue of THE BOILER MAKER. On one point only I beg to differ; that being, that with the exception of the locomotive, boilers are not likely to explode from shortness of water. It will be interesting to see how many precautions are taken to avoid shortness of water, and firstly the Factory and Workshops Act, 1901, viz.: "Every boiler used for generating steam whether separate or in one range must have attached to it a proper safety valve, a steam gage, and a *water gage*." The Metalliferous Mines Act, Coal Mines Regulation Act and the Quarries Act all demand the attachment of water gages. In addition to this, modern internally fired boilers have a fusible plug screwed into the crown, the inside of the plug being filled with lead or blanca tin, and when the water gets below the crown sheet the plug metal gets hot and melts and allows the steam to rush into the furnace through a very small hole. This action of the fusible plug warns the attendant that the water is down below the crown and he opens the feed valve.

USE OF SAFETY VALVES

A further precaution is the high steam and low water valve. Inside the boiler attached to this valve is a beam with dead weights on one end and earthenware float on the other so balanced that when the water goes down the float goes down also; this tilts the lever thereby opening the valve that shrieks out the equivalent to: *Low Water*.

It would therefore appear that low water in a boiler is rather a dangerous atmosphere to be in or why all these demands and precautions.

I have before me a book "Working of Steam Boilers" by Edward G. Hiller, M. I. C. E., M. I. M. E., chief engineer for the National Boiler and General Insurance Company and one paragraph runs thus: "If an attendant finds on opening the fire door that the furnace crowns are red hot, the best course is to withdraw from the front of the boiler at once and warn everyone in the neighborhood, as it is probable that an explosion or more serious accident is about to occur."

The collapse of a furnace crown in a locomotive, vertical, Lancashire, Cornish, Yorkshire, dry back, launch or marine boiler is very often followed by a rupture, and then in Mr. Fenner's own words—"the rupture always precedes the explosion."

I have before me a number of photographs of exploded boilers; seven of these are attributed to low water and each offers a hideous picture of ruined buildings, twisted pipes and plates, etc.

In conclusion my points are that actual explosions due to low water, authorities' views and demands, the attachment of water gages, fusible plugs and low water valves, all prove how important it is to keep the water at its proper working level, and the attendant who neglects this may not live to regret it.

Leeds, England. JOHN GORDON KIRKLAND.

New Rule for Losses Due to Scale

TO THE EDITOR:

Authentic reports show that in a series of 120 tests by a large company 11 percent greater output was obtained from engines during the month after freeing the boilers from scale than was obtained during the three months previous to cleaning. This is equivalent to a saving of 11 percent of the fuel. In similar tests by other concerns savings range all the way from 8 percent to 16 percent. In a series of tests performed by Professor Schmidt of the University of Illinois on locomotive tubes covered with scale of thicknesses varying from zero up to 1/9 inch it was found that heat losses vary from zero at zero thickness to 16 percent at a thickness of 1/9 inch.

On making a study of the curves plotted from the above tests this writer has developed the following rule: "48 multiplied by the square root of the thickness of the scale is equal to the percent loss." This the writer found closely represents the relation between scale thickness and fuel loss. The curve plotted from this rule shows that there is a rapid increase in loss when the scale is very thin and that the increase is not directly proportional to the thickness but rather as some power of the thickness. It also shows plainly that after a thickness of 1/9 inch is reached the rate of loss is not so great—not nearly so great—as during the earlier scale forming stages. After a thick scale is once formed a little added thickness or a considerably greater thickness doesn't make much difference. The important point is take ALL of the scale off and take it off frequently.

Periodical scale removal is desirable for other reasons besides economy. Scale is often directly responsible for the overheating and burning out of boiler tubes when operating at heavy loads. At light loads a given thickness of scale may be harmless, the heat being transmitted without trouble. However, when forcing the boilers the temperature of the boiler shell naturally increases often to such an extent that the scale adjacent to the shell becomes dry. When dry, scale is a more effective heat insulator than when wet and as a result there is grave danger of overheating and burning the shell or tubes. It is not uncommon in plants where the scale menace is lightly regarded to retube boilers completely every two or three years. With proper care tubes should last nearly as long as the boiler itself. It is cheaper to clean old tubes, and to provide proper means for cleaning them, than to buy new ones.

There are thousands of engineers and owners of plants throughout the United States who are still ignorant of the scale problem who do not even know that their boiler tubes are coated with scale. One manufacturer writes, "In 75 percent of the reports to us the officials or engineers claim that they have no scale or are using water which does not produce scale. In other words, because the water is clear and safe for drinking purposes and shows no muddy deposit they seem to think that it is free from scale properties. There are thousands of plants where no attention whatever is paid to scale, yet every little while they find it necessary to retube their boilers and they simply put that down to wear and tear." Rain water, snow water and distilled water are about the only waters that do not produce a serious amount of scale in boilers.

Newark, N. J. W. F. SCHAPHORST.

NEW BOOKS

LOCOMOTIVE AND BOILER INSPECTORS HANDBOOK, *by A. J. O'Neil, locomotive inspector, Public Service and Transit Commission for the State of New York. 274 pages, illustrated, 4½ inches by 7½ inches. Bound in cloth. Published by the Simmons-Boardman Publishing Co., 30 Church street, New York.*

Boilermakers, machinists, enginemen and firemen may work on locomoitves for years and claim that they know an engine from coupler to coupler and from the rail to the sand dome, but when they are required to take a written or oral examination, many of them fail to make a passing mark. The reason for this is that they have gained their knowledge piecemeal over a period of years and have never given serious thought to the fundamental reasons why locomotives and boilers have to be maintained to meet a certain set of required rules and regulations. Many of these men never have had the opportunity to study these rules and regulations and do not know what to expect in a competitive examination for the position of a federal or state locomotive inspector.

Every year many thousands of such men take the federal and state examinations for locomotive inspectors. To assist these men properly to prepare for these examinations, the author of this volume has compiled in an orderly fashion the rules and regulations, questions and answers and other pertinent information on locomotive boilers and machinery which, if properly studied, should prepare competent practical men to pass an examination on locomotive inspection.

The first six chapters cover the laws, rules and instructions for the inspection and testing of locomotives and tenders and their appurtenances as laid down by the division of locomotive inspection of the Interstate Commerce Commission. The first chapter contains the original locomotive inspection law passed in 1911, and all subsequent additions made to that law up to the present date. It is imperative that all locomotive inspectors thoroughly understand this law as all of the rules and regulations governing the inspection of locomotives on all the railways in the United States are based on these laws which have been approved by Congress. Rules and Regulations for the Inspection of Locomotive Boilers, Rules and Interpretations for the Inspection of Steam Locomotives and Tenders, Locomotive and Safety Appliance Standards, are the headings for the following three chapters. Chapter VI contains the rules and instructions relative to the method of preparing and filing the inspection reports required by the Interstate Commerce Commission. This chapter contains reproductions of these reports which are filled out according to standard practice.

Chapter III contains a list of questions and answers asked in examinations given to those whose ambition it is to become a locomotive inspector. This list indicates the type of questions on both boiler and mechanical work which are apt to be given in an examination. The author offers to amplify, on the request of the reader, any questions which may require a further explanation. These questions are grouped according to the subject matter, each group headed with a sub-head such as the construction of the locomotive boiler, joints and strength of boiler, combustion and evaporation, boiler inspection and defects, etc.

Chapter VIII contains 52 pages on the rapidly increasing important subject of welding. Welding is a comparatively new process of making repairs which is used very extensively by the railroads. A competent locomotive inspector should know the fundamental principles governing both gas and electric welding and be able to inspect a welded job in order to determine whether the

(Continued on page 354)

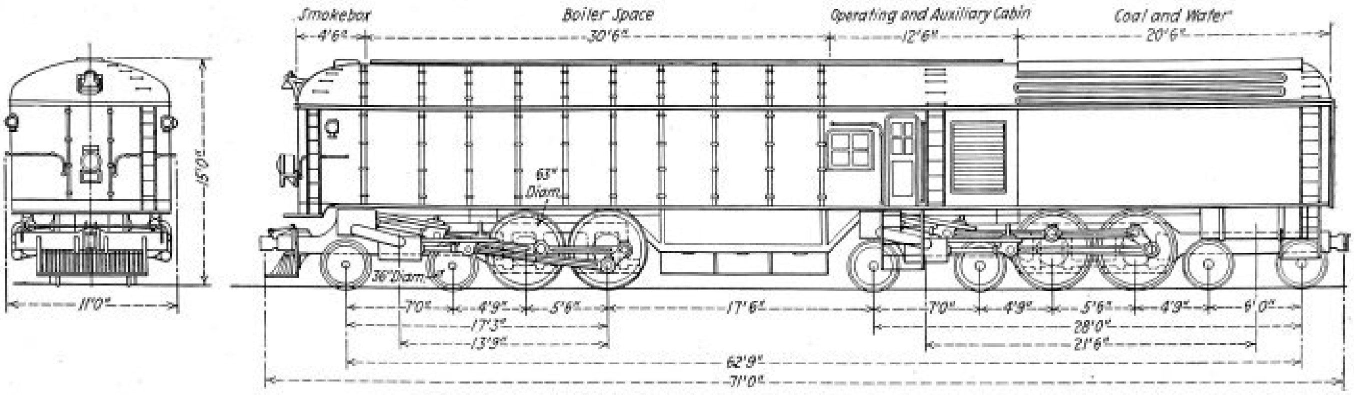


Fig. 1.—Schematic view of proposed steam locomotive

Ideas and Suggestions for Future Locomotive Development

General outline of mechanical features of proposed steam locomotive with special reference to boiler details

By William A. Newman*

UP to within the past few years, the development of the steam locomotive has been along the lines of a natural increase in capacity, weight and refinement of details. At the present time, we find that through normal growth, the modern locomotive in America has just about reached its ultimate stage of development, as regards physical restrictions of height, width and length. The weight factor is also becoming one of extreme seriousness, with the continued increase in axle loads.

The present trend of development still appears to be along the lines of further increases in capacity, together with improvements in operating and fuel efficiency. Efforts in this direction are in the main still centered on refinement and changes in details of construction, together with the addition of auxiliary equipment and appliances.

In considering the possibilities of the locomotive of the future, the electric locomotive should merit first consideration. It has many manifest and marked advantages as an operating unit, and without doubt, will be more widely used in the future than in the past. The very large initial plant and equipment investment required for electrification makes it doubtful, however, whether the use of the electric locomotive can ever be universal, as long as present first costs are maintained and further reductions in cost of transportation are still possible with more improved forms of heat engines. It would, therefore, appear logical that the future development of motive power will naturally include more refined and efficient forms of the heat engine, in view of the great possibilities for large gains in economy.

Fundamentals Defined for Proposed Locomotive

To determine what would be possible from this standpoint, a proposed type of locomotive has been worked out and at the outset it must be stated that the following constitutes only a grouping of ideas, which, although fairly well thought out as regards the detailed form of construction, have not been fully investigated, so that it is the ideas themselves that must be adopted or discarded on their own merits. It should also be clearly stated that the whole object in putting forward this suggested type of locomotive is to demonstrate that the possibilities of increased capacity and greater economy of the steam locomotive have by no means been exhausted.

As a starting point, two features of the electric locomotive have been adopted as permitting a wide range in flexibility of control and operation. These are:

First—The electric control and operation of all auxiliaries and auxiliary devices.

Second—As close an approach to the constant torque of the electric locomotive as is feasible.

To accomplish the first it is proposed to use a turbine-driven generator for the developing of sufficient current to take care of the operation of auxiliaries, the manipulation of main distributing valves and throttle and reversing controls. To obtain the second objective, it is proposed to use multi-cylinder construction.

To obtain the maximum thermal efficiency, high steam pressure and high superheat are necessary, and also tend to improve construction through the use of smaller parts and the greater possibilities for work production of the more highly superheated steam.

The Design of the Boiler and Frame

With these fundamentals defined, the selection of a form of assembly is the next step. Here boiler construction enters, and it becomes at once apparent that a revision in the type of boiler is essential for the use of higher pressures and the obtaining of greater steam-producing capacity. The particular form of boiler to be used is more or less immaterial, in fact, it might be possible to develop a boiler along several different lines which might be perfectly capable of the development necessary to take care of the further growth of locomotive capacity. It is, however, felt that any boiler design that is now proposed will only be tentative at the best, as it is practically a certainty that radical departures in methods of steam generation will in the future open new fields of locomotive development. In order to present the form of the locomotive now proposed as a whole,

*Mechanical Engineer, Canadian Pacific Railway, Montreal, Canada.

one type of boiler has been worked up in which only more or less accepted forms of construction have been followed. While higher pressures will undoubtedly be used in the future, it is thought advisable to adhere to a moderate advance in pressure at the start. For this reason 300 pounds boiler pressure is suggested. The boiler itself is divided into two stages, the high pressure stage carrying 300 pounds in which pressure is confined entirely to small diameter evaporating tubes, a central storage drum, together with the necessary headers.

The low pressure stage acts as a combined secondary feedwater heater and water purifier. The low pressure side of the boiler also forms a container for the nests of evaporating and superheater tubes. Briefly the water is first fed into the low pressure stage at 170 pounds pressure, in which the water is heated to the corresponding temperature for this pressure, and then passed into high pressure stage where the evaporation occurs.

As height and weight restrictions are immovable, it is imperative that the weight be used to a better advantage, which is possible in multi-cylinder construction, as the adhesion necessary is reduced. The utilization of the weight of fuel and water also forms a possible means of the better use of weight. It is suggested that the locomotive construction as a whole be in the form of a main unit, consisting of the boiler, operating cabin, fuel and water storage space, with the necessary auxiliaries, etc., all mounted on one frame of which the boiler construction forms parts. This frame would be mounted on forward and rear pivoting trucks. Each truck would consist of a group of driving wheels and smaller guiding wheels with four steam cylinders to each truck or driving unit, the steam supply and exhaust for which are carried through the pivoting center, so as to reduce the angular movement to be provided for in the flexible connections. To demonstrate the possibilities of construction of this form, a moderate size locomotive has been selected which is shown to scale in one of the illustrations. This particular locomotive is suggested as a general service unit suitable for either freight or passenger requirements, as the characteristics of the proposed engine would make the size of the wheels selected suitable for moderate high speed work, as well as heavy sustained tractive force. The various details of construction that are suggested may now best be described by an explanation of the different constructional features of the proposed locomotive which, on account of the electrical control, has been termed a thermo-electric locomotive.

The description of the various details will be given in the following order:

(1) Forward and rear driving units.
(2) Boiler construction, including feedwater equipment, stoker arrangement and provisions for draft.
(3) Feedwater heater in conjunction with the water reservoir.
(4) Auxiliary equipment.
(5) General comment on the electrical control, general construction and possibilities for future development.

Forward and Rear Driving Units

The forward driving unit consists of two pairs of drivers with one four-wheel guiding truck. The rear driving unit is a duplicate of the leading, with the exception that a four-wheel trailing truck is used as well as the four-wheel guiding truck. The exhaust from the forward cylinders is emitted directly through the stack, whereas the exhaust from the cylinders of the rear unit is led into the water storage space, and partially utilized for feedwater heating. Outside of the foregoing differences, both trucks are alike in all details and the parts are largely interchangeable.

The frames are cast with both sides integral with cross ties and bracing, similar to what has been done on recent electric locomotives to give maximum strength with minimum weight. In each driving unit the two pairs of drivers are driven by four cylinders, all cylinders being mounted on the outside of the frames, the upper pair of cylinders driving the first driving wheels and the lower pair of cylinders the second driving wheels. The upper cylinder drives direct on a main crank-pin, such as is used in customary locomotive practice. The lower cylinder drives on a crank-pin carried on a return crank, the inner portion of the return crank serving as a bearing for the side rod connecting the two pair of drivers together. This return crank with both inner and outer bearings is constructed from a solid forging pressed and keyed directly in the driving wheel center. The cylinders to develop a tractive effort of 71,400 pounds are 13 inches in diameter with a 26-inch stroke. These take up a very small amount of room compared with modern practice, and together with the use of frames cast integral will permit the use of four-wheel trucks having outside bearings which allow the use of standard A. R. A. axles and journal boxes, etc., and should materially assist in engine truck maintenance.

Boiler Construction, Including Feedwater Equipment, Stoker Arrangement and Provisions for Draft

The boiler itself forms the forward portion of the main locomotive frame, that is the strength of the boiler structure is made use of to partially support its own weight. A channel side sill will run throughout the length of the locomotive which would be attached at intervals to body bolsters serving as ties across the bottom of the boiler and also serving as center plate supports at the pivoting centers of the forward and rear trucks. The side walls of the water storage space at the rear of the main portion of the locomotive would also be constructed so as to be self-supporting and would be carried forward by structural members and attached to the side sill and top of the boiler construction in order to give the requisite strength through the operating cabin.

The general arrangement of the form of boiler suggested is shown herewith. While some details have been indicated on this drawing, they are entirely optional, as there are a multitude of forms of construction that can be adopted to give the required results. However, it will be seen that the boiler, as shown, consists of two longitudinal drums running for the length of the boiler at the top, which are riveted to a water-leg on each side of the boiler which extend down to form the firebox at the rear, and to give a rectangular space in front of the firebox which is carried through to the front end of the boiler. A larger central drum is carried between the two smaller drums, the three drums being fastened rigidly together at the front of the boiler and the central drum slung or suspended towards the rear so as to be free to expand and contract due to differences in temperature. This central drum is connected with nests of evaporating and superheating tubes, which really constitutes the steam generating side of the boiler. The underlying principle in the construction proposed, aims at the elimination of all scale-forming solids before the water is introduced into the small diameter high pressure evaporating tubes. Practically all scale-forming solids are in solution in water at a temperature up to 360 degrees F. Beyond this temperature the solids go out of solution and become mechanically suspended in the water, at which stage they are in such a form that they would be readily deposited or baked into scale through adherence to hot surfaces.

It is proposed to retain all solids in the first stage, the feedwater being fed directly into the two upper small diameter drums from where it is circulated down into the water-legs. This first stage while carrying 170 pounds pressure is not intended as an evaporator, but simply as a water heater, the water being carried at a high level in the drums and only sufficient space allowed to take care of the necessary expansion. The water level would be automatically regulated so as to be kept constant and if a rise in pressure occurred water would be automatically passed into the second stage and make up water supplied from the water storage tank, all the automatic regulation being worked out electrically by means of making and breaking of electric contacts.

To transfer water from the low pressure stage into the higher pressure stage, two pumps are proposed mounted directly on the rear heads of the two small diameter outer drums. These pumps would consist of rotors submerged under the constant water level at all times, the rotor shaft having one bearing in the boiler and extending out through a packing gland to the outside of the boiler head where the rotor shaft would be driven by an electric motor. The rotor construction proposed, which would be mounted in a cast housing, also submerged in the interior of the boiler, would first impart a radially outward motion to the water which would tend to create a movement of the water in the casing in which the heavier solids in suspension would be thrown radially outwards, and a small core of water at the center of the moving mass would then be picked up and pressure imparted to it by the pump rotor proper and forced out through a delivery passage and into the central high pressure drum carrying 300 pounds pressure.

At the forward or smokebox end of the boiler a combined smokebox and header chamber is built up by two vertical side headers and one horizontal top header which are bolted rigidly together and to the side water-legs of the first stage, a plate connection also being made between the back wall of the horizontal header and the drum ends. The top horizontal header is the superheater header. The two side vertical headers provide connections for evaporating tubes. The water in the high pressure central drum is led through two delivery pipes to the side headers where it is carried through downward slanting diagonal passages to the front of the headers, and then passed down to horizontal passages at the bottom of the header from which comb passages rise vertically, exactly as is customary on the standard type "A" superheater headers.

Nests of evaporating tubes are then connected with ball joints to these lower comb passages, so that the water circulates through the tubes, which have a constant vertical rise and then is carried to comb passages at the top of the vertical side headers which feed into a common top passage, which in turn has a connecting pipe back into the central high pressure drum. All of this construction can be followed by reference to Fig. 2, and it will be noted that in order to reduce the number of header connections the evaporating pipes are made in multiples, two pipes being merged into one before the bend is made to establish the connection to the header, which will be carried out with a ball ring similar to what is now followed in superheater practice.

The evaporating unit clamps are secured to either header by through bolts, the nuts being applied on the outside of the header where they are exposed and readily removed and applied. In order to make the headers gastight through the bolt holes the nuts seat on ball washers. The upper or superheater header is connected directly onto the steam space of the central drum, the course of the steam and the unit arrangement being exactly similar to the standard type "A" superheater construction. In order to reduce connections, the unit pipes are merged together before the bend to the header connection occurs. All superheating and evaporating pipes are $1\frac{1}{2}$-inch diameter. In order to give a definite circulation of water and steam, the feedwater is discharged into the center drum at the rear, is led into the evaporating headers from the front and is discharged from the latter in the form of steam towards the rear and the superheater intake is again at the front. The superheater always contains steam and in the superheated steam passage of the header, there are two outlets at which throttle valves are located, which are controlled separately and operated electrically. One throttle governs the supply of steam to the forward driving truck, and the other to the rear driving truck.

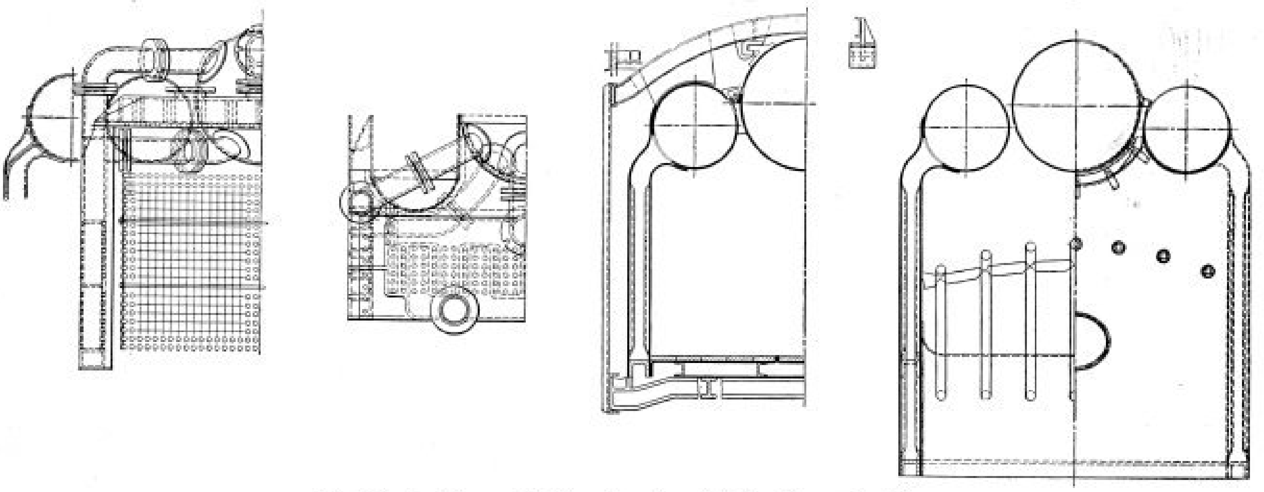


Fig. 2.—Sections of boiler, showing details of construction

Some details of boiler construction have been indicated in Fig. 2, among which is the side water leg construction, which is shown in the form of vertical corrugations. These are introduced for the purpose of taking up the expansion which would be considerable in water-legs of such length. They also serve to stiffen up the construction considerably, which is desirable on account of the boiler partially carrying its own weight. The use of staybolts is necessary in the water-legs and backhead, and in this connection, while no definite details are submitted herewith, it is suggested that some new type of flexible staybolt is necessary as none of the bolts heretofore in use are theoretically correct, as the relative movement of the sheets sets up severe strains at the junction of the threaded portion of the bolt and sheet.

It is possible that flexible bolts could be made of flexible multi-strand cable which can be developed of very strong wire so that the diameter of the stay will be very much reduced. The flexible cable could be made up with one end permanently secured in a sleeve approximately $1\frac{1}{4}$-inch long, which would be in the form of a truncated cone with the entrance belled where the cable enters. This cone would rest against a beveled reamed hole in the sheet and the head project about 1/16-inch above the sheet to permit a beading being applied by electric welding. After this fixed end is inserted in one side sheet, a similar cone would be slipped over the end of the cable at the outer side sheet, the cable drawn tight, and bonded electrically to the sleeve by passing a current between contacts gripping the sleeve between them. The circumference of the outer sleeve would also be welded to the sheet as was done for the opposite end. Considerable development would be necessary to bring this arrangement to the practical stage, but the use of such stays should materially improve conditions in side sheets.

An alternative construction could be used whereby the water-legs could be divided into sections and expansion joints provided to take up the fore-and-aft sheet movement. It will be noted that considerable care has been taken in the proposed construction to allow the location of washout plugs directly above the side passages, so that free access to the sides for washing out is readily obtained. Manholes would also be located in the three upper drums to permit easy access for cleaning.

At the rear of the operating cabin is located the fuel and water storage space. The fuel storage space consists of—a wedge-shaped hopper of uniform width, the rear wall being sloped at such an angle that the coal is fed at the bottom, the coal is delivered to the stoker conveyor.

As previously mentioned the exhaust steam from the forward driving unit is ejected directly into the stack in practically the same way as is done at present. It is felt that this draft should be sufficient to provide the necessary air for combustion during a considerable portion of the time that a locomotive is in operation. To take care of higher evaporative rates, it is proposed to supplement the stack draft by forced draft to be provided by a compact centrifugal fan located in the operating cabin, driven either by a steam turbine or electric motor, depending upon the amount of power required.

Combined Condenser and Feedwater Heater in Conjunction with Water Reservoir

The water storage space at the rear of the locomotive consists of a solid rectangular storage tank, with the exception of a wedge-shaped space, through the center, which serves as a fuel storage well, the whole structure being rigidly braced after the manner of current tender practice. The side walls of the water tank will be riveted directly to the structural steel members to give strength to the locomotive body side framing. The side walls would then be panel insulated and covered on the exterior by a series of removable panels which form the exterior of the locomotive. The exhaust from the rear power truck would be used for preheating the feedwater. The heater may be of either the closed or open type, but the closed type is suggested to consist of a horizontal steam cylinder, inclosing water circulating coils after the manner of existing heater construction. The heater would be located in the water tank space at the top, so as to drain the condensate by gravity into the water storage space. The exhaust from the main auxiliary turbo generator would also discharge into the feedwater heater. The feedwater would be fed direct to the first pressure stage by a compact triplex pump, located below the lowest water level, so that a gravity feed is obtained. The triplex pump would be gear driven by an electric motor, so that it can operate at low speed to give a constant low velocity discharge and permit maximum flexibility of regulation.

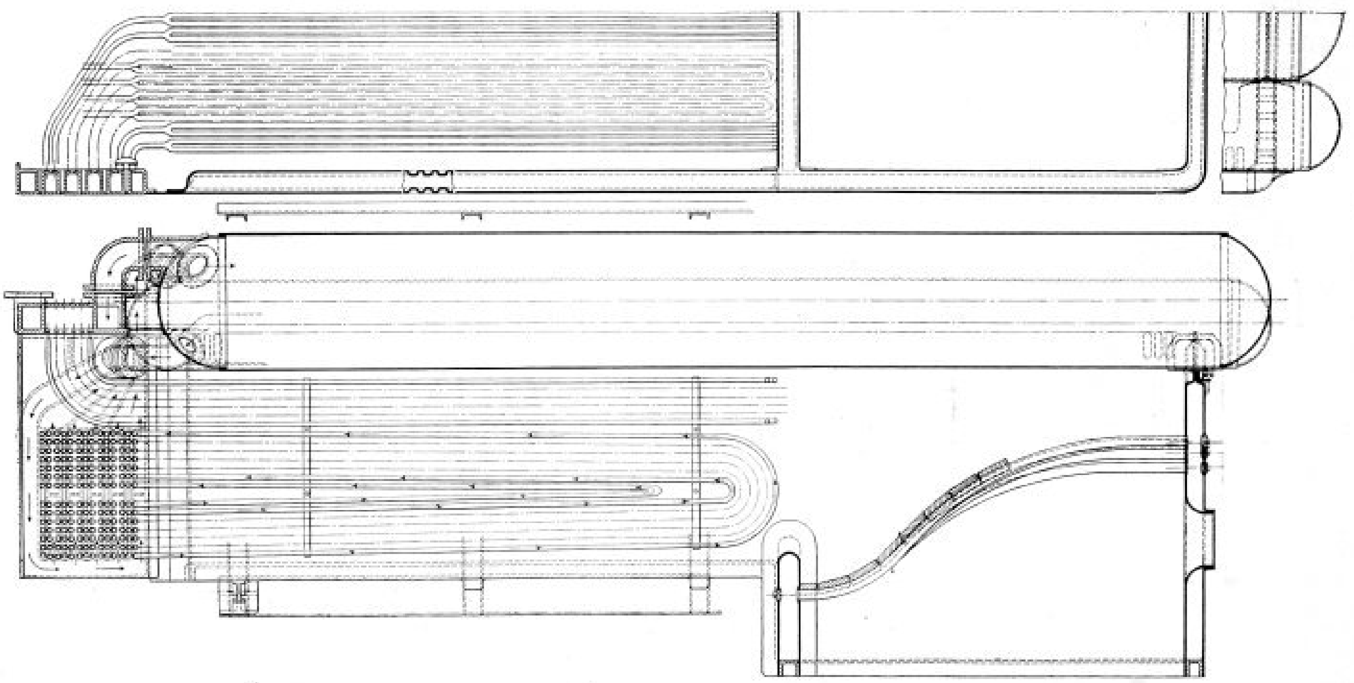


Fig. 3.—General arrangement of boiler for the steam locomotive proposed for development

Auxiliary Equipment

In general it is proposed to operate all auxiliaries by electrical energy developed by a compact direct current generator, direct connected to a steam turbine.

Most of the auxiliary equipment has been already referred to, the boiler feed pumps being electrically driven and the draft pressure fan either steam or electric driven. The air compressor it is also proposed to drive electrically, and the lubrication will be attended to by individual electric motor-driven oil pumps located on the frame of each driving unit. The throttle regulation will also be carried out by electrical control, it being possible to operate the throttles, either separately or in parallel. The cut-off regulation only requires the manual manipulation of a comparatively small lever, as all that it is necessary to do is to establish electric connections with proper segments on the commutators surrounding the main axles.

It is proposed that all water levels be automatically regulated by electrical means, so that pumps are automatically cut in as the water levels fall, and cut out as they rise to a predetermined level, it being further possible for the engineer to manually control the level if desired. It is further proposed that all water levels be registered electrically on a central instrument board. To allow the operation of two locomotives together, it is proposed to arrange the controls so that the throttle and valve motion can be entirely regulated from the leading locomotive by cutting in electrical connections between the two engines. The water levels and pressures can also be electrically registered on duplicate registering devices on the first engine so that one engineer and two firemen may readily operate two locomotives operating together.

General Comments

It will be noted that on the locomotive shown in Fig. 1 the total overall length between coupler knuckles is 71 feet, which is considerably less than for modern locomotives of equal capacity. It is felt that the length of the present modern steel passenger cars may be taken as a possible limit of length, which is 85 feet. There is, therefore, 14 feet expansion still possible for greater capacity locomotives. The locomotive shown can have its wheel arrangement modified to provide for two wheel engine trucks, which would permit the use of three pairs of 58-inch diameter driving wheels in practically the same length of wheel base, so with very little increase in length, it would be possible to develop a tractive effort of 110,000 pounds without exceeding a 60,000-pound axle load. With further increases in weight on drivers within limits that are now being worked to, still further large increases in tractive effort are possible if necessary for special designs of heavy service locomotives. All tractive efforts quoted have been for quite conservative factors of adhesion, and it is expected that with a practically constant torque, especially with the increase in the number of drivers, that lower adhesion can be worked to, which again will permit further increases in tractive effort.

With eight 58-inch diameter drivers and adhering to 300 pounds steam pressure, cylinders 20 inches in diameter would develop a tractive effort of 180,000 pounds, so it will be seen that there is ample possibilities for development of the proposed type of locomotive without going to excessive weights or size of cylinders. It is, however, thought that further development can be made with higher pressures, as this is one of the most fruitful sources for gains in economy of operation. Three hundred pounds pressure has been selected as a moderate advance which would permit appreciable superheat without exceeding a total steam temperature of 700 to 750 degrees. With the construction proposed, however, there is no reason why higher pressures cannot be used as soon as sufficient experience has been gained, which will have the effect of holding down cylinder sizes with minimum effect on weights of reciprocating parts. The cost of a locomotive as herein described would be greater on a weight basis than the standard type steam locomotive. The cost should, however, be very much less than equal capacity electric locomotives, and the gain in economy and increased flexibility of operation should warrant any increase in cost, which viewed from any angle should be very much less than any type of Diesel or turbine locomotive yet proposed.

In conclusion, it should be stated that although there is very little that is new in what has been suggested, yet the proposed regrouping of old ideas constitutes some novel and some radical combinations. All these require very thorough investigation before adoption is possible, which on account of the magnitude of the task, it is almost impossible to make without the undivided efforts of a considerable and experienced engineering staff. For this reason it is thought more desirable to submit the above grouping of ideas for discussion and comment, in the hope that locomotive engineering as a whole will benefit, rather than attempt to prove or disprove the proposals by private development.

General Uhler Resigns

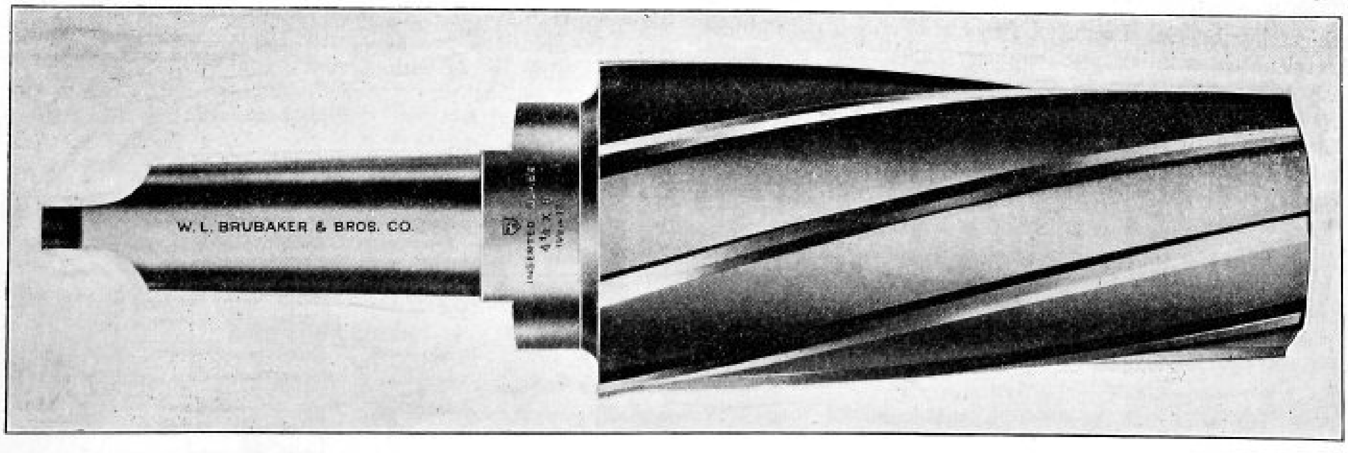
The resignation of General George Uhler as supervising inspector general of the Steamboat Inspection Service was announced on December 6. His resignation will take effect December 31. No successor to General Uhler has been selected, it was stated at the Department of Commerce.

Spiral Inserted Blade Reamer

When the cutting edges of solid reamers are worn down to the point where they cannot be reground, it is necessary to scrap the tool. This is a loss that can be reduced to a minimum by inserted tooth reamers. Such a reamer has been designed and placed on the market by the W. L. Brubaker & Brothers Company, 50 Church street, New York. The body of this reamer is made of a steel which can be subjected to abuse without the danger of breakage or twisting.

The blades are made of high-speed steel and are heat treated so as to stand great strain without breakage. New blades can be furnished but as they are inserted by a special process, the reamer body should be sent to the factory for this work in order to obtain the best results.

The reamer can be obtained in any taper and size above 3 inches in diameter.



Brubaker spiral inserted tooth reamer

Standardization of Hose Connections for Welding and Cutting Torches and Regulators

WELDING and cutting equipment is in use in almost every manufacturing plant, railroad shop and ship yard, and on construction, erection and demolition jobs all over the country. In fact, gas welding and cutting equipment is universally used. There are in all twenty-five or thirty or more different makes of torches, regulators, etc., which in the past have been equipped with various diameters and threads for hose connections. Lack of uniformity in the design and size of these fittings has caused users of equipment considerable trouble in providing adaptors and making connection between different makes of torches, regulators, etc.

In order to eliminate this inconvenience in connecting up one make of torch with a different make of regulator or vice versa, the manufacturers of welding and cutting equipment have established a standard for hose connection, nuts and nipples for both torches and regulators, which will soon become effective. After an exhaustive discussion of the subject by the Gas Products' Association, the International Acetylene Association and engineers and other representatives of apparatus manufacturers, a standard thread and a standard design of nut and nipple have been developed and adopted.

The two associations mentioned above have been cooperating to obtain the acceptance of this standard and up to the present time the following apparatus manufacturers have accepted the standard and agreed to make it effective beginning January 1, 1926: Air Reduction Sales Company, New York City; The Bastian-Blessing Company, Chicago, Illinois; Burdett Manufacturing Company, Chicago, Illinois; Harris-Calorific Company, Cleveland, Ohio; Imperial Brass Manufacturing Company, Chicago, Illinois; Alexander Milburn Company, Baltimore, Md.; Modern Engineering Company, St. Louis, Mo.; Oxweld Acetylene Company, Newark, N. J.; Purox Company, Denver, Colo.; Smith's Inventions, Inc., Minneapolis, Minn.; Torchweld Equipment Company, Chicago, Illinois, and United States Welding Company, Minneapolis, Minn. These companies combined produce the greater portion of welding and cutting apparatus and equipment manufactured in this country. Negotiations are being carried on with other equipment manufacturers with a view to making the acceptance

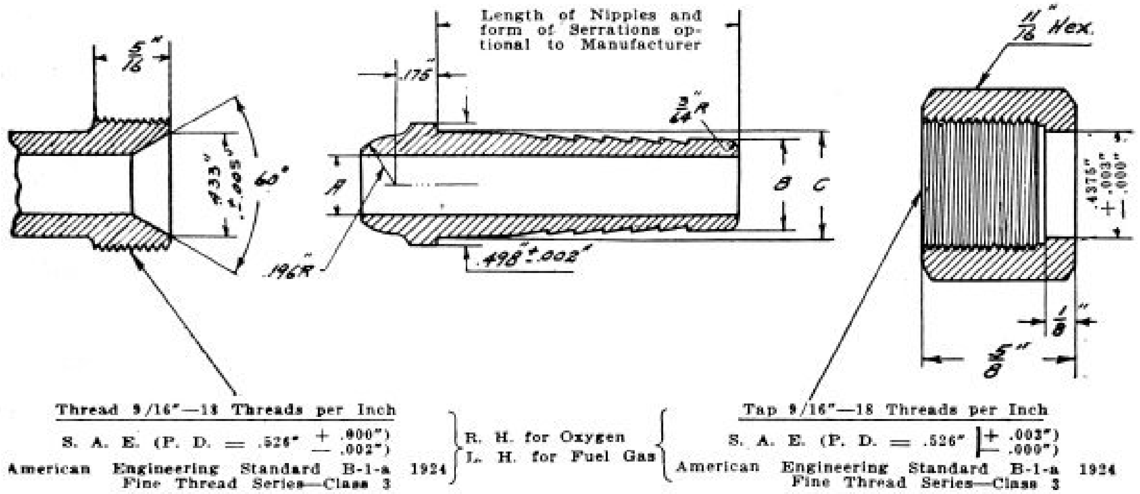


Fig. 1.—Standard design of "B" size hose connection for large size torches and for regulators

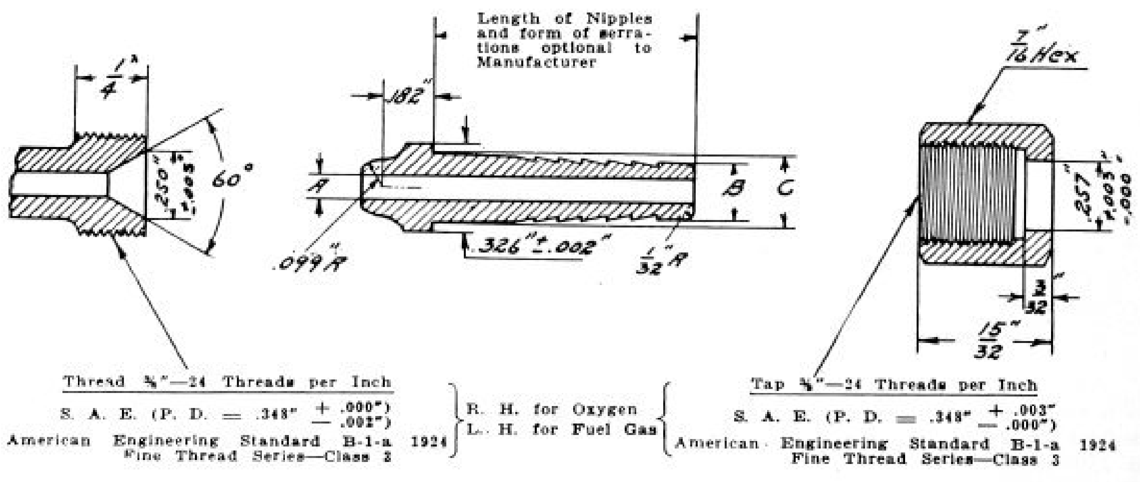


Fig. 2.—Standard design for size "A" hose connection for small torches

of this standard as nearly universal in America as possible.

The standard has already been approved by the Gas Products' Association, Chicago, Illinois, the International Acetylene Association, New York City, and the Underwriters' Laboratories, Chicago, Illinois. It is under consideration, but has not yet been formally approved by the American Welding Society, Bureau of Standards, Compressed Gas Manufacturers' Association, National Safety Council, and the United States Navy. It is anticipated that favorable action will be taken by these bodies in the near future and that the standard will be universally recommended and adopted in the United States.

"B" Size

Hose	A	B	C
3/8"	.250" +.003" —.000"	.375"	.430" +.000" —.005"
5/16"	.187" +.002" —.000"	.3125"	.375" +.000" —.005"
1/4"	.125" +.002" —.000"	.250"	.312" +.000" —.005"
3/16"	.093" +.001" —.000"	.187"	.250" +.000" —.005"
1/8"	.062" +.001" —.000"	.125"	.187" +.000" —.005"

In establishing this standard design for hose, nuts and nipples very careful consideration was given by the committees appointed for this purpose to adopting a design of nut and nipple and size of thread which would produce a convenient hose connection sufficiently large to permit a plentiful supply of gas to pass through the nipple and yet avoid a clumsy connection or one heavier than necessary.

A second consideration was the elimination, as far as practicable of the possibility of placing an oxygen hose upon a fuel gas nipple, or vice versa, and for this reason right hand threads were adopted for oxygen and left hand threads for fuel gas.

It was also recommended that the oxygen and fuel gas nuts be marked with distinguishing letters and that the fuel gas nut be made with a groove of some sort around the hex to make it clearly distinguishable from the oxygen nut to operators, who could not read English letters.

A third consideration was the avoidance of exposed conical or rounded seats which might be damaged if struck.

Various designs and types of nuts and nipples were considered from all points of view and it was believed that the standard, as adopted, represented the most practical hose nut and nipple which could be found.

In order that the new standard insure interchangeability of parts made by various manufacturers, it will be necessary to require manufacturers to hold certain dimensions within the limits of the drawings shown in Figs. 1 and 2.

Fig. 1 shows the "B" size nut and nipple, which is ordinarily used upon large torches and Fig. 2 the "A" size ordinarily used for small torches. The "B" size will be the standard for regulator hose connections.

In order that the manufacturers may use their own judgment or follow their usual practice, as far as possible, they are permitted to vary that part of the design, which does not interfere with interchangeability. For this reason standard and optional requirements have been definitely set forth, as follows:

Standard Requirements

A. Size, type and kind of thread.
B. Angle and outside diameter of female seat.
C. Radius and distance of radius center of male seat from nipple shoulder.
D. Diameter of nipple shoulder.
E. Diameter of hole in nut.
F. Small and large diameters of hose nipple.
G. Diameter of drilling through hole.

Optional Requirements

A. Material strength equal to or greater than free turning high brass.
B. Diameter of drilling through male fitting.
C. Form of end of nipple, except seat section, as covered in "C" under "Standard."
D. Length of hose nipple.
E. Type and number of serrations on hose nipple.
F. A second shoulder equal to the large diameter of the largest nipple to extend through the hole in the nut for appearance to be used or omitted for smaller diameter nipples.
G. Length and location of hexagon section on nut.

The adoption of this standard is considered a very important step in the right direction by those most familiar with welding and cutting equipment and its use as it will enable the user of such apparatus to connect up various makes of equipment quickly and conveniently and to avoid the trouble and inconvenience heretofore experienced when a hose sent out with equipment did not properly fit and could not be attached without special adaptors.

"A" Size

Hose	A	B	C
3/16"	.093" +.001" —.000"	.187"	.248" +.000" —.005"
1/8"	.062" +.001" —.000"	.125"	.187" +.000" —.005"

After January 1, 1926, manufacturers who have accepted this standard will make all new equipment with connections, which are in accordance with the standard and will provide means by which users of present equipment can connect up with the new apparatus. It is believed that the matter is of so much importance to users of equipment, that those who are using a number of makes of apparatus will quickly take advantage of the arrangements made by manufacturers and change over old equipment to the new standard as promptly as it can be accomplished. The saving in time and money in using various makes of apparatus will undoubtedly offset the cost of such changes many times over.

Stresses in Flat Plates

In tank and plate metal construction it is very often necessary to use flat plates subject to a considerable stress due to a loading caused by a head of water. Such cases occur in flat bottoms of tanks placed on grillages, side walls of rectangular tanks, and watertight partitions carrying a water load on one side.

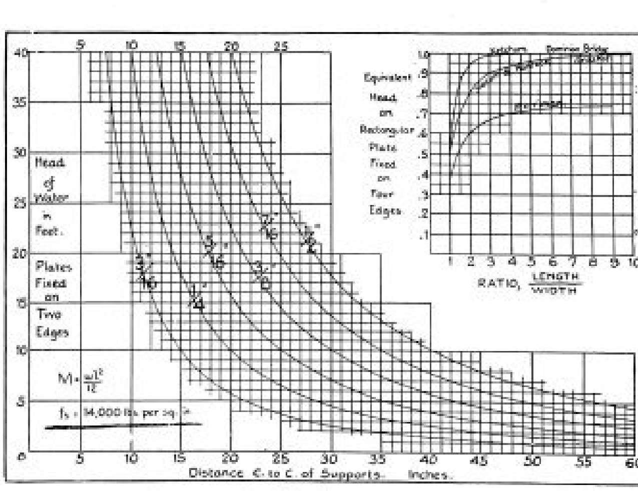


Diagram showing loads on flat plates

If the plates are supported on two parallel edges only, the computation of the stress is a comparatively simple matter. The ends being riveted and the plate being continuous over a number of supports, the beam formula applicable to a beam with fixed ends is used, and the moment coefficient is 1/12.

The larger part of the accompanying diagram is a graphical solution of this problem for various thicknesses of plate, based on a unit stress of 14,000 pounds per square inch. Let us suppose we have a tank 15 feet in height with a flat bottom ⅜ inch thick. The tank is to be supported on beams in a building and we want to know how close together the beams should be spaced. From the diagram we follow the 15 foot line across until it intersects the ⅜-inch curve and then from the lower margin we see that the spacing should be 24½ inches. In the same way the plate thickness may be determined if the spacing is known.

If a plate is supported on four edges an exact determination of the stress is impossible and an approximate formula is used. Three of these formulae taken from five different sources and the results they give are illustrated in the upper right hand corner of the diagram. If a plate is fixed on four edges and its length is twice as great as its breadth, it is seen that the stress is from 0.6 to 0.94 times the stress if fixed on two long sides only.

Let us take, for example, the case of a rectangular tank 12 feet deep and nine feet square. It is desired to find the necessary plate thickness for the lower part of the side wall. We may divide the tank up into three panels in width by means of two vertical supports or stiffeners, and three panels in height by means of two horizontal supports. The dimensions of a panel are then three feet wide by four feet high and the average head on a lower panel is 10 feet. The ratio of length to width is 1:33. From the middle curve of the upper diagram we see that our head may be reduced to 0.67 of what we would figure if the plate were supported on two opposite edges only, or 6.7 feet. From the lower diagram we see that with a head of 6.7 feet and a spacing of 36 inches our plate should be ⅜-inch thick. It is assumed that the four edges are riveted to members capable of taking the bending.

If the allowable unit stress is to be increased, the head should be decreased in the same ratio. For example: If we desire to use 20,000 pounds per square inch instead of 14,000 we may use 0.7 of the head shown on the diagram. In certain classes of construction, notably condensor boxes for oil refineries, the unit stresses used are very high, and very often cause buckling of the plate. This may not lead to failure, however, as the plate would no longer take straight bending, but would take a combination of bending and direct tension and our diagram would not hold good.

In the case of the plate fixed on four edges we have considerable leeway if we attempt to follow the upper diagram. Of the three curves shown, the middle one appears to be the most reasonable, although tests made by J. Montgomerie (*Engineering*, London, June 13, 1919) would indicate that the actual plate stress is about 60 percent of the stress given by the formula from which the curve is plotted.—*The Water Tower.*

Conserving Time With the Uniform Invoice

A Ford Motor Company development that has found application in a wide diversity of industries

As a means of bringing about general uniformity in billing among business firms of America, lessening office work, saving time, cutting labor waste, insuring greater accuracy and reducing mailing volume, the Ford Motor Company, Detroit, Mich., is presenting for the consideration of business executives generally the uniform invoice, devised by the company itself.

Everyone is more or less familiar with the efficiency and economy effected by the company in standardization as applied to its manufacturing. The uniform invoice is standardized efficiency carried into office practice with the same economical results.

Invoices may seem to be small things to the average person, but they assume impressive proportions in modern business. This is strikingly exemplified in the case of the Ford Motor Company. It handles more than half a million invoices a year. The incoming invoices cover everything from toothpicks and cheese to steel and railroad cars, to say nothing of outgoing invoices for automobiles, trucks and tractors and numerous by-products which the company sells.

Out of its experience the company developed the uniform invoice and first passed it along to its own suppliers for their consideration.

The response was more than expected. Many firms adopted it at once, while others, endorsing it, held off putting it into practice only until their invoice stocks on hand were exhausted. But it did not end there, for it was passed on from one to another until at present hundreds and hundreds of representative firms, many with whom the Ford Motor Company does not do any business, have adopted it for their use.

The uniform invoice advantages of saving are quickly apparent. It is simple in make up. It has only two zones, one for the shipper's use and one for the customer's use, so that it eliminates any elements of misunderstanding and difficulties in an invoicing department.

While Zone One meets all the requirements of modern invoicing with the distinct advantage of the "Customers Order" column permitting consolidated as well as single billing, Zone Two, devoted to the customer's needs, is in keeping with the idea of service on which all business is dependent for its success. It reserves for the use of the shipper's customer a place for any data he may wish to affix in his method of checking or approving charges. The customer begins to save time with the arrival of the invoice in his mailing department and on through his whole office organization.

Briefly the advantages of the uniform invoice may be summed up as follows:

For the shipper:

Centralization of shipping data.

Continuous writing spaces.

Natural carriage shifts for speed in typing.

Fixed column for customer's order number, permitting consolidated billing—that is, all shipments for one day, regardless of order number, appearing on one invoice, effecting a reduction of twenty-five percent in papers to be handled by shipper and customer.

For the customer:

Reservation centralizes customer's approvals.

Eliminates customer's use of rubber stamps and sticker riders.

Prevents defacing invoice and obliterating important data.

The desirability of the "Customer's Order" column feature of the uniform invoice, which permits accumulative billing, was forcibly brought out in a recent comparison made by the company with another form of invoice, designed for single order billing.

This case was that of an account payable invoice of the

SHOW EMBLEM OR TRADE MARK HERE (If any)

UNIFORM INVOICE

Always print "Uniform Invoice" in above position

YOUR NAME GOES HERE

NATURE OF BUSINESS

STREET AND NUMBER

TOWN AND STATE

INVOICE NO.

DATE

SOLD TO

This space reserved for address, permits the use of window envelopes, thus saving the time to address envelopes for the purpose of mailing.

SHIPPED TO

SHIPPED FROM

F. O. B.

TERMS

SHIPPED VIA

CAR

FOR CUSTOMER'S USE

TERMS

F. O. B.

ACCOUNT

APPROVAL

TRANSPORTATION

RECEIVAL

CALCULATIONS

ADJUSTMENT

AUDITED

CUSTOMER'S ORDER	SHIPPER'S ORDER	QUANTITY SHIPPED	PACKAGE NUMBER	DESCRIPTION	UNIT PRICE	AMOUNT

Columns and Captions within this red block subject to change to fit particular business involved.

Advantages of Shipper's Zone

1. *Centralization of shipping data.*
2. *Continuous writing spaces.*
3. *Natural carriage shifts making for speed in typing.*
4. *Fixed column for Customer's Order Number permitting consolidated billing—that is, all shipments for one day, regardless of order number, should appear on one invoice. This will reduce papers to be handled by twenty-five per cent at least for Shipper and Customer.*

Advantages of Customer's Zone

1. *Reservation centralizes Customer's approvals.*
2. *Eliminates Customer's use of rubber stamps and sticker riders with possible loss of riders.*
3. *Prevents defacing invoice and obliterating important data.*

Size

The size may be varied from 8½" x 11" (letter size) to 8½" x 7" or 8½" x 14", depending upon the number of items usually billed.

If desirable, the entire form may be printed the long way of the sheet, but in such cases the up and down dimension should always be kept to 8½" for filing.

It can be used on any type of billing or writing machine.

A Two Zone Invoice

(One Zone for Shipper—One Zone for Customer)

SPECIAL: This "Uniform Invoice" is sponsored by the Ford Motor Company. When adopted by you, it will be appreciated if you will mail three copies of your "Uniform Invoice" to the Ford Motor Co., Attention P-30, Detroit, Mich., for record purposes

Uniform invoice developed by Ford Motor Company, now being used by widely diversified industries uniform form on which seventeen items were listed as compared with the other single order form:

Advantages shown for the uniform invoice were:

1.—One insertion of invoice form in machine instead of seventeen.
2.—One writing of heading instead of seventeen.
3.—Saving in typewriter travel that measures a loss, due to wear on the machine as well as time loss for the operator, of 39 feet, 1¾ inches.
4.—Conservation of paper. The uniform invoice was just twice as long as the other single order form.
5.—Saved writing of 17 individual invoices with possible loss of postage through separate mailing.
6.—Saved extra envelopes, preventing paper waste.
7.—Saved seven square feet of invoice paper on originals alone.
8.—Reduced paper handling by customer.
9.—Lessened congestion in files.

Presented in cold type, as it is, the uniform invoice, at first glance appears to be a very rigid and set form of invoice, but its adoption, as worked out for months by the Ford Motor Company, has shown that it is most flexible and applies to every type of industry. Uniform invoices from bakers, shoe manufacturers, forging companies, steel mills, lumber mills, boat builders, chemical manufacturers and many others in the files of the company all attest to the practicability of the form.

The uniform invoice requires no change in systems in any office organization. It is simply one of typographical arrangement of the basic elements required for every type of invoice.

Invoice Easily Adapted

It is adaptable to any form of billing machine or typewriter and has been successfully used in fanfold, multifold and pad forms, through Hextrograph and other duplicator systems. Furthermore, the uniform invoice in no way interferes with any other clearances which are used by some firms when issuing invoices to their customers.

Since the adoption of the uniform invoice, the Ford Motor Company has found that, aside from the great saving in the volume of incoming invoices, it has simplified office work, eliminated annoyances that were expensive one way or another, and effected a direct saving of money through the reduction of personnel.

It is because of this that the company is presenting the plan of the uniform invoice to American business for general adoption so that all may share in its advantages and economic values.

American Welding Society Meeting Successful

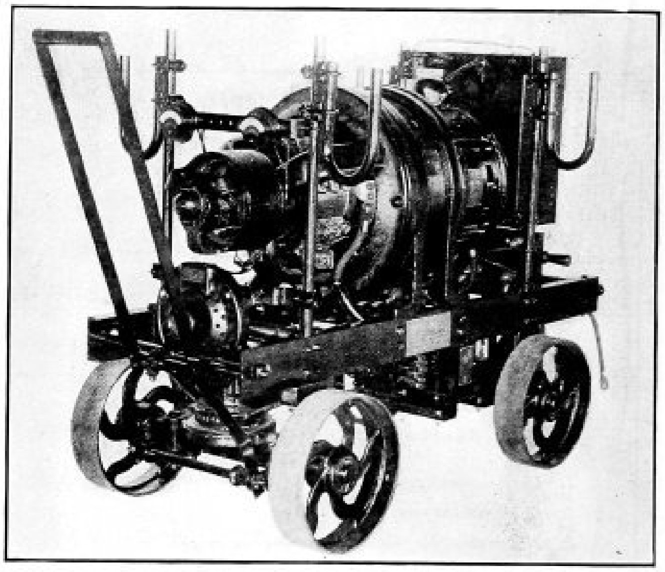
THROUGH the efforts of the Boston section of the American Welding Society the parent body held a successful and enthusiastic fall meeting at the Massachusetts Institute of Technology, Cambridge, Mass., on October 21 to 23, 1925, inclusive. The meeting was featured for the first time by an exhibition of welding equipment and supplies which were exhibited and demonstrated by 25 manufacturers. The exhibit showed the latest developments in gas, electric, thermit and fusion welding. A number of papers were presented at the technical sessions on the various methods employed in autogenous welding. A feature of this convention was the extended discussions in which many valuable ideas were brought out. The papers presented during the meeting are published in the October issue of the journal of the Society.

The final event of the meeting was a banquet held in the Hotel Somerset, Boston, which was presided over by A. G. Oehler, president of the Society. The list of speakers included the Hon. James M. Curley, Mayor of Boston; Prof. Elihu Thomson, General Electric Company; Prof. Comfort A. Adams, Harvard University, and Prof. Alfred S. Kinsey, Stevens Institute.

Interpoles Added to Welding Generator

THE USL welding generator, manufactured by the U. S. Light & Heat Corporation, Niagara Falls, N. Y., in 200 and 300 ampere capacities is a four-pole self- and separately-excited shunt machine with an all laminated magnetic structure. This type of construction permits a rapid change of magnetism so that the arc will respond quickly to the varying conditions and adjust itself to any demand. Each main pole is provided with two shunt field windings. One set of field coils receives current from a small exciter generator, while the other set is connected to the brushes of the welding generator. The effective flux is produced by the combined action of the self- and separately-excited fields.

In order to provide perfect commutation under severe service conditions the USL 300 ampere arc welder is



USL Portable Welding Outfit

equipped with four commutating poles. With the addition of these commutating poles perfectly black commutation at any load up to 350 amperes is assured. Maintenance cost and brush wear are therefore a minimum.

The feature of good commutation on machines with variable and fluctuating loads is of utmost importance in view of the fact that instantaneous inherent regulation is most effective on machines with smooth commutators. Another advantage gained through interpoles is the slight compounding action of the interpole flux which results in a steadier and more tenacious arc. This feature will be appreciated by all engineers experienced in the art and application of arc welding. The last advantage is the inherent arc current stabilizing action of the interpole.

Andrew Fletcher Dies Suddenly

Andrew Fletcher, president of the American Locomotive Company, Schenectady, N. Y., died of heart disease on November 29 at his home in New York city. While Mr. Fletcher devoted the greater part of his life to the field of marine engineering, he built a large reputation for himself in the railroad field because of his successful leadership of the American Locomotive Company during recent years. His business interests were wide in scope, his activities extending into the railroad and marine fields, the iron and steel industry and in oil and banking. Mr. Fletcher became president of the American Locomotive Company in 1916.

Modern Staybolt Inspection Methods*

Device obviates necessity of removing caps from flexible staybolts for periodic inspection

By E. S. Fitz Simmons†

THE development of the flexible staybolt in this country dates back to about 1890, and early experimentation was stimulated by the enormous number of breakages which occurred in the rigid type of staybolt. Probably the first type of flexible staybolt which could be readily inspected without removal was one of the round headed design, using a sleeve and removable cap, which was designed by John B. Tate of the Pennsylvania Railroad and introduced by the Flannery Bolt Company about 1904.

This design gave promise of eliminating many of the weaknesses of former types and provided a means, though an expensive one, of ascertaining the condition of the bolt without removing it from the boiler. For these reasons it was quite generally tried out by many railroads and the results obtained were so satisfactory that its adoption and general use almost immediately followed.

In 1905 a committee of the American Railway Association reporting on flexible staybolts said of it: "Though of comparatively recent date, it has been received with great favor, indicating the rapidity with which a new bolt of promising design is given a practical trial in the effort to cure the staybolt trouble." Further in this same report the committee stated the following: "A simple means of positively detecting cracked and broken bolts is an improvement needed by all flexible bolts that are in service at the present time. The removal of the cap, which will allow an examination of the bolt, is the only absolute means possible with flexible bolts of the present design."

In 1911 the act commonly known as the Locomotive Boiler Inspection Law became effective, under authority of which, rules requiring among other things the removal of caps from flexible staybolts for inspection purposes at special stated intervals, were promulgated and enforced.

The generally satisfactory service rendered and the very small percentage of breakage to total number in service (this type having become practically standard) created a doubt in the minds of many railroad mechanical officers of the justification of such a rule or requirement, and it was quite generally, and for a time quite strenuously, opposed. However, the Locomotive Inspection Bureau, through its corps of inspectors, had indisputable evidence of the necessity for thorough and regular inspection, for while it was admitted that the percentage of breakage to the total number in service was small, it was shown beyond question of doubt that in certain instances breakage did occur to such an extent as to become a menace to life and property.

Investigations were begun to determine the cause of breakage in an endeavor to apply a remedy. A number of investigations confirmed the absolute necessity for careful and frequent inspections and also clearly demonstrated the need of a more accurate and positive method of test than the mere removal of the caps and an examination of the bolt heads.

Instances were found where, under bad water conditions, accumulations of scale between the body of the bolt and the inner wall of the sleeve were such as to solidly lock the bolt in the sleeve. The result was to render ineffectual the flexible feature and to cause the bolt to break at the firebox sheet.

During the past ten years, and more diligently during the past five years, after these abnormal conditions had been prominently developed, constant effort has been made to perfect a method of inspection that would provide greater safety and insure against loss of life, injury to persons and damage to property.

The first actual service test of such a method was made in August, 1920, on large Mallet type locomotives where abnormal conditions existed and where breakage of flexible bolts was excessive. This method consisted of the installation of flexible bolts with telltale holes extending from the firebox end entirely through the body section and terminating within the bolt head, and the testing of these bolts at regular intervals with a specially constructed instrument to determine definitely that the telltale holes were open and, therefore, operative throughout their entire length. This was accomplished by so constructing the instrument that an electrical circuit would be established when contact was made with the end of the telltale hole.

During this service test, two distinct features were developed.

First—that moisture, due to temperature changes, condensed in the telltale hole and formed rust or iron oxide which gradually increased to such an extent as to interfere with the insertion of the testing instrument. In seeking a remedy for this condition, various methods were tried, the most satisfactory and the one at present in use being the electro-plating of the walls of the telltale hole with copper. Four years experimental work and service tests have demonstrated the complete success of eliminating the difficulty by this method.

Second—that cinder and other foreign matter accumulated in the telltale holes to such an extent as to require excessive labor to dislodge and remove it in order to permit the insertion of the testing instrument. The cost and time required for this made the method impractical. After numerous experiments it was found that a closure of fire-proof porous material applied in the end of the telltale hole prevented the accumulation and at the same time permitted leakage of steam or water in case of fracture, and that it was also readily and cheaply removable to allow insertion of the testing instrument.

Application of Telltale Flexible Bolts

The telltale flexible bolt is identically the same as the Tate bolt, with the addition of a telltale hole extending through the entire length of the body section and terminating within the head of the bolt. The walls of the telltale hole are copper-plated to prevent rust or corrosion within the hole and to prevent them from becoming closed from this cause.

They are applied exactly the same as the ordinary flexible bolt. If the method of riveting closes the end of the hole, it may easily and quickly be re-opened, after which a porous fireproof closure is applied that will prevent the accumulation of foreign matter from entering the telltale hole and that will permit leakage of steam or water in case of a break or fracture, which serves as a daily indicator of the condition of the bolt.

Inspection of Telltale Flexible Staybolts

In addition to depending on the leakage through the telltale hole, an inexpensive method of periodically checking

*Abstract of a paper presented at a meeting of the Southern Railway Club, Atlanta, Ga., September 17, 1925.

†Sales Manager, Flannery Bolt Company, Pittsburgh, Pa.

up the condition of the telltale hole is provided in the following manner:

The fireproof porous closure is first removed, after which the specially constructed testing instrument is inserted. Upon reaching the extreme end of the telltale hole and making contact therewith, a light flashes in the handle of the tester indicating that the hole is open and, therefore, operative throughout its entire length.

The method of testing has been built upon the fact that a broken bolt having a telltale hole will show leakage of water or steam, providing the telltale hole is open and operative and that it extends to every breakable part of the bolt.

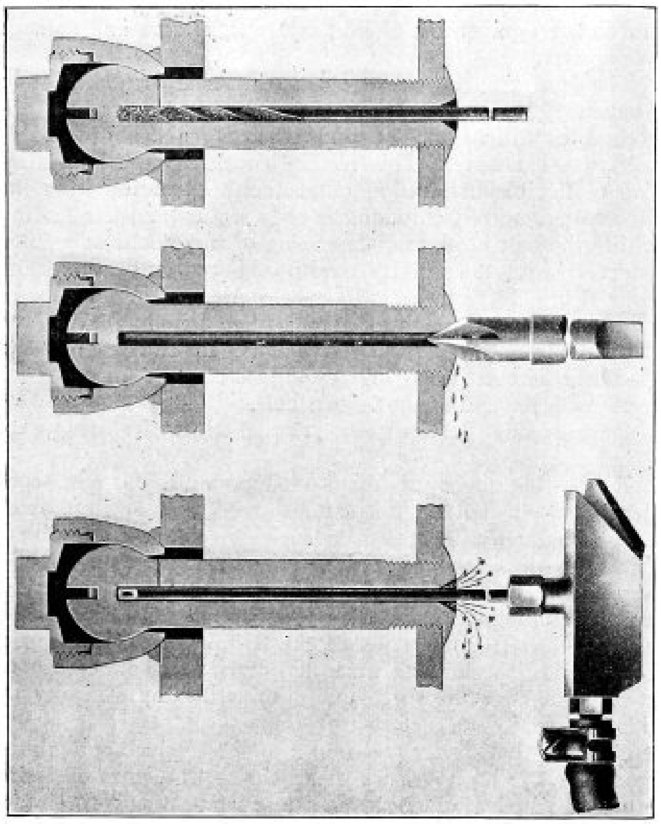


Fig. 1—Cleaning out the telltale hole by means of special air tool

The tester is so designed and constructed that it will positively indicate whether or not the telltale holes are open throughout their entire length. After inserting the tester in each telltale hole and securing light in the handle (which indicates that contact has been made with the extreme inner end of the hole), if the bolt is broken or fractured into the hole, leakage will occur when water pressure is applied to the boiler.

Use of the Tester

First, with a sharp pointed pin or punch and a light hammer, break through the porous closure; then blow all of the remaining particles out of the telltale hole with the air tool—shown in Fig. 1. Attach the ground connection in any convenient telltale hole, then insert the tester rod into each telltale hole until contact with the end of each hole is secured. Such contact is indicated by the lighting of the bulb in the tester handle, as shown in Fig. 2. After contact has been secured in every bolt, apply water pressure to the boiler and every defective bolt will be indicated by leakage through the telltale hole. If no defective bolts are found, or after replacing any that are found, again close the telltale hole with the fireproof porous material and the locomotive is ready for service.

Cases may occur where breakage or fracture will be indicated by leakage and will not be observed or detected at the time they develop, as for instance bolts in locomotives in pusher service at isolated points or bolts located behind brick arches, grate bars, etc., and in which the telltale hole will gradually become filled by accumulation of scale from the boiler water. Therefore, whenever the tester is inserted, it strikes an obstruction and fails to show a light in the handle, as is shown in Fig. 3. In such cases the tester should be removed and a special cleaning drill applied to remove the obstruction. After drilling, blow clean with the air tool such as was shown in Fig. 1, re-insert the tester, and if the hole has been thoroughly cleaned, contact will be secured and indicated by the lighting of the bulb as before described and when water pressure is applied, leakage will occur.

Bear in mind that securing contact in the telltale hole does not indicate that the bolt is in good condition, but only that the telltale hole is open and operative throughout its entire length. It is the failure of the bolt to leak under pressure after contact has been obtained which indicates that it is not broken.

The present method of inspection requires from three to four or more days, the principal part of the work being the removal and replacement of parts, rather than the actual time required by the inspector to examine the bolts.

By the new method herein described, it is not necessary to touch or remove anything on the outside of the boiler and the entire test on a modern locomotive boiler containing a full installation of flexible bolts can be completed within an eight-hour day and at a labor cost of from \$10 to \$20, depending on the size of the installation.

The cost to strip, remove caps, inspect, and replace runs

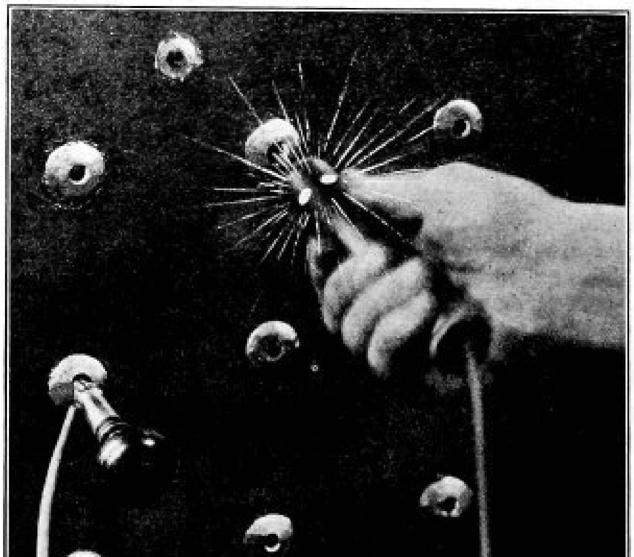


Fig. 2—A light in the tester handle indicates that the telltale hole is open the full length

from \$100 to \$250, depending upon the size of the locomotive and upon the facilities at hand and, in addition, results in two, three, and sometimes more, days' loss of engine service.

The principal advantages of the new method of inspection are: Greater safety by constant daily indication of bolt conditions; material reduction in maintenance costs by reason of eliminating a vast amount of labor now required under the old method of inspection, and a substantial saving in locomotive service by reason of being able to make inspection by the new method at the time of the regular annual hydrostatic test and without additional loss of locomotive service.

A number of railroads have been using the new method of inspection just described for some time, irrespective of the fact that the government had not yet approved it, because they were convinced that it added such an immeasurably increased factor of safety that it would more than compensate for the additional cost of this method of testing, in addition to complying with the Interstate Commerce Commission rules that require the removal of caps every two years. The Locomotive Inspection Bureau, however, has been fully aware of the use of this new method for the last four or five years, has been checking up the results carefully, and when a number of the railroads that have been using this method of inspection for some time made an application for a modification of Rule 23, careful consideration was given with the result that, at a general session of the Interstate Commerce Commission held at its office in Washington on July 26, 1925, it was ordered that Rule 23 as approved in the order of the commission entered April 7, 1919, be amended to read as follows:

23—*Methods of testing flexible staybolts with caps.*

Except as provided in paragraph (b), all staybolts having caps over the outer ends shall have the caps removed at least once every two years and the bolts and sleeves examined for break-

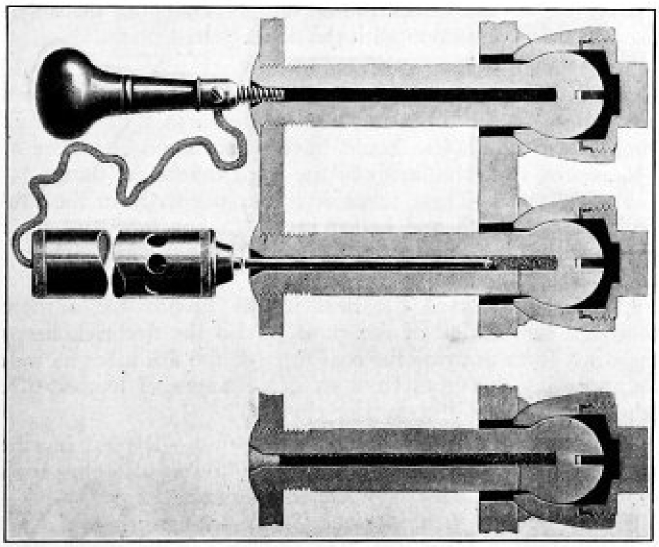


Fig. 3—An obstruction in the telltale hole prevents the tester rod from making contact. This condition is indicated by the failure of test lamp to light

age. Each time the hydrostatic test is applied, the hammer test required by Rules 21 and 22 shall be made while the boiler is under hydrostatic pressure not less than the allowed working pressure.

(b) When all flexible staybolts with which any boiler is equipped are provided with a telltale hole not less than 3/16 in. nor more than 7/32 in. in diameter, extending the entire length of the bolt and into the head not less than one-third of its diameter and these holes are protected from becoming closed by rust and corrosion by copper plating or other approved method, and are opened and tested, each time the hydrostatic test is applied, with an electrical or other instrument approved by the Bureau of Locomotive Inspection, that will positively indicate when the telltale holes are open their entire length, the caps will not be required to be removed. When this test is completed, the hydrostatic test must be applied, and all staybolts removed which show leakage through the telltale holes.

The inner ends of the telltale holes must be kept closed with a fire-proof porous material that will exclude foreign matter and permit leakage of steam or water, if the bolt is broken or fractured into the telltale hole. When this test is completed, the ends of the telltale holes shall be closed with material of different color than that removed and a record kept of the colors used.

(c) The removal of flexible staybolt caps and other tests shall be reported on the report of inspection Form No. 3 and a proper record kept in the office of the railroad company of the inspections and tests made.

(d) Firebox sheets must be carefully examined at least once every month for mud burn, bulging and broken staybolts. staybolts.

(e) Staybolt caps shall be removed or any of the above tests

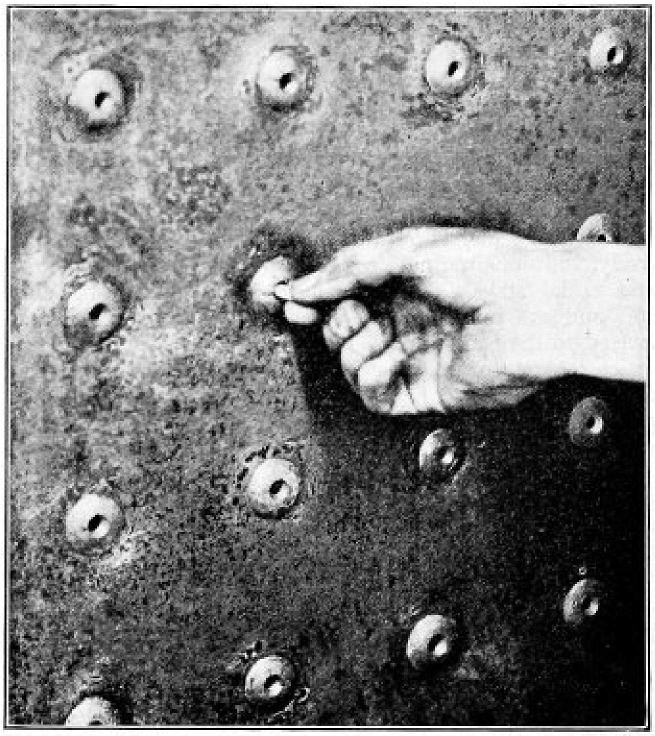


Fig. 4—Applying the porous closure to telltale hole after inspection

made whenever the United States Inspection or the railroad company's inspector considers it desirable in order to thoroughly determine the condition of staybolts or staybolt sleeves.

W. H. Woodin Made President American Locomotive Company

William H. Woodin, president of the American Car & Foundry Company, New York, has been elected president of the American Locomotive Company, Schenectady, N. Y., in the place of the late Andrew Fletcher, who died here early last week. Mr. Woodin, who was a close friend of Mr. Fletcher for many years, will not relinquish his presidency of the American Car & Foundry Company, but will be the active head of both companies.

Always closely identified with the railroad equipment business since the beginning of his business career, Mr. Woodin learned his trade in the shops of the Jackson & Woodin Manufacturing Company at Berwick, Pa., founded by his grandfather. Later he became general superintendent, then vice president and finally president of the firm. In 1899 he joined the American Car & Foundry Company, then just organized, as district manager, becoming president in 1916. He was a director and member of the executive committee of the American Locomotive Company for many years.

Among his other official connections, Mr. Woodin is a director of the General Motors Corporation, the Montreal Locomotive Works, the Chase Securities Corporation and the American Exchange Securities Corporation.

Laying Out Locomotive Boilers—XI*

Tapering backhead and firebox back sheet flange radii—Firetubes—Arch tubes—Brace feet layout

By W. E. Joynes†

EXPANSION stays are of the same general design as a flexible staybolt. The bolt head, sleeve and cap are larger and the sleeve is also seated deeper to allow a greater expansion of the firebox. Expansion stay sleeves are at an angle to the shell and therefore due to the angle and the larger sleeve and cap, expansion stay caps project farther beyond the shell than the flexible staybolts.

Backhead.—The backhead plate above the staybolts is braced to the roof sheet and the back ring or course respectively, with longitudinal brace rods passing between the crown and radial stays. The rods have a jaw on the backhead end and are pinned to tee irons and crow feet which are riveted to the backhead. The front end of the rods have an upset tongue to fit in a jaw foot on the roof and ring. Several longitudinal braces should be carried through to the ring when possible, to relieve the roof sheet from unnecessary strain.

The front tube sheet above the tubes is also braced by the same kind of longitudinal brace rods which are fastened to tee irons and crow feet with a pin and with a jaw foot riveted to the ring courses.

The tube sheet also has an opening and a solid ring for receiving the dry pipe and the superheater header. The dry pipe feeds steam from the throttle in the dome to the superheater header—the steam then passes from the header through the superheater units, which consist of return pipes leading into the superheater flues and back to a separate passage in the header; thence, through the steam pipes to the cylinders.

With the outside type of throttle, which is located at the top of the smokebox, the steam in the dome is fed down a vertical pipe (with shut-off valve) to the dry pipe, through the header and units to the throttle, thence to the steam pipes and cylinders. This throttle arrangement feeds superheated steam through the throttle.

A firebox back sheet tapering corner flange radius is for extending the width of the top flange to bring the last top radial stay at a right angle to the crown sheet.

A tapering backhead flange radius is used to reduce the flat sheet space between the last radial stay and the roof and backhead seam to be self-supporting. The tapered radius reduces the width of the flange at the top which also makes it more possible to have the top crown stay 90 degrees to the crown sheet.

Back tube sheet braces brace the tube sheet between the fire tubes and the staybolts.

Throat braces brace the inside throat sheet and should be located to come centrally between the combustion chamber staybolts.

Dome.—The steam dome is flanged in one piece, from a flat plate, to a maximum height of 22 inches when required. A large round opening is machined through the top for application of the throttle and for access to the boiler. The opening is made steam tight with a copper wire gasket and a pressed steel cover studded to the dome.

The old style dome is made in three pieces, viz., flanged base, plate body or barrel, flanged ring on top, which is also covered with the same kind of pressed steel cap as a one piece dome.

For the purpose of obtaining the driest steam, the dome should be located on top of the largest or back boiler ring for non-combustion chamber boilers and on the ring adjoining the combustion chamber ring for combustion chamber boilers.

Radial Stay Holes Through Liners and Welt Strips.—Holes through inside roof sheet liners and inside combustion chamber welt strips need not be threaded for crown, radial, or expansion stays, unless it is impossible to obtain a full or one continuous thread in the shell.

Firebox Ring Corner Radii.—Four and one half inches outside and 2¼ inches inside radii make suitable corners for the firebox and outer shell at the firebox ring—tapering to the backhead and firebox back sheet flange radii 18 inches and 13 inches, respectively, above the bottom of the firebox ring. The same height of taper applies for straight throats. The extent of the corner radius taper for sloping throats is explained in connection with the development plates.

Fire Tubes.—The tube holes in the back tube sheet should be located to give a minimum clearance of 2 inches between the bottom of the tubes and the inside surface of the back ring. The tube holes should have a minimum clearance of 1¼ inches, from the inside of the front tube sheet flange.

Arch Tubes.—These tubes arch longitudinally in the firebox and are rolled and belled in the firebox tube and back sheets or inside throat sheet. They support the firebrick and add heating surface to the firebox. The purpose of the firebrick is to retard the heat in the firebox for a more thorough combustion of the gases. Also the firebrick keeps the draft from drawing the coal through the fire tubes as well as protecting the tubes from sudden changes of temperature when the firedoor is opened or closed.

Longitudinal Brace Feet Distribution.—Rivets in the shell for brace feet should not be opposite for adjoining rows of feet, but should be opposite for alternate rows.

Dome Course Longitudinal Seam.—When there is not enough space between the throat seam and the dome liner for the longitudinal seam the seam should not be omitted and the dome liner lengthened longitudinally to form a seam at the top center. Though the seam is welded full length at either end of the dome opening it is not considered a good design. What should be done is to extend the dome liner longitudinally and circumferentially to form a seam outside of the dome base. This arrangement makes a regular design seam for the outside welt strip and the bottom half of the inside welt strip.

Combustion Chamber Ring Longitudinal Seam.—In locating a longitudinal seam between the top and side center line of a combustion chamber ring the center line of the seam should come in a location between the stays as to cause the least tipping of the stays out of their radial position. The regular pich of rivets in the front circumferential seam for this quarter are not likely to come in the correct location for the outer welt strip when the seam is located to suit the stays, therefore the rivets in the seam quarter for the front circumferential seam only, should be pitched to suit the new seam location unless only a small difference of ¼ inch is noted in the two locations—when the seam should then be located to suit the regular pitch of rivets; providing throwing

* Previous installments of this article appeared on page 1, January issue page 40, February issue; page 72, March issue; page 99, April issue; page 129, May issue; page 166, June issue; page 235, August issue; page 263 of the September issue, page 293 of the October issue, and page 324 November issue.

†Boiler Designing Department, American Locomotive Company, Schenectady, New York.

the stays out of radial this extra 1/4 inch or fraction does not look unreasonable to an experienced eye.

It should not be forgotten that the rivets in the seam quarter for the adjoining ring will also be affected when the rivets are not regular pitch.

Rivet Pitch—Longitudinal Seams.—When all the rings are straight on a non-combustion chamber boiler the longitudinal pitch of the seam rivets should be standard for all rings except the first ring—the odd spacing to be in the longitudinal seam for this ring. On extended wagon top boilers the odd spacing should be in the longitudinal seam of the conical connection. Combustion chamber boilers should have the odd spacing in the combustion chamber ring longitudinal seam.

Circumferential Seams.—The number of rivets in each row of all circumferential seams should be divisible by four (4) and the rivets should come on the four centers of the back row when possible.

Throat Seam Location.—The bottom of the throat seam

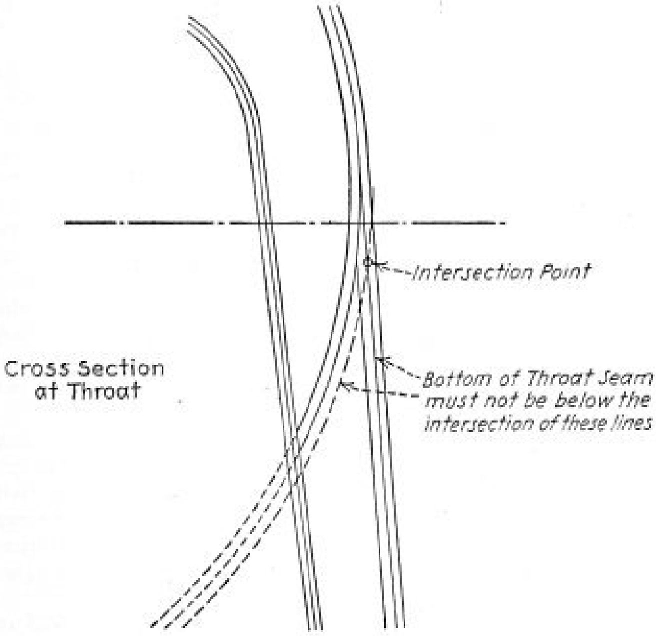


Fig. 48.—Throat seam location

must not come below the intersection of the outside surface of the front and back flange of the throat sheet and as shown by Fig. 48.

The boiler should be provided with plug holes for cleaning the boiler. These plugs are called "washout plugs" and should be located between every fourth or fifth space of radial stays on alternate sides of the firebox, about 4 inches above the top of the crown sheet; one in each corner of the outside firebox just above the firebox ring; one in the bottom of the first ring, near the front tube sheet and one in the back ring near the back end of the ring; three or four in the backhead—between the tee irons and about 2 inches above the bottom tee iron rivets.

Waist sheet angles, guide yoke angles and the lugs on the front and back end of the firebox ring are for bolting expansion plates to the same and to the frame crossties for supporting the boiler above the frame. This arrangement allows the boiler to expand and contract freely over the frame of the engine.

All holes in the boiler that are not plugs or screw connections, such as the injector check, throttle stuffing box, cab turret, etc., are made steam tight by the use of a ball joint seat. This design consists of a cast iron ring with a ground radius to fit a 45 degree bevel in the shell and a ground joint top to fit the turret, etc., and as shown by Fig. 49.

All stud or other screw connections, such as washout plugs, blow-off cocks, etc., through the shell of the boiler that is under pressure must be tapered tap, 12 threads per inch or pipe threads if not more than a 2-inch pipe tap.

A water column is a hollow casting connected at the bottom through the backhead, below the water level, and an outlet through the top to the upper part of the backhead or

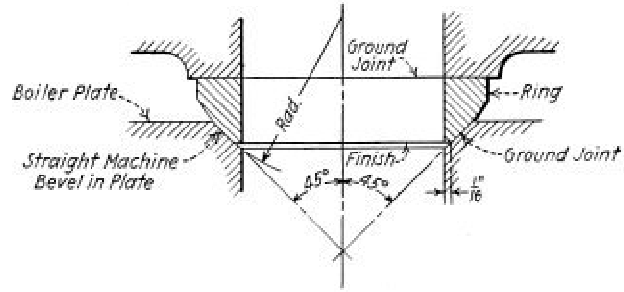


Fig. 49.—Details of ball joint

back of the roof sheet. The gage cocks and one water glass are tapped into this column instead of being tapped direct into the backhead plate. A water column or water glass must not be located directly above an arch tube. The rapid water circulation through the tube will give an incorrect reading in the water glass and gage cock test.

(To be continued)

Boiler Tubes for High Steam Capacities*

THE Mannesmann-Röhrenwerke choose only such of the round rolled bars manufactured in their steel works for the raw material of high grade tubes, which are derived from the central or lower cast block, and fully satisfy the chemical analyses and strength tests. The bars selected are bent and notched to the required tube length on hydraulic presses, then heated in gas furnaces to the necessary temperature for rolling and finally rolled to hollow blocks with thick walls on the Mannesmann oblique rolling mill. This process lasts just about 1 minute, whereupon the hot hollow block is placed on a hard steel mandrel and rolled to the finished tube on the Mannesmann-Pilgerschritt rolling mill.

After testing the tubes as to their faultless condition, exact diameter and thickness of the walls, the approved tubes are straightened by hand, or mechanically where larger tubes are concerned, cut to the required lengths and the superfluous ends rejected. A further test of the tubes is performed in the shops by means of incandescent lamps, chiefly to ascertain inner faults of the material and finally the tubes are subjected to a hydraulic pressure of 80 atmospheres, the workmen receiving a premium for each leaky tube they discover. The tubes destined for high-pressure boilers are tempered 15 to 20 minutes in furnaces equipped with recording pyrometer at varying temperatures.

Superheater tubes are manufactured in precisely the same way, however, the smallest diameters are hot-drawn, while small diameters are cold-drawn, in both cases with subsequent annealing. Long superheater spirals are welded autogenously; for maximum pressure boilers, a special sleeve with threaded central part in connection with electric arc welding is employed, which relieves the welded joint of all stresses. The highly-taxed boiler feed tubes and steam pipes are manufactured in the same manner as the water tubes.

* From *Engineering Progress*, a monthly German review edited by the Verein Deutscher Ingenieure.

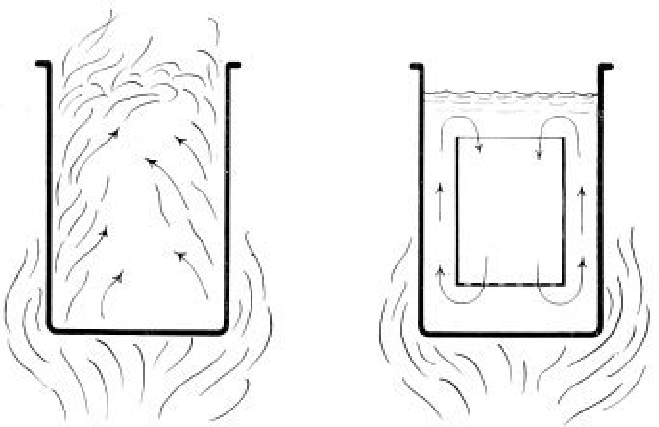
Improving Water Circulation In Locomotive Boilers

Thermic syphons, circulating plates and watertube fireboxes are advantageous in promoting circulation and hence boiler efficiency

By Louis A. Rehfuss

MANY years ago in a lecture to students, George H. Babcock in illustrating the value of circulation in a steam boiler, made use of a homely demonstration, which may well be briefly restated. If we take an ordinary kettle or pot of water and set it over a fire, before long the water will boil tumultuously, bubbling up the sides of the kettle so that it is with difficulty that we can prevent it from boiling over.

If now we take a smaller kettle, perforated in the bottom as shown in Fig. 1 and insert it in the first and repeat the



Figs. 1 and 2.—Method of increasing circulation in open vessel

experiment, we notice a marked change. A swift circulation ensues, but the water boils quietly, moving swiftly up the sides which are the hottest and descending in the center. The heat may be increased considerably without boiling over; the water changes into steam much more rapidly than in the first case and the steam is dry in place of wet. This is the result of an adequate circulation, which means greater efficiency in the production of steam, drier steam and greater safety as well.

Yet how many present day designers of locomotive boilers consider these principles at all. In place of improved circulation, in the hunt for greater efficiency, the main tendency has been to crowd in the maximum evaporative surface.

Evaporative surface as a factor in locomotive boiler design has been overestimated. We may block up 25 percent of the tubes of a boiler on the road and impair its efficiency scarcely at all, simply because the same amount of hot gas is passing through a lessened number of tubes and consequently maintaining a higher temperature therein. The increase in the velocity of gas flow also stimulates the evaporative efficiency of a unit tube.

As is well known the evaporative efficiency of any unit of evaporative surface is proportional to the difference in temperatures between the hot gases and the water on opposite sides of the metal separating them. Increasing the length of boiler tubes 25 percent in the average locomotive increases the boiler efficiency only possibly 2 percent, simply because the gases issuing forth at the smokebox end are at too low a temperature to make the additional length of tube very effective. We very soon arrive at a point where piling on additional evaporative surface is not worth the additional expense.

Improving Evaporative Efficiency

The best way to improve the efficiency of evaporative surfaces is to increase the circulation of the fluids in contact therewith. We do not want to increase the speed of the hot gases, or we would lose heat in higher smokebox temperatures. But we can emulate stationary steam plant engineers and increase the water circulation in the boiler itself. Thus Clement and Garland conducted a series of experiments to determine the effect of velocity of flow on the heat transmitted from steam to water flowing in tubes. Increasing the velocity of water flow in the tubes from 2.19 to 17.64 feet per second, the heat conductance increased from 2,081 to 3,144 heat units per square foot of heating surface per minute.

Another beneficial action induced by circulation is keeping down the scale deposits. This is caused partly by the scouring action of swiftly moving water and also by the fact that the loose sediment is kept in suspension and prevented from settling and caking. Particularly in bad water districts ought this matter of circulation to be given more serious thought.

The modern locomotive boiler is often forced to 500 or 800 percent over its normal rating, when its efficiency drops as low as 50 percent. Wet steam with 10 or 15 percent moisture then becomes a troublesome factor, which improved circulation would be bound to check. Unfortunately practically no provision has been made for adequate circulation in the locomotive boiler of today. It is like a kettle with heating tubes running all through it, but with no channel provided to guide circulation, nothing to prevent the formation of eddy currents, foaming, priming, or boiling over when the fires are forced. The wet steam we get is then only a natural consequence.

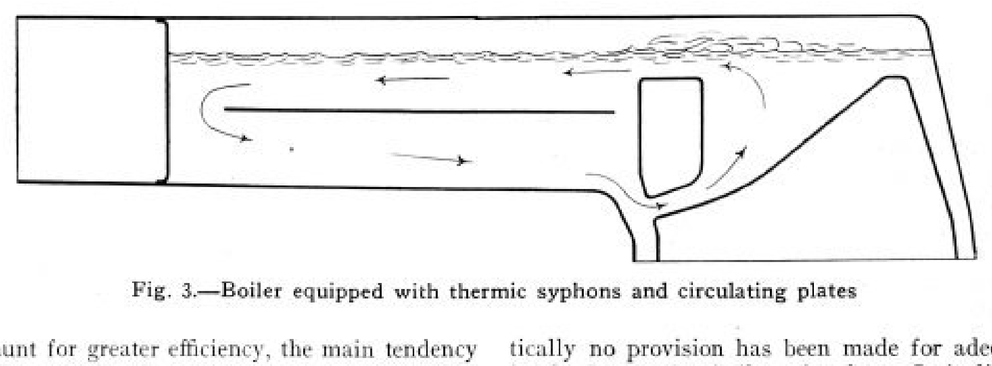
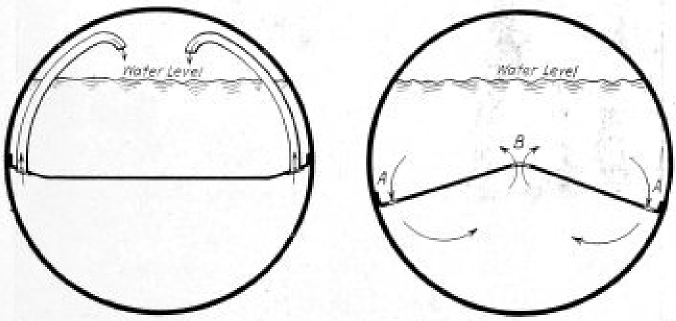


Fig. 3.—Boiler equipped with thermic syphons and circulating plates

Of late years there have been attempts made to improve the circulation in locomotive boiler design. Among these may be mentioned:

(1) THE THERMIC SYPHON.
(2) THE CIRCULATING PLATE.
(3) WATERTUBE FIREBOXES.

The thermic syphon unquestionably does tend to improve the circulation. Unfortunately however its action is limited by inlet entrances but 6 inches in diameter, so that but a very small volume of water is kept in circulation at any one time. Assuming two thermic syphons in a firebox we have a sectional channel of water of say 56 square inches or 0.4 square feet to draw the contents of the lower half of a boiler barrel, of possibly 16 to 18 square feet in section, a ratio of about 1 to 40. Assuming a speed of the water through the syphon neck of 20 feet per second, the net resultant on the main body of boiler water is an acceleration of only about



Figs. 4 and 5.—General type of circulating plate and improved type (right)

½ foot per second. The syphon does stimulate markedly the circulation of the water in the firebox area but has too little effect on the main body of water in the barrel.

The circulating plate in connection with syphons, seems based on sound principles. Thus in Fig. 3, it is evident that the water will rise all around the firebox or hot end of the boiler, move forward and descend at the cooler smokebox end, if there be a plate as shown to guide and control the currents. We feel, however, that the type of circulating plate usually employed, shown in Fig. 4, is capable of improvement.

From a study of Fig. 4 it is evident that the steam is expected to collect at the sides and escape through the overflow pipes. However, unlike our kettle where the heat comes from the outside causing the steam to form on the sides of the vessel, in a locomotive boiler the metal sides of the boiler barrel will be the coolest portion of the barrel, and the steam

Of late years boilers with watertube fireboxes have been introduced, which is a move in the right direction, since the customary staybolted waterleg side of a normal firebox resembles too closely the boiling first kettle of Babcock's lec-

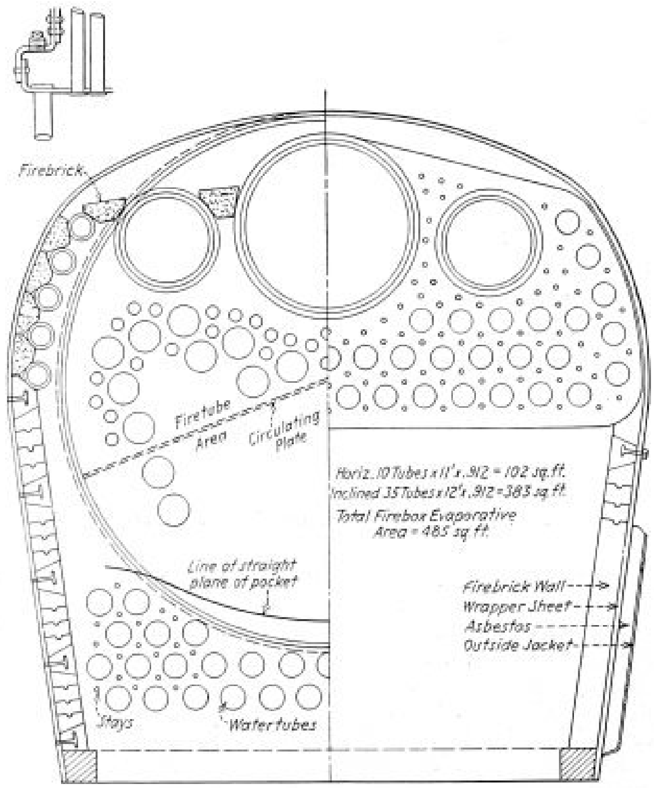


Fig. 7.—Section of boiler showing means for improving circulation

ture. The designs of watertube fireboxes so far presented we feel might be improved:

(1) By making a flow more directly in line with that of the barrel and adding a circulation plate in the barrel to guide the flow longitudinally.

(2) By not striving for an excessive amount of evaporative surface in the firebox, so as not to chill the flames before they attain the maximum temperature.

(3) By making the feed inlet into the firebox tubes of sufficient area to create a pronounced circulation in the boiler as a whole.

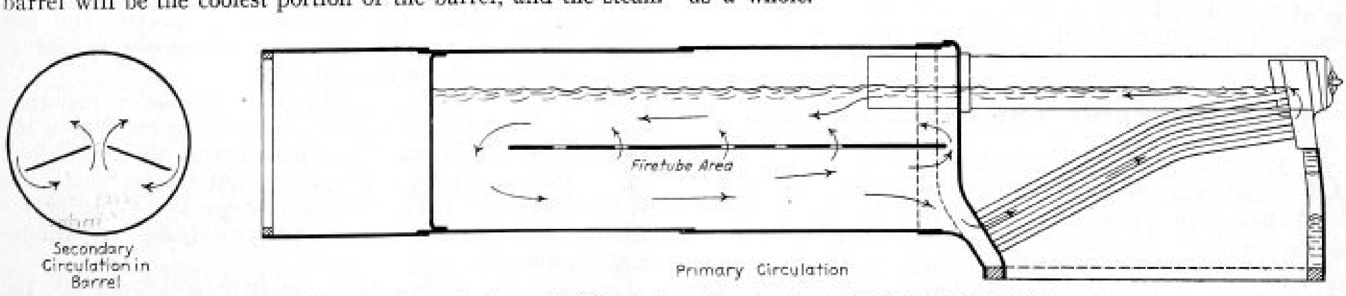


Fig. 6.—General view of boiler designed to improve circulation of water

will form most thickly at the center where the firetube groupings are the thickest. From the writer's viewpoint the circulating plate should be made more after the shape shown in Fig. 5. Then the steam gathering most heavily at the center, would escape through perforations along the top center line of the plate, while a secondary circulation in addition to the longitudinal one is maintained and started as shown from *B* to *A* in Fig. 5.

As a suggestion in these respects, the author is appending a few sketches, Figs. 6, 7 and 8, which he feels ought to result in an improved circulation over what is generally attained today.

The watertubes all run longitudinally and, save the few on the crown level at the top of the brick side walls, all rise from the throat sheet on their way to the back header. In this way, as is shown in Fig. 6, in combination with a circulation plate, a direct flow is obtained. The total firebox evaporative area is little greater than that used in normal firebox construction and any tendency to chill the flames which the position of the tubes might have, is counterbalanced by the reflection of heat from firebrick walls. The inlet area of the throat tubes is 2⅓ square feet, considerably

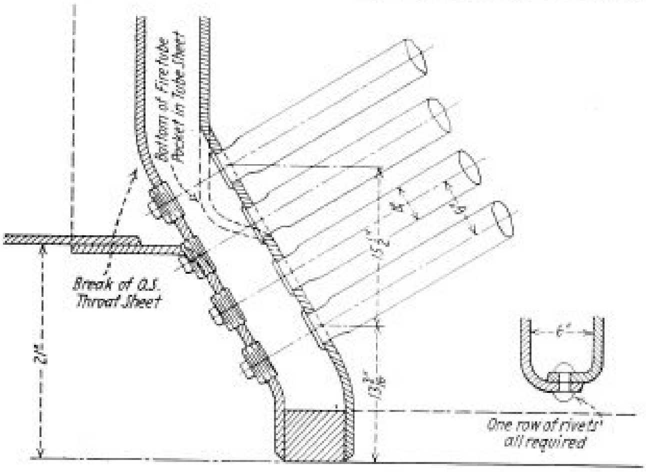


Fig. 8.—Circulation tubes at throat sheet

greater than any syphon installation and hence have so much the greater influence on circulation. Assuming that the water in the lower section of the barrel (below the circulating plate) has a sectional area of 18 square feet and that the water passes into the tubes at the rate of 20 feet per second, the longitudinal water circulation in the barrel will be increased 2½ feet per second by the tubes in the sketch shown.

Regardless of what designs or devices are used in locomotive boilers to promote the water circulation, we cannot reiterate too strongly the fact that in the improvement of that circulation lies much of the hope for future improved service and efficiency. Babcock's kettle is but one illustration of this principle, which is borne out in all lines of heat transmission. Thus from a field as remote from locomotives as that of house heating we may even borrow an analogy. When a 15-mile wind blows across the face of a house it has been found that the heat radiation from the house is three times greater than it is in still air of the same temperature. As in the boiling kettle it is circulation, movement, that stimulates the evaporation. So it is with locomotive boilers.

The heat itself will set up the currents, but unless they are mechanically guided along proper channels, they will be dissipated and wasted in the production of eddies, currents and the like that will nullify their effect.

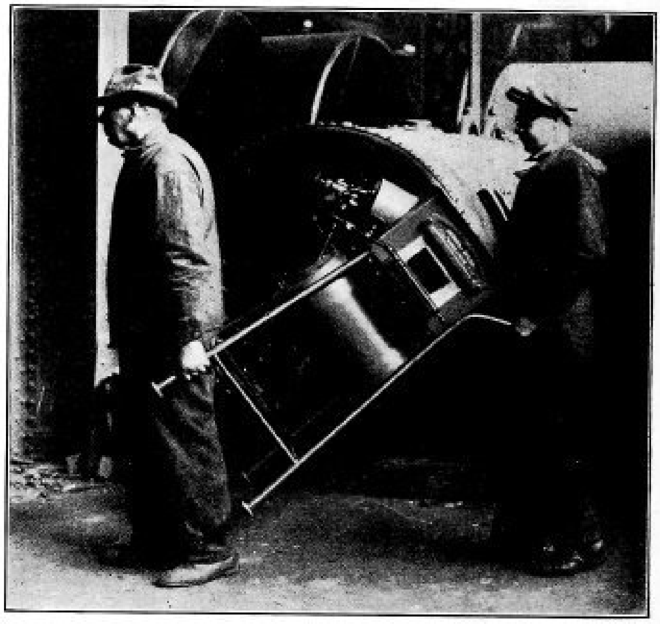
Light Portable Oil Rivet Furnace

An oil burning, hand portable rivet forge for shops and yards where a forge can be carried most conveniently, has been placed on the market by the Johnston Manufacturing Company, Minneapolis, Minn. It is equipped with the Johnston non-clogging vacuum oil burner. It is designed so that it can be readily carried from one job to another by two workmen.

The hearth of this forge is 40 inches above the floor so that the operator can see the rivets without stooping. The gases from the heating chamber are vented high enough so that they cannot be blown by the wind against the workmen. The closed top chamber provides good combustion as the vent gases leave the bottom or coolest part of the heating chamber. The heating chamber is designed to give a rapid motion to the gases which come in contact with the rivets. This chamber is lined with standard sizes of fire brick and is made thicker at the points of maximum temperature. The frame is made of pipe and welded together which gives a minimum weight in proportion to the strength.

The oil supply to the burner is regulated indirectly by an air valve which, it is claimed, can never clog or vary. There is no choke or restriction in the oil passages, therefore the burner will operate continuously without clogging on oil containing free carbon and dirt. The burner has only two working parts; these are the two needle point air valves, one of which regulates the compressed air and the other regulates the oil feed indirectly.

The furnace operates on compressed air between 60 to 125 pounds and burns either kerosene, distillate or fuel oil. It uses six cubic feet of air per minute and burns one gallon



The Johnston oil rivet furnace can be easily carried by two men

of fuel per hour. The fuel tank capacity is 7½ gallons per hour. The heating chamber is 8½ by 10 inches and its charging opening 5½ by 3½ inches. It requires a floor space of 20 by 36 inches and weighs 240 pounds.

New Books

(*Continued from page 336*)

weld has been properly made and whether it will withstand hard service. The application of electric and gas welding to all locomotive parts now commonly welded is thoroughly discussed in this chapter.

The chapters on the specifications for boiler materials and types of longitudinal joints and patches explain in the language of the layman the fundamental theories which govern these subjects. Simple formulas and facts are given which will enable an inspector quickly to verify his physical examinations by an analysis based on fundamental principles.

Locomotives contain many appurtenances such as the superheater, injectors, air operated fire doors and grates, stokers, boosters, etc., all of which must be inspected. In order to make a competent inspection, the inspector should know how these devices are constructed and operate. The above mentioned appurtenances and many others are illustrated and described in Chapter XI. This chapter also contains information as to the best methods of inspecting various types of staybolts.

The last chapter contains 12 tables which are used in connection with the construction of locomotives.

British Boiler Construction Details

Manufacture of boiler plates and rivets with details of tests to which they are subjected

By Engineer Captain F. J. Drover, R. N.

RIVETS for boiler work are made from steel bars, and made by the acid open-hearth process; for ordinary steel rivets—by the open-hearth process, either acid or basic.

Rivets are submitted to the following tests before being accepted for use in boiler construction:

(a) A piece of bar selected from every fifty or portion of fifty.

	Tensile not more than	Elongation in 8 inches
Boiler rivets	26-30 tons	25 percent
Ordinary rivets	24-27 tons	25 percent

(b) Pieces cut from every bar, heated uniformly to a blood red and cooled in water at about 80 degrees F. must stand bending double in a press to a curve of which the inner diameter is equal to the diameter of the bar.

(c) One rivet selected from every hundred to be bent double when cold without fracture.

(d) To be bent double when hot and hammered till two parts of shank touch each other without fracture.

(e) Rivet head to be flattened when hot to two and a half times diameter of rivet without cracking the edges.

(f) Shank of rivet nicked on one side and bent cold to show quality of fracture.

Methods of Riveting

Riveting may be performed either by hand hammering, pneumatic tools or by hydraulic machine. Hydraulic machine riveting is now considered the best, and is always adopted in the best naval practice as the steady pressure produced on the head of the rivet stays it up better and causes it to fill the hole more completely than is likely to be the case when the riveting is done by steam or hand. The average riveter requires a space of 24 inches to drive a rivet by hand, but it is possible to close it in 16 inches. Allowance for riveting often determines the spaces that must be made in design. In order to be tight rivets should be driven from the water pressure or steam side. Power riveting machines are operated either by gearing, water, steam, or compressed air; generally, as previously mentioned, hydraulic machines are preferred, since the work is done more gradually and with less shock or blows, and owing to the speed of operation there is less chance of the rivet getting cold, or the head being formed before the rivet fills the hole. Hydraulic pressure is usually 1,200 to 1,600 pounds per square inch, but with large machines care should be taken that too great a pressure is not applied to the rivet or the plate will stretch along the seam. For hot rivets when short a pressure of 50 tons has been found effective, and slightly over this pressure when long. For ⅜-inch rivets driven cold a pressure of 15 tons has been found sufficient, and at 20 tons the plates have stretched.

Machine rivets do not require calking. Contractors using a well known system claim a saving of $2,250 per year by using hydraulic machines; and the makers guarantee that with their hydraulic riveter, in Cornish, Lancashire and locomotive boilers, the shells can be riveted at the rate of $0.25 to $0.31 per 100. The cost of riveting in a marine boiler with 1-inch plates and 1⅛-inch rivets would be as an estimate $2.50 per hundred with a machine, and by hand $7.50 to $12.50.

Pneumatic Riveting

The hammers are made to close rivets up to 1½ inches in diameter. For large rivets and heavy shell work, the weight of the hammer requires special supports. For naval work pneumatic tools are used for riveting tanks, calking, drilling on a large scale, and chipping and scaling boiler tubes.

Tightness of a Riveted Joint

The power of a joint to resist tendency to leakage when subjected to steam and water pressure depends chiefly on the nearness of the rivets together and nearness of the rivets to the edge of the plates. The metal between two rivets is in the position of a beam subjected to a uniform pressure and tending to deflect. If the joint is not naturally staunch it may be rendered so by calking, i.e., by burring down the narrow strip of the plate by a calking tool, as shown in Fig. 1. *A* is a fullering tool used for closing up the plates, and *B* a calking tool used for burring down the thin edge of the plate as shown. Locomotive engineers will not use calking, but only fullering tools. For boiler work all edges are planed to an angle of 75 degrees before riveting, see Fig. 1 *C*, and this helps the closing of the plate for fullering.

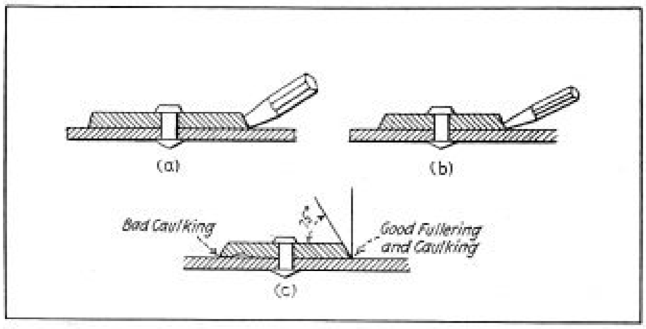


Fig. 1.—Calking tools and methods of calking

Diameter of Rivets

The diameter of rivets for boiler work bears a direct proportion to the thickness of the plate. Unwin's latest experiment gives the following rule:

$D = 1.25 \sqrt{t}$ where t = thickness of plate.

More frequently, however, the earlier rule is used, i.e.:

$D = 1.2 \sqrt{t}$ for double or multiple joints and

$D = 1.4 \sqrt{t}$ for single riveted joint.

D = diameter of rivet in inches.

Rivets in single shear, for example, a lap joint; rivets in double shear, for example, a butt joint.

Tolerances for Rivet Holes

For machine work—1-inch diameter and under—1/32-inch clearance.

For machine work—above 1-inch diameter—1/16-inch clearance.

For hand work—up to 1¼-inch diameter—1/32-inch clearance.

For hand work—above 1¼-inch diameter—1/16-inch clearance.

Boiler Plates

Boiler plates are either of wrought iron or mild steel. Steel is now universally used because of its evenness of structure. It is not considerably stronger than wrought iron, but is much more reliable. A test piece taken from a steel plate represents the whole plate, but a strip from a wrought iron plate does not. Steel plates are termed mild because they contain a little more carbon than wrought iron plates. Steel plates possess 30 percent more strength than wrought iron plates with one and a half to twice the elongation. Steel boiler plates contain from 0.19 to 0.25 percent more carbon than iron plates. In steel plates the strength in the direction of rolling is the same as across it, also steel plates are made with a much wider area than wrought iron plates.

Maximum Width of British Standard Test Piece

Over ⅞-inch in thickness	1½ inches wide
⅜ to ⅞ inch in thickness	2 inches wide
Under ⅜ inch in thickness	2½ inches wide

The steel from which boiler plates are made must be of British manufacture made by the acid open-hearth process, and must be submitted to the following tests. Test pieces are taken from every plate or bar which is liable to stress, and should stand as follows:

Description of Material	Ultimate Tensile Strength	Elongation Percent in 8-inch Length
(a) Plates that will not be exposed to flame and will not be flanged	Not less than 28 and not more than 32 tons per square inch	20 percent
(b) Plates which will be exposed to flame and which are flanged	Not less than 26 and not more than 30 tons per square inch	23 percent
(c) Plates to be corrugated and ribbed	Not less than 23 and not more than 25 tons per square inch	27 percent

Bending Tests For All Plates

Strips are cut lengthwise or crosswise 1½ inches wide, heated uniformly to blood-red and cooled in water 80 degrees F. They must stand bending in a press to a curvature the inner radius of which is one and a half times the thickness of the plate tested.

Welding Tests

Strips are to be cut from the plates, which are exposed to the flame and welded; these strips are then put on a testing machine and broken to ascertain the efficiency of the weld. Plates (a) on table include shell plates and girders; (b) include end plates, combustion chamber plates and plain furnaces; (c) include corrugated furnaces.

The cold or temper-bend test is taken from each plate as rolled. For plates exceeding 2½ tons in weight, one bending test is taken from each end, one test temper and the other cold. All plates are to be free from lamination and injurious defects. For angle and stay bars, a cold or temper bend test must be made from each angle and stay bar when rolled. Tee angles and bar steel must also stand such other forge tests, both hot and cold, to prove soundness of material and fitness for the service intended.

Treatment of Boiler Plates Before Use

Steel plates for furnaces and boilers which are subject to stress must be pickled in a liquid containing 19 parts of water and 1 part of hydrochloric acid, until the black oxide or scale formed during manufacture is completely removed. Plates should be placed on edge and not laid flat, and when taken out of the dilute acid all the surfaces should be brushed and washed to clear off all the loose scale. They should then be placed in a bath, filled and kept well supplied with fresh water, or should be thoroughly washed with a hose and placed on end to dry—this is naval practice. Some engineers contend that the black oxide on the surface of the plates when they come from the rolling mills reduces the staunchness of the joint, so the following practice is carried out: Sponge the whole surface of the plate with a weak solution of salammoniac before riveting, this process causing the plates to adhere more closely, and consequently they require less calking. Sometimes the whole interior is sponged in the same way, this tending to prevent corrosion in working.

Plates and bars which can be bent cold are not to be heated, and if the whole length cannot be bent cold, as little heating as possible should take place. In rolling plates, the greatest difficulty is experienced in dealing with the edges; this being overcome by setting up the edges for a length of about 6 inches over the rolls by wooden mallets. The use of vertical rolls is fast going out in boiler shops, owing to the fact that hydraulic bending machines can bend plates up to 1½ inches in thickness to a complete circle without any heating, more quickly, much more cheaply and uniformly, and with no difficulty with the edges of the plates. The flanging of the plates should be done by hydraulic pressure in as few heats as possible. In cases where plates and bars have to be heated, the greatest care must be taken to prevent any work being done on the material after the temperature has fallen to the dangerous limit—known as blue heat, say from 600 degrees to 400 degrees F. Should this limit be reached during working, the plates and bars should be reheated. Plates and bars which have been worked while hot are to be afterwards annealed over the whole of the plate. Furnaces of cylindrical boilers are to be thoroughly annealed and are not afterwards to be subjected to any local heat.

Solutions to Prevent Corrosion

Acids, alkalies, and moisture are the three main factors which cause the corrosion of steel railway rolling stock. Tests have proved that it is important that a protective coating should penetrate the exposed pores of the metal or surface to be protected. It should adhere firmly and fill every hole and crevice to seal the surface against the destructive action of water, acids or alkali.

The Quigley Furnace Specialties Company, Inc., 26 Cortland street, New York, have placed on the market a corrosive preventative solution, known as Triple A. These solutions are compounded from coal tar derivatives, carefully heat treated and are claimed not to crack, chip or peel. They contain no vegetable or animal oils, grease or turpentine and are said to form a lasting union with the surface covered which does not allow moisture or gases to creep through to the metal. This prevents oxidation and the pitting action of electrolysis.

These solutions are applied with a brush on a clean metal surface, free from grease, dust or oil. They spread easily, leaving a firm, smooth and elastic surface. Triple A solutions are furnished in several colors, the usual standard base coat being black. Over this black may be applied additional Triple A colors, such as maroon, olive green, deep-green, yellow, etc. The black solution will cover 300 to 400 square feet of surface per gallon on iron or steel.

International Combustion Corporation Expands.—An announcement has been made that the Ladd Watertube Boiler Company had been purchased by the International Combustion Engineering Corporation of New York. The new company has reserved $3,500,000 cash out of capital to construct a modern plant, with machinery to manufacture boilers.

Questions and Answers for Boiler Makers

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

Conducted by C. B. Lindstrom

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

Information Wanted On Shear Attachment

Q.—One of my customers asked me to try and find out who made a shear that cuts up the scrap as it comes off a rotary shear. He said he understood someone made an attachment that went on the rotary shear that chopped off the scrap into pieces about 9 inches long as fast as it was made. If you know of such an attachment, will you please advise me, as I have been unable to locate it anywhere.—R. A. A.

A.—Will some of our readers furnish the information required?

Tank Construction

Q.—Will you please publish in the next issue of The Boiler Maker the information given below. If you cannot in the November issue, please get it in the December.

Information on construction of tank:

This drum was originally used as an air reservoir for a locomotive at a pressure of 110 pounds of air previous to cutting it down to present size.

Drum, outside diameter, 24 inches.
Both heads, pressed in as per sketch, each welded.
Both heads, dished 2 inches.
Both heads, of ⅜-inch material.
Six tie rods, spaced 4¾ inches on a 9½-inch diameter circle, as per sketch.
Drum, inside diameter, 23½ inches.
Length inside, 60½ inches.
Single riveted lap seam, ¾-inch rivets, 2-inch pitch.
Circumference seam was beveled and acetylene welded.
Thickness of shell, ¼ inch.
Tensile strength between 40,000 and 55,000 pounds. (You may know at what pressure a locomotive air reservoir should be tested for tensile strength.)
This drum is to be used for an oil pressure tank. I do not know what pressure they intend using.

Information as to strength of tank:

1. What load can these bolts carry?
2. Have we bolts enough, or too many, to carry load?
3. What is the radius on this head?
4. What is the bursting pressure of the tank?
5. What is the safe working pressure?
6. What is the efficiency of the riveted joint?
7. Would the heads hold required pressure, without stay rods?
8. What pressure could this drum hold, built as per sketch? I mean by this could you exceed the required pressure, seeing the heads are stayed.
9. Or, does the longitudinal seam control this? S. C. D.

A.—The tensile strength of staybolt iron ranges from 48,000 to 52,000 pounds per square inch. Use the least cross sectional area of the stay and the least tensile strength value in calculating the strength of a stay.

Assume for example, that the least diameter of the stay is 1 inch. The cross sectional area equals 1 × 1 × 0.7854 = 0.7854 square inch. The maximum allowable tensile stress on the stay, using 5 as a factor of safety, equals

$$\frac{0.7854 \times 48{,}000}{5} = 7{,}339.8 \text{ pounds.}$$

Refer to table 7 of the A. S. M. E. Code for the maximum allowable stress on stays.

Dished heads are usually bumped to a radius equal to the diameter of the shell or drum, and a head 23½ inches outside diameter dished to a radius equal to the inside diameter of the drum has a dish of approximately 3 inches.

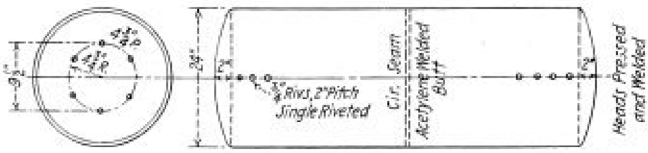


Fig. 1.—Tank construction problems

In this example the dish equals 2 inches; the radius of the dish may be found as follows:

Refer to Fig. 2, in which,

r = radius of dish, inches
l = length of chord
h = depth of dish, or height of segment.

$$r = \frac{(\frac{1}{2}\, l)^2}{2h} + h^2$$

Example.—The length of chord l = 23½ inches and the

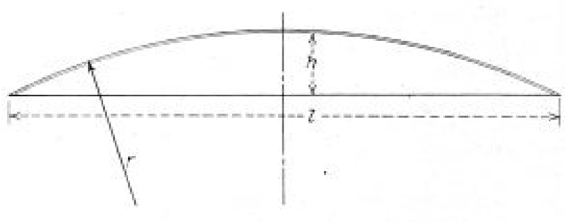


Fig. 2.—Method of finding radius of dish

depth of dish h = 2 inches, find the radius to which the head is dished.

Solution.—Substitute the given values in the formula, then

$$r = \frac{(\frac{1}{2} \times 23\frac{1}{2})^2}{2 \times 2} + 2^2 = 36.515 \text{ inches.}$$

The A. S. M. E. Code gives the following data on dished heads:

$$t = \frac{5.5 \times P \times L}{2 \times TS} + \frac{1}{8} \qquad (1)$$

in which;

t = thickness of plate, inches
P = maximum allowable pressure, pounds per square inch
TS = tensile strength, pounds per square inch
L = radius to which the head is dished, inches.

From this formula the value of P may be found, thus

$$P = \frac{(t - \frac{1}{8}) \times 2 \times TS}{5.5 \times L}. \qquad (2)$$

Where the radius is less than 80 percent of the diameter of the shell, the thickness shall be at least that found by making L equal to 80 percent of the diameter of the shell or drum.

The maximum allowable pressure on an unstayed head of the type shown in this case, provided the circumferential seam is properly riveted, may be found from formula (2). Substitute the given values, then

$$P = \frac{(3/8 - 1/8) \times 2 \times 55{,}000}{5.5 \times 36.515} = 131.4 \text{ pounds per square inch.}$$

The theoretical internal pressure required to burst a cylindrical shell having no seams may be figured from the formula:

$$\text{Bursting Pressure} = \frac{2 \times t \times TS}{D} \qquad (1)$$

Introducing a factor of safety and the joint efficiency in the above formula the allowable working pressure may be found from the formula:

$$p = \frac{2 \times t \times TS \times E}{D \times FS} \qquad (2)$$

in which,

p = maximum allowable working pressure, pounds per square inch
t = thickness of plate, inches
TS = tensile strength of plate, pounds per square inch
D = diameter of shell, inches
FS = factor of safety
E = efficiency of longitudinal seam, in percentage.

The ratio of the strength of the riveted joint to the strength of the solid plate section of the same length, is called the *efficiency of the joint*.

For the calculation of the riveted joint efficiency in this example the factors involved therein are designated as follows:

TS = tensile strength of plate, pounds per square inch
t = thickness of plate, inches
P = pitch of rivets, inches
d = diameter of rivet holes, inches
a = cross sectional area of rivet after driving, square inches
S = shearing strength of rivets, in single shear, pounds per square inch, equals 44,000 pounds per square inch for steel
c = crushing strength of boiler steel plate, pounds per square inch, equals 95,000 pounds per square inch
n = number of rivets in single shear in a unit length P.

A single riveted lap joint may fail (1) by tearing the net plate section, that is between rivet holes; (2) by shearing the rivets, or (3) by crushing the plate in front of the rivets.

To determine the efficiency of the joint, figure the strength of the joint for each of the respective modes of failure. Divide the least of these by the strength of the unit solid plate section. Thus, using the values in the example:

(1) = strength of plate between rivet holes $= (p-d) \times t \times TS = (2 - 13/16) \times 1/4 \times 55{,}000 = 16{,}328$ pounds.
(2) = shearing strength of 1 rivet in single shear $= n \times s \times a = 1 \times 44{,}000 \times 0.5185 = 22{,}814$ pounds.
(3) = crushing of plate in front of 1 rivet $= d \times t \times c = 13/16 \times 1/4 \times 95{,}000 = 19{,}296$ pounds.
(4) = strength of solid plate in the unit length or pitch $= p \times t \times TS = 2 \times 1/4 \times 55{,}000 = 27{,}500$ pounds.

The net section of plate between rivet holes is the weakest, then $16{,}328 \div 27{,}500 = 59.3$ percent $= 0.593$ efficiency of joint.

The maximum allowable working pressure on the shell may be found from the formula (2)

$$p = \frac{2 \times t \times TS \times E}{D \times FS}.$$

Substitute the given values, then

$$p = \frac{2 \times 1/4 \times 55{,}000 \times .593}{23.5 \times 5} = 138.7 \text{ pounds per square inch.}$$

From the foregoing calculations, the head is the weakest section, and the purpose of the stays is to relieve the load on the welded joint. Refer to table 6, of the Code governing the maximum allowable pitch, for screw stays with ends riveted over.

The A. S. M. E. Boiler Code will permit autogenous welding provided the load is carried by other construction that meets the requirement of the Code, and where the safety of the vessel is not dependent upon the strength of the weld.

The calculated pressure on the head, pounds per square inch, for the number of staybolts indicated may be found as follows:

Multiply the maximum allowable load on each stay by the number of stays and divide the product by the area of the head in square inches, as measured on the inside diameter of the shell; then

$$\frac{7{,}339.8 \times 6}{433.7} = 105 \text{ pounds per square inch.}$$

This pressure would not be permitted on the welded joint. The circumferential seams should be lap jointed and welded inside and outside. Fuel oil storage vessels in New York city are tested to a pressure of 30 pounds per square inch. The rules governing the installation of oil storage tanks in your locality should be followed.

Calculating Capacity of Cylindrical Tanks

Q.—Will you please advise what equation will bring the result of 0.0034 used in finding capacity of round tanks U. S. Gal.? I instruct a boiler layout class at the Dunwoody Industrial School of 15 students who all subscribe for THE BOILER MAKER. Thanking you in advance for an early reply. R. S. M.

A.—A short rule for finding the capacity of cylindrical tanks of any size is as follows. Use the given dimensions in inches; multiply the length of the tank by the square of the diameter, and by 0.0034.

The theoretical method may be expressed as in the formula:

$$\frac{d^2 \times 0.7854 \times L}{231}$$

in which, d = diameter of cylinder, inches
L = length of cylinder, inches
231 = number of cubic inches in 1 gallon.

To simplify the calculation, the value $\frac{0.7854}{231}$ in the equation is reduced to the factor 0.0034 and used as a multiplier.

WALTER F. MULHALL, who for the past four years has been an account executive with the G. M. Basford Company, New York, has been elected vice-president of that company. Before going with G. M. Basford Company, Mr. Mulhall was assistant to the general superintendent of the Midvale Steel Company.

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

States

Arkansas	Missouri	Rhode Island
California	New Jersey	Utah
Delaware	New York	Washington
Indiana	Ohio	Wisconsin
Maryland	Oklahoma	District of Columbia
Michigan	Oregon	Panama Canal Zone
Minnesota	Pennsylvania	Allegheny County, Pa.

Cities

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

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

States

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

Cities

Chicago, Ill.	Nashville, Tenn.	St. Louis, Mo.
Kansas City, Mo.	Parkersburg, W. Va.	Seattle, Wash.

SELECTED BOILER PATENTS

Compiled by

DWIGHT B. GALT, Patent Attorney,

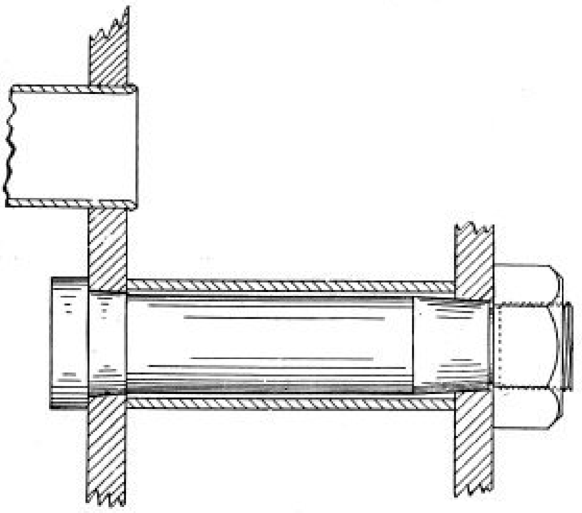
Washington Loan and Trust Building

Washington, D. C.

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

1,551,781. JOHN F. L. BAKER, OF SAGINAW, MICHIGAN, ASSIGNOR TO THE WICKES BOILER CO., OF SAGINAW, MICHIGAN, A CORPORATION OF MICHIGAN. STAY BOLT.

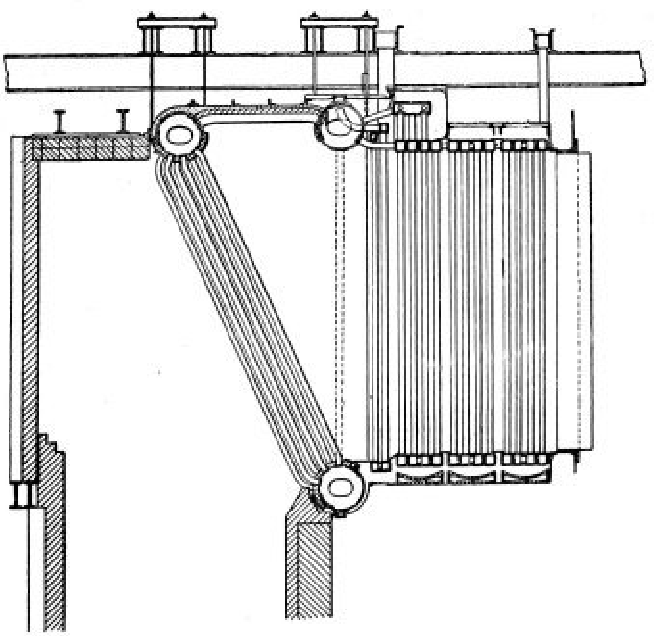
Claim. In combination, a pair of plates spaced apart, a thimble between said plates, each plate formed with a tapered aperture extending therethrough, the aperture of one plate of larger diameter than the aperture of the other plate, and the tapers in the opposing plates being in the same direction, a bolt comprising a body, a head, a threaded end, and a nut



therefor, a part of said bolt body adjacent the head tapered to fit the aperture of one of said plates, a part of said bolt body adjacent the threaded end tapered to fit the aperture of the other plate, whereby tightening said nut produces endwise compression in said thimble and draws both of the tapered parts of said bolts simultaneously into close engagement with the walls of the tapered openings in the respective plates.

1,552,020. GEORGE C. VENNUM, OF WESTFIELD, NEW JERSEY, AND HENRY B. BRADFORD, OF EDGE MOOR, BRANDYWINE HUNDRED, DELAWARE, ASSIGNORS TO EDGE MOOR IRON COMPANY, OF EDGE MOOR, DELAWARE, A CORPORATION OF DELAWARE. STEAM SUPERHEATER.

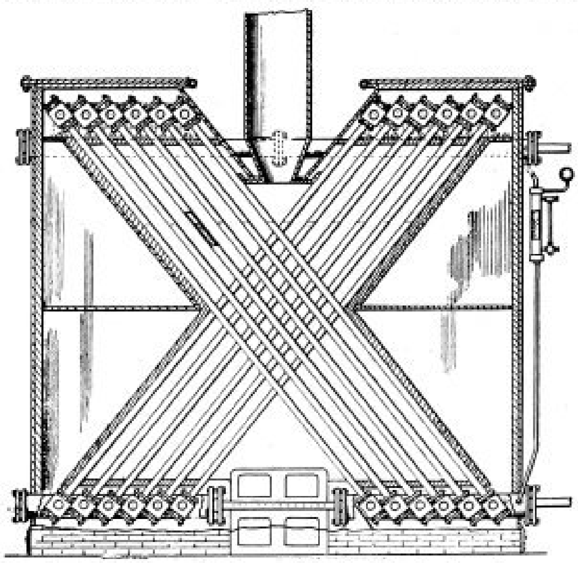
Claim 1. In combination with a steam boiler having a contracting gas pass through which the heating gases pass, a wide and comparatively shallow



superheater made up of substantially straight tubes connected at their ends to headers, said superheater being located in and extending substantially across the full width and height of said gas pass, and having its tubes arranged in groups with an open space or spaces between said groups, and one or more dampers located in said open spaces, whereby said spaces can be regulated in area. Five claims.

1,546,009. WATER-TUBE BOILER. CHARLES E. CHAPMAN, OF FORT EDWARD, NEW YORK, ASSIGNOR OF ONE-HALF TO JOSEPH GOODFELLOW, OF FORT EDWARD, NEW YORK.

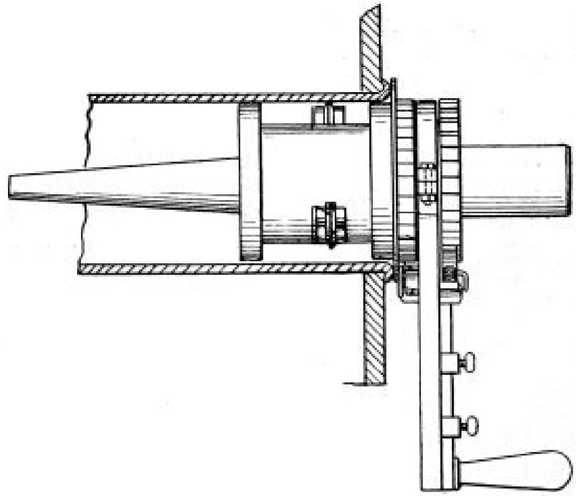
Claim 1. In a water tube boiler, a fire box, the said fire box comprising a back, a front, side walls, and a top, the top having a sunken portion at its intermediate part, a flue leading upwardly from the sunken portion and communicating with the fire box, upper partition walls extending between the side walls of the fire box and the sunken portion of the top and providing air spaces at the opposite sides of the flue, baffle walls extending between the front and back of the fire box and inclined downwardly toward each other, other baffle walls inclined downwardly and outwardly away from each other from the lower edges of the first mentioned baffle walls and



extending likewise between the front and back of the fire box, lower partition walls extending above the bottom of the fire box and between the lower portions of the last mentioned baffle walls and providing beneath them an air space, banks of water tubes arranged in crossed relation with their lower portions extending parallel to the under sides of the respective second mentioned baffle walls and having their upper portions extending parallel to the upper faces of the respective first mentioned baffle walls, the upper ends of the tubes of each bank extending through the upper partition wall and the lower ends extending through the lower partition wall, headers connecting the upper ends of the series of tubes comprising each bank and located within the first mentioned air spaces, headers connecting the lower ends of the series of tubes comprising each bank and located within the last mentioned air spaces, and means for supplying water to the last mentioned headers.

1,554,936. WILLIE CALEB WILLIAMS, OF MOBILE, ALABAMA, FLUE CUTTER.

Claim. A boiler tube cutter including a cylindrical tubular body having an integral annular flange at its outer end provided with peripheral ratchet teeth, a ratchet collar fixedly mounted on the body in spaced relation to said flange, an operating handle rotatably mounted between said flange and said collar, independently operable pawls pivotally mounted on the



operating handle and adapted for independent co-operation with the ratchet teeth on said flange and collar for effecting a rotation of the body in the direction of movement of the handle, said body being provided between its ends with circumferentially spaced openings, a pair of longitudinally spaced guide rings removably mounted on the body on opposite sides of said openings, cutting elements extending through said openings and having their inner ends disposed within the tubular body, the inner ends of said cutting elements being of arcuate formation, spring means anchored on said body and connected with said cutting element to normally move the latter inwardly, and an expanding pin inserted into said body and having an inner tapered end upon which the arcuate inner portions of said cutting elements are engaged.