# The Boiler Maker

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# THE BOILER MAKER

JANUARY, 1920


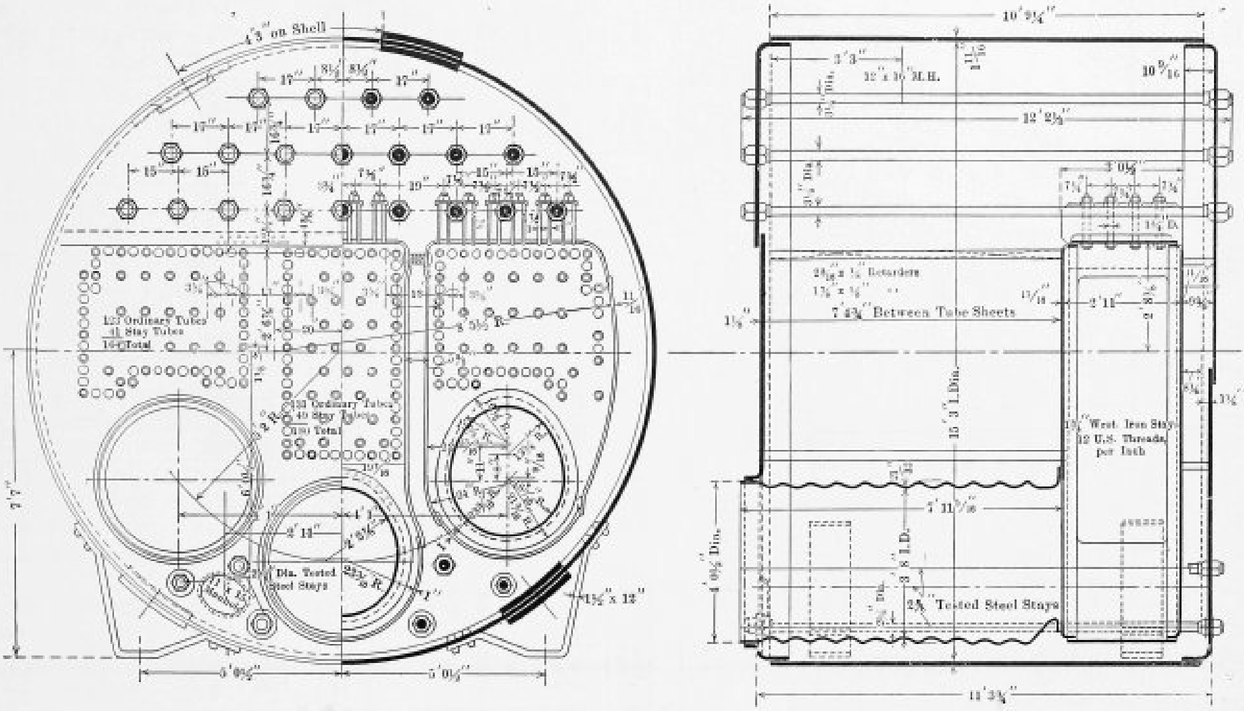


Fig. 1.—General Arrangement of Scotch Boiler as Used on Ships of the Emergency Fleet Corporation

# Boilers of the New Emergency Fleet

**Comparative Results Obtained with Scotch and Watertube Boilers—Relative Costs and Weights and Service Records—Details of Construction**

BY JOS. J. NELIS*

Before the world war the American merchant marine had for a number of years consisted of a very small proportion of the world's tonnage. Owing to its restricted size, operating engineers and designers were inclined to follow established foreign precedence as regards propelling equipment. Therefore, nearly all American merchant ships were fitted with Scotch marine boilers and triple expansion engines. This equipment, when properly handled by trained crews, gave satisfactory service as regards reliable operation. Reliability in operation is the most essential requirement of marine propelling equipment, but economy of operation, while desirable, has in the past been neglected owing to the conservatism of marine engineers in all countries.

The development of the watertube boiler in land plants has shown it to be considerably more economical than the firetube boiler, but it had not been adopted to any great extent by the American merchant marine. The American navy, however, and practically all foreign navies, have adopted the watertube boiler almost exclusively on account of its lower weight, reduced size, greater economy and much greater capacity than the Scotch boiler.

When America entered the world war in 1917 the necessity for a larger merchant marine, which had been well known for a number of years by all naval and marine interests, was suddenly discovered by the rest of the country, as the necessity arose for transports for our troops and their supplies. The Government promptly formed an organization to build ships and also requistioned all the ships then building in the shipyards of the country. A review of the situation at that time showed that the requirements were so vast that it would be necessary to develop a number of new shipyards and to expand the American merchant marine tremendously in the shortest possible period of time.

This programme was handled for the Government by the Emergency Fleet Corporation, and at one time contracts had been entered into for more than 14,000,000 deadweight

* Manager marine department, Power Specialty Company, New York, and formerly senior marine engineer, boiler unit, engineering section, United States Shipping Board, Emergency Fleet Corporation.

# TABLE 1.—MAIN PARTICULARS OF SCOTCH BOILERS IN THE EMERGENCY FLEET

| Drawing Number | Diameter of Boiler | Length of Boiler | Square In. Working Press. | Length of Grate | Square Ft. Area of Grate | Heating Surface: Tubes | Heating Surface: Furnace | Heating Surface: Com. Cham | Heating Surface: Total | | H. S. / G. A. | G. A. / T. A. | Cu. Ft. Volume Steam | Lbs. Weight Wet | Lbs. Weight Dry | Number, Size, Kind and Thickness of Tubes: Stay | Number, Size, Kind and Thickness of Tubes: Common | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E-15000....... | 15'-3" | 11'-3¾" | 210 | 6'-8" | 73. | 2459<br>2459 | 150<br>270 | 260<br>321 | 2869<br>3050 | Coal<br>Oil | 39.3 | 6.08 | 480 | 187490 | 131740 | 131-2½"-No.2 B. W. G. | 377-2½" No. 10 B. W. G. | 508 |
| E-15002....... | 14'-9" | 11'-0" | 210 | 5'-6" | 60.3 | 2331<br>2331 | 146<br>262 | 273<br>342 | 2750<br>2935 | Coal<br>Oil | 45.5 | 4.8 | 380 | 190126 | 118930 | 125-2½"-5/16" Thick | 367-2½"- No. 10 B. W. G. | 492 |
| E-15003....... | 14'-6" | 11'-7 9/16" | 210 | 5'-6" | 60.5 | 2116<br>2116 | 152.3<br>275 | 260.2<br>322 | 2528.5<br>2713. | Coal<br>Oil | 41.8 | 5.54 | 419 | | | 102-2½"-5/16" Thick | 322-2½" No. 10 B. W. G. | 424 |
| E-15004....... | 14'-6" | 11'-7 9/16" | 210 | 5'-6" | 60.5 | 1952.3<br>1952.3 | 152.3<br>272.3 | 253.5<br>315.5 | 2358.1<br>2540.1 | Coal<br>Oil | 39 | 4.70 | 407 | 165900 | 117500 | 124-3"-¼" Thick | 202-3" No. 10 B. W. G. | 326 |
| E-15005....... | 14'-6" | 12'-0" | 155 | 6'-3½" | 70.78 | 2121<br>2121 | 169<br>305 | 234<br>304 | 2524<br>2730 | Coal<br>Oil | 35.7 | 5.38 | 348 | 141300 | 94700 | 82-3"- No. 5 B. W. G. | 252-3"-No. 10 B. W. G. | 334 |
| E-15006....... | 14'-6" | 11'-7 9/16" | 190 | 5'-6" | 60.5 | 1951<br>1951 | 153<br>273 | 254<br>316 | 2358<br>2540 | Coal<br>Oil | 39 | 4.8 | 410 | | | 124-3"-¼" Thick | 202-3"-No. 11 B. W. G. | 326 |
| E-15007....... | 11'-6" | 12'-0" | 180 | 6'-5½" | 48.3 | 1241<br>1241 | 124<br>225 | 157<br>186 | 1522<br>1652 | Coal<br>Oil | 31.5 | 6.86 | 142 | 106400 | 68700 | 40-3"-No. 5 B. W. G. | 138-3"- No. 10 B. W. G. | 178 |
| E-15008....... | 13'-0" | 11'-0" | 190 | 6'-3" | 50. | 1626<br>1626 | 109<br>200 | 179<br>219 | 1914<br>2045 | Coal<br>Oil | 38.3 | 5.86 | 312 | | | 72-2½"-5/8 Thick | 252-2½" No. 11 B. W. G. | 324 |
| E-15009....... | 52" | 96" High | 100 | 3'-8½"D | 10.8 | 266 | 67.5 | | 333.5 | | 30.8 | 4.596 | ... | | | 2-2"-No. 7 U. S. S. | 126-2"- No. 13 U. S. S. | 128 |
| Newport News 85878....... | 15'-3" | 11'-3¾" | 210 | 6'-8" | 73. | 2459<br>2459 | 150<br>270 | 260<br>321 | 2869<br>3060 | Coal<br>Oil | 39.3 | 5.66 | 470 | | | 134-2½" No. 2 B. W. G. | 374-2½" No. 10 B. W. G. | 508 |
| Sun. S. B. Co. 26-862-1..... | 15'-3" | 11'-5" | 190 | 5'-6" | 61.8 | 2329.5 | 164 | 283.6 | 2777 | Coal | 44.9 | 5.2 | 445 | | 117756 | 1222½"-¼" Thick | 341-2½" No. 10 B. W. G. | 463 |
| Beth. S. Co. E-1376-35-1.. | 14'-2" | 11'-10" | 190 | 5'-0" | 55 | 2050 | 187 | 238 | 2475 | Coal | 45 | 5.6 | 347 | | | 110-2½"-5/16" Thick | 276-2½"-.120" Thick | 386 |
| Newport News 73998....... | 15'-9" | 11'-5" | 220 | 5'-4½" | 71 2/3 | 2336 | 212 | 352 | 2900 | Coal | 40.5 | 5.43 | 440 | 198400 | 141600 | 124-2¾"-5/16" Thick<br>19-5"-¼" Thick | 302-2¾"- No. 10 B. W. G. | 426 |
| Union I. Wks. 25546....... | 15'-6" | 12'-1" | 220 | 6'-0" | 67.5 | 2600<br>2600 | 167<br>300 | 265<br>325 | 3032<br>3225 | Coal<br>Oil | 45. | 5.08 | 444 | 190900 | 125000 | 103-2½"-5/8" Thick | 339-2½"-No. 9 B. W. G. | 361 |

| Drawing Number | Distance Between Tube Sheets | Square Ft. Area Thru Tubes | % of Dia. Top of C.C. from C.of B | Size of Safety Valve | C. of B. to Top of C. C. | Hour Lbs. Water Evap per Sq. Ft. of Grate | Thickness Plate: Shell | Thickness Plate: Front Head | Thickness Plate: Back Head | Thickness Plate: Butt Straps | Furnace: Inside Dia. | Furnace: Outside Dia. | Furnace: Type | Furnace: No. | Furnace: Thickness | Furnace: Length | Combustion Chambers: Depth Inside | Combustion Chambers: Greatest Width | Combustion Chambers: Height | Combustion Chambers: Front | Combustion Chambers: Top | Combustion Chambers: Back | Combustion Chambers: Wrapper |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| E-15000....... | 7'-4¾" | 12. | 32 | 2-3½" | 2'-8 3/8" | 270 | 1 11/16" | 1 3/16"<br>1 1/8"<br>1 3/32" | 1 3/16"<br>1 1/8"<br>1 3/32" | 1 5/16" 0<br>1 5/16" 1 | 3"<br>3'-8" | 4'-0 9/16" | Str. Mouth Morrison | 3 | 21/32" | 7'-11 5/16" | 2'-11" | C 3'-3½"<br>S 4'-7" | 9'-5"<br>7'-5" | 13/16 | 5/8 | 11/16 | 1" |
| E-15002...... | 7'-2 7/8" | 12.49 | 34 | 2-3½" | 2'-11¼" | 270 | 1 3/8" | 1 3/16" | 1 1/16" | 1¼" | 3'-8" | 4'-0 9/16" | " | 3 | 21/32" | 7'-9½" | 2'-10" | C 3'-0"<br>S 4'-11" | 9'-3"<br>7'-3" | 13/16 | 11/16 | 11/16 | 15/16 |
| E-15003....... | 7'-7½" | 10.92 | 31.07 | 2-3½" | 2'-8¼" | 270 | 1 13/32" | 1 1/32" | 1 1/32" | 1 7/32" | 3'-8" | 4'-0 9/16" | | | | | | | | | | | |
| E-15004....... | 7'-7½" | 12.62 | 30.5 | 2-3½" | 2'-9 3/8" | 270 | 1 19/32" | 1 1/32" | 1 1/32" | 1 7/32" | 3'-8" | 4'-0 9/16" | " | 3 | 21/32" | 8'-2¼" | 2'-10" | C 3'-1"<br>S 4'-8" | 9'-6"<br>7'-6" | ¾ | 11/16 | ¾ | 15/16 |
| E-15005....... | 8'-1 1/16" | 13.17 | 27.9 | 4½" | 3'-1¾" | 180 | 1 3/16" | 1"<br>7/8" | 1"<br>9/16" | 7/8" | 2'-10" | 4'-2 1/16" | " | 3 | 21/32" | 8'-2¼" | 2'-10" | C 7'-8"<br>S 9'-9" | 9'-9"<br>7'-8" | 27/32 | 11/16 | ¾ | 11/16 |
| E-15006....... | 7'-7½" | 12.6 | 30.5 | 2-3½" | 2'-9 3/8" | 270 | 1 7/16" | 1 1/32"<br>29/32" | 1 1/32"<br>31/32" | 1 1/8" | 3'-8" | 4'-0 9/16" | " | 3 | 17/32" | 8'-7¼" | 2' 10½" | 13' 8" | 10'-0" | 11/16 | 9/16 | 9/16 | 9/16 |
| E-15007....... | 8'-10 9/16" | 7.04 | 25.7 | 2½" Du. | 2'-8¾" | 180 | 1 3/32" | 15/16"<br>7/8" | 15/16"<br>9/16" | 13/16" | 3'-9 5/8" | 4' 2 1/16" | " | 3 | 19/32" | 8'-2¼" | 2'-10" | C 3'-0¾"<br>S 4'-5 5/8" | 9'-9"<br>7'-8" | 13/16 | 5/8 | 21/32 | 7/8 |
| E-15008....... | 7'-8" | 8.49 | 30.7 | 2-3" | 2'-5 3/8" | 250 | 1 5/16" | 1 1/16"<br>¾" | 1 1/16"<br>5/8" | 1" | 4'-0" | 4'-4¼" | " | 2 | 19/32" | 9'-4½" | 2'-3½" | 5'-1" | 7'-3" | 11/16 | 9/16 | 9/16 | 9/16 |
| E-15009....... | 54" | 2.35 | ... | 2" | .... | .... | 5/16" | 7/16" | .... | .... | 3'-9¾" | ...... | " | 2 | 21/32" | 8'-3" | 2'-3" | 5'-4" | 7'-6" | 11/16 | 1¼ | 5/8 | 1 3/32 |
| Newport News. 85878....... | 7'-4¾" | 12.9 | 32 | .... | 2' 6 7/8" | .... | 1 11/16" | 1 3/16" | 1 3/16" | 1 5/16" | 3'-8" | 4'-0 9/16" | ........ | .. | ...... | ...... | ...... | ........ | ...... | .. | .. | .. | .... |
| Sun. S. B. Co. 26-862-1.... | 7'-8¾" | 11.9 | 30 | 3½" Twin | 2'-11 7/8" | 270 | 1 11/32" | 1 1/8"<br>1" | 1 1/8"<br>1" | 1 3/16" 0<br>1 9/16" 1 | 3'-9" | 4'-1¼" | Str. Mouth Morrison | 3 | 21/32" | 7'-11 3/8" | 2'-11" | 3'-4"<br>4'-9" | 9'-4"<br>7'-8" | 13/16 | 5/8 | 11/16 | 1" |
| Beth. S. Co. E-1376-35-1.... | 8'-1½" | 9.81 | 27 | 3½" Dup. | 3'-1¼" | 200 | 1 3/8" | 1 1/8"<br>¾" | 1 1/ "<br>¾" | 1¼" | 3'-8" | 4'-0¼" | " | 3 | 5/8" | 8'-3½" | 2'-11" | 3'-1"<br>4'-10" | 9'-10"<br>7'-9" | ¾ | 5/8 | ¾ | 15/16 |
| | | | | | | | | | | | | | " | 3 | 5/8" | 8'-8 5/8" | 2'-9"<br>3'-0" | 2'-9"<br>4'-9" | 9'-4"<br>7'-10½" | ¾ | 5/8 | 5/8 | 7/8 |
| Newport News 73998....... | 7'-7 13/32" | 13.2 | .285 | 3½" Twin | 3'-4" | 235 | 1 49/64" | 1 1/8"<br>25/32 | 1 1/8"<br>¾" | 1 9/32" 0<br>1 19/32" 1 | 3'-4" | 3'-8¼" | " | 4 | 5/8" | 8'-2 9/16" | 2'-10" | C 2'-4" 2<br>S 4'-3" 2 | 9'-10" 2<br>7'-1" 2 | 13/16 | 21/32 | 21/32 | 15/16 |
| Union I. Wks. 25546....... | 8'-2" | 13.28 | .282 | .... | 3'-4½" | .... | 1 23/32" | 19/32"<br>15/16" | 1 9/32"<br>15/16" | 1¼" 0<br>1½" 1 | 3'-9" | 4'-1 3/8" | Flanged Morrison | 3 | 13/16" | 8'-5 5/8" | 2'-11" | C 3'-1"<br>S 5'-3" | 10'-1½"<br>7'-10" | 7/8 | 23/32 | 23/32 | 1 |

tons of shipping. This included both the requisitioned ships then building, which were taken over by the Government, and new contracts for ships made by the Emergency Fleet Corporation. Since the signing of the armistice this programme has been reduced approximately 20 percent.

It developed during the expansion period that it would be possible to produce hulls much faster than the propelling equipment, particularly if Scotch boilers and triple-expansion engines were to be used exclusively. It was, therefore, necessary to place orders for propelling equipment with all shops available, in order to prevent delay in fitting out hulls with propelling machinery after launching.

### EMERGENCY FLEET REQUIREMENTS

As new ship contracts were being constantly made, propelling equipment was ordered in standard units and sizes in large quantities and later allocated to the various shipyards as their needs developed. The necessity for making advance contracts for large amounts of propelling machinery can be realized by the fact that in one day (July 4, 1918) ninety-five hulls were launched, which required over 250 boilers. Contracts were entered into for all Scotch boilers that could be built in the time available by plants equipped for this work, and contracts were also entered into for new plants and the shop equipment required for the building of additional Scotch boilers; also about 50 percent of the total capacity of the country for the building of watertube boilers was used to produce boilers of this type. A large number of turbines were also ordered to supplement the engine-building capacity of the country. If the original programme of the Emergency Fleet Corporation had not been reduced there would have been a shortage of propelling equipment late in 1919, in spite of the fact that this equipment was ordered in excess of requirements shown by the ship contracts at any period. When the shipbuilding programme was reduced the propelling equipment contracts for these ships were canceled where manufacture had not been too far advanced. In other cases the propelling equipment was completed and stored for future use.

At the present time the new emergency fleet, including both requisitioned and contract ships, without further cancellations or reinstatement of contracts, when completed will have in service approximately the following boilers:

WATERTUBE BOILERS

| Type | Number |
|---|---|
| Babcock & Wilcox | 1,100 |
| Emergency Fleet Standard | 600 |
| Foster | 450 |
| Heine | 185 |
| Badenhausen | 65 |
| Yarrow | 64 |
| Ward | 48 |
| Colvin | 32 |
| Scott | 30 |
| Wickes | 24 |
| Ballin | 20 |
| Howden | 16 |
| Craig | 4 |
| | 2,638 |

SCOTCH MARINE BOILERS

| Size | Number |
|---|---|
| 11 feet 0 inches to 11 feet 8 inches diameter | 132 |
| 12 " 0 " " 12 " 11 " " | 46 |
| 13 " 0 " " 13 " 11 " " | 290 |
| 14 " 0 " " 14 " 3 " " | 175 |
| 14 " 6 " " 14 " 8 " " | 231 |
| 14 " 9 " " 14 " 11 " " | 665 |
| 15 " 0 " " 15 " 3 " " | 526 |
| 15 " 4 " " 15 " 11 " " | 150 |
| 16 " 1 " " 16 " 6 " " | 26 |
| Total boilers, 4,879 | 2,241 |

This tabulation shows approximately one-half the ships being built were fitted with Scotch boilers and a similar number with watertube boilers. Scotch boilers are being fitted principally in steel cargo ships and tugs. The designs of Scotch boilers used were prepared by shipbuilders for established shipyards and by the Emergency Fleet Corporation for the new shipyards. All of these boilers are

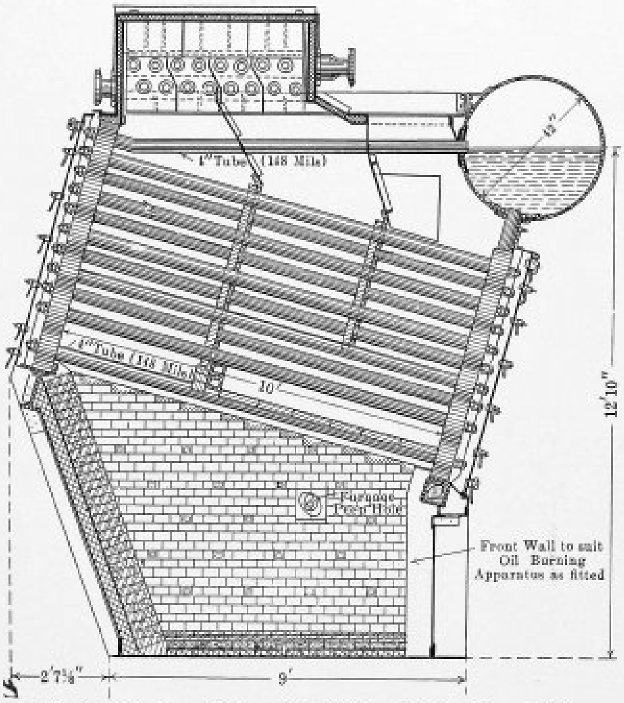


Fig. 2.—Section of Babcock & Wilcox Marine Type Boiler

of the more or less conventional design formerly used almost exclusively in merchant marine practice.

### SCOTCH BOILERS

To obtain as economical an arrangement as possible, the Scotch boilers for the emergency fleet were designed to give a ratio of heating surface to indicated horsepower of 3 to 1. For example, a considerable number of standard steel cargo ships were of approximately 8,800 to 9,400 deadweight tons and were equipped with three Scotch boilers built for 210 pounds working pressure, 14 feet 9 inches diameter by 11 feet long, having a total of 8,700 square feet heating surface. These boilers supplied steam to one triple-expansion engine with cylinders 24½ inches, 41½ inches and 72 inches diameter by 48 inches stroke, rated at 2,800 indicated horsepower at 88 revolutions per minute.

The steam consumption of a ship of this type is approximately 45,000 pounds per hour for all purposes. The steam requirements per boiler are therefore 15,000 pounds of steam per hour, equal to an evaporation of slightly more than 5 pounds per square foot heating surface per hour. Under these conditions the average trial trip data of a number of ships showed that the temperature of the gases leaving the boiler averaged 650 degrees F. This was reduced 100 degrees by the waste heat type superheater located in the uptakes above the boiler tubes and further reduced 75 to 100 degrees by the heated forced draft air tubes, giving a final stack temperature of 450 to 475 degrees F. The installation of the waste heat superheater and air heater tubes resulted in giving much greater fuel economy than was formerly obtained in Scotch marine boilers not fitted with these devices. With this arrangement the economy of the Scotch boiler, its superheater and air heater, closely approximates that of the average watertube boiler.

Ships for the merchant marine are primarily designed to carry cargo, and any unnecessary weight in the propelling equipment reduces the cargo-carrying capacity of

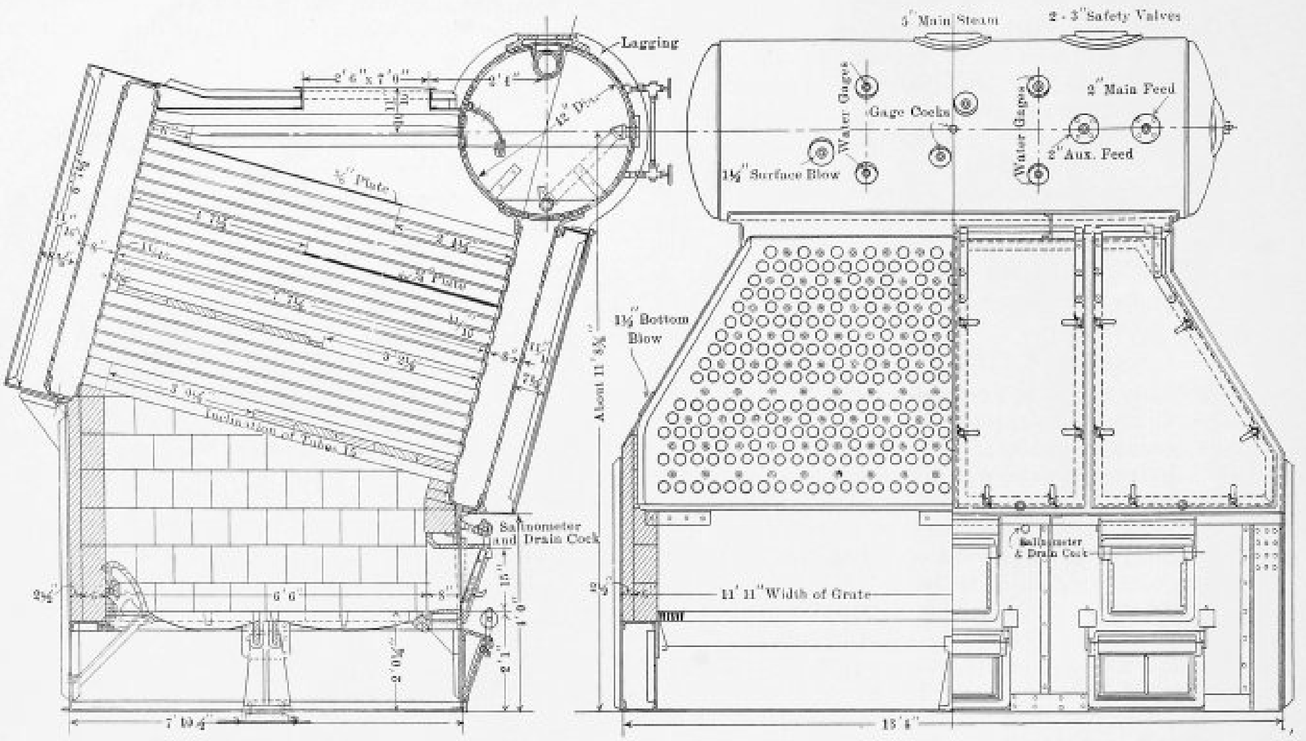


Fig. 3.—General Arrangement of Standard Watertube Boiler for Emergency Fleet Corporation Designed by Technical Department, Washington

the ship. The Scotch boiler is at a serious disadvantage compared with the watertube boiler as regards weight. A comparison of these two types of boilers, both built for 225 pounds working pressure, is as follows:

| | Scotch | Watertube |
|---|---|---|
| Heating surface..... | 2,500 square feet | 2,500 square feet |
| Size of boiler....... | 14 feet 6 inches by 11 feet | 42-inch cross drum |
| Weight of metal..... | 120,087 pounds | 45,991 pounds |
| Weight of brickwork and baffles......... | ....... | 15,160 pounds |
| Weight of insulation. | 5,364 pounds | 840 pounds |
| Weight of water..... | 45,048 pounds | 17,000 pounds |
| Total .......... | 170,499 pounds | 78,991 pounds |

The weight given for the Scotch boiler does not take into consideration the weight of the heated forced-draft system, and superheaters which are necessary for a boiler of this type if reasonable fuel economy is to be obtained or the extra weight of boiler foundations and saddles.

An analysis of the weights of sixty representative Scotch boilers made by different manufacturers shows that this averages from 60 to 70 pounds per square foot heating surface when built for 210 pounds working pressure. The weight of any Scotch marine boiler can be very closely calculated by the following formula:

$W$ = diameter$^2 \times L \times P \times .22 \times 1.05$ = tons of 2,000 pounds.

.22 = factor.
1.05 = manufacturers' allowance for overweight of material.
Diameter = inside diameter in feet.
$L$ = overall length in feet.
$P$ = working pressure in pounds per square inch.
$W$ = total weight in tons without water.

The weight of the water in the Scotch boiler is usually more than double the weight of the water in the watertube boiler. This additional weight of water allows a steadier lower level to be carried and gives a larger reserve in case of trouble with feed pumps, but also seriously reduces the weight-carrying capacity of the ship.

The design of Scotch boilers has become so standardized by the rules and regulations of classification societies of the United States Government, and past experience, that all shipbuilders followed closely these rules. This is clearly shown by Table 1, giving in detail the construction, pressure, weights, areas, and dimensions of nine Scotch boilers designed by the Emergency Fleet Corporation and five Scotch boilers designed by the leading shipbuilders. Fig. 1 shows a representative Emergency Fleet boiler as used in steel cargo ships. All the designs are for single-ended boilers. The majority of them are of the three-furnace type. It has been found from past experience that double-ended boilers require considerable repairs and are short lived. It is therefore more economical in cargo ships where small power is required to use single-ended Scotch boilers, although this requires additional space in the ship, at a moderate evaporation rate, to secure long life and a minimum of repairs.

### Service of the Scotch Boiler

The Scotch marine boiler has, in the past, given satisfactory service, due to its manufacture having been in the hands of experienced shipbuilders and its operation in the hands of experienced marine engineers. When well built, well designed and well operated by a trained crew, with not less than one-third of its area for steam space it will give satisfactory service and will stand a considerable amount of salt feed without priming troubles, but, due to its defective circulation and the different expansion of its various parts at working pressure and temperature, the repairs required are considerable. This is particularly true of ships in the coastwise service on short runs where the boilers are alternately heated and cooled much oftener than on long ocean voyages. In many cases the time required for annual repairs to a ship is governed by the time required for repairs to Scotch boilers, as these boiler repairs require more time than other annual repairs of the ship.

In many cases Scotch boilers at sea when carrying pressures from 180 to 210 pounds have been found with the bottom of the shell at not over 100 degrees F. This is due to the lack of circulation and to the bottom of the boiler not usually being insulated. A great number of devices have been patented and tried out for circulating the water in Scotch boilers, but as none of them has been used for any length of time, it is evident that no successful method of securing the necessary circulation has yet been found.

Due to nearly all merchant ships being fitted with this type of boiler in the past, practically all American and foreign ports were equipped with shops who specialized in the necessary repairs and boiler scaling required when a ship was in port.

### Repairs to Scotch Boilers

At the present time a number of Scotch boilers have been installed in the new emergency fleet which are not operated by trained crews, and in some cases have not been properly built. As a result, repairs to Scotch boilers in these ships have been excessive. Practically 80 percent of the boiler repairs on vessels of the emergency fleet that are now in operation are being made on Scotch boilers, although only 50 percent of the boilers in operation are of this type. In many cases leaks due to poor workmanship of Scotch boilers cannot be made tight by the usual calking, and various kinds of welding have been resorted to. Welding, even when properly done, does not keep seams of Scotch boilers tight more than four or five years, due to the constant movement of these seams. When welding is not properly done it is the source of more trouble than the original leak.

In one recent case an inexperienced crew raised steam in Scotch boilers in less than four hours without circulating the boiler water. As a result the ship was laid up for a considerable length of time to weld and calk the major portion of the shell and combustion-chamber seams. The cost of these repairs on Scotch boilers, coupled with the increased first cost and the short life as compared with watertube boilers, makes the final cost of Scotch boilers for marine use excessive.

In some Scotch boiler designs, principally on requisitioned ships, which were building before the Emergency Fleet took charge, an attempt has been made to install too much heating surface for the diameter of shell used, with the result that the steam space is considerably less than one-third of the total shell area and the boilers, if slightly salted, prime badly. This design also makes it difficult, if not impossible, to scale the furnace crowns and properly clean the other parts of the boiler.

### Forcing Scotch Boilers Uneconomical

In some ships an attempt has been made to use Scotch boilers at an evaporation of from 6 to 7 pounds per square foot heating surface. This evaporation can be maintained with oil fuel, but it results in a very uneconomical boiler, due to its extremely high stack temperature. It is also an expensive boiler to operate, due to the repairs required and the very short life of the boiler when operated at this excessive evaporation rate for a boiler of this type. In other cases Scotch boilers have been installed for an evaporation of approximately 4 pounds per square foot heating surface. This, while resulting in an efficient boiler, will give an increased weight of over 200 tons per ship on a 10,000 deadweight ton ship. Its repair cost will be low and its life considerably lengthened, but the increased weight makes it an expensive boiler for the shipowner, due to the space and weight required, resulting in a loss of cargo-carrying capacity.

The majority of the watertube boilers installed in the emergency fleet are of the well-known cross-drum, straight-tube type, which has given successful service both in the navy and merchant marine in the past.

### Watertube Boilers

The watertube boilers for the steel ships were principally oil-fired, as it was generally recognized by marine engineers that the watertube boiler is better fitted to withstand oil-firing than the Scotch boiler. Watertube boilers were also almost exclusively used in the wood ships, and were designed for coal-firing, as it was not considered advisable to make these ships oil burners. The watertube boilers used in the wood ships were of the Emergency Fleet standard design and were built by various manufacturers under the supervision of the Emergency Fleet inspection service.

It was necessary, however, to accept and use in the wood ships a number of other watertube boiler designs

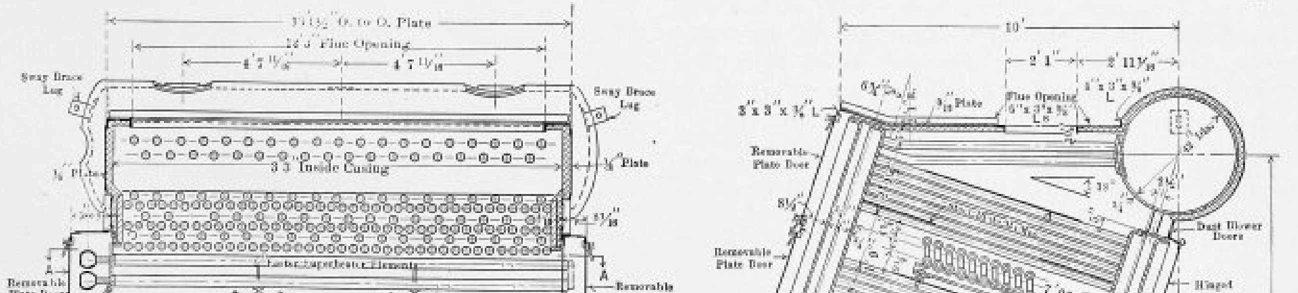


Fig. 4.—Cross-Section of the Foster Marine Boiler

which had not been successfully developed for marine practice. Most of these boilers are not satisfactory for marine use.

### Babcock and Wilcox Watertube Boiler

The Babcock and Wilcox boiler, Fig. 2, designed especially for use in the Emergency Fleet Corporation cargo ships, is a special large tube design and is a modification of the same boiler as used in land practice. This boiler, while not as efficient as the Babcock and Wilcox standard small tube marine boiler, has a larger furnace volume, larger gas passages, more water storage and is fitted with more than the usual number of oil burners. The result is an easy steaming boiler that can be readily cleaned, and which is more economical than the average Scotch marine boiler.

### Emergency Fleet Standard Watertube Boiler

The Emergency Fleet standard watertube boiler was designed to obtain the maximum grate area to enable it to give sufficient steam when operated by inexperienced firemen using poor coal with natural draft. Later, induced draft fans were fitted, but are not used except with very poor coal. This boiler follows the conventional cross-drum marine design. The headers are of staybolted construction with closer tube spacings than were formerly used in marine practice, which, with the four horizontal baffles, has resulted in a satisfactory, economical, as well as a high capacity boiler. Fig. 3 shows the design of this boiler. It will be noted that the rear of grate is fitted with Wager bridge wall, which has proved very successful in practice by allowing excess air at the rear of furnace to assist proper combustion of the furnace gases and in preventing clinkers adhering to the rear brick wall of the furnace.

These boilers are used exclusively in wooden ships, which are generally operated by the younger and more inexperienced engineers. Notwithstanding this handicap, they have in a majority of cases shown remarkable records for reliability and economy, capacity and low cost of repairs. As an evidence of the care these boilers have been compelled to operate under, in two of the wooden ships the boilers have been heavily fired until all the water has been evaporated and the lower tubes melted. In neither case did an explosion occur due to the water having been completely evaporated. These burned-out boilers were replaced by new boilers of the same type.

### Foster Watertube Boiler

The Foster watertube boiler, Fig. 4, is also of the conventional cross-drum, horizontal, straight-tube type. Its essential features are the close tube spacing, steel baffles and the location of the superheating chamber, which allows any degree of superheat to be obtained that may be required for either marine engines or turbines. The close tube spacing and arrangement of baffles insure the greatest possible economy. The steel baffles are more satisfactory than brick baffles, which have been found difficult to keep tight and therefore need constant repair. The headers are of staybolted construction and have an unusually large capacity for water storage, insuring steadier water level than is usually found in boilers of this type.

*(To be continued.)*

## Mismanagement of Boilers*

S. ROSENBERG

Of all the prizes ever drawn in power plant management it is the belief of the writer that this is the star. I was instructed to inspect the boiler room of an Atlantic coast hotel which was commandeered for the purpose of remodeling it into a hospital for convalescing soldiers.

There were two Stirling boilers, hand-fired, herringbone grates, low setting, rated at 150 horsepower at 150 pounds pressure. They were set in 1909. The boiler tubes were so thin in places that, when applying a center punch, a slight hammer blow sent the punch clean through the side of the tube; 54 tubes were condemned in one boiler and 29 in another. The automatic stop valves did not work because the disks did not close down on their seats. Blow-off valves were below the floor level in a pit, encrusted with scale and leaking. There was no plug-cock between the blow-off valve and the mud drum.

Ashpit doors were cracked and had been repaired with strap iron. Lost baffles had been replaced with firebrick. This baffling was not cemented and of course short-circuited the gases flowing around the baffling. The water columns were in a leaky condition, gage-glasses were milky with scale, gage-glass fittings were green from the chemical action of the scale and water, try-cocks were missing on one of the water columns and those on the water column of the second boiler were too full of scale to permit lifting by hand. Insulation on all piping had entirely disappeared. The glass faces of the steam gages were missing, and water leaking past the dials indicated the need of new gages.

The top of the windbox of the blower formed the bottom of the ashpit. This forced ashes over the front of the mud drum when the draft was on. Ash handling was difficult because the floor of the boiler room was four feet below the street surface. A water meter was set at the entrance of the boiler room between the boilers and the door. Thus ashes had to be handled twice.

The exhaust from the steam engine was piped inside of the chimney to the top instead of passing through the feed-water heater. The heater drew live steam from the boiler to heat the feed water. The water pump follower rings were cracked and the piston scored, but it managed to feed "some" water to the boiler. Engine crosshead guides had to be rebabbitted, as they had been running iron-to-iron. The top of the frame was cracked, but had been oxy-acetylene welded. Both cylinder and piston were scored, the packing worn and loose, the Corliss gear out of alinement and knocking, and the valves were not set for proper lap and lead. The separator insulation was missing and the drainage plugged. No trap had been provided to catch the drain from the separator.

Investigation of the water conditions disclosed the fact that at certain times salt marshes would overflow into the wells and no further attention was paid to this water as far as chemical analysis was concerned. The result is apparent.

* Reprinted from *Power*, December 30, 1919.

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The Thomas Spacing Machine Company has purchased the well-known line of open back inclinable presses of the Sidney Power Press Company, Sidney, Ohio. This includes the entire business of the Sidney Power Press Company, with all patterns, drawings, and stock material. These machines are now being manufactured by the Thomas Spacing Machine Company at their Pittsburgh plant.

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The Mahr Manufacturing Company, makers of oil-burning equipment, Minneapolis, Minn., announces that J. R. Matthews, formerly New York City representative, has been transferred to the state of Michigan, with headquarters in Detroit. A. S. Hayes has been appointed New York representative.

# A. S. M. E. Boiler Code

## Preliminary Report on Rules for the Construction of Boilers of Locomotives Which Are Not Subject to Federal Inspection and Control*

It is important that every man connected with the boiler making industry be well informed of the findings of the Boiler Code Committee of the American Society of Mechanical Engineers, and for this purpose the preliminary reports of the Boiler Code, Part I, Sections III and IV, presented at the spring and winter meetings of the Society should be studied carefully for the bearing they have on the construction of all manner of boilers and pressure vessels.

The provisions of the Section published in this issue of THE BOILER MAKER have been discussed by those interested in the Code for several months, and were brought to the attention of the Society at the December meeting. They finally have been referred to the Council for the approval necessary to incorporate them in the Boiler Code, which will without doubt be given at the meeting, January 20.

### Part I—Section III

L—1 (X—1) Specifications are given in the Rules for Power Boilers, paragraphs 23 to 178, for the important materials used in the construction of boilers, and where so given the materials herein mentioned shall conform thereto, except as noted in paragraph L—18.

L—2 (X—2) Steel plates for any part of a boiler when exposed to the fire or products of combustion, and under pressure, *excepting front tube sheets*, shall be of firebox quality as designated in the Specifications for Boiler Plate Steel.

L—3 (3) Steel plates for any part of a boiler, where firebox quality is not specified, when under pressure, shall be of firebox or flange quality, as designated in the Specifications for Boiler Plate Steel.

L—4 (4) Braces, when welded, shall be of wrought iron of the quality designated in the Specifications for Refined Wrought Iron Bars.

L—5 (5) Manhole and handhole covers and other parts subjected to pressure, and braces and lugs when made of steel plate, shall be of firebox or flange quality, as designated in the Specifications for Boiler Plate Steel.

L—6 (6) Steel bars for braces and for other boiler parts, except as otherwise specified herein, shall be of the quality designated in the Specifications for Steel Bars.

L—7 (X—7) Staybolts shall be of iron of the quality designated in the Specifications for Staybolt Iron.

L—8 (8) Rivets shall be of steel or iron of the quality designated in the Specifications for Boiler Rivet Steel, or in the Specifications for Boiler Rivet Iron.

L—9 (X—12) Throttle and throttle pipe, dry pipe or dry pipe ring, tee head, superheater header and steam pipes to cylinders, may be of cast iron.

L—10 (13) Water-leg and door-frame rings shall be of wrought iron or steel, or cast steel of Class A or Class B grade, as designated in the Specifications for Steel Castings. The OG or other flanged construction may be used as a substitute in any case.

* Numbers in parentheses at the beginning of paragraphs indicate paragraphs in A. S. M. E. Boiler Code (Edition of 1918) to which these paragraphs correspond.
The letters X, Y and Z indicate as follows: X—Rules of present Boiler Code modified; Y—New rules; Z—Interstate Commerce Commission rules.

L—11 (14) In determining the maximum allowable working pressure, the tensile strength used in the computations for steel plates shall be that stamped on the plates as herein provided, which is the minimum of the stipulated range, or 55,000 pounds per square inch for all steel plates, except for special grades having a lower tensile strength.

TABLE 1—MINIMUM THICKNESS OF BUTT STRAPS

| Thickness of Shell Plates, Inches | Minimum Thickness of Butt Straps, Inches | Thickness of Shell Plates, Inches | Minimum Thickness of Butt Straps, Inches |
|---|---|---|---|
| 1/4 | 1/4 | 17/32 | 7/16 |
| 9/32 | 1/4 | 9/16 | 7/16 |
| 5/16 | 1/4 | 5/8 | 1/2 |
| 11/32 | 1/4 | 3/4 | 1/2 |
| 3/8 | 5/16 | 7/8 | 5/8 |
| 13/32 | 5/16 | 1 | 11/16 |
| 7/16 | 3/8 | 1 1/8 | 3/4 |
| 15/32 | 3/8 | 1 1/4 | 7/8 |
| 1/2 | 7/16 | ... | ... |

L—12 (15) The resistance to crushing of steel plate shall be taken at 95,000 pounds per square inch of cross-sectional area.

ULTIMATE STRENGTH OF MATERIAL USED IN COMPUTING JOINTS

L—13 (16) In computing the ultimate strength of rivets in shear, the following values in pounds per square inch of the cross-sectional area of the rivet shank shall be used:

| | |
|---|---|
| Iron rivets in single shear | 38,000 |
| Iron rivets in double shear | 76,000 |
| Steel rivets in single shear | 44,000 |
| Steel rivets in double shear | 88,000 |

The cross-sectional area used in the computations shall be that of the rivet shank after driving.

MINIMUM THICKNESS OF PLATES AND TUBES

L—14 (17) The minimum thickness of any boiler plate under pressure shall be 1/4 inch.

L—15 (18) The minimum thickness of shell plates, and dome plates after flanging, shall be as follows:

WHEN THE INSIDE DIAMETER OF SHELL IS

| | Inch |
|---|---|
| 36 inches or under | 1/4 |
| Over 36 inches to 54 inches | 5/16 |
| Over 54 inches to 72 inches | 3/8 |
| Over 72 inches | 1/2 |

L—16 (19) The minimum thickness of butt straps for double strap joints shall be as given in Table 1. Intermediate values shall be determined by interpolation. For plate thicknesses exceeding 1 1/4 inches, the thickness of the butt straps shall be not less than two-thirds of the thickness of the plate.

L—17 (X—20) The minimum thickness of tube sheets for locomotive boilers shall be as follows:

WHEN DIAMETER OF TUBE SHEET IS

| | Inch |
|---|---|
| 42 inches or under | 3/8 |
| Over 42 inches to 54 inches | 7/16 |
| Over 54 inches | 1/2 |

L—18 (X—22) The minimum gage thickness of tubes or flues exposed to the products of combustion an the inside shall be as specified in Table 2 for the various pressures and outside diameters given.

The gage thickness in Table 2 is that measured by the

B. W. gage with a permitted variation in thickness at any section nor varying more than 10 percent from that specified, except at the weld of lap welded tubes where an additional thickness of 0.015 inch shall be allowed. In the case of superheater tubes which are expanded, the gage of the expanded end may be 1½ gages lighter and the swaged end two gages heavier than the gage thickness.

TABLE 2—MINIMUM THICKNESS OF WALLS OF FIRE TUBES

| Outside Diameter, Inches | Maximum Allowable Working Pressure, Pounds per Square Inch | | | | |
|---|---|---|---|---|---|
| | 160 | 180 | 200 | 225 | 250 |
| 1½ | 13 | 13 | 12 | .. | .. |
| 1¾ | 13 | 12 | 12 | .. | .. |
| 2 | 12 | 12 | 12 | 11 | 11 |
| 2¼ | 12 | 12 | 12 | 11 | 11 |
| 2½ | 12 | 12 | 11 | 11 | 11 |
| 3 | 12 | 11 | 11 | 11 | 10 |
| 3½ | 11 | 11 | 11 | 10 | 10 |
| 4 | 11 | 10 | 10 | 10 | 9 |
| 4½ | 10 | 10 | 10 | 9 | 9 |
| 5 | 10 | 9 | 9 | 9 | 8 |
| 5½ | 9 | 9 | 9 | 8 | 8 |
| 6 | 9 | 9 | 8 | 8 | 7 |

L—19 (Y) The minimum thickness of walls of brick arch tubes shall be determined by the following formula:

$$t = \frac{PD}{16{,}000} + \tfrac{1}{8} \text{ inch}$$

$P$ = allowable boiler pressure, pounds per square inch,
$t$ = thickness of walls, inches,
$D$ = outside diameter, inches.

CONSTRUCTION AND MAXIMUM ALLOWABLE WORKING PRESSURE FOR BOILERS OF LOCOMOTIVES

L—20 (179) The maximum allowable working pressure is that at which a boiler may be operated as determined by employing the factors of safety, stresses and dimensions designated in these rules.

No boiler shall be operated at a higher pressure than the maximum allowable working pressure, except when the safety valve or valves are blowing, at which time the maximum allowable working pressure shall not be exceeded by more than six percent.

Wherever the term "Maximum Allowable Working Pressure" is used herein, it refers to gage pressure, or the pressure above the atmosphere, in pounds per square inch.

L—21 (X—180) The maximum allowable working pressure on the shell of a boiler shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength stamped thereon, as provided for in Specifications for Boiler Plate Steel, the efficiency of the longitudinal joint, the inside diameter of the course, and the factor of safety.

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working pressure, pounds per square inch}$$

where

$TS$ = ultimate tensile strength stamped on shell plates, as provided for in Specifications for Boiler Plate Steel, pounds per square inch,
$t$ = minimum thickness of shell plates in weakest course, inches,
$E$ = efficiency of longitudinal joint,
$R$ = inside radius of the weakest course of the shell, inches,
$FS$ = factor of safety, or the ratio of the ultimate strength of the material to the allowable stress. For new constructions covered in Part III, $FS$ in the above formula = 4.

L—22 (181) The efficiency of a joint is the ratio which the strength of the joint bears to the strength of the solid plate. In the case of a riveted joint this is determined by calculating the breaking strength of a unit section of the joint, considering each possible mode of failure separately, and dividing the lowest result by the breaking strength of the solid plate of a length equal to that of the section considered. (See Appendix, paragraphs 410 to 416, Power Boilers, for detailed methods and examples.)

L—23 (X—182) The distance between the center lines of any two adjacent rows of rivets, or the "back pitch" measured at right angles to the direction of the joint, shall have the following minimum values:

*a.* If $\frac{P}{D}$ is 4 or less, the minimum value shall be $1.75\,D$.

*b.* If $\frac{P}{D}$ is over 4, the minimum value shall be:

$$1.75\,D + 0.1\,(P - 4\,D)$$

$P$ = pitch of rivets in outer row where a rivet in the inner row comes midway between two rivets in the outer row, inches,
$P$ = pitch of rivets in the outer row less pitch of rivets in the inner row where two rivets in the inner row come between two rivets in the outer row, inches. (It is here assumed that the joints are of the usual construction where the rivets are symmetrically spaced.)
$D$ = diameter of the rivet holes, inches.

L—24 (X—183) On longitudinal joints the distance from the centers of rivet holes to the edge of the plates, except rivet holes in the ends of butt straps, shall be not less than one and one-third times the diameter of the rivet holes.

L—25 (X—184) The strength of circumferential joints of boilers shall be at least 50 percent of that required for the longitudinal joints of the same structure.

L—26 (187) The longitudinal joints of a shell which exceeds 36 inches in diameter, shall be of butt and double-strap construction.

This rule does not apply to the portion of a boiler shell which is stayed to the firebox or combustion chamber.

L—27 (188) The longitudinal joints of a shell which does not exceed 36 inches in diameter, may be of lap-riveted construction; but the maximum allowable working pressure shall not exceed 100 pounds per square inch.

L—28 (X—190) With butt and double-strap construction longitudinal joints of any length may be used, provided the tension test specimens are so cut from shell plates and butt strap plates that their lengthwise direction is parallel with the circumferential steams of the boiler, and the tests meet the standards prescribed in the Specifications for Boiler Plate Steel.

L—29 (191) Butt straps and the ends of shell plates, forming the longitudinal joints shall be rolled or formed by pressure, not blows, to the proper curvature.

L—30 (X—194) The longitudinal joints of a dome shall be of butt and double strap construction, or made without a seam of one piece of steel pressed into shape, and its flange shall be double-riveted to the boiler shell unless the dome be less than 24 inches in diameter, in which case the longitudinal joint may be of the lap type, and its flange may be single-riveted to the boiler shell provided the maximum allowable working pressure on such a dome does not exceed 160 pounds per square inch, and is computed with a factor of safety not less than 8.

(Y) When boiler shells are cut to apply steam domes or manholes, the amount of metal in flange and liner, if used, must provide strength equivalent to that of the metal removed multiplied by the efficiency factor of the longitudinal seams. A height of vertical flange equal to three times the thickness of the flange shall constitute flange reinforcement, using net area after rivet holes are deducted.

### BRACED AND STAYED SURFACES

L—31 (X—199) The maximum allowable working pressure for various thicknesses of braced and stayed flat plates and those which by these Rules require staying as flat surfaces with braces or stays of uniform diameter symmetrically spaced, shall be calculated by the formula:

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

where:

- $P$ = maximum allowable working pressure, pounds per square inch,
- $T$ = thickness of plate in sixteenths of an inch,
- $p$ = maximum pitch measured between straight lines passing through the centers of the staybolts in the different rows, which lines may be horizontal, vertical or inclined, inches,
- $C$ = 112 for stays screwed through plates not over 7/16 inch thick with ends riveted over,
- $C$ = 120 for stays screwed through plates over 7/16 inch thick with ends riveted over,
- $C$ = 135 for stays screwed through plates and fitted with single nuts outside of plate,
- $C$ = 150 for stays with heads not less than 1.3 times the diameter of the stays, screwed through plates or made a taper fit and having the heads formed on the stays before installing them and not riveted over, said heads being made to have a true bearing on the plate.

If flat boiler plates not less than ⅜-inch thick are strengthened with doubling plates securely riveted thereto and having a thickness of not less than ⅔ $T$, then the value of $T$ in the formula shall be three-quarters of the combined thickness of the boiler plate, and doubling plates, but not more than one and one-half times the thickness of the boiler plate, and the values of $C$ given above may also be increased 15 percent.

When two sheets are connected by stays and but one of these sheets requires staying, the value of $C$ is governed by the thickness of the sheet requiring staying.

In curved sheets of a combustion chamber, half of which is a semicircle (radius $R$, inches) an increased pitch ($p_1$, inches) based on the following formula may be used:

$$p_1 = p \sqrt{\frac{PR}{PR - 250\,T}}$$

L—32 (X—200) The ends of screwed staybolts shall be riveted over or upset by equivalent process. The outside ends of solid staybolts 8 inches and less in length shall be drilled with a hole at least 3/16 inch in diameter to a depth extending at least ½ inch beyond the inside of the plates, or hollow staybolts may be used. Solid staybolts over 8 inches long and flexible staybolts of either the jointed or ball and socket type need not be drilled.

Staybolts behind brickwork, frame braces, or grate bearers shall have holes at least 3/16-inch diameter for entire length, which must be kept open at all times.

L—33 (201) When channel irons or other members are securely riveted to the boiler heads, the stress on such members shall not exceed 12,500 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. This spacing of the rivets over the supported surface shall conform 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 boiler, and provided that the spacing of those 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.

L—34 (202) The ends of stays fitted with nuts shall not be exposed to the direct radiant heat of the fire.

L—35 (X—203) *a.* The maximum spacing between centers of rivets or between the edges of tube holes and the centers of rivets attaching the crowfeet of braces to the braced surface, shall be determined by the formula in paragraph L—31, using 135 for the value of $C$.

*b.* The maximum distance between the edges of tube holes and the centers of other types of stays shall be determined by the formula in paragraph L—31, using the value of $C$ given for the thickness of plate and type of stay used.

*c.* The maximum spacing between the inner surface of the shell and lines parallel to the surface of the shell passing through the center of the rivets attaching the crowfeet of braces to the head shall be determined by the formula in paragraph L—31, using 175 for the value of $C$.

*d.* 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 paragraph L—31, using a value of $C$ equal to 1.3 times that value of $C$ which applies to the thickness of the plate and type of stay as therein specified.

*e.* In applying these Rules and those in paragraph L—31 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.

L—36 (Y) *a.* When the edge of a stayed plate is flat and is fastened by riveting, the distance from the center line of the rivets to a line through the centers of the nearest row of stays may be made to equal the pitch of the stays as given in Table 3.

TABLE 3—MAXIMUM ALLOWABLE PITCH, IN INCHES, OF SCREWED STAYS, ENDS RIVETED OVER

| Pressure Pounds per Square Inch. | Thickness of Plate, Inches | | | | | | |
|---|---|---|---|---|---|---|---|
| | 5/16 | 3/8 | 7/16 | 1/2 | 9/16 | 5/8 | 11/16 |
| | Maximum Pitch of Staybolts, Inches | | | | | | |
| 100 | 5¼ | 6⅜ | 7⅜ | ... | ... | ... | ... |
| 110 | 5 | 6 | 7 | 8⅜ | ... | ... | ... |
| 120 | 4¾ | 5¾ | 6¾ | 8 | ... | ... | ... |
| 125 | 4¾ | 5⅝ | 6⅝ | 7¾ | ... | ... | ... |
| 130 | 4⅝ | 5½ | 6½ | 7⅝ | ... | ... | ... |
| 140 | 4½ | 5⅜ | 6¼ | 7⅜ | 8⅜ | ... | ... |
| 150 | 4¼ | 5⅛ | 6 | 7⅛ | 8 | ... | ... |
| 160 | 4⅛ | 5 | 5⅞ | 6⅞ | 7¾ | ... | ... |
| 170 | 4³/16 | 4⅞ | 5⅝ | 6¾ | 7½ | 8⅜ | ... |
| 180 | 3¹⁵/16 | 4¾ | 5½ | 6½ | 7⅜ | 8⅛ | ... |
| 190 | 3¹³/16 | 4⅝ | 5⅜ | 6⅜ | 7⅛ | 7⅞ | ... |
| 200 | 3¹¹/16 | 4½ | 5¼ | 6⅛ | 7 | 7¾ | 8½ |
| 225 | 3½ | 4¼ | 4⅞ | 5⅞ | 6½ | 7¼ | 8 |
| 250 | ... | 4 | 4⅝ | 5½ | 6¼ | 6⅞ | 7⅝ |
| 300 | ... | ... | 4¼ | 5 | 5⅝ | 6¼ | 7 |

L—38 (206) The distance between the edges of the staybolt holes may be substituted for $p$ for staybolts adjacent to a furnace door or other boiler fitting, tube hole, handhole or other opening.

L—39 (X—208) The diameter of a screw stay shall be taken at the bottom of the thread, or at the body of the bolt between the threads—whichever is the lesser.

L—40 (X—209) The least cross-sectional area of a stay shall be taken in calculating the allowable stress except 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.

L—41 (210) 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.

L—43 (X—212) *a*. The maximum allowable working pressure for any curved stay surface subject to internal pressure shall be obtained by the two following methods, and the minimum value obtained shall be used:

*First*, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure secured by the formula for braced and stayed surfaces given in paragraph L—31, using 70 for the value of *C*.

*Second*, the maximum allowable working pressure shall be computed without allowing for the holding power of the stays, due allowance being made for the weakening effect of the holes for the stays. To this pressure there shall be added the pressure corresponding to the strength of the stays for the stresses given in Table 4, each stay being assumed to resist the steam pressure acting on the full area of the external surface supported by the stay.

TABLE 4—MAXIMUM ALLOWABLE STRESSES FOR STAYS AND STAYBOLTS

| Description of Stays | Stresses, Pounds per Square Inch | |
|---|---|---|
| | For lengths between supports not exceeding 120 diameters | For lengths between supports exceeding 120 diameters |
| *a* Unwelded or flexible stays less than twenty diameters long, screwed through plates with ends riveted over.......... | 7500 | .... |
| *b* Hollow steel stays less than 20 diameters long, screwed through plates with ends riveted over.............. | 8000 | .... |
| *c* Unwelded stays and unwelded portions of welded stays, except as specified in line *a* and line *b*................ | 9500 | 8500 |
| *d* Welded portions of stays...... | 6000 | 6000 |

*b*. The maximum allowable working pressure for a stayed wrapper sheet of a locomotive-type boiler shall be determined by the two methods given above and by the method which follows, and the minimum value obtained shall be used:

$$P = \frac{13{,}500\, t \times E}{R - s \Sigma \sin \alpha},$$

in which:

$\alpha$ = angle any crown stay makes with vertical axis of boiler,

$\Sigma \sin \alpha$ = summated value of $\sin \alpha$ for all crown stays considered in one transverse plane and on one side of vertical axis of boiler,

$s$ = transverse spacing of crown stays in crown sheet, inches,

$E$ = minimum efficiency of wrapper sheet through joints or stay holes,

$t$ = thickness of wrapper sheet, inches,

$R$ = radius of wrapper sheet, inches,

$P$ = working pressure of boiler, pounds per square inch,

13,500 = allowable stress, pounds per square inch.

L—44 (X—213) A segment of a head shall be stayed by through, diagonal, crowfoot or gusset stays.

L—45 (X—214) The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 inches from the tubes and at a distance *d* from the shell, as shown in Figs. 15 and 16, Part I, Section I. The value of *d* used may be the larger, of the following values:

(1) $d$ = the outer radius of the flange, not exceeding eight times the thickness of the head.

(2) $$d = \frac{5 \times T}{\sqrt{P}}$$

where:

$d$ = unstayed distance from shell in inches,

$T$ = thickness of head in sixteenths of an inch,

$P$ = maximum allowable working pressure in pounds per square inch.

(Y) The feet for braces to back head and front tube sheet should be distributed so as not to concentrate the stress on any one section; preferably a proportion of the braces should be attached to the second course from the back head or front tube sheet.

(Y) No supporting value shall be assigned to the stiffness of inside liner plates on flat surfaces, except as provided in L—31.

L—46 (X—221) In calculating stresses for diagonal stays in paragraphs L—47-48 the angularity of the stays must be taken into account.

L—47 (X—223) All rivet and pin holes shall conform to the requirements in paragraph L—54, and the pins shall be made a neat fit. To determine the sizes that shall be used, proceed as follows:

1. Determine the "required cross-sectional area of the brace" by first computing the total load to be carried by the brace, and dividing the total load by the values of stresses given in Table 4.
2. Design the body of the brace so that the cross-sectional area shall be at least equal to the "required cross-sectional area of the brace."
3. Make the area of pins to resist double shear at least three-quarters of the "required cross-sectional area of the brace."
4. Make the combined cross-section of the eye of the side of the pin (in crowfoot braces) at least 25 percent greater than the "required cross-sectional area of the brace."
5. Make the cross-sectional area through the blades of diagonal braces where attached to the shell of the boiler at least equal to the required rivet section; that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."
6. Design each branch of a crowfoot to carry two-thirds the total load on the brace.
7. Make the net sectional area through the sides of the crowfoot, tee irons, or similar fastenings at the rivet holes at least equal to the required rivet section; that is, at least equal to one and one-quarter times the "required cross-sectional area of the brace."
8. Make the combined cross-sectional area of the rivets at each end of the brace at least one and one-quarter times the "required cross-sectional area of the brace."

L—48 (X—224) Gusset stays when constructed of triangular web plates secured to single or double angle bars along the two sides at right angles, shall have a cross-sectional area (in a plane at right angles to the longest side and passing through the intersection of the two shortest sides) not less than 10 percent greater than would be required for a diagonal stay to support the same surface, assuming the diagonal stay is at the same angle as the longest side of the gusset plate.

L—49 (X—230) Crown bars and girder stays for tops of combustion chambers and back connections, or wherever used, shall be proportioned to conform to the following formula:

Maximum allowable working pressure =

$$\frac{C \times d^2 \times t}{(W - P) \times D \times W}$$

where:

$W$ = extreme distance between supports, inches,
$P$ = pitch of supporting bolts, inches,
$D$ = distance between girders from center to center, inches,
$d$ = depth of girder, inches,
$t$ = thickness of girder, inches,
$C$ = 7,000 when the girder is fitted with one supporting bolt,
$C$ = 10,000 when the girder is fitted with two or three supporting bolts,
$C$ = 11,000 when the girder is fitted with four or five supporting bolts,
$C$ = 11,500 when the girder is fitted with six or seven supporting bolts,
$C$ = 12,000 when the girder is fitted with eight or more supporting bolts.

*Example:* Given $W = 34$ inches, $P = 7.5$ inches, $D = 7.75$ inches, $d = 7.5$ inches, $t = 2$ inches; three stays per girder, $C = 10{,}000$; then substituting in formula:

Maximum allowable working pressure =

$$\frac{10{,}000 \times 7.5 \times 7.5 \times 2}{(34 - 7.5) \times 7.75 \times 34} = 161.1 \text{ pounds per square inch.}$$

(Y) In boilers with crown bars supported on firebox side sheets, and sling stays, the sling stays shall be considered as carrying the entire load.

L—50 (248) *Tubes.* Tube holes shall be drilled full size from the solid plate, or they may be punched at least ½ inch smaller in diameter than full size, and then drilled, reamed or finished full size with a rotating cutter.

L—51 (249) The sharp edges of tube holes shall be taken off on both sides of the plate with a file or other tool.

L—52 (X—250) The ends of the tubes shall be substantially rolled and beaded, or rolled and welded, at the firebox or combustion-chamber end, and rolled at the smokebox end; 10 percent of the flues at the smokebox shall be beaded.

### RIVETING

L—53 (253) All rivet holes and staybolt holes and holes in braces and lugs shall be drilled full size or they may be punched not to exceed ¼ inch less than full diameter for material over 5/16 inch in thickness, and ⅛ inch less than full diameter for material not exceeding 5/16 inch in thickness, and then drilled or reamed to full diameter. Plates, butt straps, braces, heads and lugs shall be firmly bolted in position by tack bolts for drilling or reaming all rivet holes in boiler plates, except those used for the tack bolts.

L—54 (254) After drilling or reaming rivet holes the plates and butt straps shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

L—55 (X—255) Rivets shall be of sufficient length to completely fill the rivet holes and form heads at least equal to those shown in Fig. 20, Part I, Section I.

L—56 (256) Rivets shall be machine-driven wherever possible, with sufficient pressure to fill the rivet holes, and shall be allowed to cool and shrink under pressure. Barrel pins fitting the holes and tack bolts to hold the plates firmly together shall be used. A rivet shall be driven each side of each tack bolt before removing the tack bolt.

L—57 (257) The calking edges of plates, butt straps and heads shall be beveled to an angle not less than 70 degrees to the plane of the plate, and as near thereto as practicable. Every portion of the sheared surfaces of the calking edges of plates, butt straps and heads shall be planed, milled or chipped to a depth of not less than ⅛ inch. Calking shall be done with a round-nosed tool.

L—58 (X—265) A locomotive boiler shall have wash-out handholes or screw plugs, as follows: One at each corner of firebox just above mud ring; one in back head over fire door; one or more on each side of roof sheet above the level of crown sheet, which shall be staggered on opposite sides; one or more in barrel of boiler; and one or more in back head above crown sheet.

(Y) Screw plugs must have at least four full threads in the sheet, including reinforcement, if such is used.

L—59 (Y—268) All holes for injector checks, whistle, and safety valves when screwed into boiler, and all holes in boiler barrel, firebox, roof sheet, and all unstayed surfaces when diameter of the hole is over 3¼ inches and exceeds 4½ times the thickness of the plate, must be reinforced with a liner or flange riveted to the boiler.

The thickness of the liner or flange must be at least 75 percent of the thickness of the plate. The rivets must have a shearing strength of at least 52 percent of the tensile strength of the metal removed.

### SAFETY VALVES

L—60 (Z—269) Every locomotive boiler shall be equipped with at least two safety valves, the capacity of which shall be sufficient to prevent, under any conditions of service, an accumulation of pressure more than 6 percent above the specified boiler pressure.

L—61 (Z—271) Safety valves shall be set to pop at pressures not exceeding 6 pounds above the working steam pressure. When setting safety valves, two steam gages shall be used, one of which must be so located that it will be in full view of the person engaged in setting such valves; and if the pressure indicated by the gages varies more than 3 pounds, they shall be removed from the boiler, tested and corrected before the safety valves are set. Gages shall in all cases be tested immediately before the safety valves are set or any change made in the setting. When setting safety valves, the water level in the boiler shall not be above the highest gage cock.

L—62 (X—272) Safety valves may have the seat and bearing surface of the disk inclined at any angle between 45 degrees and 90 degrees to the center line of the spindle. The valves shall be rated at a pressure of 3 percent in excess of that at which the valve is set to blow.

All safety valves shall be so constructed that no detrimental shocks are produced through the operation of the valve.

L—63 (273) Each safety valve shall be plainly marked by the manufacturer. The markings may be stamped on the body, cast on the body, or stamped or cast on a plate or plates permanently secured to the body, and shall contain the following:

*a.* The name or identifying trademark of the manufacturer.
*b.* The nominal diameter.
*c.* The steam pressure at which it is set to blow.
*d.* Blow down, or difference between the opening and closing pressures.
*e.* The weight of steam discharged in pounds per hour at a pressure 3 percent higher than that for which the valve is set to blow.

*f*. American Society Mechanical Engineers' Standard.

L—64 (X—275) Safety-valve capacity may be checked in the following manner; and, if found sufficient, additional capacity need not be provided: By making an accumulation test with fire in good bright condition, and all steam exits closed, and fire forced under these conditions, the safety valves should relieve boiler and not allow an excess pressure of more than 6 percent above the working pressure.

L—65 (X—278) Each safety valve shall have full-sized direct connection to the boiler.

L—66 (X—279) If a muffler is used on a safety valve it shall have sufficient outlet area to prevent back pressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid any possibility of restriction of the steam passages due to deposit.

L—67 (280) When a boiler is fitted with two or more safety valves on one connection, this connection to the boiler shall have a cross-sectional area not less than the combined area of all of the safety valves with which it connects.

L—68 (X—283) The seats and disks of safety valves shall be of non-ferrous material.

L—69 (284) Springs used in safety valves shall not show a permanent set exceeding 1/16-inch ten minutes after being released from a cold compression test closing the spring solid. The spring shall be so constructed that the valve can lift from its seat at least one-tenth the diameter of the seat before the coils are closed or before there is other interference.

L—70 (285) The spring in a safety valve shall not be used for any pressure more than 10 percent above or below that for which it was designed.

L—71 (287) When the valve body is marked with the letters A.S.M.E. Std. as required by paragraph L—64, this shall be a guarantee by the manufacturer that the valve conforms to the details of construction herein specified.

L—72 (X—290) Every boiler shall have proper outlet connections for the required safety valve or valves, independent of any other steam outlet connection or of any internal pipe in the steam space of the boiler, the area of opening to be at least equal to the aggregate nominal area of all the safety valves to be attached thereto.

L—73 (X—291) Each boiler should have at least one water glass and lamp and two gage cocks for boilers 36 inches in diameter and under, and three gage cocks for boilers over 36 inches in diameter.

(Y) The lowest gage cock and the lowest reading of water glass should not be less than 2 inches above the highest point of crown sheet on boilers 36 inches in diameter and under, and 3 inches for boilers over 36 inches in diameter. These are minimum dimensions, and on large locomotives, and those operating on steep grades, the height should be increased if necessary to compensate for change of water level on descending grades.

L—74 (X—292) No water-glass connection shall be fitted with an automatic shut-off valve.

L—75 (Z—296) Every boiler shall have at least one steam gage which will correctly indicate the working pressure. Care must be taken to locate the gage so that it will be kept reasonably cool, and can be conveniently read by the engineman.

Every gage shall have a siphon of ample capacity to prevent steam entering the gage. The pipe connection shall enter the boiler direct, and shall be maintained steam-tight between boiler and gage. The siphon shall be of brass, copper or bronze composition.

L—76 (297) The dial of the steam gage shall be graduated to not less than 1½ times the maximum allowable working pressure on the boiler.

L—77 (298) Each boiler shall be provided with a valved connection not less than ¼-inch pipe size for attaching a test gage when the boiler is in service, so that the accuracy of the boiler steam gage can be ascertained.

### Fittings and Appliances

L—78 (X—311) Locomotive boilers are to be equipped with at least one blow-off cock located at the lowest water space practicable, directly connected to the boiler, either with screw connections or flanged.

L—79 (X—315) Each boiler shall be equipped with two injectors, or two pumps, or one ejector and one pump, with separate delivery pipes connected to the injector checks. The water shall be delivered to the boiler at a point nearer the front than the back-flue sheet.

### Hydrostatic Tests

L—80 (X—329) After a boiler has been completed, it shall be subjected to a hydrostatic test of 25 percent above the maximum allowable working pressure. The pressure shall be under proper control so that in no case shall the required test pressure be exceeded by more than 6 percent.

L—81 (330) During a hydrostatic test, the safety valve or valves shall be removed, or each valve disk shall be held to its seat by means of a testing clamp, and not by screwing down the compression screw upon the spring.

L—82 (X—331) In laying out shell plates, furnace sheets and heads in the boiler shop, care shall be taken to leave at least one of the stamps, specified in paragraph 36 of Part I, Section I, so located as to be plainly visible when the boiler is completed. Butt straps shall have at least a portion of such stamps visible, sufficient for identification when the boiler is completed.

L—83 (X—332) Each boiler shall confirm in every detail to these Rules, and shall be distinctly stamped with the symbol as shown in Fig. 23, Part I, Section I, denoting that the boiler was constructed in accordance therewith.

After obtaining the stamp to be used when boilers are to be constructed to conform with the A.S.M.E. Boiler Code, a state inspector, municipal inspector or an inspector employed regularly by an insurancce company which is authorized to do a boiler insurance business in the State in which the boiler is built and in the State in which it is to be used, if known, is to be notified that an inspection is to be made and he shall inspect such boilers during construction and after completion. At least two inspections shall be made, one before reaming rivet holes and one at the hydrostatic test. In stamping the boiler after completion, if built in compliance with the Code, the builder shall stamp the boiler in the presence of the inspector, after the hydrostatic test, with the A.S.M.E. Code stemp, the builder's name and the serial number of the manufacturer. A data sheet shall be filled out and signed

A. S. M. E. Code Symbol

by the manufacturer and inspector. This data sheet, together with the stamp on the boiler, shall denote that it was constructed in accordance with the A.S.M.E. Boiler Code.

Each boiler shall be stamped adjacent to the symbol as shown in Fig. 24, Part I, Section I, with the following items, with intervals of about one-half inch between the lines:

1. Manufacturer's serial number.
2. State in which boiler is to be used.
3. Manufacturer's State state standard number.
4. Name of manufacturer.
5. State's number.
6. Year put in service.
7. Working pressure when built.

Items 1, 2, 3, 4 and 7 are to be stamped at the shop where built.

Items 5 and 6 are to be stamped by the proper authority at point of installation.

L—84 (X—333) The stamps shall be located on the boiler head in the cab, and should not be covered by lagging and jacketing if the boiler head is lagged.

L—85 (X—334) Each boiler shall be equipped with a metal badge plate, showing the maximum allowable working pressure which shall be attached to boiler head in the cab. If the boiler head is lagged, the lagging and jacketing shall be cut away a sufficient amount to leave the plate visible.

# How to Design and Lay Out a Boiler—XV

## Reinforcing Shell Manholes—Calculating Single- and Double-Riveted Rings—Determining the Length of Longitudinal Seams

BY WILLIAM C. STROTT*

It was decided to place the upper manhole in the shell. Unlike those in the heads, shell manholes must be reinforced to make up for the loss in plate strength, due to removing the metal from the hole. It is possible to turn in the metal around the hole, thus forming a flange identical with the flanged manhole in the flat plates. Although such flanging provided a certain degree of rigidity, it is, nevertheless, insufficient for the purpose.

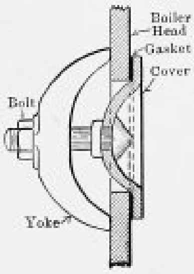


Fig. 51

At any rate, however, the flange around the manhole is primarily not for the purpose of a reinforcement, even in the case of flat plates. This flange provides a seat for the gasket, and presents a surface which may be readily milled or chipped to accurately accommodate the gasket. There is no reason whatever why the manhole cover in a flat plate cannot bear directly against the flat surface of the head. In fact, this is the identical condition prevailing in some types of horizontal watertube boilers, where the hand holes (one at each end of every tube) are not flanged, but the hand hole covers and gaskets bear directly against the flat plate. This condition is illustrated in Fig. 51.

The surface of a flat plate is ordinarily irregular, and, unless the boiler head is milled, the gasket cannot be made to give a true bearing against the plate. It is exceedingly difficult to keep such manholes, or handholes, tight against steam pressure. The other factor tending to increase this difficulty is that the edge of the plate around the hole is quite flexible when the reinforcing effect of a flange is not present. The result is a springing action of the metal, particularly while the hole is being pulled up tight. This action distorts the bearing surface for the gasket, and is practically the chief reason for the inefficiency of this form of construction.

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

Manholes in flat plates do not require reinforcing rings, because the diagonal or through braces furnish the necessary support. Fig. 52 illustrates how openings in the shells or drums of cylindrical pressure vessels must be reinforced.

The most convenient method for carrying out this discussion is probably by means of a practical example. We shall suppose that our boiler is to be equipped with a steam dome similar to Fig. 45, and that instead of the manhole being placed in the main boiler shell it is to be located in the dome head. A manhole of equivalent size must then also be cut in the shell, under the dome, in order to permit access into the boiler. The usual reinforcement for such an opening is indicated in Fig. 48, and to an enlarged scale in Fig. 52.

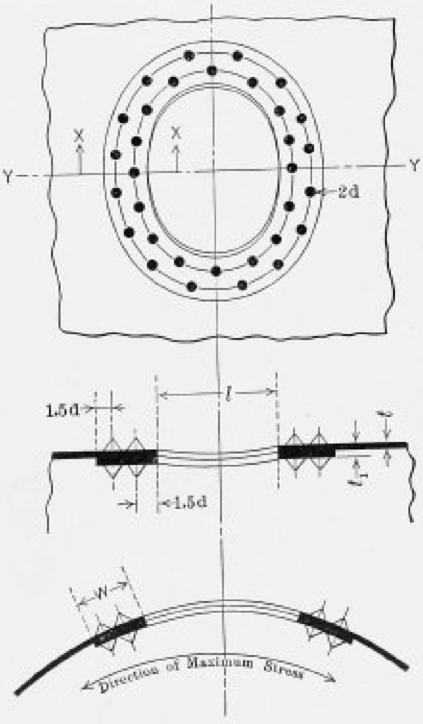


Fig. 52

As was stated previously, manhole openings may be round, but, as will soon be demonstrated, it is always more economical to make them oval or elliptical in shape and placed with the minor axis parallel to the longitudinal centerline of the boiler. This arrangement will remove as little plate as possible in the direction of greatest stress, since it was proven that the hoop tension in a cylinder is approximately twice the end stress in tension.

The thickness $t$ of the reinforcing ring should be at least equal to the boiler shell plate $t$, and the net section

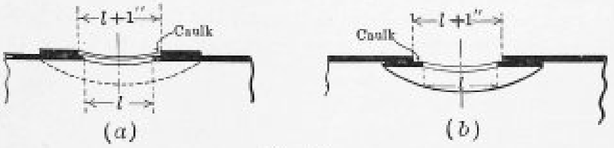



Fig. 53

of the reinforcing ring through $x$-$x$ shall be at least equal to one-half the section of shell plate removed on line $Y$-$Y$.

In all of the calculations covering the design of reinforcing rings, the following notations will be employed:

$W$ = least width of reinforcing ring in inches.
$t$ = thickness of shell plate, inches.
$t_1$ = thickness of reinforcing ring, inches.
$d$ = diameter of rivet holes.
$T_s$ = ultimate tensile strength of reinforcing ring, pounds per square inch.
$a$ = net section of one side of the ring or rings, square inches.
$S$ = ultimate shearing strength of rivets, pounds per square inch.
$l$ = width of shell plate removed at right angles to the line of maximum stress.

The formula for $W$ for a double-riveted ring is:

$$W = \frac{l \times t}{2 \times t} + (2 \times d). \qquad (20)$$

Substituting, we have:

$$W = \frac{11 \times 0.53125}{2 \times 0.53125} + (2 \times 0.9375), \text{ or } 7\tfrac{3}{8} \text{ inches.}$$

In case of a single-riveted ring we would add but one rivet hole diameter in the above formula. This results in rather a wide ring—in fact, it would take up entirely too much space on the boiler shell. It is, therefore, customary to use two rings—one on the outside and one on the inside of the shell. This will permit of a more reasonable dimension for $W$, which, for our case, would be

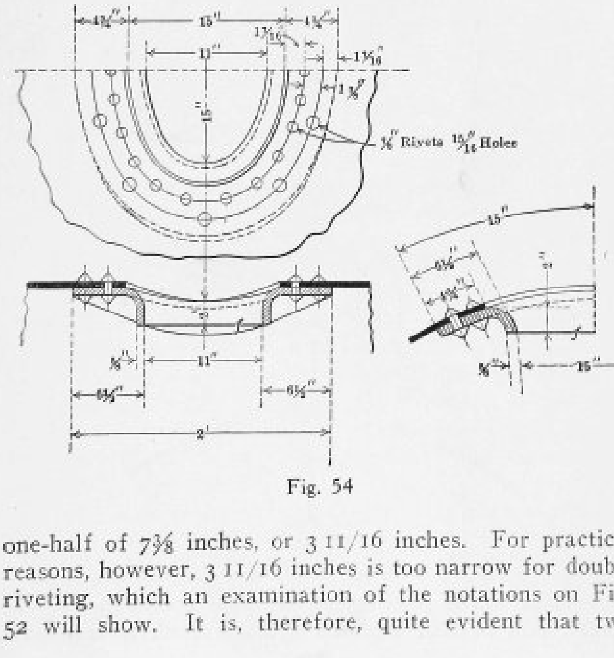



Fig. 54

one-half of 7⅜ inches, or 3 11/16 inches. For practical reasons, however, 3 11/16 inches is too narrow for double riveting, which an examination of the notations on Fig. 52 will show. It is, therefore, quite evident that two single-riveted rings 3½ inches wide by 17/32 inch thick would be satisfactory for the purpose.

### Double-Riveted Reinforcing

If desired, one double-riveted ring of sufficient thickness may also be employed. In that case, we first assume an approximate width of ring necessary to accommodate two rows of rivets and then solve for $t$ in formula (20). Trying this in our example, we find that the least width $W$, using 15/16-inch rivet holes, is $(1.5d) + (2d) + (1.5d)$, or 4 11/16 inches—say 4¾ inches. Transposing formula (20) for $t_1$, we write:

$$t_1 = \frac{0.5 \times l \times t}{W - (2 \times d)}. \qquad (21)$$

Substituting and solving as before gives:

$$t_1 = \frac{0.5 \times 11 \times 0.53125}{4.75 - (2 \times 0.9375)}, \text{ or exactly one inch.}$$

The number of rivets on each side of the centerline $Y$-$Y$, Fig. 52, should be such that their resistance to shear will be equal to the net strength of the reinforcing ring. To find the total number of rivets for a single or double reinforcing ring, the following formula has been devised:

$$N = \frac{5.1 \times T_s\, a}{S \times d^2}. \qquad (22)$$

Substituting in our problem, first in the case of two

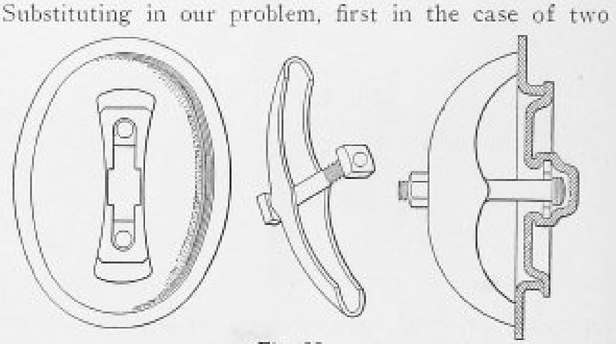


Fig. 55

single-riveted rings, in which $a$ would be $2 \times (3.25 - 0.9375) \times 0.53125$, or 2.457 square inches. Note also that $S$ = 88,000 pounds, same being the strength of the rivets in double shear.

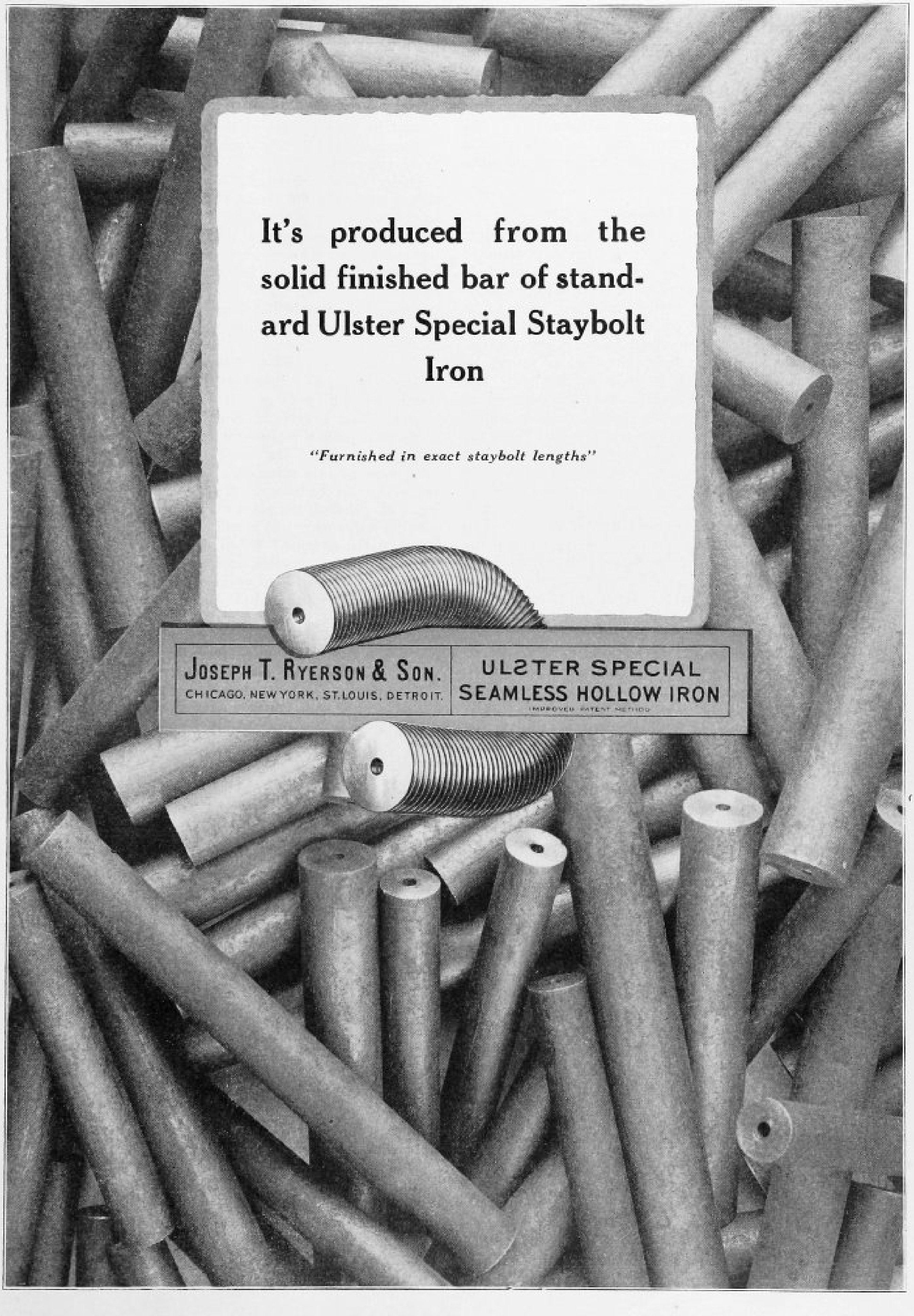
$$N = \frac{5.1 \times 55{,}000 \times 2.457}{88{,}000 \times 0.9375 \times 0.9375}, \text{ or approximately 9.}$$

In the case of one double-riveted ring, in which $a$ would be $4.75 - (2 \times 0.9375) \times 1$, or 2.875 square inches. The rivets being in single shear, the value of $S$ is taken as 44,000 pounds. Substituting as before, we have:

$$N = \frac{5.1 \times 55{,}000 \times 2.875}{44{,}000 \times 0.9375 \times 0.9375}, \text{ or approximately 21 rivets.}$$

### Reinforcing Under the Dome

It is obvious that the theoretical number of rivets required for such purpose is not great. In fact, when dealing with a reinforcing ring for an opening in the boiler shell under a dome, as was illustrated in Fig. 48, the calculated number of rivets will be sufficient, providing that a satisfactory arrangement may be secured. Occasionally one or two additional rivets will be required to accomplish this. On the other hand, however, when such a reinforcement is located where leakage between the two surfaces of plate may occur, the inside edge of the plate around the hole must be calked. If a reinforcement is located on the outside of the shell, then the reinforcing ring is calked


It's produced from the solid finished bar of standard Ulster Special Staybolt Iron
"Furnished in exact staybolt lengths"
JOSEPH T. RYERSON & SON.
CHICAGO, NEW YORK, ST. LOUIS, DETROIT.
ULSTER SPECIAL
SEAMLESS HOLLOW IRON

against the shell; if on the inside, the shell is calked against the reinforcing ring. This is illustrated in Fig. 53 (a) and (b).

It should be noted from Fig. 53 (a), if there is also a reinforcement on the inside, that both rings must be calked against the shell. In such cases, the rivets on the inside edge of the hole must be spaced so as to provide calkability. This fact will generally determine the number of rivets required.

### USE OF FLANGED MANHOLE FRAME

Evidently a flat reinforcing ring, such as we have just designed, would be impractical for an external manhole opening in the shell, for the reason that the manhole cover would have to be curved to fit the shell accurately. A large variety of forms would, therefore, have to be carried on hand to meet the different diameters of boilers. For this reason a flanged manhole frame is provided instead of the flat ring. A complete detail of an 11-inch by 15-inch manhole and frame is given in Fig. 54. The A. S. M. E. Code further requires that the edge of all manhole or other openings when flanged shall be turned in to a depth of not less than one and one-half times the thickness of the plate. This is indicated by the 2-inch dimension on Fig. 54. This must be strictly adhered to when placing manholes in flat plates, such as the heads of our boiler. If this requirement is not met, then the 2-inch allowance around the opening will not be allowed when figuring for bracing. The width of bearing surface for the gasket between the flange and cover must not be less than ½ inch. This requirement is met when the plate is not less than 9/16-inch thick. Even if ½-inch thick, there is a tendency of the metal to thin down at the edge, due to the flanging process.

However, when thinner plates than 9/16-inch are necessary, the required ½-inch bearing surface is easily obtained by shrinking a band 1½ inches wide around the flange. The thickness may be made as required, usually ⅜-inch to ½-inch. If too thin, there is liability of the band breaking during shrinkage. The two edges are then milled or chipped to a true surface.

### COMMERCIAL MANHOLE COVERS

The ordinary commercial manhole cover was illustrated in Fig. 51. It consists of a dished plate, having a flange to receive the gasket. A special upset-bolt is riveted to the center of the plate. The collar on the bolt is necessary to provide a means for "bucking-up" this collar while the head is being formed. Such construction is a source of leakage. The bolt is usually not perpendicular with the gasket flange, and the result is that while the nut is being pulled up the bolt is forced to straighten itself, with a consequent strain on the riveted connection.

Corrugated pressed steel manhole covers, as illustrated in Fig. 55 are at present widely employed.

There are no holes through the plate liable to leakage, and the bolts, being loose in their sockets, are self-alining. A manhole in the top of the shell should be located back far enough from the head so as to clear the diagonal braces. When a boiler is equipped with through-rod bracing above the tubes and it is necessary to locate the rods directly under the manhole, the designer need not worry, because, unlike diagonal staying, which is permanently riveted in place, through-rods are merely attached with nuts and may be easily removed when access into the boiler is desired.

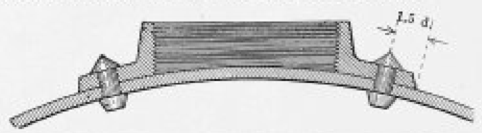
### LONGITUDINAL SEAMS

Having by this time designed and located the manhole saddle, we may now locate the longitudinal seam. This must be placed as high up as it is possible to get it, but the limit is reached when the inside butt strap touches the manhole saddle. When the longitudinal joint is placed too low, it cannot be carefully inspected, because the lower part of the joint will extend below the tubes, where it cannot be seen. Even in the event that repairs should be necessary, the tubes adjacent to the trouble would have to be removed.

Under no circumstances is a longitudinal seam permitted below the fire line. This requires no explanation, as the reason for which the student should by this time be able to deduce for himself. Suffice it to say that the practice is condemned absolutely. Various openings must now be provided in the boiler for steam exit, feed water, water column, safety valve and blow-off connections. A discussion of the nozzle and flange in general, attached to a boiler, will be entered into first.

### NOZZLES AND FLANGES

Any opening in a boiler over 2-inch pipe size must be reinforced with a forged or cast steel boiler flange or nozzle. Cast iron is absolutely prohibited for use in connection with the pressure parts of any steam boiler, on account of the low tensile strength and consequent brittleness of this material. There is also considerable uncertainty in the interior structure of a heavy iron casting, and, although the piece may appear perfect from the outside, a fracture will usually disclose numerous blowholes on the interior. When dealing with pipe connections on pressure vessels we have the same condition as in the case of manholes or handholes cut into the shell. Therefore, the width and thickness of the flange and also the number and size of the rivets must be sufficient to thoroughly reinforce the shell around the hole. In practice it is not necessary to perform these calculations when the proportions of the standard flanges and nozzles to be had on the market are adhered to, since these have been designed to provide the necessary strength. Fig. 56 illustrates the ordinary forged steel boiler flange.

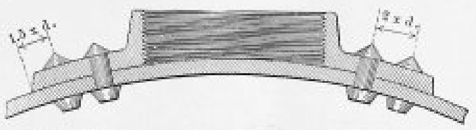



| Nominal Size Inches | Outside Diameter Inches | Thickness Inches | Depth of Hub Inches | Diameter of Hub Inches |
|---|---|---|---|---|
| 1 | 6 | ⅜ | 1 1/16 | 2 |
| 1¼ | 6½ | ⅜ | 1 1/16 | 2⅛ |
| 1½ | 7 | ½ | 1⅜ | 2 13/16 |
| 2 | 8 | ½ | 1⅜ | 3 5/16 |
| 2½ | 8½ | ½ | 1⅝ | 3⅞ |
| 3 | 9 | ½ | 1⅝ | 4⅜ |
| 3½ | 9½ | 9/16 | 1⅝ | 5 |
| 4 | 10 | 9/16 | 1⅝ | 5 9/16 |
| 4½ | 10½ | ⅝ | 1⅝ | 6 |
| 5 | 11½ | ⅝ | 2⅛ | 6 11/16 |
| 6 | 12½ | ⅝ | 2⅛ | 7¾ |
| 7 | 14 | ¾ | 2⅜ | 8⅞ |
| 8 | 15 | ¾ | 2⅜ | 9⅞ |
| 9 | 16 | ⅞ | 2⅝ | 11 |
| 10 | 17½ | ⅞ | 2⅝ | 12 3/16 |
| 12 | 20 | 1 | 3⅛ | 14⅝ |

Fig. 56

The riveting has not been absolutely standardized, but the rivets should be close enough together to permit calkability of the flange against the boiler plate. The size of the rivets may be determined arbitrarily, but generally are not made any smaller than the rivets employed throughout the boiler. Knowing the outside diameter of the flange, the rivet circle is readily found by fixing the rivet gage as usual: $1.5 \times d$. Then the maximum number of rivets is calculated by assuming a certain maximum value for the calking pitch, usually 2¼ inches for single and 3½ inches for double riveting.

For extremely high pressure, double-riveted flanges are preferred, as illustrated in Fig. 57. The same elements in design covering the single-riveted flanges are also embodied in the double-riveted type. The tables of dimensions in connection with both Figs. 56 and 57 are a convenience to the designer when preparing the working drawings of the boiler.



| Nominal Size Inches | Outside Inches | Thickness Inches | Depth of Hub Inches | Diameter of Hub Inches |
|---|---|---|---|---|
| 1 | 7½ | 3/8 | 1 1/16 | 2 |
| 1¼ | 8½ | 3/8 | 1½ | 2½ |
| 1½ | 9 | ½ | 1½ | 2 13/16 |
| 2 | 9½ | ½ | 1½ | 3 3/16 |
| 2½ | 10 | ½ | 1⅝ | 3⅞ |
| 3 | 10½ | ½ | 1⅝ | 4⅝ |
| 3½ | 11 | 9/16 | 1⅝ | 5 |
| 4 | 11½ | 9/16 | 1⅝ | 5 9/16 |
| 4½ | 12¼ | ⅝ | 1⅝ | 6 |
| 5 | 13 | ⅝ | 2⅛ | 6 11/16 |
| 6 | 14 | ⅝ | 2⅛ | 7¾ |

Fig. 57

*(To be continued.)*

## Autogenous Welding Accepted in Boiler and Pressure Vessel Repairs

The following report of autogenous welding was unanimously adopted at a recent meeting of the Engineers' Committee of the Steam Boiler and Fly-Wheel Service Bureau, which was made up of representatives from all companies writing steam boiler insurance. The committee decided that the report fully stated the position of the companies with respect to the insurability of steam boilers repaired by autogenous welding. The data will prove valuable to the experienced welder as a guide in preparing his work for the inspector and may well be used as a basis for the instruction of the beginner in the art of welding.

As the report has been accepted by companies throughout the United States, the methods of autogenous welding will necessarily become uniform, a condition which is most desirable in modern production.

### Details of Report

By autogenous welding is meant any form of welding by fusion, that is, where the metal of the parts to be joined or added metal used for the purpose is melted and flowed together to form the weld. Such welding is accomplished by the oxy-acetylene, hydrogen or other flame processes, or by the electric arc; no distinction is made between any of these processes. The general rule to govern the acceptance of such welds in insured vessels is that prescribed by the Boiler Code of the American Society of Mechanical Engineers, paragraph 186, as follows:

"Autogenous welding may be used in boilers in cases where the strain is carried by other construction which conforms to the requirements of the Code, and where the safety of the structure is not dependent upon the strength of the welds."

The following illustrations will serve to point out where such work should be accepted or rejected:

Any autogenous weld of reasonable length will be permitted in a staybolted surface or one adequately stayed by other means, so that should the weld fail the parts would be held together by the stays. It is necessary for the inspector to use judgment in interpreting the meaning of *reasonable length* as given above, since it may vary in different cases. In the average case it should be not more than 3 feet. Autogenous welding will not be accepted in an unsupported surface.

The edges of the inner and outer sheets of vertical firebox boilers or boilers of the locomotive type may be joined by autogenous welding to form the door openings if the surrounding surfaces are thoroughly stayed. This would also apply to other openings of a similar character in such surfaces.

For low-pressure, plate steel boilers operated at a pressure not exceeding 15 pounds per square inch, or for higher pressures in unfired vessels subjected to water pressure only, rectangular headers may be autogenously welded at the edges if the sheets are properly held together by stays. Autogenous welding of cracks and fractures in cast iron boilers will not be permitted.

### Welding Fire Cracks

Fire cracks in girth seams extending from the edge of the plate to the rivet hole may be autogenously welded provided the cracks are properly prepared by cutting out the metal at the crack in the form of a letter "V" to permit fusion through the entire thickness of the plates. Similar cracks in girth seams located between the rivet holes may also be autogenously welded, provided the cracks do not extend beyond the edge of the lap of the inner plate. In the latter class of cracks it is advisable to drill a hole not exceeding ⅜ inch in diameter at the end of the crack before the weld is made. Cracks extending from rivet hole to rivet hole on girth seams cannot be welded. Calking edges of girth seams may be built up by autogenous welding where the original section of the metal between the rivet holes and calking edge to be built up is on the average equivalent to one-fourth of the diameter of the rivet hole and the portion of calking edge to be replaced does not exceed 30 inches in length in a girthwise direction. In all repairs to girth seams by autogenous welding the rivets must be removed over the portions to be welded and for a distance of at least 6 inches at each and beyond such portions. After repairs are made the rivet holes should be seamed before the rivets are redriven.

Stayed sheets which have corroded to a depth of not more than 40 percent of their original thickness may be reinforced or built up by autogenous welding. In such cases the stays shall come completely through the reinforcing metal so as to be plainly visible to the inspector.

Where tubes enter flat surfaces and the tube sheets have been corroded or where cracks exist between the tube ligaments, autogenous welding may be used to reinforce or repair such defects. The ends of such tubes may be autogenously welded to the tube sheets. The above-mentioned repairs for tube sheets and the welding in of tubes in the sheets are not to be permitted where such sheets form the shell of a drum or boiler such as in the case of the Stirling type boiler.

When external corrosion has reduced the thickness of plate around handholes to not more than 50 percent of the original thickness, and for a distance not exceeding 2 inches from the edge of the hole, the plate may be built up by autogenous welding.

Pipe lines will be accepted where the flanges or other connections have been welded autogenously, provided the work has been performed by a reputable manufacturer and the parts annealed before being placed in position.

Such welding when made with the part in place and unannealed will not be acceptable.

Autogenous welded patches in the shell of a boiler will not be acceptable regardless of the size of such patches. Autogenous welding of cracks in the shell of a boiler, except those previously specified, regardless of the direction in which they may lie, will not be permitted unless such welding is only for the purpose of securing tightness and the stresses on the parts is fully cared for by properly riveted-on patches or straps placed over the weld. The plates at the ends of joints may be welded together for tightness, provided the straps or other construction is ample to care for the stresses on the parts so welded.

Re-ending or piecing of tubes for either firetube or watertube boilers by the autogenous process will not be permitted.

## Special Meeting of the American Boiler Manufacturers' Association

The second special meeting of the American Boiler Manufacturers' Association was held at the Astor Hotel, New York City, January 8. At the meeting the cost questionnaires previously distributed to the members were discussed and the thirty-one sets of answers submitted were compared.

The attendance was remarkably good and indicated the value of the quarterly meetings to the members.

A complete report of the proceedings will be published in the February issue of THE BOILER MAKER.

REGISTRATION

Adams, Honer, Kewanee Boiler Works, Kewanee, Ill.
Bach, Geo. W., Union Iron Works, Erie, Pa.
Barder, B. R., The Biggs Boiler Works, Akron, O.
Barnum, G. S., The Bigelow Co., New Haven, Conn.
Barnum, S. H., The Bigelow Co., New Haven, Conn.
Bart, B. F., Standard Seamless Tube Co., New York City.
Bateman, W. H. S., Champion Rivet Co., Parkesburg Iron Co., Philadelphia, Pa.
Berry, C. P., Oil City Boiler Works, Oil City, Pa.
Bigelow, P., The Bigelow Co., New Haven, Conn.
Bliss, Geo. T., Erie City Iron Works, Erie, Pa.
Blodgett, L. S., THE BOILER MAKER, New York City.
Brandt, C. A., Locomotive Superheater Co., New York City.
Brangs, P. H., Heine Safety Boiler Co., St. Louis, Mo.
Broderick, M. H., The Broderick Co., Muncie, Ind.
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Brown, O., Springfield Boiler Co., Springfield, Ill.
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Connelly, W. C., The D. Connelly Boiler Co., Cleveland, O.
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Figsby, F. H., Ernst & Ernst, New York City.
Fish, E. R., Heine Safety Boiler Co., St. Louis, Mo.
Fisher, E. C., The Wickes Boiler Co., Saginaw, Mich.
Fitzgibbons, David, Fitzgibbons Boiler Co., Oswego, N. Y.
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Glenn, John F., Edge Moor Iron Co., Edge Moor, Del.
Harter, Isaac, Babcock & Wilcox Co., New York City.
Hammerslough, J. S., Springfield Boiler Co., Springfield, Ill.
Hose, M. C., Erie City Iron Works, Erie, Pa.
Houston, H. M., The Houston Stanwood Gamble Co., Cincinnati, O.
Jeter, S. F., Hartford Steam Boiler Insp. & Ins. Co., Hartford, Conn.
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Morgan, John, Locomotive Superheater Co., New York City.
Myers, C. O., Chief Boiler Inspector State of Ohio, Columbus, O.
Pratt, A. G., The Babcock & Wilcox Co., New York City.
Primrose, Durward, Atlantic Coast Shipbuilders Assn., New York City.
Ryder, Gilbert E., Locomotive Superheater Co., New York City.
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Schlade, T. F., Ames Iron Works, Oswego, N. Y.
Shoemaker, C. B., 2nd., Glasgow Iron Co., Philadelphia, Pa.
Tudor, Cliff. M., The Tudor Boiler Mfg. Co., Cincinnati, O.
Turner, Chas. R., International Boiler Works Co., East Stroudsburg, Pa.
Walz, C. W., International Boiler Works Co., East Stroudsburg, Pa.
Weigel, A. C., The Walsh & Weidner Boiler Co., Chattanooga, Tenn.
Wein, E. G., E. Keeler Co., Williamsport, Pa.
Wolfe, M. E., The Iron Age, New York City.

## Tensile Tests on Electrically Welded Staybolt Parts*

The following tensile tests on welded staybolts are instructive because of the very little laboratory work that that has been done in this connection. Oftentimes the value of such work is neglected in the attempt to devote the energy of an organization to increasing production. As a matter of fact, production and the quality of material produced may be greatly benefited in any industry by the intelligent use of a well-equipped laboratory. If the limiting qualities of material are known, the maximum efficiencies may be utilized to the best advantage.

Series No. 1—3/8-Inch by 4-Inch Plate with 1-Inch 12V Thread Tapped Hole

| | Ultimate Strength Pounds |
|---|---|
| A—With open hole | 75,700 |
| B—With 1-inch bolt—head riveted | 73,200 |
| C—With 1-inch bolt—head welded | 79,800 |

Riveting reduces the plate strength by 3.3 percent.
Welding increases the plate strength by 5.4 percent.

Series No. 2—3/4-Inch by 4-Inch Plate

| | Ultimate Strength Pounds |
|---|---|
| D—With hole tapped 1 11/16 inches, 12V thread (3/4-inch taper), standard sleeve (style F) applied | 109,300 |
| E—Recessed for bolt and welded cap (cap not applied) | 120,200 |
| F—Recessed as in Test E, but with cap applied | 146,300 |
| G—With U sleeve applied | 135,800 |

Preparation for bolt and welded cap leaves the plate 10.0 percent stronger than when the plate is prepared for and equipped with the standard sleeve.

Plate recessed and reinforced by the welded cap is 33.8 percent stronger than the plate prepared for and equipped with the standard sleeve.

Plate recessed and reinforced by U sleeve is 24.2 percent stronger than the plate prepared for and equipped with the standard sleeve.

Series No. 3—3/8-Inch by 4-Inch Plate with 1 1/8-Inch 12V Thread Tapped Hole

| | Ultimate Strength Pounds |
|---|---|
| H—With 1 1/8-inch button head bolt | 72,100 |
| I—With 1 1/8-inch welded head bolt | 82,000 |

Welding the head increases plate strength by 13.7 percent.

The exposition of American manufacturers, which was to have been held at Buenos Aires April, 1920, has been postponed until the fall on account of the inability of the representative industries to prepare the necessary exhibits by the original date. Direct control of arrangements has been in the hands of the American National Expositions, Inc., with offices in New York City.

The Chicago Pneumatic Tool Company announces the appointment of E. A. Woodworth and C. E. Laverenz as special railroad representatives attached to the staff of the manager of Western railroad sales, with headquarters at Fisher Building, Chicago, Ill. The former has been for several years secretary of the Committee on Standards of the United States Railroad Administration and was at one time associated with the Oxweld Railroad Service Company and general mechanical superintendent of the Chicago, Rock Island and Pacific Railroad. The latter, who has for several years been an inspector in the ordnance department of the United States Navy, previously held positions as boiler maker and foreman of the Chicago, Northwestern and Illinois Central Railroads.

* Tests conducted by the Flannery Bolt Company, Pittsburgh, Pa.

# The Boiler Maker

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E. L. SUMNER, Secretary
H. H. BROWN, Editor.
L. S. BLODGETT, Associate Editor

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In December an association of inspectors and officials having charge of the enforcement of regulations governing the manufacture and use of boilers was formed in New York City. Membership in this association was made up from states and cities basing their boiler requirements on the A. S. M. E. Code. The purpose of the organization is to discuss methods of inspection, the interpretation of rulings, the approval of new designs and other matters pertaining directly or indirectly to the boiler industry. There can be no question of the advisability of organizing in this manner a body of men whose decisions will have great weight in determining the future requirements for boilers and pressure vessels.

As legislation is passed in states enforcing a uniform system of boiler laws, the inspection departments of such states are eligible for membership in this society. With the progress that is being made in various sections of the country in the adoption of a uniform code, it will not be long until the body becomes national in its scope.

The real aim of a national society will be to reduce the accidents and casualties caused by boiler explosions to more nearly the proportion that exists in other countries, where uniform boiler requirements and uniform inspection departments have been in operation for many years.

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Few people in this country until within the last few months have realized that an attempt was being made, both in the United States and Great Britain, to replace the English system of weights and measures, standard in both countries, with the metric system of Continental Europe.

The movement has become of so much importance that legislation making the metric system compulsory and prohibiting the use of the English system is now pending in the United States Congress and in the British Parliament.

The advantages and disadvantages of either system need not be dealt with here, but to bring the matter home to the boiler making industry it simply needs to be pointed out that the adoption of any new system of measurements would work a real hardship on the industry. The mere fact of having to educate the men in the plants in the use of such a system, as well as to redesign the various standardized types of boilers now being built, would almost automatically place the boiler manufacturers on record as opposed to any change from the present system.

The only way to effectively combat the changes which, as in many other instances, are liable to be passed by Congress before sufficient sentiment has arisen against them, is to immediately get in touch with the congressmen of the states in which individual companies operate and to convince them that industry is not in favor of the metric system.

---

The plan of exhibiting American manufactured products in South America during the coming fall is directly in pursuance of the policy of international trade expansion, so necessary to the retention of the new position this nation holds in the world's affairs. No publicity nor propaganda could have a more beneficial effect on our commercial relations with the southern continent than to show in direct comparison, and conveniently for inspection, the various products that we wish to sell and the countries of South America want to buy so badly.

England and Germany in the past have controlled most of the trade in South American countries, the former in manufactured products in general and the latter in machinery and other steel products. Systematic exhibitions and ready distribution, combined with the ever-important credit extensions, aided in obtaining the trade control by these two countries. At the present time, however, these nations need hardly be considered as competitors, and until their domestic readjustments and recuperation have been completed the door to the world's markets is open to us. Once established in the field, we will be able to hold our own against any competition of foreign powers.

The exposition in Buenos Aires, which is the natural center of commercial activities, extending into Chili and southern Brazil as well as the Argentine, is merely the beginning of a systematic campaign which, if properly supported, will end with the foundation of a prosperous future for American products in South America.

This exposition would seem to afford an excellent opportunity to the boiler manufacturers of the country to place their products in the South American market. Although at present the output of nearly all boiler shops is taken care of by domestic orders, the condition is only temporary, and in two or three years the reward of any immediate attempt to establish a foreign trade, particularly in South America, will be a steady demand for American boiler units and equipment in these countries.

---

The pending Ohio legislation, designed to eliminate the existing boiler inspection department and to install a new and untried system of inspection, calls for prompt action on the part of boiler manufacturers of the state if the passage of the measure is to be combated successfully.

If such a law is passed, endless trouble will be experienced by boiler manufacturers in trying to satisfy the new requirements.

# Engineering Specialties for Boiler Making

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

### Portable Furnace Generates Heat of 3,000 Degrees in Five Minutes

A high, sustained temperature, generated in a short period of time, is the principle upon which the design of a new furnace of the Champion Kerosene-Burner Company of Kenton, Ohio, is based. This heating unit is used

New Portable Rivet Heating Apparatus

for heating rivets, heat-treating tools, shrinking-on processes and similar operations calling for an intense heat in a small, portable hearth.

It is claimed that a quick, fierce-burning flame is produced by the kerosene (paraffine), which is reduced to a gas just the moment before it is ignited. The effect is similar to that secured by the vaporizing jet in the carburetor of an internal combustion engine in utilizing all of the fuel for combustion. A heat of 2,500 to 3,000 degrees Fahrenheit may be maintained.

The furnace is self-contained, having a fuel storage tank on the lower platform of the stand. These tanks are of various sizes, depending upon the use to which the furnace is to be put and are intended to supply the furnace for a 10-hour day without refilling. For this reason no pipe connections need be installed at different points in the shop or field. Compressed air, at a pressure of from 80 to 90 pounds, forces the fuel from the storage tank to the burner, which is located just above the hearth.

In spite of the fact that fuel is constantly being drawn out of the tank, with a consequent lowering of the fluid level and enlargement of the air space, the original air pressure remains adequate to properly feed the burner.

From a series of tests extending over more than a year's time, the company bases its statement of the fuel consumption and performance of the furnace, which is ¾ gallon per hour operating at capacity. In addition to the fuel consumption, these tests indicated that the flame was practically non-oxidizing, so that material might be left in the furnace indefinitely without burning or becoming reduced in size.

In heating rivets, the furnace is of such size that a whole keg may be preheated together. Rivets for immediate use may be placed directly under the flame and, as others are needed, they may be raked into this position of maximum heat.

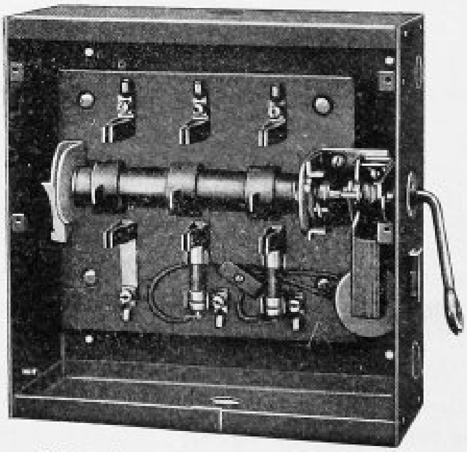
Various sizes of furnaces are available with one or more burners, depending on the use for which they are intended.

### New Safety Motor Starting Switch

A new type of motor-starting switch, which provides protection to both the operator and the motor, has just been placed on the market by the Westinghouse Electric and Manufacturing Company. It is known as the type WK-100 switch and is designed for connecting single or polyphase, alternating-current motors of from 1 to 10 horsepower, 250 and 550 volts, directly to the line without the use of auto-transformers or resistances.

All of the mechanism, with the exception of the operating handle, is inclosed within a steel box. The protective devices are easily accessible on opening a door in the cover. This door, however, cannot be opened except when the switch is in the off position (nor can the switch be closed when the door is open), and all parts within reach are then dead. The upper part of the cover is held in place by screws, and so can be removed without difficulty by authorized persons, thus exposing the entire mechanism to inspection.

No-voltage protection to the motor is provided by a magnetic release which opens the switch automatically on



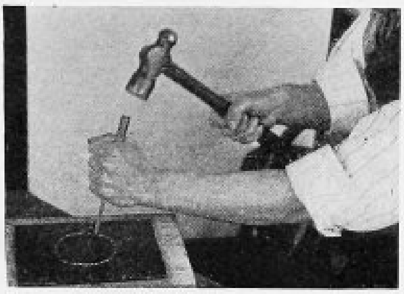
Westinghouse Safety Starting Switch

a failure of voltage. Overload protection is provided by means of relays, resembling cartridge fuses in appearance, each of which contains a contact connected in series with the release magnet. Harmless momentary overloads have no effect on the relays, but as soon as the load on the motor becomes dangerous the relay contacts open the magnetic circuit and the switch automatically flies open. The relays then automatically reset themselves. The switch is so arranged that it cannot be kept closed on an overload or no-voltage, even if the handle is held in the on-position.

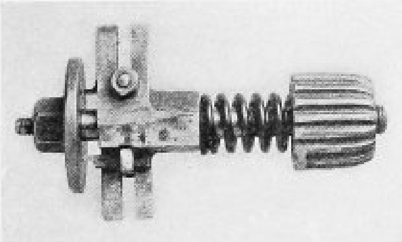
The entire mechanism is mounted on a slate base and can be removed as a unit without disturbing the box or the conduits. Damaged switches are in this way easily replaced.

## Portable Cutting Tool

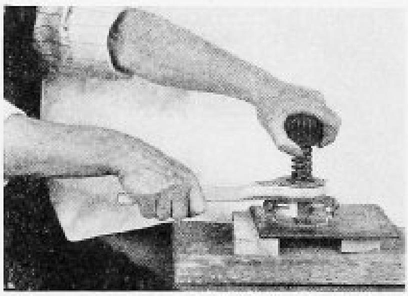
As a portable tool for cutting large holes in places where the acetylene flame might not be entirely practical, the adjustable cutter illustrated below should be of value to the boiler maker. The cutter consists of a chuck holding two cutting tools adjustable for various diameters from 1¼ to 6 inches. Pressure is applied to the cutting tools by means of a heavy spring. A ratchet wrench is used to rotate the chuck to cut a round, clean hole through steel plates up to ½ inch in thickness. Since this Jiffy cutter, which is put on the market by Koch & Sandidge, Chicago, Ill., is light, it will be found convenient for cutting in tight places.



Former Hand Method



Portable Cutting Tool



Cutting Tool in Operation

## Double-Gagged Punching Attachment

A new device, known as the Cleveland double-gagged punching attachment, is being placed on the market by the Cleveland Punch and Shear Works Company, Cleveland, Ohio. As shown in the illustration, each stem of the Cleveland double-gagged punching attachment is fitted with a spring to lift the punch clear of the material when the gag is withdrawn. Each gag is individually operated and has a long taper end, so that when the gag is inserted the taper end acts as a wedge and forces the punch stem down. This attachment is very desirable when used with a spacing table and when the plate has two sizes of holes, as one punch stem will be entirely clear of the material even when the plunger is at the bottom of its stroke. There is, therefore, no interference or dragging of the disengaged member. The centers are fixed.

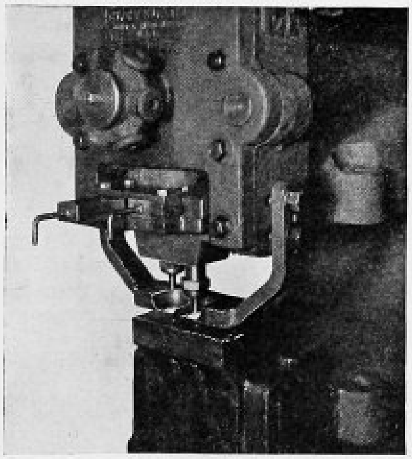
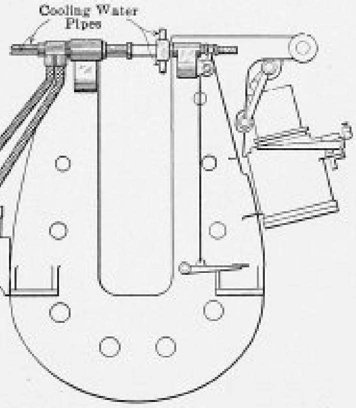


Fig. 1.—Cleveland Double Gagged Punching Attachment

## Electric Rivet-Heating Attachment for Bull-Riveting Machine

An electrical rivet-heating device, intended for use on gap, bull and hydraulic riveting machines, has recently been placed on the market by the United States Electric Company, New London, Conn. The attachment is arranged so that a hot rivet is left in front of the plunger at all times during the riveting operation.

Rivets are placed in their holes cold and the work to be riveted is moved so that it comes in contact with the electrodes automatically or by the motion of the plunger operated by a hand lever. The electrodes are so constructed that the rivets may be heated at once by bringing one rivet to the proper heat while the other is being preheated.




Electric Rivet Heating Attachment Applied to "Hanna" Riveter

Ordinary equipments are built to heat rivets of ½ inch to 1¼ inches diameter, but special machines may be built for larger diameters.

All sizes are available for use with alternating currents of 110 or 220 volts.

The Black & Decker Manufacturing Company has opened an additional Pacific Coast office at 201 Maynard building, Seattle, Wash. This office is in charge of A. E. Nordwall, who is well known on the Pacific Coast, and who will have charge of the distribution of Black & Decker products in the state of Washington, working under the direction of the main Pacific Coast office, San Francisco, Cal.

# Questions and Answers for Boiler Makers

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

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

*Address your communication to the Editor of the Question and Answer Department of* The Boiler Maker, *6 East 39th Street, New York City.*

## Funnel Problem

Q.—What is the quickest way of marking out the rake of an oval funnel having a major axis of 2 feet 6 inches, minor axis 1 feet 6 inches, rake 3 inches, and length 7 feet 6 inches?

What tools should be used to calk ⅞-inch rivets and larger sizes?

J. K. H.

A.—To lay off the slope of the stack from the horizontal line *CD*, first determine the length of *CD*, Fig. 1, as follows:

*CD* may be considered as the hypotenuse of the right angle triangle *CED*.

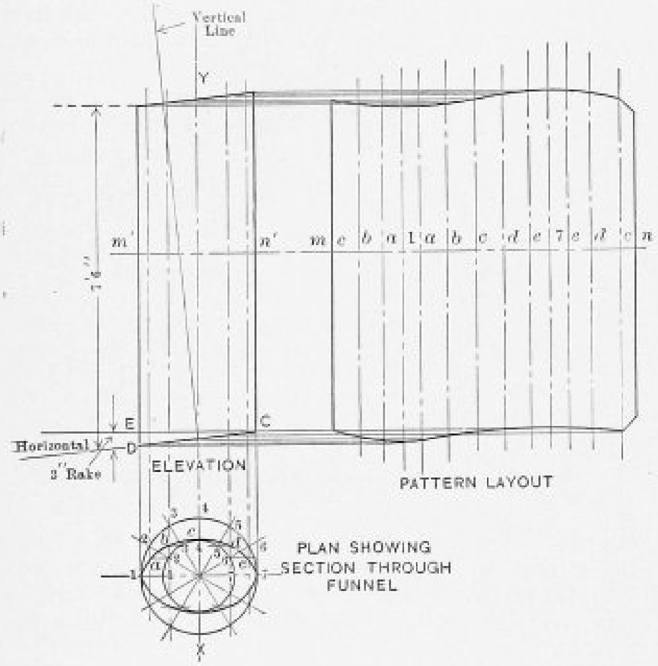



Fig. 1.—Development Indicating Method of Marking Out Rake of Funnel

Line *ED* being the base and *EC* the perpendicular, then

$$DC = \sqrt{ED^2 + EC^2}.$$

Using the given values for these,

$$DC = \sqrt{3^2 + 30^2} = \sqrt{9 + 900} = 30.15 \text{ inches.}$$

Lay off *DC* equal to this length, and with point *D* as a center and with the compasses set to 3 inches, describe an arc. With *C* as a center and compasses set to 30 inches, describe an arc intersecting the one previously drawn, locating point *E*. At right angles to *EC* draw the sides of the funnel. Lay off from point *D* point 1 equal to the length of the funnel, or 7 feet 6 inches. Line 1-7 is parallel with *DC*, which lies in a horizontal position.

The profile of the funnel is elliptical, as shown in the plan view. To construct the ellipse, first draw two circles with radii equal, respectively, to one-half the diameters of the axes of the ellipse. Divide either circle into a number of equal parts and draw radial lines joining the center of the ellipse. Projectors are then drawn parallel with the centerline *XY* from points on the outer circle, and horizontal ones from the corresponding ones on the

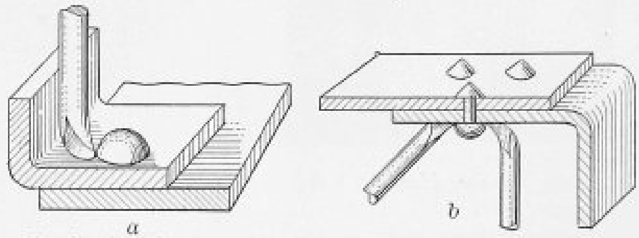



Fig. 2.—Straight and Bent Fullers for Heavy and Light Calking

smaller circle, which intersect at *a*, *b*, *c*, *d* and *e*. These are points lying on the ellipse. Projectors are extended as shown to the upper and lower bases of the funnel in the elevation. For the pattern lay off the line *m-n* at right angles to *x-y*. Set off the required stretchout of the funnel, using the arc length from 1 to *a*, *a* to *b*, *b* to *c* of the ellipse. From the points on *m-n*, as *c-b-a*, etc., draw lines on which are located the required measurement for the pattern.

### Calking Rivets

For calking rivets, straight and bent fullers are employed. These may be made in various shapes suitable

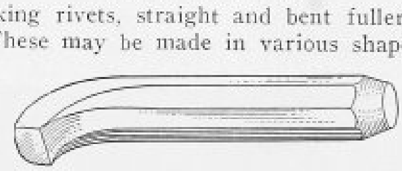


Fig. 3.—Calking Tool Known as a Frenchman

for heavy and light calking. Fig. 2, (a) and (b), shows how the fullers are placed for calking overhead and inaccessible places. The nose or calking ends of the fullers are made round, straight and with a sharp round edge for finishing purposes. Rivets driven by hand are often finished with a calking tool, Fig. 3, commonly called a *frenchman*.

## Tube Sheet Calculations

Q.—I am attaching herewith sketches of three boilers. Figs. 1 and 2 are return tubular boilers, 60 inches in diameter, plates ½-inch and, as you will note, the back head is braced both top and bottom; front head braced on top but no braces in the bottom around the manhole. This manhole is flanged 1¾ inches from the outside face of plate, and it is our contention that no braces are needed, as the boiler carries but 100 pounds steam pressure.

The boiler in Fig. 3 is 66 inches in diameter, ½-inch heads, back head braced top and bottom; front head braced at top and a reinforced flange riveted on bottom forming a seat for the manhole. It is also our contention that this head does not require bracing, as this boiler carries but 100 pounds of steam pressure. Are these assumptions correct?

A.—According to the A. S. M. E. Code the areas of segments of heads requiring stay supports are based on the following rules:

*Paragraph* 214. Areas of segments of heads to be

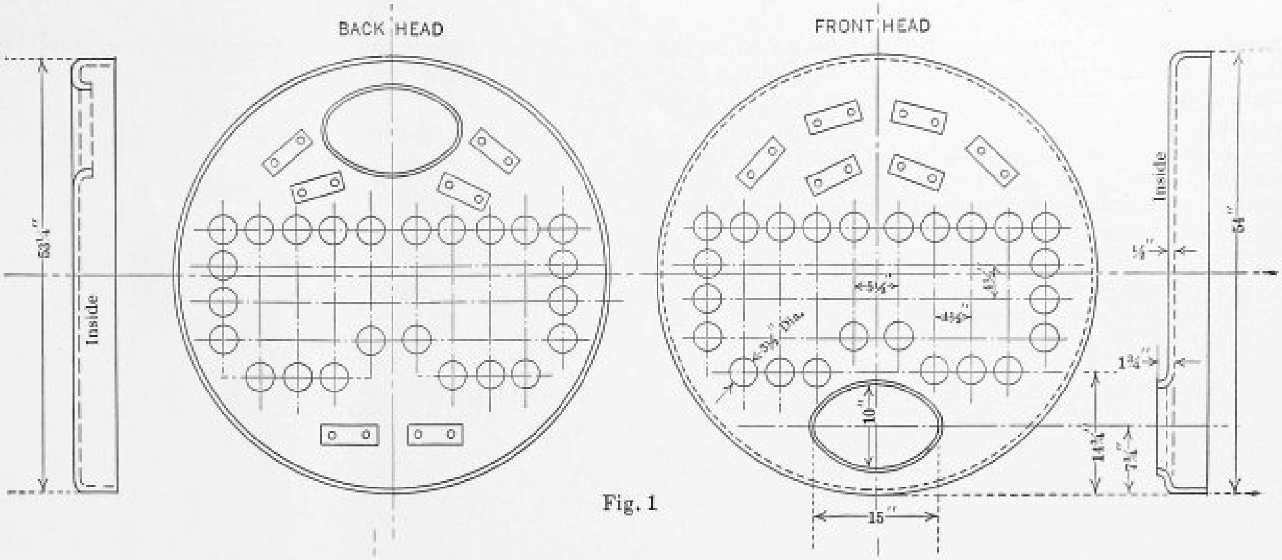



Fig. 1

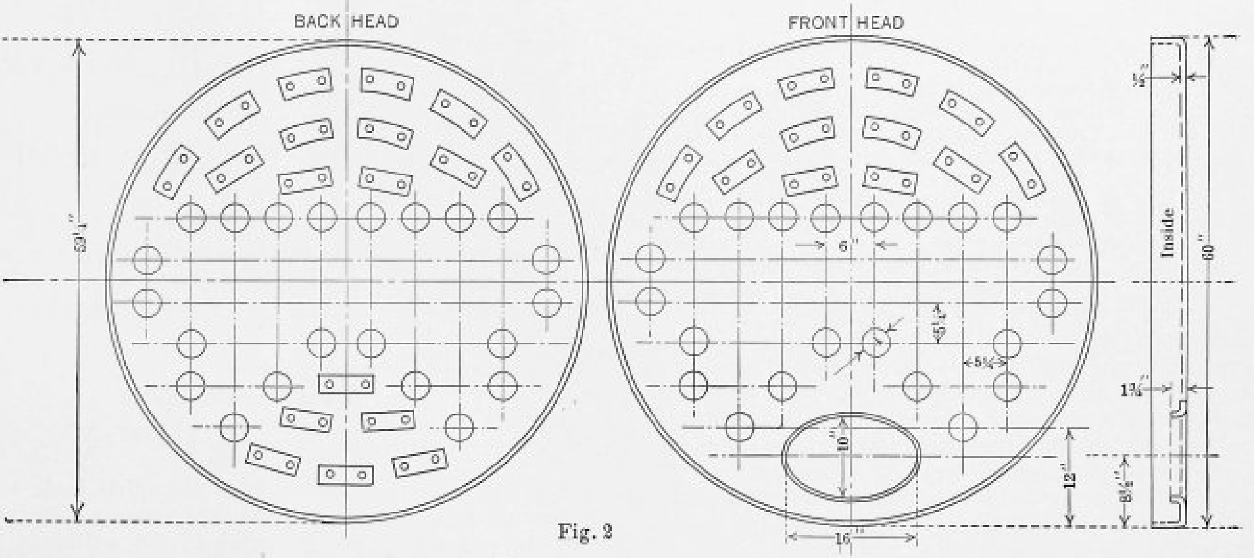



Fig. 2

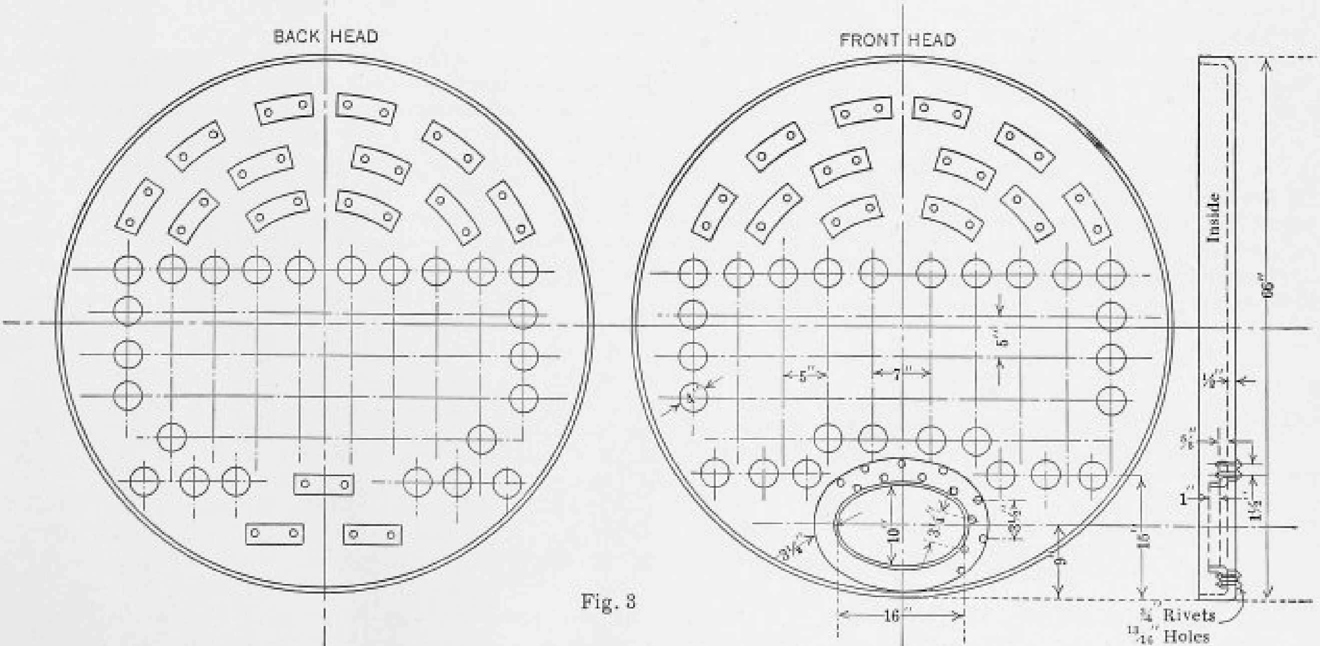



Fig. 3

Calculations of Tube Sheets for Various Sizes of Scotch Boilers stayed. The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 3 inches from the shell and 2 inches from the tubes, as shown in Figs. 4 and 5.

*Paragraph* 216. In a firetube boiler having a tube sheet 7/16-inch thick or over, that part of the tube sheet which comes between the tubes and the shell need not be stayed when the distance from the inside of the shell to the outer surface of the tubes does not exceed that given by the formula in paragraph 199, using 160 for the value of *c*. When stays are required the area to be stayed shall be determined as indicated by the rule given in paragraph 214.

*Paragraph* 199. The maximum allowable working pressures for various thicknesses of braced and stayed flat plates and those which by these rules require staying as flat surfaces with braces or staybolts of uniform diameter symmetrically spaced, shall be calculated by the formula:

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

where,

$P$ = maximum allowable working pressure, pound per square inch.
$t$ = thickness of plate in *sixteenths* of an inch.
$C$ = 112 for stays screwed through plates not over 7/16-inch thick with ends riveted over.
$C$ = 120 for stays screwed through plates over 7/16-inch thick with ends riveted over.
$C$ = 135 for stays screwed through plates and fitted with nuts outside of plate.
$C$ = 175 for stays fitted with inside and outside nuts and outside washers where the diameter of washers is not less than $0.4p$ and thickness not less than $t$.

If flat plates not less than 3/8-inch thick are strengthened with doubling plates securely riveted thereto and having a thickness of not less than 2/3 $t$, nor more than $t$, then the value of $t$ in the formula shall be three-fourths of the combined thickness of the plates and the value of $C$ given above may also be increased 15 percent.

To determine if the lower segment of the front head boiler, Fig. 1, requires staying according to paragraph 216, we will work out formula given in paragraph 199.

To find the pitch or distance from the inside of the shell to the outer surface of the shell it is necessary to transpose values in the formula:

$$p = \sqrt{\frac{160 \times 8^2}{100}} = 10.1 \text{ inches.}$$

The depth of the segment measured from the inside edge of the shell to the outer surface of the tubes equals in boiler, Fig. 1, 14¾ — one-half diameter of the tube equals 14¾ — 1¾ = 13 inches.

According to paragraph 218, when the portion of the head below the tubes in a horizontal tubular boiler is provided with a manhole opening, the flange of which is formed from the solid plate and turned inward to a depth of not less than three times the thickness of the head, measured from the outside, the area to be stayed as indicated in Fig. 5 may be reduced by 100 square inches.

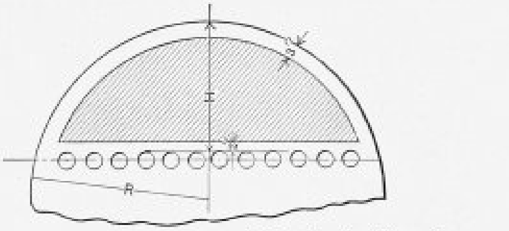


Fig. 4.—Area of Segment of Head to be Stayed

The surface around the manhole shall be supported by through stays with nuts inside and outside at the front head.

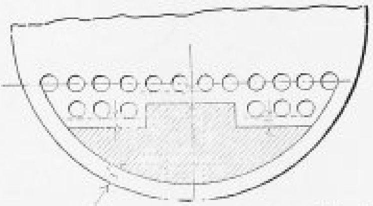


Fig. 5.—Area to be Stayed Equals Area Indicated by Shaded Portion

In paragraph 217 the following formula is given with regard to calculating the net area in a segment to be stayed:

$$\frac{4\,(H-5)^2}{3}\sqrt{\frac{2\,(R-3)}{(H-5)}} - 0.608 = \text{area to be stayed, square inches.}$$

Where,

$H$ = distance from tubes to shell, Figs. 4 and 5.
$R$ = radius of boiler head, inches.

Using values given for boiler Fig. 1, and substituting them in the formula, we have:

$$\frac{4 \times (13-5)^2}{6}\sqrt{\frac{2\,(27-3)}{(13-5)}} - 0.608 = 198.14 \text{ square inches.}$$

$$198.14 - 100 = 98.14 \text{ square inches to be stayed.}$$

According to the rules and formulas stated, it is necessary to stay the lower segment for boiler Fig. 1. Make the calculations for the other two boilers, using the rules given in the A. S. M. E. Code.

## Spiral Blade Development

Q.—By what means can I lay out the pattern for a spiral blade which makes a half turn about the surface of a cone? The upper width of the blade is greater than the lower width. L. A.

A.—The general arrangement of the spiral blade with respect to the cone is illustrated in the accompanying perspective. Owing to the difference in the widths at top and bottom, it is necessary to keep a uniform change in the widths from top to bottom.

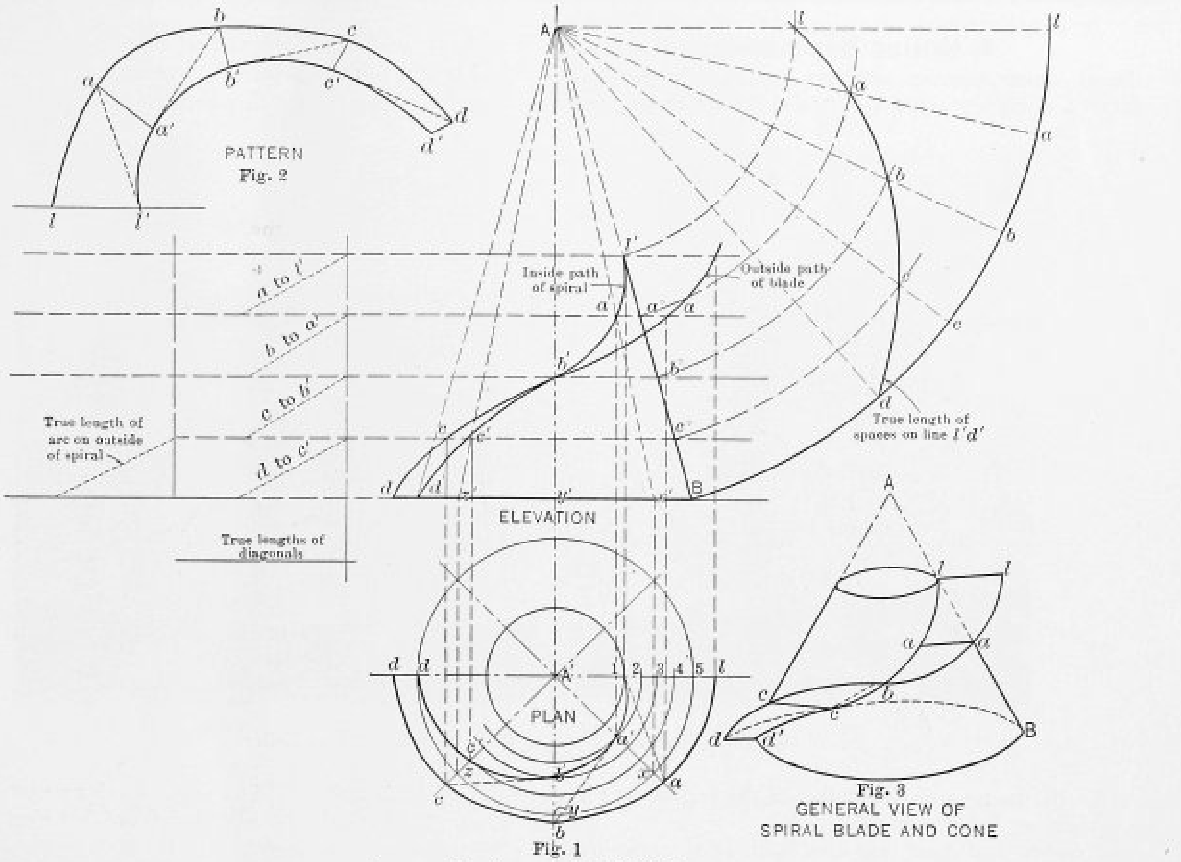
In Fig. 1 the construction work involved in preparing the views of the elevation and plan are given; the first step is to lay off the cone and the pitch of the spiral blade. The plan of the spiral curves for the inside and outside edges of the blade is then laid off in the plan view. On the horizontal axis *d-A′-l* in the plan lay off the distances 1-*l* and *d-d* equal to the respective widths of the blade at top and bottom. Produce first the path of the spiral for the inside edge. The circle drawn with *A′-d* as a radius, which is equal to the base of the cone, is divided into eight equal parts, but only one-half of these divisions are used in the layout. The blade section is a half spiral. From the points *a′-b′-c′* on the circle draw radial lines and locate corresponding radial lines in the elevation. Divide distance 1-5 on line *d-A′-l* into four equal parts. With *A′* as a center and radii *A′*-2, *A′*-3, *A′*-4, draw arcs to intersect the radial lines in points *a′*, *b′* and *c′*. The curve *d-c′-b′-a′*-1 is the projection of the one-half spiral in the plan. The path of this curve may now be located in the elevation by projecting lines from the points *a′*, *b′*, *c′*, etc., of the plan to intersect the radial lines of the cone on which they lie in points *a′-b′-c*, as indicated. Produce next the path of the curve for the outer edge of the blade. The upper and lower extremities are shown at *l-l′* and *d-d′*, so the intermediate widths may now be determined in the same manner as described for the inner edge, thus locating the points *a*, *b* and *c*. Project these points to intersect the horizontal lines drawn through *a'*, *b'* and *c'* in the elevation, which fixes the points on the curve for the outer edge.

Before the pattern can be laid off, it is necessary to determine the true lengths of the spaces between the points *l-a*, *a-b*, *b-c* and *c-d* on the inside edge of the spiral and also between those on the outer edge. The development to the right of the elevation gives the lengths for the inner edge. Imagine in this construction that one-half of the cone is unrolled in the flat, thus bringing the points *l-a-b*, etc., in the position shown. The development is made as follows:

With *A-B* of the cone as a radius, draw an arc of indefinite length. Locate conveniently line *A-d*, and from *d* space off divisions equal to the arc lengths of the circle for the base of the cone plan view; only four dimensions are required. Draw the radial lines *A-c*, *A-b*, etc. With *A* as a center, and with *A-1'*, *A-a°*, *A-b°*, *A-c°*, draw arcs intersecting the radial lines in *l-a* and *b-c*, respectively. The lengths of these arcs are used in laying off the pattern for the inner edge. The true length of the arcs for the outer edge may be found in a similar way, but in this case one triangle is laid off to determine the arc lengths, as follows:

With length of *d-c* of the plan as a base of the right-angled triangle, and the vertical distance between these two points shown in the elevation as the other leg of the triangle, the hypotenuse gives the desired length. This construction is shown to the left of elevation.

The next step is to find the true lengths of the diagonals between the points on the inner and outer edges of the blade. These true lengths are produced by using their projections in the plan for the bases of right angle triangles and the heights for the vertical legs of the triangles are obtained in the elevation; all of these true lengths are indicated on the drawing. The true lengths between points *a-a'*, *b-b'* and *c-c'* are shown in the plan view, because these projectors in the elevation show the lines parallel to the horizontal plane, and any line parallel to a plane of projection will be seen in that plane in its true length.



Layout Drawings of Spiral Blade

The pattern can now be laid off as shown in Fig. 2 by assembling the triangles in their relative positions and using the arc lengths just determined for the inner and outer edges of the spiral.

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In expectation of a year of unprecedented activity, the Seattle, Wash., plant of the Commercial Boiler Works is being thoroughly overhauled. J. H. Fox, of Fox and Jenkins, owners of the plant, says that new improvements are being made to prepare for the new era of private ship enterprise.

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Augustine Davis has resigned as president of the Davis-Bournonville Company. Mr. Davis was a pioneer in the acetylene lighting and oxy-acetylene welding industries in the United States and actively connected with those industries up to this time. He founded the Davis Acetylene Company and the Davis-Bournonville Company and has been president of both companies since their organization. The Davis Acetylene Company was dissolved in 1917.

No successor to the presidency of the Davis-Bournonville Company has been elected, and there has been no change in other officers of the company.

# Letters from Practical Boiler Makers

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

## A Boiler Explosion

About seven months ago, on a mountain road near Colorado, a very serious locomotive boiler explosion occurred. At the time of the explosion the engine was hauling a train up a four-percent grade.

The boiler had four hundred and forty-eight 2-inch flues, 15 feet 1 inch long, and was carrying a working pressure of 210 pounds. Low water was the apparent cause of the trouble, for the water mark was 8½ inches below the top of the crown sheet at the front end of the firebox. On inspection, not a bolt was found to be broken, and it was evident that the top of the crown sheet had begun to melt before it gave way. The back head of the boiler was pushed in when it fell from the trucks and the smoke box damaged as well. Each corner of the mud-ring was cracked. Because the front flue sheet was badly bent and cracked in the fall, the only parts of the boiler that could be used again were the two courses in the shell.

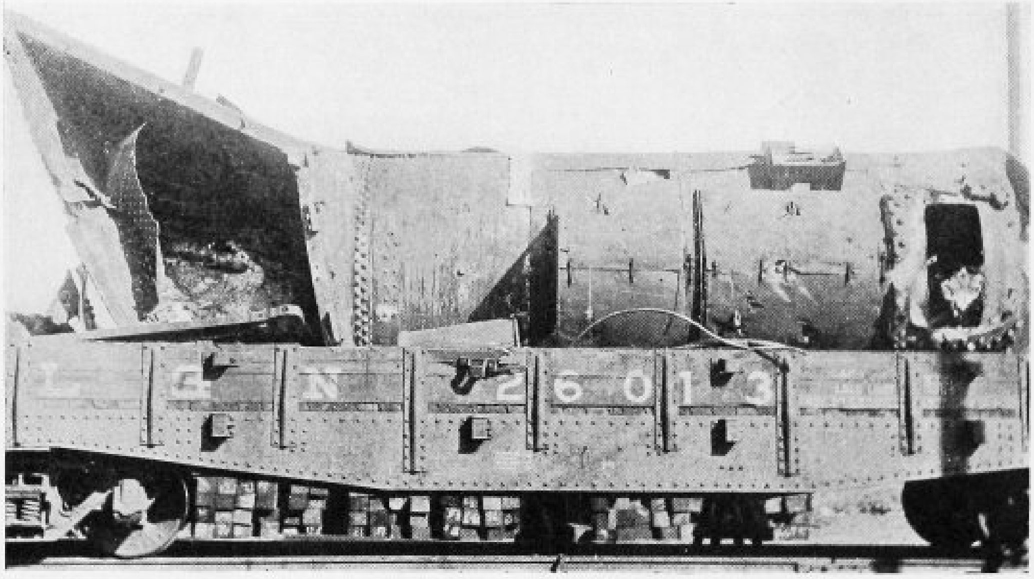



Fig. 1.—What Low Water Will Do to a Locomotive Boiler

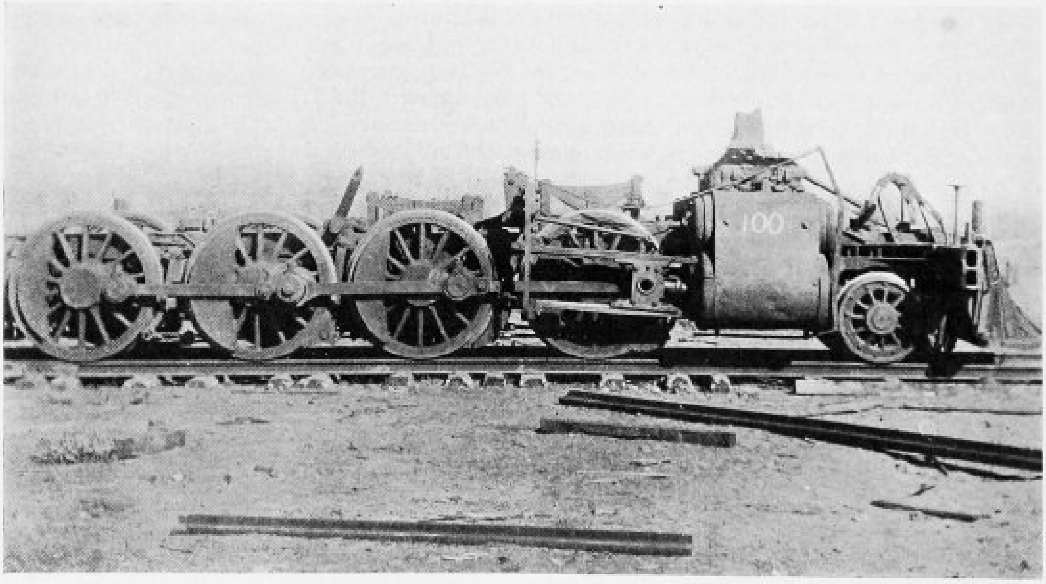



Fig. 2.—The Explosion Lifted the Boiler Entirely Clear of the Trucks, Which Remained on the Tracks

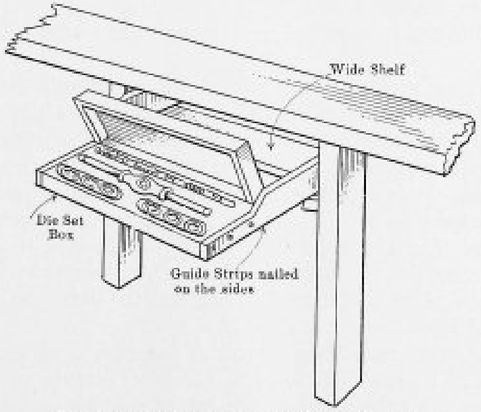
A rather curious feature of the accident is the manner in which the boiler was blown completely clear of the trucks, which never left the tracks.

Denver, Col. ARTHUR MALET.

## Handy Place for the Die Set

Most pipe or bolt die sets are sold in neat, compact cases to hold each part in its place. In order to get into this case, however, it must be set where it is easy to open the cover.

When a mechanic is doing a bit of work which calls for a die, he goes to the tool room and gets just the die he wants. If the tool room is like most that I have seen,




Convenient Arrangement of Die Set Case

the die set case has to be taken down off a shelf and then opened. To save time and make things convenient, I rigged up our die set cases as shown in the sketch, with guide strips on the sides, so that the cases can be easily drawn out and the covers opened.

TOOL ROOM MECHANIC.

## Two Methods of Laying Out an Ellipse

The laying out of an ellipse is not hard, but methods for doing the work quite simply and accurately are not generally known. There are two ways for doing this indicated in the accompanying sketches.

Layout Fig. 1, draw *A-B*, which is the long diameter, and *C-D*, the short diameter, at right angles to each other and intersecting at *E*, as the lines in the figure indicate.

With *E* as a center and the radius *E-C*, describe a circle. With the same center and *E-A* as the radius, describe another circle. Divide both circles into the same number of equal parts. The easiest way to do this is to divide the larger circle into the required number of parts and, beginning at the centerline *C-D*, draw radial lines through the points of division on this circle to the center

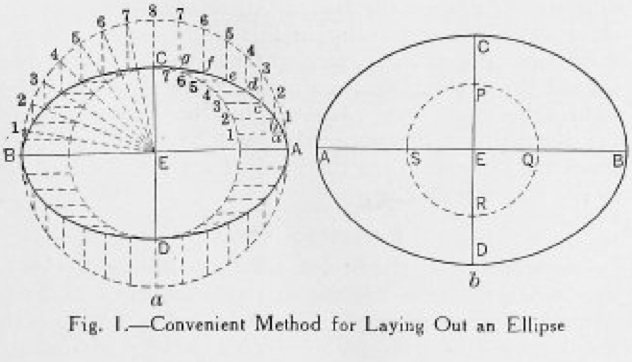



Fig. 1.—Convenient Method for Laying Out an Ellipse

*E* of the circles, as shown in the upper left-hand quarter of the figure. The radial lines will divide the smaller circle into the same number of parts that the larger one has been divided into.

Through the points of division on the smaller circle draw horizontal lines, and through the points of division on the larger circle draw vertical lines. The points of intersection of these lines will be points on the ellipse.

Thus the vertical line 1-*a* and the horizontal line 1-*a* intersect at *a* and give the point *a* on the ellipse (Fig. 1).

To lay out Fig. 2, draw *A-B*, the long diameter, and *C-D*, the short diameter, at right angles to each other, intersecting at *E*, as the lines in the figure.

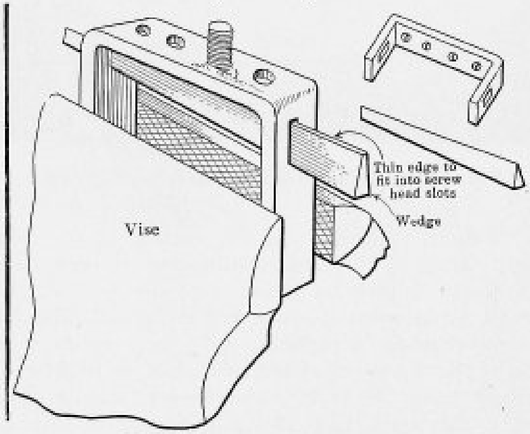
Next set the dividers to the difference between the long and short diameter less one-eight (that is to say, if the ellipse were 2 feet by 1 foot, the dividers would be set at 10½ inches). With this as a radius and *E* as a center, draw the circle *P-G-R-S*.

With *R* as a center and the radius *R-C*, describe the curve *C*. With the same radius and *P* as the center, describe the curve *D*. Then with the radius *G-B*, and from *G* as a center, describe the curve *B*. In a similar manner, with *S* as a center, describe the curve *A*, completing the ellipse.

Denver, Col. ARTHUR MALET.

## Screw Vise

Sometimes it is necessary to recut down the threads of screws or to hold them without injury while filing the end. The work is easily done by such a vise as shown in




Vise Clamp for Holding Screws

the sketch. This is made from a piece of thin flat bar stock, and a taper wedge with a thin edge that fits into the slot in the screw head, preventing it from turning. The sketch shows the tool in away that precludes further description.

Concord, N. H. CHAS. H. WILLEY.

## Mechanical Details Involved in New Flue Point

To illustrate clearly the new method of setting flues, it is necessary to explain the weakness and defects of the standard method of tube application, that is, the standard method usually followed. Locomotive boiler tubes were applied thirty-five or forty years ago identically as at the present time. The only real improvement is the welding of tubes in the tube plate in the firebox end, and this is not without its drawbacks. As a matter of fact a very small percentage of boiler tubes in the United States at the present time are welded in. The great majority of the tubes in service are simply fastened in the back tube sheet with the prosser expander, and the roller expander then applied to bead the end of them over on the plate.

We will only consider this method of setting tubes in boilers. The tube plate in the firebox is, as a rule, ½ inch thick. The tube holes are generally bored in the

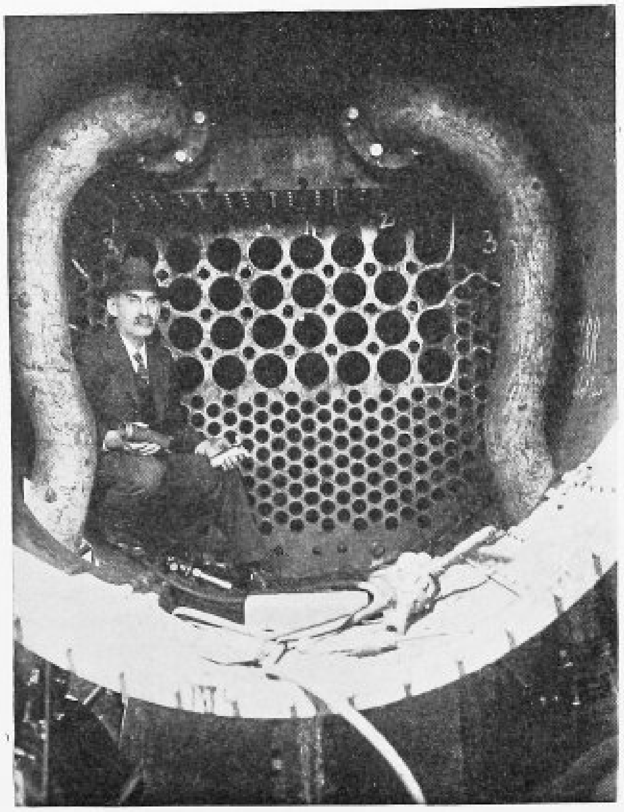


Fig. 1.—Sections of Flue End Ready for Installation

plate about the diameter of the outside of the tube, or slightly larger. The end of the tube is then swedged down about 1/8 inch to permit a copper ring or ferrule to be placed between the tube and the plate. The ferrule for a new firebox is generally 1/16 inch thick. It is the width of the thickness of the tube plate or slightly wider, generally being 5/8 inch. The copper ferrule has two primary functions, i. e., first, it acts as a soft gasket between the tube and the plate and reduces leakage trouble of tubes. Second, the copper ferrule is a greater conductor of heat than the steel tube and tube plate, hence the more rapid flow of heat through the copper ring to the water in the boiler tends to prevent overheating the ends of the tubes. The copper ferrule is fastened in a hole in the tube plate; the tube end is inserted into the ferrule until about 3/16 inch of the tube projects beyond the face of the tube plate on the fire side. The end of the tube is slightly expanded with the mandrel pin, thus fastening the tube in position. After this the tube is prosser-expanded in the plate, the projecting end of the tube beaded over with the beading tool, and the tube lightly rolled with the roller expander.

### Use of Expanders

The prosser expander makes a corrugation in the tube next to the water side of the tube plate. The object of this corrugation is to make the tube act as a strut between the front and back tube plates to stiffen the hold of the tube in the back tube plate. This corrugation against the water side of the plate and the bead clinched over on the fire side of the plate firmly fasten the tube in the plate, to the end that the uneven expansion and contraction in the set of flues or tubes cannot move or loosen the hold or joint of the tube in the firebox tube plate. The present method of fastening tubes in boilers is based on this theory.

The result of the use of the prosser expander is a vast improvement over the use of the roller expander only in setting tubes. The semi-circular corrugation on the water side of the plate in the tube greatly assists in holding the tube tight in the tube plate when the tube plate is breathing. It follows that if this semi-circular corrugation with only the edge or beginning of the circle coming in contact with the tube plate forms a strut and assists in holding the tube tight in the plate, how much more will this new device do the work with its sharp shoulder machined in the tube and placed against the water side of the plate.

The flue end obviates all of the conditions that wear out the tubes. With this device there is no use for the prosser expander. There is a mechanically correct shoulder on the tube that does not wear out and require reforming. It is a permanently formed shoulder set against the water side of the plate to remain in its original position holding the tube tightly in place. The roller expander, unlike the prosser expander, draws the tube into the tube plate and tends to enlarge the bead on the fire side of the plate.

This new system also improves the design of the copper ferrule. Instead of using a straight ferrule projecting through the tube plate on the water side 1/8 inch or more to act as a scale trap, or acid former, the ferrule is flanged before it is applied.

In bad feed water districts where the constant use of the prosser expander is necessary to maintain tubes in serviceable condition, with the standard method, the back tube plate is quickly destroyed. The frequent driving of the expander pin into the expanders in the tube has the effect of drifting and stretching the tube holes, with the result that the tube plate is distorted, buckled and holes knocked out of round, the top flange worked up high in the buckle, frequently causing the side flanges as well as the top flange to crack along the knuckles.

The new system obviates all of these evils, making it practical to run the tube plate as long as the rest of the firebox plates in all cases. As mentioned, the use of the prosser expander tapers the holes in the tube plate the wrong way, i. e., large on the water side and small on the fire side, while with the new device the hole in the tube plate is given a slight taper to begin with, the hole in the tube plate being slightly larger on the fire side of the plate. When the end of the tube is set in this hole and the bead clinched over on the fire side of the plate, the holding power of the tube in the plate is something great, because it does not depend on the bead and friction tension of the tube in the hole entirely, but partly on the tube pulling against the taper. An occasional use of the roller expander will maintain this slight taper. At the same time the roller expander tends to draw the tube toward the firebox, thus maintaining the sharp shoulder tight against the tube plate. When beading the tubes, the shoulder on the water side will be drawn up tight much the same as when the head of a rivet is drawn up to the plate on driving.

### Resetting Tubes

On removing a set of tubes from a boiler having these new tubes, the tube sheet is in good condition, ready to reapply a set with new points welded on. In applying the tubes all beads would be of uniform size because the tube would be jammed up against the shoulder on the point exactly setting itself in the proper position, whereas it now requires care and good judgment to set the slipping tube exactly in its proper position to allow the right and uniform bead to project beyond the fire side of the plate. Many tubes now leak because some beads are large and some small in the same installation.

The proof of the great saving and merit of this new system is being conclusively demonstrated as tests pro-

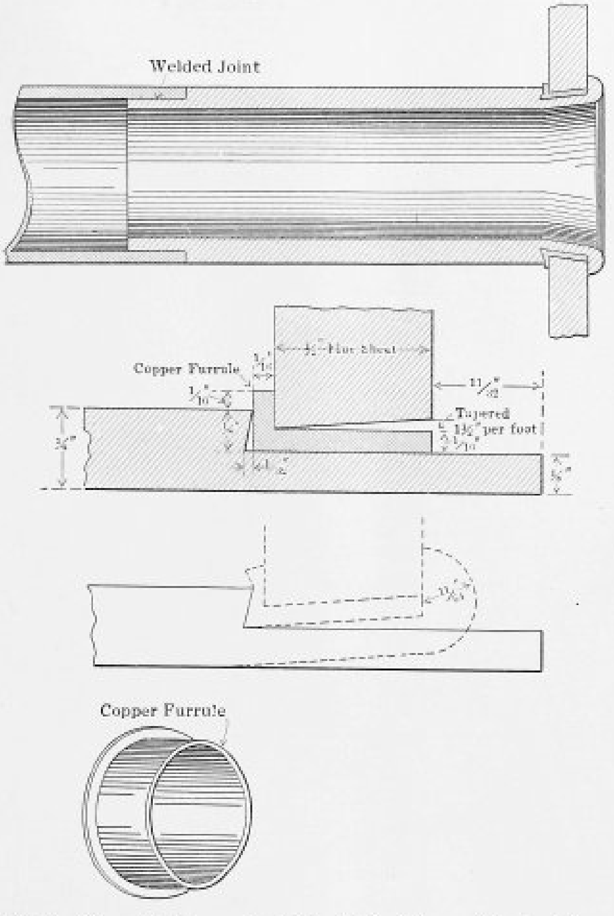



Fig. 2.—Sharp Shoulder on the Tube Makes it Impossible for Tube to Move in Sheet

gress, and the Southern Pacific Railroad is soon to try out the new device officially.

Engine No. 1117 of the Santa Fe railway was equipped with the new system in April and records have been kept of the coal consumed and mileage of this engine in comparison with several other engines on the same division not equipped with the system. Engine No. 1117 used four tons of coal per hundred miles less than No. 1147, which is not so equipped, thus showing the great saving. The Santa Fe has been testing this new flue since April 1, and it will be adopted as the standard method of setting flues if at the end of ten months the great saving in fuel continues.

### Flue Rests

This device is designed to entirely eliminate the vibration on a set of flues and not in the least interfere with the circulation of the water in the boiler and to be applied at a very small expense. The rests can be furnished at about a cent apiece, and two hours' extra labor will put them in the boiler, as a helper can get in the boiler and set them as the flues are put in place through the front end.

This will prove a valuable device for further stopping leaks in boiler tubes, as one of the causes of leaks comes from the vibration of the flues. This vibration is very great when a locomotive is running 30 or 40 miles an hour and working under heavy strain, with flues 20 feet long and 400 of them in a boiler. This vibration is one of the causes of flues becoming loose. The rests can be made out of very cheap material. The first row of rests can be made from one continuous piece of iron, and when set on the bottom of the boiler will always stay in place.

### Operating Records

In examining the following tables taken from the records of the Santa Fe, note how the coal consumption varies between the various engines during the different months. This is not because of extra tonnage, but because of leaky flues. All these engines take their maximum tonnage with the exception of No. 1117, which is equipped with the new flue. To test this engine thoroughly it has been hauling 200 tons excess over the regular capacity. The division foreman at San Marcial on the Santa Fe says that No. 1117 has continually run around other engines of the same type, but which have not been equipped with the new flues.

| Engine Number | Locomotive Miles | Tons of Coal | Tons of Coal per 100 Miles |
|---|---|---|---|
| 1117 | 4,124 | 267.25 | 6.48 |
| 1062 | 3,981 | 318. | 7.99 |
| 1147 | 4,166 | 334. | 8.04 |
| 1149 | 2,672 | 226.8 | 8.49 |
| 1131 | 2,069 | 299. | 9.74 |

Engine No. 1117 was laid off six days in July with a broken frame, due to overloading as previously stated; but, notwithstanding the lay-off, made 4,124 miles with a total coal consumption of 267.25 tons, or an average of 6.48 tons of coal per hundred miles, or a saving of 2.08 tons per hundred miles, which, with coal at $2.55 per ton, the price paid for coal on this division, made a saving for July of $218.

The total coal saving for the four-months' period of

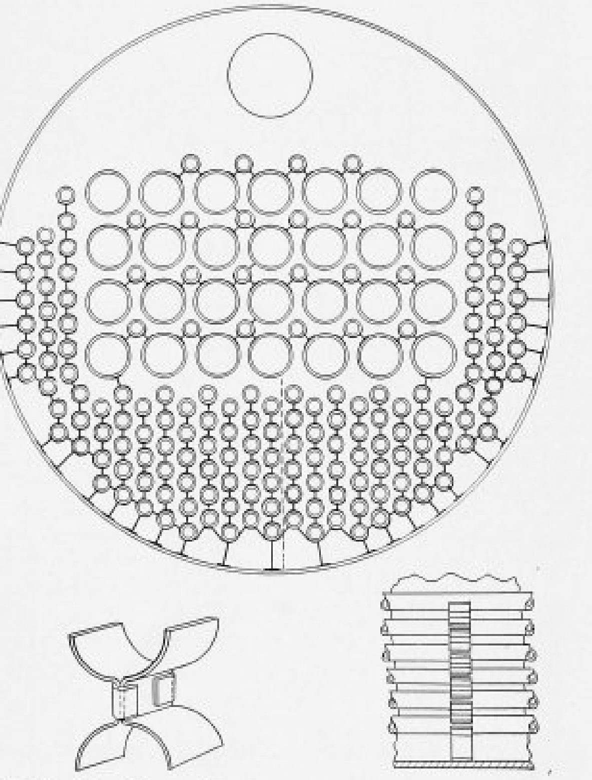


Fig. 3.—Rests Designed to Eliminate Vibration in Flue Ends

engine No. 1117, as against the average of the other engines shown in these tables, computed with coal at $2.55 a ton, is $1,109, or an average of $277 per month.

San Francisco, Cal. C. W. GEIGER.

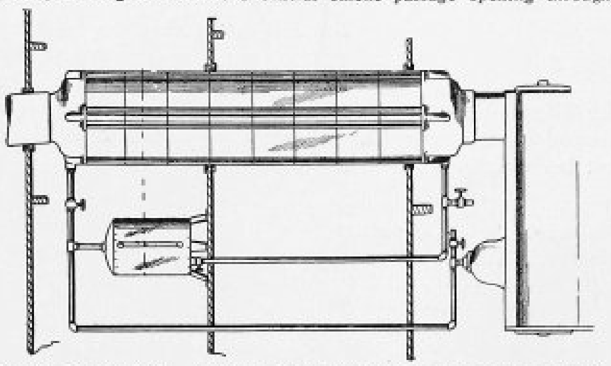
## Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,318,376. AUXILIARY STEAM GENERATOR. AI C. GORDON, OF GLENN FALLS, NEW YORK.

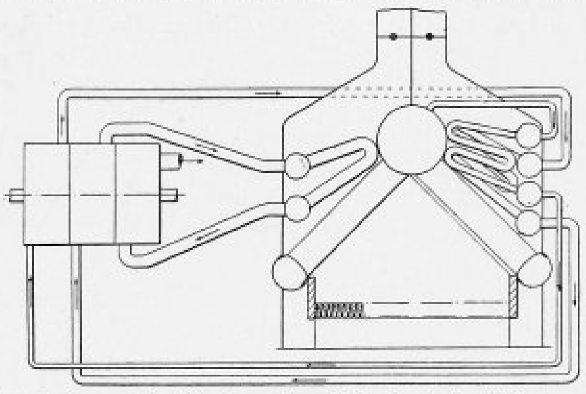
*Claim* 1.—An auxiliary steam generator including a body having a casing providing a continuous central smoke passage opening through



the ends of the body, a water jacket surrounding the casing and uniformly spaced therefrom, the body being formed of independent detachably connected sections and the space between the jacket wall and the wall of the casing upon each of the sections being uninterrupted, a water passageway formed on the walls of the jackets and open to the jackets, said passageway being enlarged to project outwardly from the jacket walls and establishing communication between the jackets of the sections, and an inlet and outlet for said jackets. Two claims.

1,319,699. STEAM SUPERHEATING. SEBASTIAN ZIANI DE FERRANTI, OF BASLOW, ENGLAND.

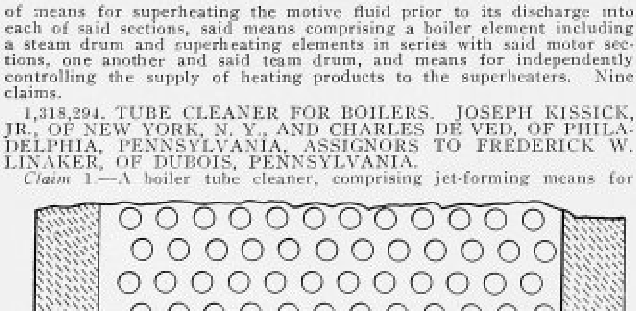
*Claim* 1.—The combination with a motor element including a plurality of sections wherein the motive fluid undergoes progressive expansion,



of means for superheating the motive fluid prior to its discharge into each of said sections, said means comprising a boiler element including a steam drum and superheating elements in series with said motor sections, one another and said team drum, and means for independently controlling the supply of heating products to the superheaters. Nine claims.

1,318,294. TUBE CLEANER FOR BOILERS. JOSEPH KISSICK, JR., OF NEW YORK, N. Y., AND CHARLES DE VED, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNORS TO FREDERICK W. LINAKER, OF DUBOIS, PENNSYLVANIA.

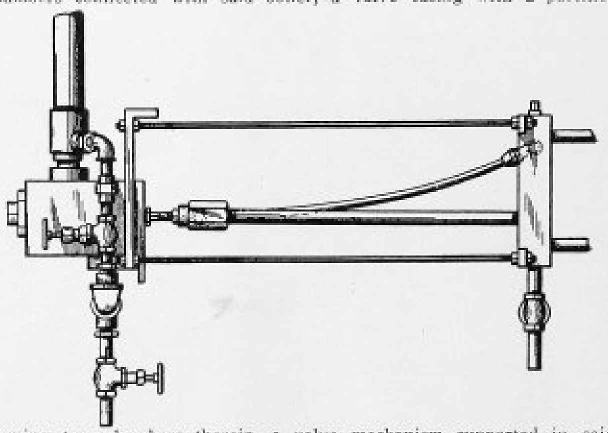
*Claim* 1.—A boiler tube cleaner, comprising jet-forming means for



directing a rotatable jet of steam toward a diagonal interval between rows of boiler tubes, and means for deflecting the jet to retain it in the diagonal interval between the rows of tubes, said deflecting means comprising a concaved curved surface. Seven claims.

1,318,642. AUTOMATIC WATER-FEED CONTROL FOR BOILERS. WILLIAM C. BLUNDELL AND OLIVER W. SMITH, OF LOS ANGELES, CALIFORNIA.

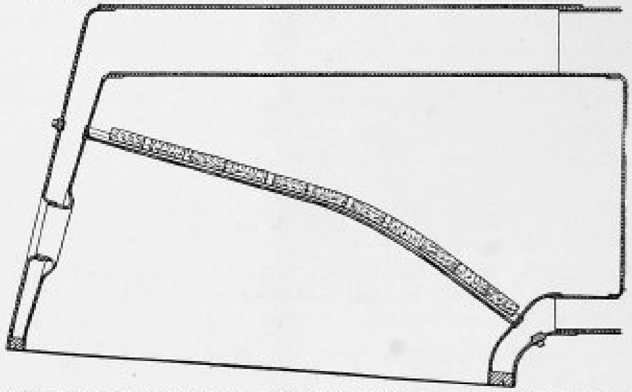
*Claim* 1.—In a device of the character shown and described comprising in combination with a boiler, a casing having upper and lower chambers connected with said boiler, a valve casing with a partition



forming two chambers therein, a valve mechanism supported in said partition and controlling communication between the chambers of said valve casing, an expansion tube connected at one end with the lower chamber of said first mentioned casing and at its other end connected within said valve casing for moving said valve mechanism to open communication between the two chambers in said valve casing, and a flexible tube connecting the upper chamber of said first mentioned casing with the end of said expansion tube adjacent said valve casing. Two claims.

1,317,810. LOCOMOTIVE FIRE-BOX. WILLIAM W. NEALE, OF RELAY, MARYLAND, ASSIGNOR TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

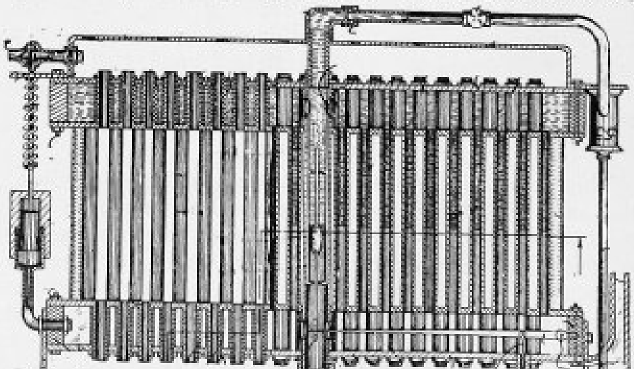
*Claim* 1.—In a locomotive fire box having water walls and circulation



tubes connecting said walls, an arch comprising a plurality of rows of arch bricks carried on said tubes and arranged in courses, and spacer blocks carried on said tubes between courses and adapted to space the courses apart so as to leave gas passages therebetween. Eight claims.

1,317,388. STEAM-GENERATOR. JAMES H. PETERSON, OF PRICE, UTAH, ASSIGNOR TO THE PETERSON-CULP GEARLESS STEAM AUTO COMPANY, OF DENVER, COLORADO, A CORPORATION OF COLORADO.

*Claim* 1.—A steam generator comprising a lower chamber constituting a water jacket and an upper chamber constituting a steam chest,



open ended water tubes connecting the water jacket with the steam chest, one of said tubes being substantially centrally located, fire tubes extending through the water jacket and fire tubes extending through the steam chest, a water supply, means to maintain a constant water level at an intermediate point in said water tubes, an operative part of said level controlling means being mounted in said steam chest, and having a portion depending into said centrally located tubes. Three claims.

THE BOILER MAKER

FEBRUARY, 1920

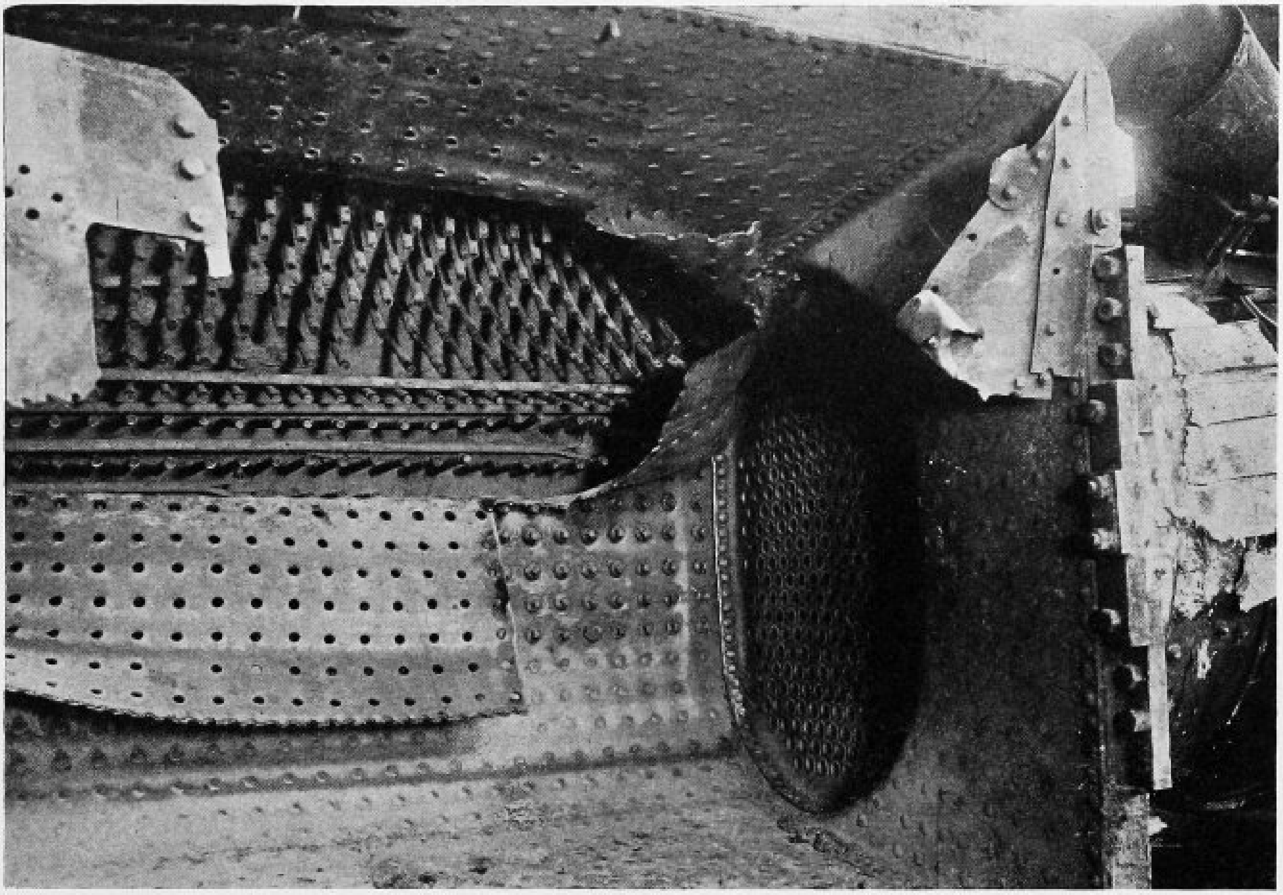


Fig. 1.—Results of Explosion Caused by Low Water, in Which the Welded Seam Between the Crown and Side Sheets Gave Way

# Locomotive Disasters of 1919

### Low Water in Boilers Combined with Autogenously Welded Fireboxes Causes Increase in Fatal Accidents

The eighth annual report of the chief inspector of the Bureau of Locomotive Inspection contains information that is of vital interest to the boiler-making industry, particularly to those shops which have adopted the practice of welding firebox seams. The accidents mentioned in the report would no doubt have occurred in any case, but in many instances where the welds let go, the disastrous effects of the explosions were greatly increased.

Comparisons of the accidents for the current year with those of past years have been incorporated in the report wherever possible. In 1919 the existing locomotive boiler inspection laws were amended so as to include the entire locomotive tender and appurtenances.

The report brings out the fact that the percentage of accidents from boiler explosions has gradually grown less since 1912, although between 1908 and 1919 the fatality from this cause increased 25 percent. The report states that all accidents and casualties, caused by the failure of the locomotive boiler and its appurtenances only, for the fiscal year ended June 30, 1912, which was the first year of the existence of the law, compared with a summary of all accidents and personal injuries which occurred during the fiscal year ended June 30, 1919, show the substantial decrease in the number of accidents, due to such failures, of 60.2 percent; a decrease in the number of persons killed of 50.5 percent and a decrease in the number injured of 58.9 percent.

The increase in the number of persons killed during the last year over the year previous is, to a considerable extent, due to some very violent explosions which occurred because of firebox crown sheet failures, which failures serve to illustrate the prime importance of proper firebox construction, inspection and repair, together with the location, inspection and maintenance of such appliances as

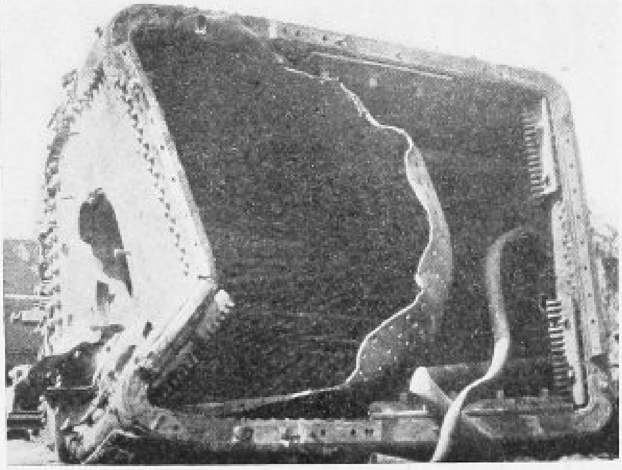


Fig. 2.—Firebox Interior Showing the General Condition After a Low Water Explosion

water glasses, gage cocks, injectors, steam gages and safety valves, upon which, to a very great extent, rest the safety of locomotive boiler operation.

While some of these explosions were primarily caused by low water, it is believed that their violence and consequent results were greatly increased by the failure of crown sheet seams which had been welded by the autogenous process. The failure of such seams, which have come into extensive use during the past few years, in most cases evidently caused the initial rupture and, in some cases, occurred with slight overheating.

Investigations of these accidents indicated that the failure of the welds occurred with a higher level of water in the boiler, and consequently a lower temperature in the sheet, than in others where crown sheets failed and did not tear.

It will be recognized that the force of a boiler explosion depends upon the extent and suddenness of the initial rupture, together with the volume and temperature of the water in the boiler at the time of the explosion.

It is true that not all autogenously welded firebox seams fail at the time of a boiler explosion, but, inasmuch as our records show that 80 percent of all such welds involved have failed under such conditions, it is believed that, until some way has been discovered through which the quality and tenacity of a weld so made may be established in advance of its failure, firebox crown sheet seams so constructed should be avoided, where overheating and failure are liable to occur, and that autogenous welding should not be used where the strength of the structure is dependent upon the weld, nor where the strain, to which the structure is subjected, is not carried by other construction; nor in any part of a locomotive boiler wholly in tension while under working conditions.

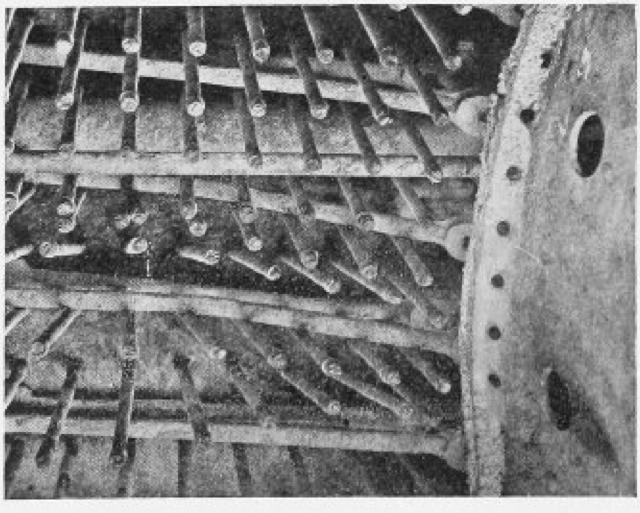


Fig. 3.—Back Head was Stripped Away From Staybolts in the Overheated Area

### BOILER EXPLOSION CASUALTIES

It is interesting to note that during the fiscal year ended June 30, 1912, there were 97 boiler explosions from all causes, resulting in the death of 81 persons and the serious injury of 209 others, while during the last year there were 67 explosions, resulting in the death of 39 persons and the serious injury of 112 others. These reductions amount to 30.9 percent in the number of explosions, 51.8 percent in the number killed, and 46.4 percent in the number injured.

Attention is also directed to the fact that, since the inception of this bureau, 516 boiler explosions have occurred, resulting in the death of 277 persons and the serious injury of 889 others.

Five of these explosions, resulting in the death of 29 persons and serious injury of 50 others, were due to failure of shell sheets, caused by overpressure or defective sheets, which could have been detected and their failure avoided by proper inspection and repairs; 289, causing the death of 156 persons and serious injury of 486 others, were due to failure of crown sheets, caused by low water, and where no contributory defects were found; 195, resulting in the death of 83 persons and the serious injury of 317 others, were due to failure of crown sheets caused by low water and where contributory defects, constituting violation of the law or rules, such as defective water glasses, gage cocks, injectors, broken stays or crown bolts, etc., were found; 22, causing the death of 4 persons and the serious injury of 31 others, were caused by failure of firebox sheets, due to defective or broken staybolts or crown stays; 5, causing the death of 5 persons and the serious injury of 5 others, were due to foaming of the water in the boiler, allowing the firebox sheets to become overheated.

The above data illustrate the vital importance of proper construction, inspection and repair of all parts and appurtenances of the boiler, especially the firebox and water-indicating and feeding devices. In addition to these, such items as steam gages, safety valves, fusible plugs, stays, braces, proper feed water and boiler washing are among the most important items in the prevention of boiler explosions.

The following table indicates the number of accidents and the number of persons killed and injured due to the failure of some part of the locomotive boiler:

| | 1919 | 1918 | 1913 | 1912 |
|---|---|---|---|---|
| Number of accidents | 341 | 398 | 820 | 856 |
| Decrease 1919 from 1918 ... Percent | 14.3 | | | |
| Decrease 1919 from 1912 ... Percent | 60.2 | | | |
| Number killed | 45 | 36 | 36 | 91 |
| Increase 1919 over 1918 ... Percent | 25 | | | |
| Decrease 1919 from 1912 ... Percent | 50.5 | | | |
| Number injured | 413 | 510 | 911 | 1,005 |
| Decrease 1919 from 1918 ... Percent | 19 | | | |
| Decrease 1919 from 1912 ... Percent | 58.9 | | | |

### MAINTENANCE OF APPURTENANCES

Investigations showed that in 19 of the explosions which occurred during the last year, due to low water, defective glasses and connections contributed to the cause of such failures, which fact clearly demonstrates again the importance of properly locating and maintaining such parts.

A review of the data contained in the report discloses other items which, as indicated by the number of accidents occurring because of failure thereof, are not receiving the attention which they deserve. For example, our records show that during the past eight years the failure of squirt hose and their connections caused 976 accidents, resulting in the death of one person and the serious injury of 984 others; the failure of 362 flues caused the death of three persons and the serious injury of 425 others; the failure of 511 water glasses or their connections caused the death of one person and the serious injury of 515 others; the failure of 148 grate-shaking appliances resulted in the death of one person and the serious injury of 147 others.

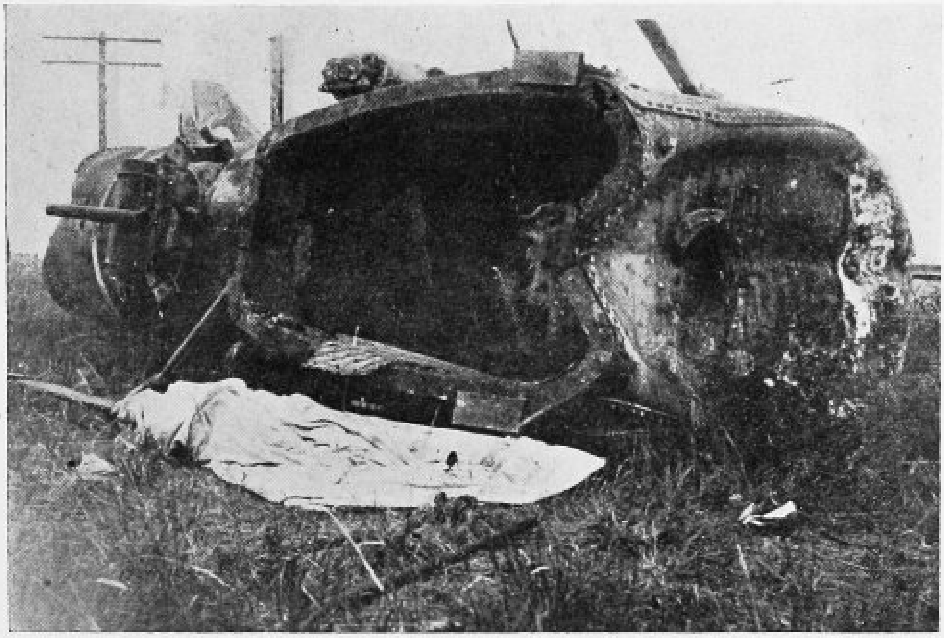


Fig. 4.—Another Low Water Explosion in Which Two Persons Were Killed

### Difficulties of Inspection

It should be borne in mind that there are in service approximately 69,000 locomotives, employed on more than 250,000 miles of railroads, which come under the jurisdiction of the law and rules. The law provides for only 50 Federal inspectors, whose duties are to see that the provisions of the law and rules are properly complied with; therefore, it is a physical impossibility for these 50 inspectors to inspect at regular intervals and be familiar with the conditions of any large percentage of these locomotives.

The law places the responsibility for general design, construction and maintenance of all locomotives and tenders upon the carrier owning or operating them. It appears, however, that many officials and employees of the carriers, who are responsible for the inspection and repair of locomotives, have tried to evade this responsibility and have apparently endeavored to transfer it to the Federal inspectors by allowing locomotives to remain in service with serious violations of the law and rules known to them, until our inspectors found them and caused the locomotives to be removed from service for needed repairs.

The data shown in this report should impress the necessity of proper performance of duties upon those who are required to inspect and report defects on locomotives, as well as upon those who are responsible for the proper repair of such defects.

If the various parts and appurtenances, which are shown in this report to have caused accidents by their failure, had been inspected and maintained as required by the law and rules, nearly all of such accidents would have been avoided. In the above paragraphs it was not thought necessary to comment upon the measures, which, if carried out, would eliminate such failures. In fact, the great majority of accidents which occur could be prevented by means which are known to every well-qualified mechanical official and employee in charge of such inspection and repairs.

The number of accidents due to the failure of the different parts and appurtenances have in most cases systematically declined since the first year of the law.

### Recommendations of Department

All locomotives not equipped with mechanical stokers or those using fuel oil should have a mechanically oper-

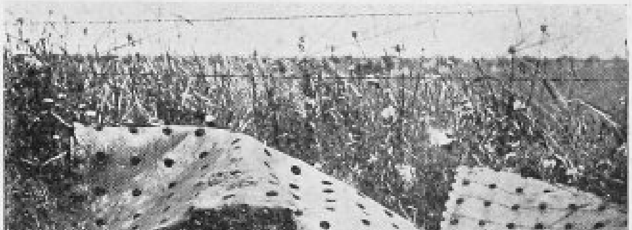


Fig. 5.—Five Rivets at Left End of Crown Sheet Held While Welded Portion Failed

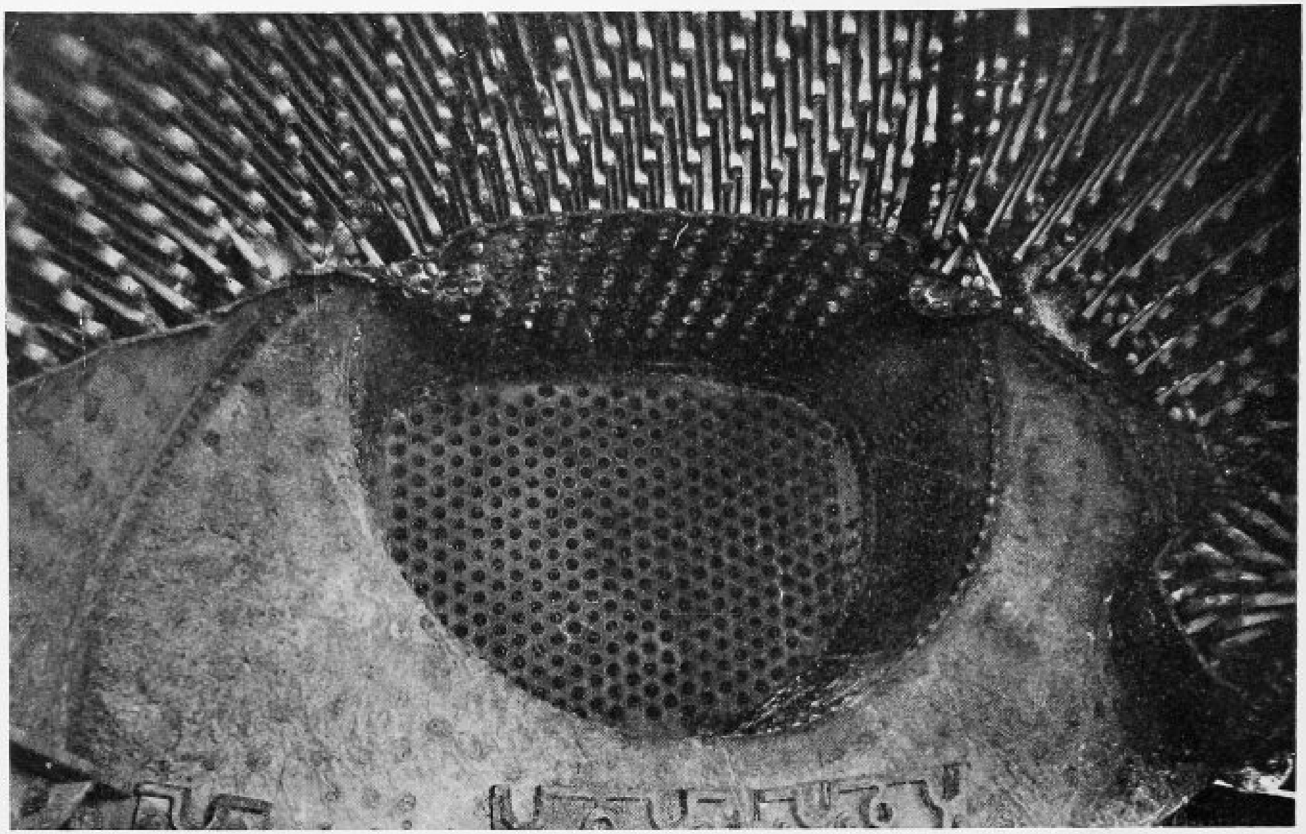


Fig. 6.—Welded Seam in Crown Sheet Failed in This Explosion While Riveted Seam at Tube Sheet Remained Intact

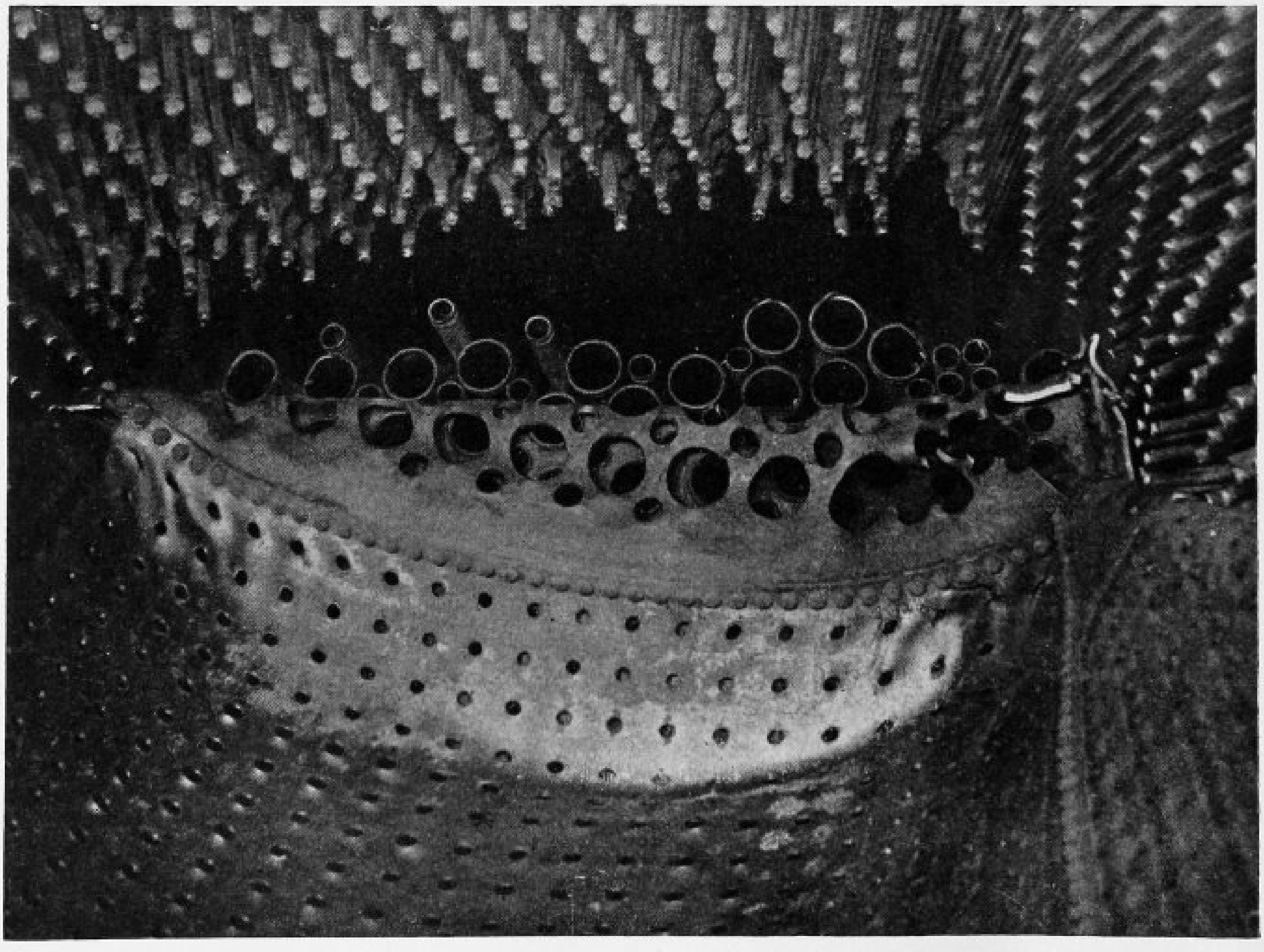


Fig. 7.—Combustion Chamber Firebox With Three-Piece Crown, and Side Sheets Which Failed With Serious Results

ated fire door, so constructed that it may be operated by pressure of the foot on a pedal, or other suitable device, located on the floor of the cab or tender at a proper distance from the fire door, so that it may be conveniently operated by the person firing the locomotive.

This recommendation is based on the results of many investigations of boiler failures of such character as to permit the steam and water contained in the boiler at the time of the accident to be discharged into the firebox, many times directed toward the firebox door.

The old swing type door, which is largely used at present, is almost invariably blown open, in case of such accidents, and permits the discharging steam and boiling water, with the contents of the firebox, to be blown into the cab of the locomotive, seriously and most frequently scalding and burning the persons therein. Such accidents frequently occur while coal is being put into the firebox and with the fire door necessarily open, and, under such circumstances, it is impossible for it to be closed.

The automatic fire door would remain closed, if closed when the failure occurs. If open, it would automatically close the moment the operator's foot was removed from the operating device, thus preventing the direct discharge of the scalding water and fire into the cab of the locomotive with such serious results.

The automatic fire door is not a new and untried device, as there are thousands of them in service, and they are required by law in some States. Their use has proven of great value in preventing serious and fatal injuries where boiler failures of this nature have occurred.

A power grate-shaker should be applied to all coal-burning locomotives. This appliance has been in use for a number of years and tried out very thoroughly, and has been adopted as standard on all road locomotives constructed under the orders of the United States Railroad Administration.

Our records indicate that since September 4, 1915, 148 accidents, resulting in the death of one person and the serious injury of 147 others, have occurred, due to the failure of some part of the grate-shaking apparatus. These casualties could have been entirely eliminated had there been in use a power grate-shaking device such as that referred to above.

This appliance would not only prove of great value in the conservation of life and limb, but would be of great value in the conservation of fuel used on locomotives by enabling the firemen to keep the fire in proper condition at all times.

### Typical Boiler Explosions

The report includes detailed descriptions of some of the worst boiler explosions that have come to the attention of the department. One outstanding cause of these accidents is low water, and Figs. 2 and 3 show the effect on one boiler which blew up, killing three people.

The water, at the time of the accident, was approximately 5 inches below the highest point of the crown sheet. The locomotive was double-heading a freight train, moving at an approximate speed of 30 miles per hour, when the explosion occurred with such terrific force that the boiler was thrown 165 feet ahead, rebounded and landed about 230 feet from point of accident.

The firebox was a semi-wide, radial-stayed type, applied new about two months previous to the accident, with crown sheet supported by button-head radial stays throughout, spaced 4 by 4 inches. The side and crown sheets were of one-piece construction, with the door and flue sheet seams autogenously welded, without any riveting, the only riveted seams in the firebox being the mud ring.

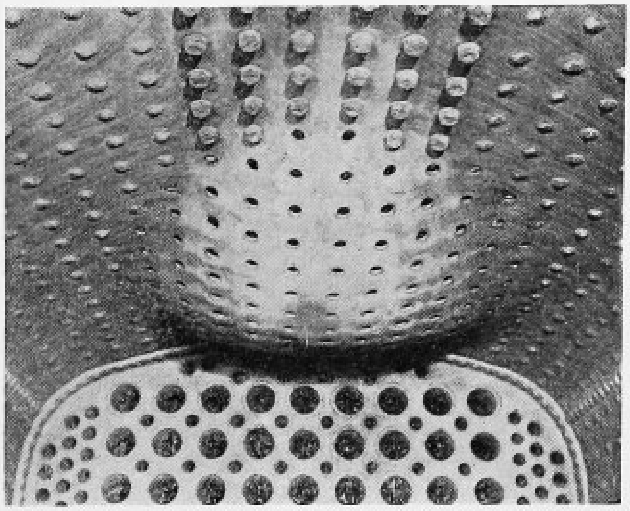


Fig. 8.—Bagged Crown Sheet in Combustion Chamber, Where 130 Radial Stays Pulled Out of Sheet

The front end of the crown sheet, being 3 inches higher than back end, would of necessity have been unprotected by water from the intense heat for a longer time, and therefore should have been the hottest and consequently the weakest, which was not the case, as the crown sheet seam failed.

The appurtenances were so badly damaged by wreckage that their conditions, previous to the accident, could not be determined by investigation.

The investigation of this accident was made by two government inspectors and participated in by an assistant chief inspector. All these men were of the opinion that the force of the explosion was greatly intensified, due to the failure of the autogenously welded seam.

Another boiler failure due to low water occurred in the case of a locomotive engaged in hauling a passenger train at an estimated speed of 25 miles per hour at the time of accident. General repairs had been made to this locomotive and a new set of radial stays applied about six months previous to the accident, when the longitudinal seams between the crown and side sheets had been converted from riveted to autogenously welded seams by cutting through the centerline of rivet holes and the sheets made flush,

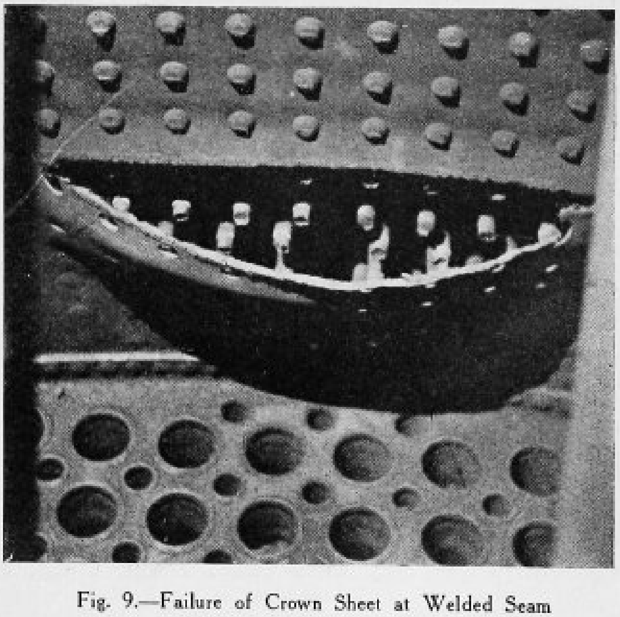


Fig. 9.—Failure of Crown Sheet at Welded Seam

which were then welded by the oxy-acetylene process, with the exception of 5 inches at each end.

These seams failed their entire length, with the exception of the riveted portion, and the crown sheet, Figs. 4 and 5, was blown entirely out of the firebox.

It is believed that, due to the weakness of these seams, the force of the explosion, with its consequent results, was greatly increased.

Fig. 6 indicates the after effects of an explosion in which two persons were killed and three others seriously injured. The low-water mark at the time of the explosion was 5 inches below the highest point of the crown sheet.

The boiler was thrown 100 feet ahead and landed in reversed position. This was a Wooten type, combustion-chamber firebox, without a brick arch. The crown and side sheets of the firebox proper were of one-piece construction, with combustion chamber crown sheet seam autogenously welded, and crown sheet was supported by button-head radial stays throughout.

The initial rupture occurred at the transverse autogenously welded seam, 38 inches back from the flue sheet. The crown sheet of the firebox proper was blown down, taking with it a portion of both side sheets, which tore diagonally downward from each end of transverse-welded seam. The crown sheet of the combustion chamber, it will be noted, remained intact. The calking edge of top flue sheet seam, which was 2 inches higher than back end of crown sheet, was not sprung on either the water or fire sides.

While being transferred under its own steam from the builders to the operating road, the locomotive boiler, Fig. 7, failed from low water. In this case the line of demarkation was 10 inches below the highest point of the crown sheet. The combustion chamber firebox with crown and side sheets was constructed of three pieces having riveted longitudinal crown and side sheet seams without a transverse longitudinal welded seam, which so often fails with serious results. The holes in the crown sheet had stretched as much as 1⅛ inches in many instances and the sheet pocketed between the stays to a depth of ¼ inch, indicating the extreme heat to which this sheet was subjected before failure occurred.

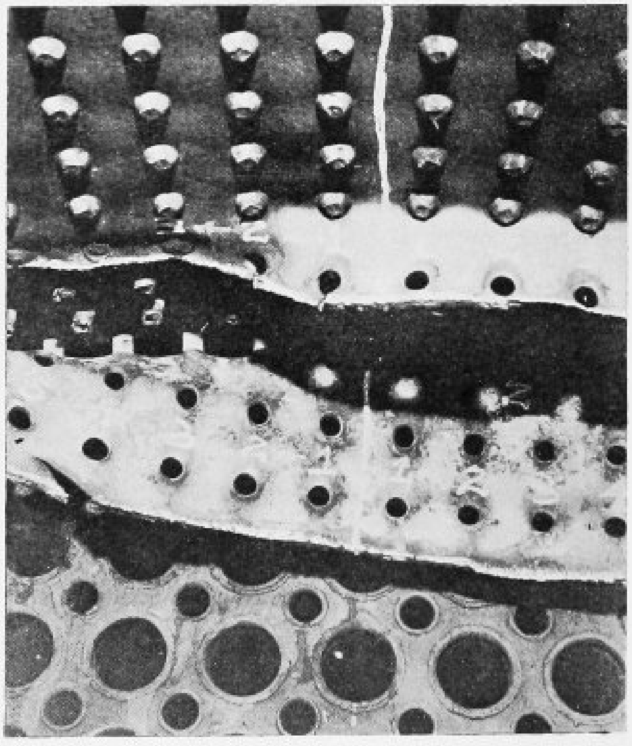


Fig. 10.—Typical Failure Along Transverse Welded Seam of Crown Sheet

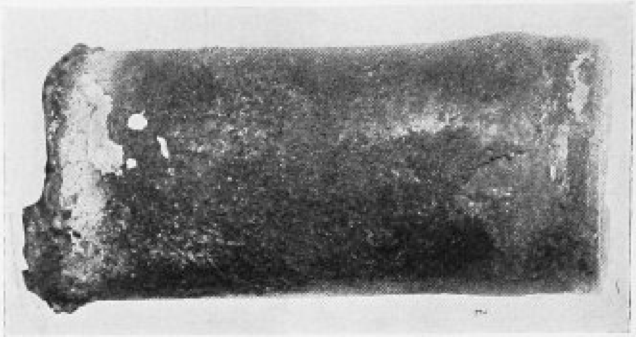


Fig. 11.—Section of Arch Tube Never Properly Expanded

Water glass gage cocks oftentimes are a strong contributory cause of crown sheet failure by becoming damaged or obstructed. As a result of obstructions, the water in the glass is not allowed to circulate, as is evidenced in the case of a locomotive employed in hauling a passenger train, which was within five miles of its initial terminal when the crown sheet pulled away from 130 radial stays, allowing the sheet to pocket to a depth of 9 inches. The line of water was 6 inches below the highest point of the crown sheet.

It was very evident on inspecting the boiler after the explosion that the water was below the crown sheet before the train left its terminal, and the engineer believed that the water in the boiler was sufficient.

DETAILS OF BOILER ACCIDENTS

| Part of appurtenance which caused accident. | Year ending June 30— 1919 | | | 1918 | | | 1917 | | | 1916 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Accidents. | Killed. | Injured. | Accidents. | Killed. | Injured. | Accidents. | Killed. | Injured. | Accidents. | Killed. | Injured. |
| Arch tubes | 7 | 2 | 9 | 9 | .... | 16 | 9 | .... | 15 | 5 | 1 | 7 |
| Ashpan blowers | 11 | 1 | 10 | 7 | .... | 7 | 7 | 1 | 6 | 4 | 1 | 4 |
| Blow-off cocks | 4 | .... | 4 | 17 | 1 | 18 | 22 | .... | 23 | 19 | .... | 20 |
| Boiler checks | 4 | .... | 4 | 13 | .... | 14 | 13 | .... | 13 | 8 | .... | 9 |
| Boiler explosions: | | | | | | | | | | | | |
| A. Shell explosions | .... | .... | .... | .... | .... | .... | 1 | 2 | 8 | .... | .... | .... |
| B. Crown sheet; low water; no contributory causes found | 31 | 26 | 46 | 34 | 15 | 61 | 38 | 30 | 66 | 23 | 7 | 38 |
| C. Crown sheet; low water; contributory causes or defects found | 34 | 13 | 63 | 51 | 17 | 82 | 23 | 15 | 32 | 16 | 13 | 21 |
| D. Firebox; defective staybolts, crown stays, or sheets | 2 | .... | 3 | 5 | .... | 6 | 2 | .... | 2 | 1 | .... | 3 |
| E. Firebox; water foaming | .... | .... | .... | .... | .... | .... | .... | .... | .... | 1 | .... | 2 |
| Dome caps | .... | .... | .... | 1 | .... | 1 | .... | .... | .... | 1 | 1 | .... |
| Draft appliances | 2 | .... | 4 | 5 | .... | 5 | 2 | .... | 3 | 1 | .... | 2 |
| Fire doors, levers, etc | 7 | .... | 7 | 6 | .... | 6 | 5 | .... | 5 | 2 | .... | 2 |
| Flues | 33 | 1 | 39 | 40 | .... | 47 | 50 | .... | 60 | 37 | .... | 46 |
| Flue pockets | 2 | .... | 2 | 2 | .... | 2 | 2 | .... | 2 | 1 | .... | 2 |
| Gage cocks | .... | .... | .... | 1 | .... | 1 | .... | .... | .... | 1 | .... | 1 |
| Grate shakers | 37 | 1 | 36 | 39 | .... | 39 | 51 | .... | 51 | 23 | .... | 23 |
| Handholds | 16 | 1 | 15 | 15 | 1 | 14 | 15 | .... | 15 | 4 | 1 | 3 |
| Injectors and connections (not including injector steam pipes) | 21 | .... | 22 | 23 | .... | 24 | 18 | .... | 19 | 27 | .... | 28 |
| Injector steam pipes | 14 | .... | 20 | 16 | .... | 18 | 16 | 1 | 18 | 11 | .... | 14 |
| Lubricators and connections | 11 | .... | 13 | 12 | .... | 12 | 11 | 1 | 12 | 13 | .... | 13 |
| Lubricator glasses | 9 | .... | 9 | 12 | .... | 12 | 13 | .... | 13 | 11 | .... | 11 |
| Patch bolts | .... | .... | .... | 2 | .... | 3 | 1 | .... | 1 | 2 | .... | 3 |
| Plugs, arch tube and washout | 30 | 1 | 34 | 14 | 2 | 19 | 8 | .... | 12 | 17 | 2 | 22 |
| Plugs in firebox sheets | 2 | 1 | 1 | 3 | .... | 3 | 1 | .... | 1 | 3 | .... | 3 |
| Rivets | 2 | .... | 2 | 3 | .... | 3 | 4 | .... | 4 | 4 | .... | 4 |
| Safety valves | 1 | .... | 1 | .... | .... | .... | 1 | .... | 1 | 1 | .... | 1 |
| Staybolts | 2 | .... | 2 | 6 | .... | 8 | 3 | .... | 5 | 1 | .... | 1 |
| Steam piping and blowers | 8 | .... | 11 | 10 | .... | 11 | 9 | 1 | 13 | 16 | .... | 22 |
| Steam valves | 9 | .... | 10 | 7 | .... | 17 | 6 | 1 | 5 | 10 | 1 | 13 |
| Superheater tubes | 1 | .... | 1 | 3 | .... | 4 | .... | .... | .... | 3 | .... | 4 |
| Water glasses | 26 | .... | 26 | 20 | .... | 20 | 36 | .... | 37 | 29 | .... | 29 |
| Water glass fittings | 4 | .... | 4 | 11 | 1 | 10 | 7 | .... | 7 | 7 | .... | 7 |

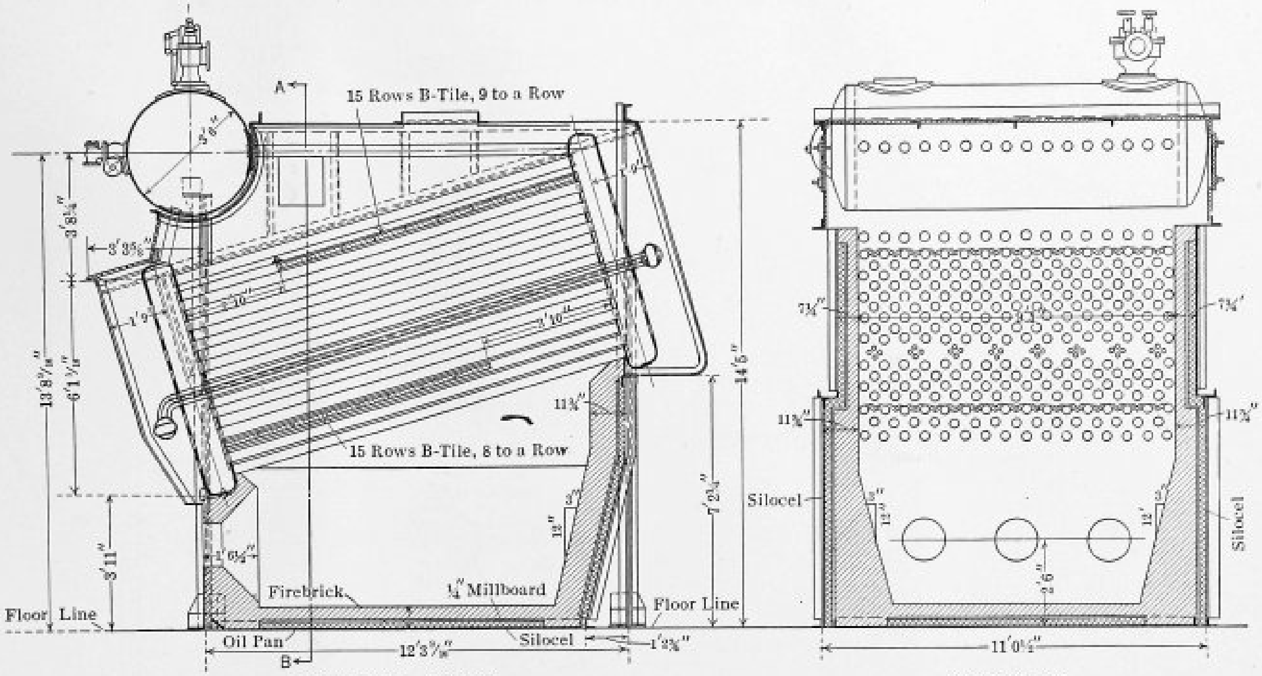



Fig. 5.—Arrangement of Setting for Heine Safety Boiler Built for the Emergency Fleet Corporation. This Boiler Has a Heating Surface of 3,170 Square Feet

# Boilers of the New Emergency Fleet*

### Watertube Boilers Prove More Serviceable Than Scotch Type in Marine Installations — Comparative Upkeep and Repair Costs

BY JOS. J. NELIS†

The Heine boiler, Fig. 5, is also of the cross-drum, straight-tube type and is a modified form of their land boiler. The tubes are longer than is customary in marine work, which results in a long, narrow furnace not suitable for coal firing. This narrow furnace, when oil fired, results in considerable furnace brickwork repairs. This boiler, owing to the restricted furnace width, is, however, well adapted to stoker firing. An arrangement of stokers, as shown in Fig. 6, was prepared by the Emergency Fleet for these boilers, but after the armistice, owing to the lower price of oil fuel, nearly all ships were arranged for oil-burning and these stokers were not installed.

Watertube boilers are the only marine type that can be adopted for stoker firing. When the price of coal reaches a point at which it will again be used extensively in marine practice it is evident that stokers of this type or a similar design will be used, as these boilers can then be operated at the same capacity and economy now attained with oil fuel, which is not possible when hand fired by the character of labor available for marine firing.

#### Badenhausen Boilers

The Badenhausen boiler, Fig. 7, is a distinct departure from the conventional marine watertube boiler, as it uses a large curved tube design with practically no modifications from the land boiler of this type, except the small upper steam drum and steel casing. Boilers of the curved tube type have given very satisfactory operation in land plants and have been used extensively in naval practice, but with tubes of smaller diameters.

#### Yarrow Express Type Boiler

The Yarrow boiler, Fig. 9, is the well-known express type as used in naval work. The Emergency Fleet ships being fitted with this boiler were originally intended for transports, and will now be used for passenger ships. These boilers are admirably suited for high-powered vessels of this type. No Yarow boilers are being fitted in slow-speed, low-powered cargo boats.

#### Ward Boilers

The Ward boiler, Fig. 10, is also of the cross-drum, horizontal, straight-tube type. Its essential features are the position and location of the horizontal baffles and the method of manufacturing the headers, which gives the circulation of the sectional header boiler without the use of staybolts. It will be noted that this boiler is fitted with an exceptionally large steam drum, but as the headers are small the amount of water contained in the boiler is not greater than is usually found in boilers of this type.

#### The Colvin Boiler

The Colvin boiler, Fig. 11, is of the curved-tube, three-drum type, somewhat similar to the express type of boiler, and is fitted with 1½-inch tubes. The essential difference of this boiler from standard designs is the arrangement of baffling with the addition of a steam soot blower. This soot blower enables the operator to keep the tube surfaces clean. Soot blowers are now standard on practically all

* The first installment of this article was published in the January, 1920, issue of The Boiler Maker.

† Manager marine department, Power Specialty Company, New York, and formerly senior marine engineer, boiler unit, engineering section, United States Shipping Board, Emergency Fleet Corporation.

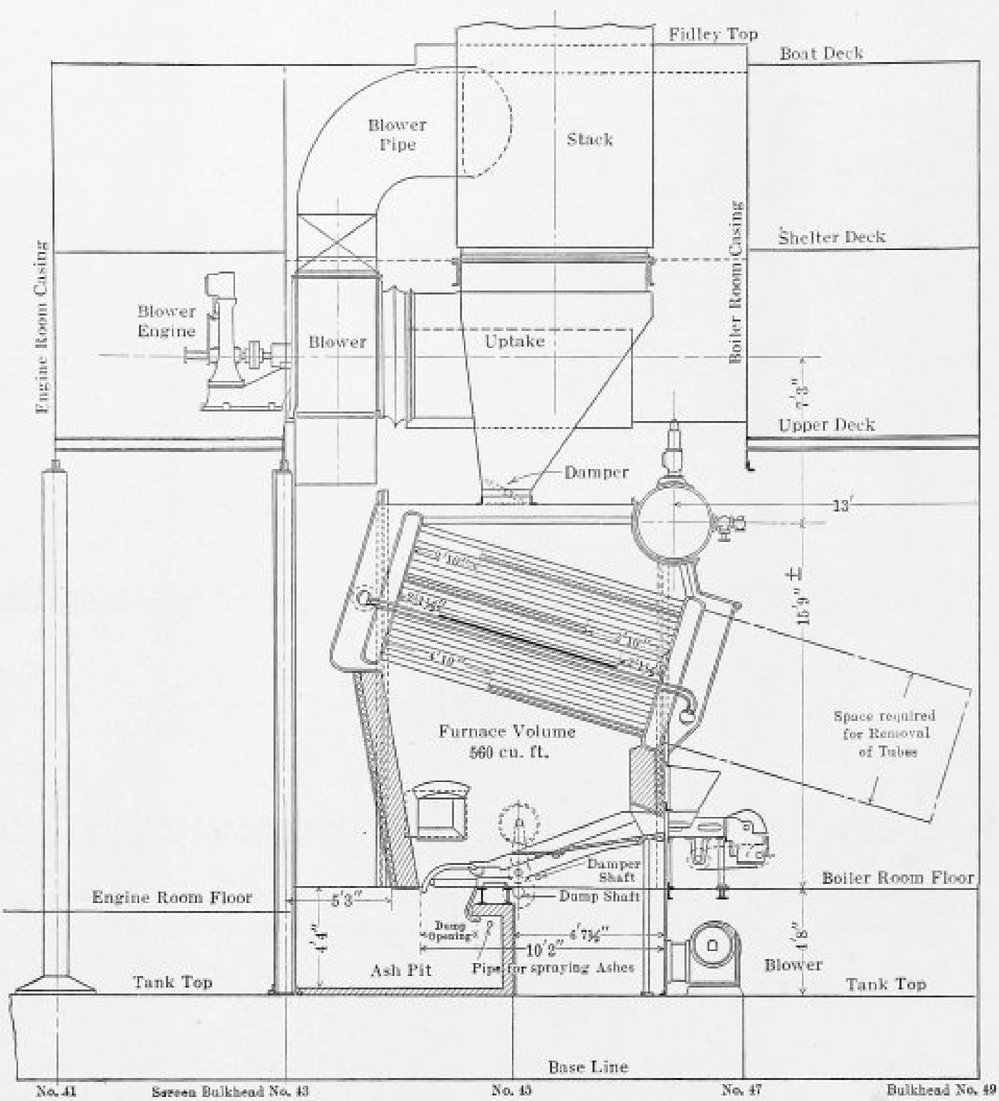



Fig. 6.—Arrangement of Riley Stokers Under Heine Marine Boilers as Contracted for by the United States Shipping Board Emergency Fleet Corporation

land boilers, and it is expected that they will be used on all marine boilers in the near future.

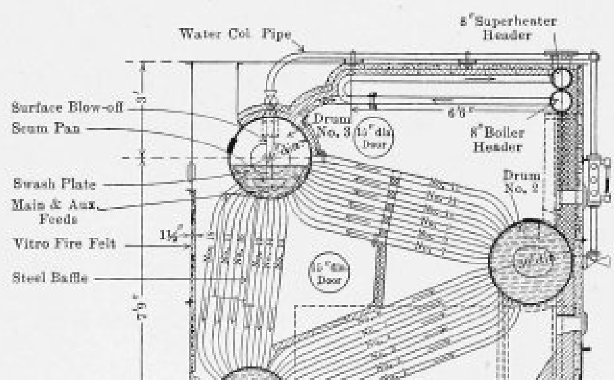



Fig. 7.—Badenhausen Setting, Elevation

### The Scott Boiler

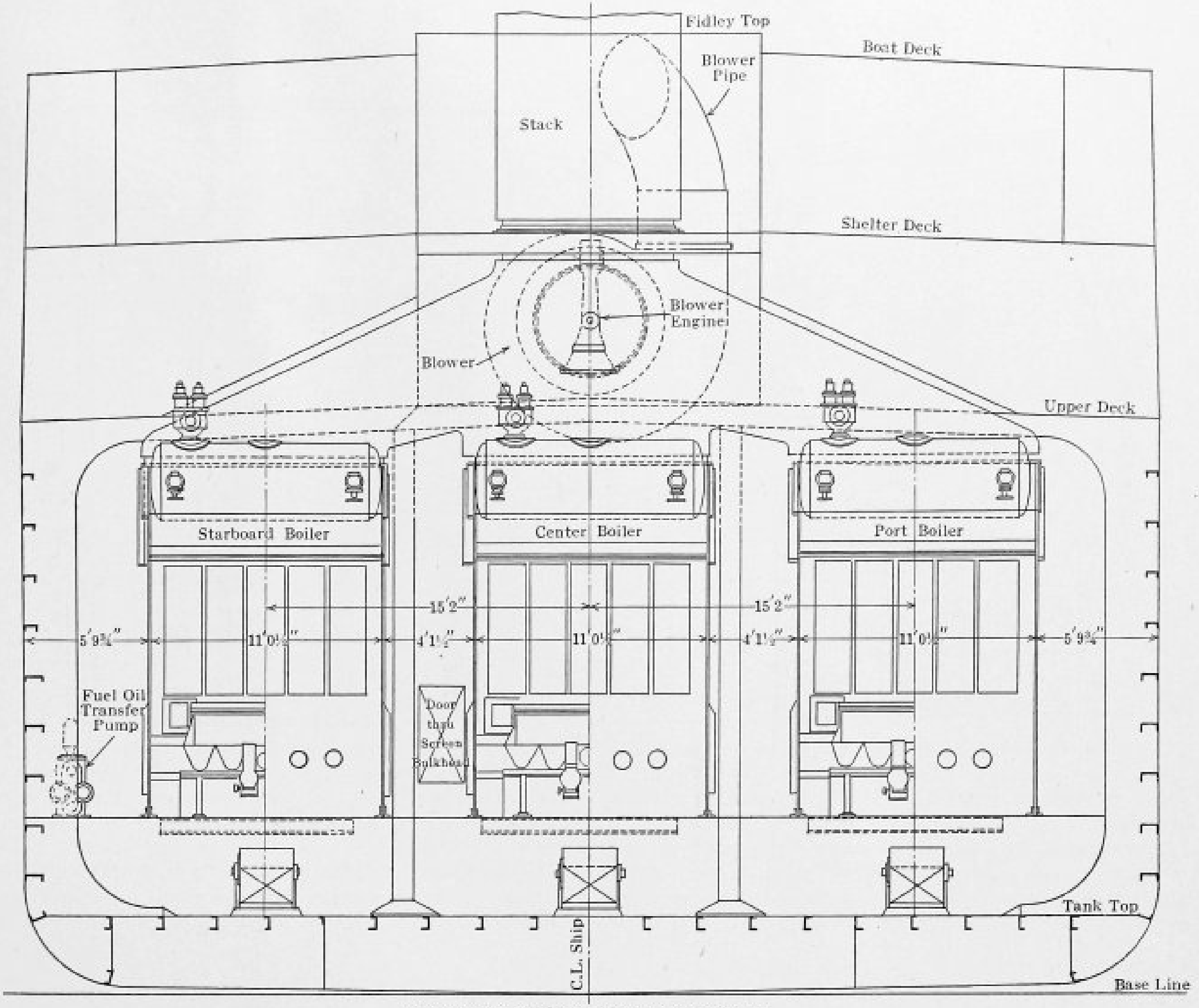
The Scott boiler, Fig. 12, is also of the curved-tube, three-drum type. This boiler has little, if any, baffling and depends practically on the tube spacing for its economy. Its casing insulation has not proved sufficient for merchant marine service.

### The Wickes Boiler

The Wickes boiler, Fig. 13, is of the cross-drum, horizontal, straight-tube type, with a combination of horizontal and vertical baffles similar to other well-known boilers. Its essential feature is the method of manufacturing the headers, which can be completely machine riveted and have no joints in the fire. This boiler was used on small steel lake vessels exclusively.

### Watertube Boilers of Radical Design

The Ballin boiler, Fig. 14, is a radical departure in design from previous successful watertube boilers. It was used on wood and composite types of ships. Its essential features are the long, narow furnaces and the small amount of grate surface for the heating surface installed. The furnace gases do not cover all of the heating surface, resulting in high stack temperatures. This boiler also has a very restricted water circulation. It has not proved satisfactory in service and is being replaced in




SECTION AT BULKHEAD No. 49 LOOKING AFT

Fig. 8.—Section Through Boiler Room of Vessel Equipped with Riley Stokers Under Heine Boilers

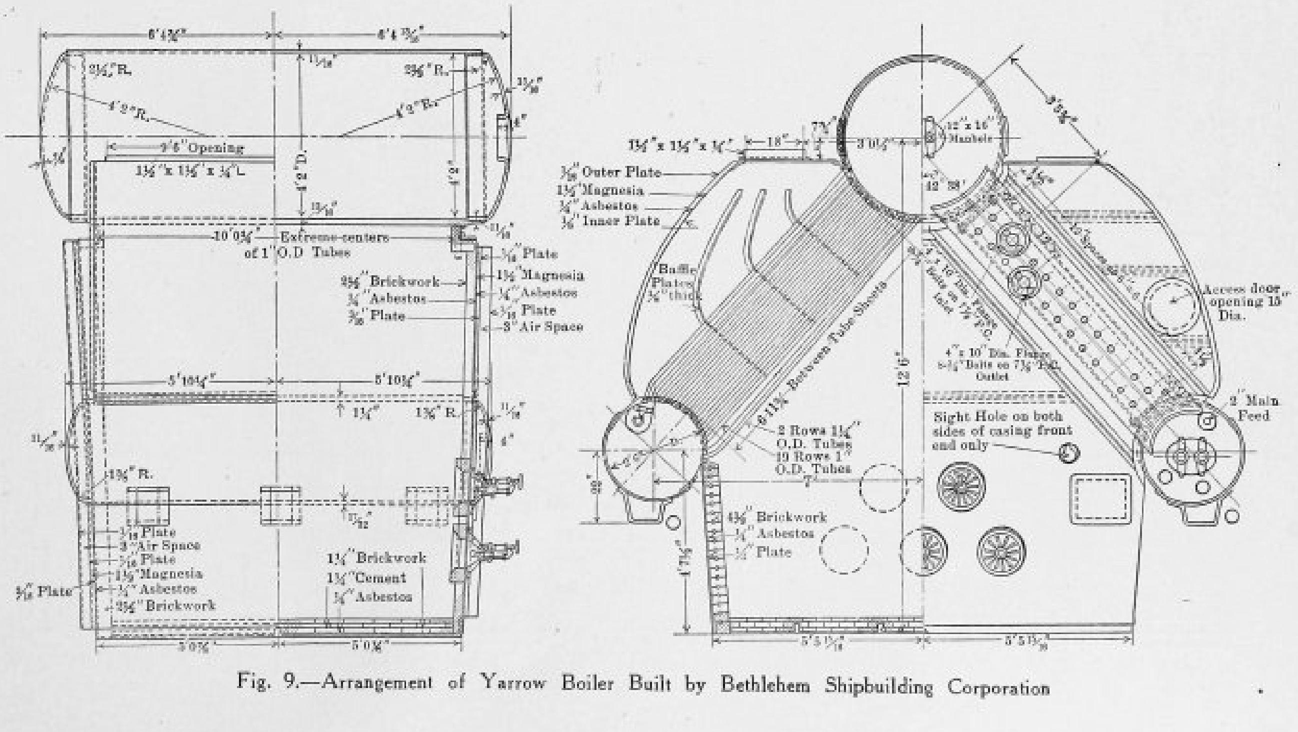



Fig. 9.—Arrangement of Yarrow Boiler Built by Bethlehem Shipbuilding Corporation

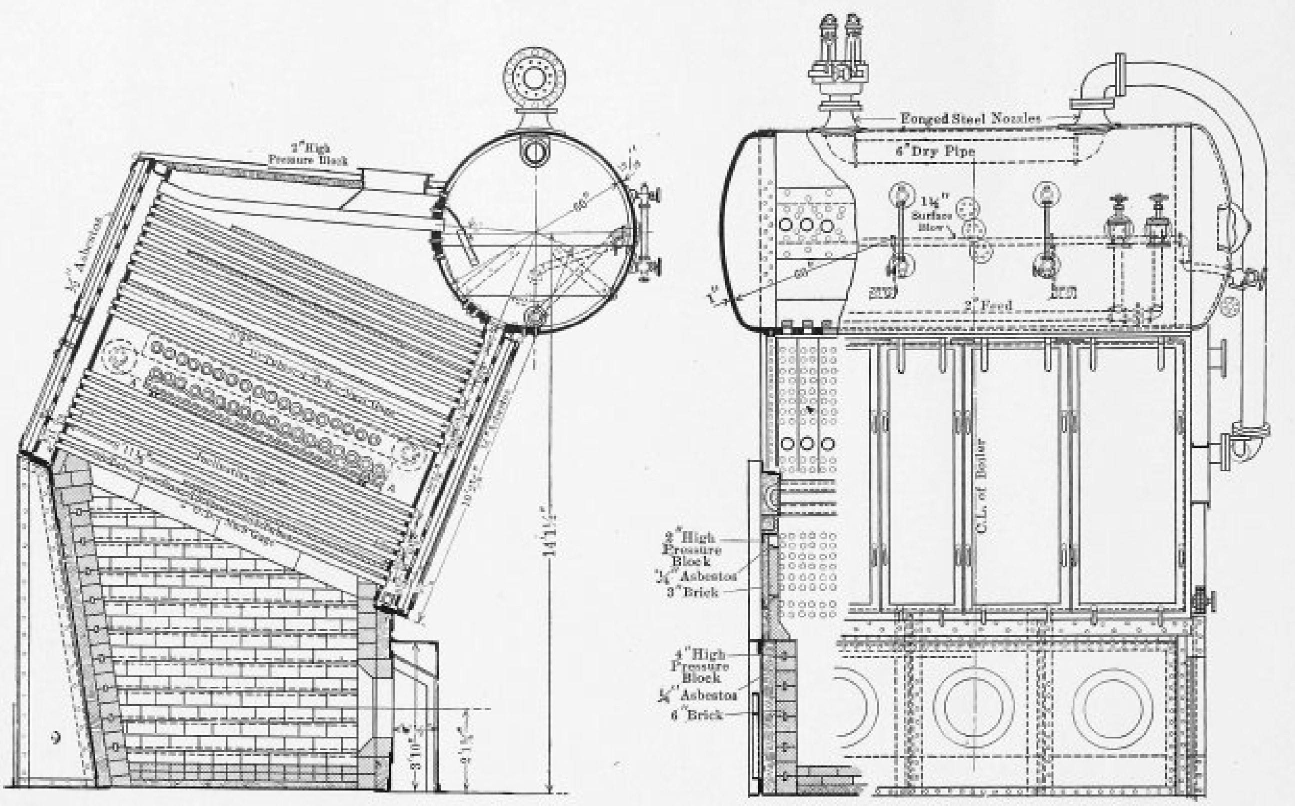



Fig. 10.—Ward Marine Watertube Boiler. Heating Surface, 3,500 Square Feet; Pressure, 300 Pounds per Square Inch

some cases with Emergency Fleet standard watertube boilers.

The Craig boiler, Fig. 15, is also a departure from previous successful marine watertube boilers. Its essential features are the lack of furnace volume and the sectional header construction, using the downflow principle, which was formerly tried out in land practice without success. This boiler was fitted in two ships, neither of which has given satisfactory operation.

The Howden boiler, Fig. 16, is a British type of a radically different design from previous successful marine watertube boilers. Its essential features are the lack

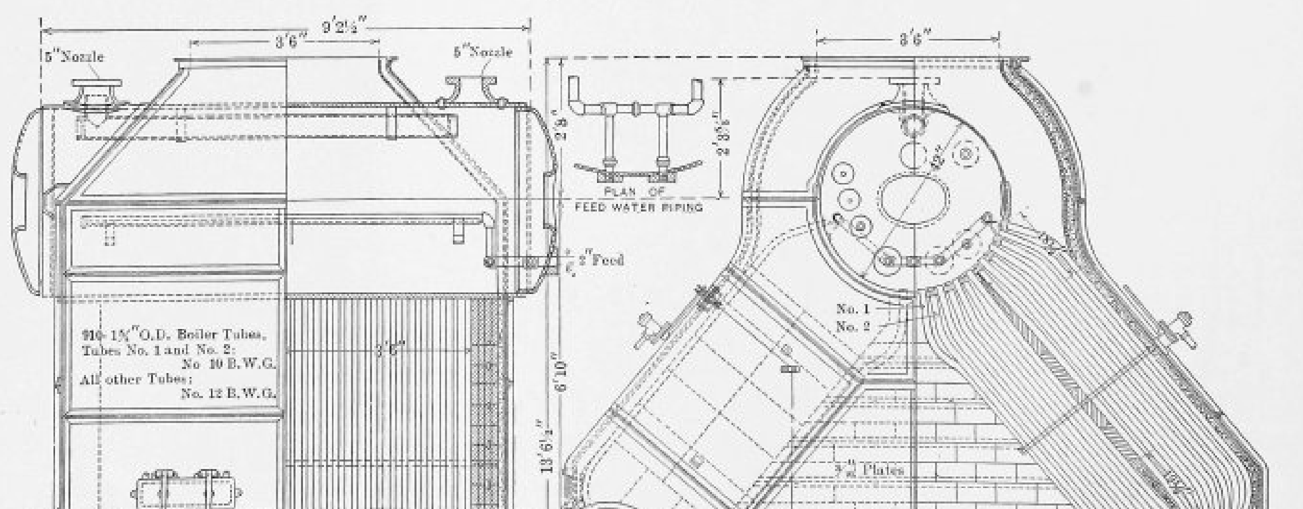



Fig. 11.—Colvin Watertube Boiler

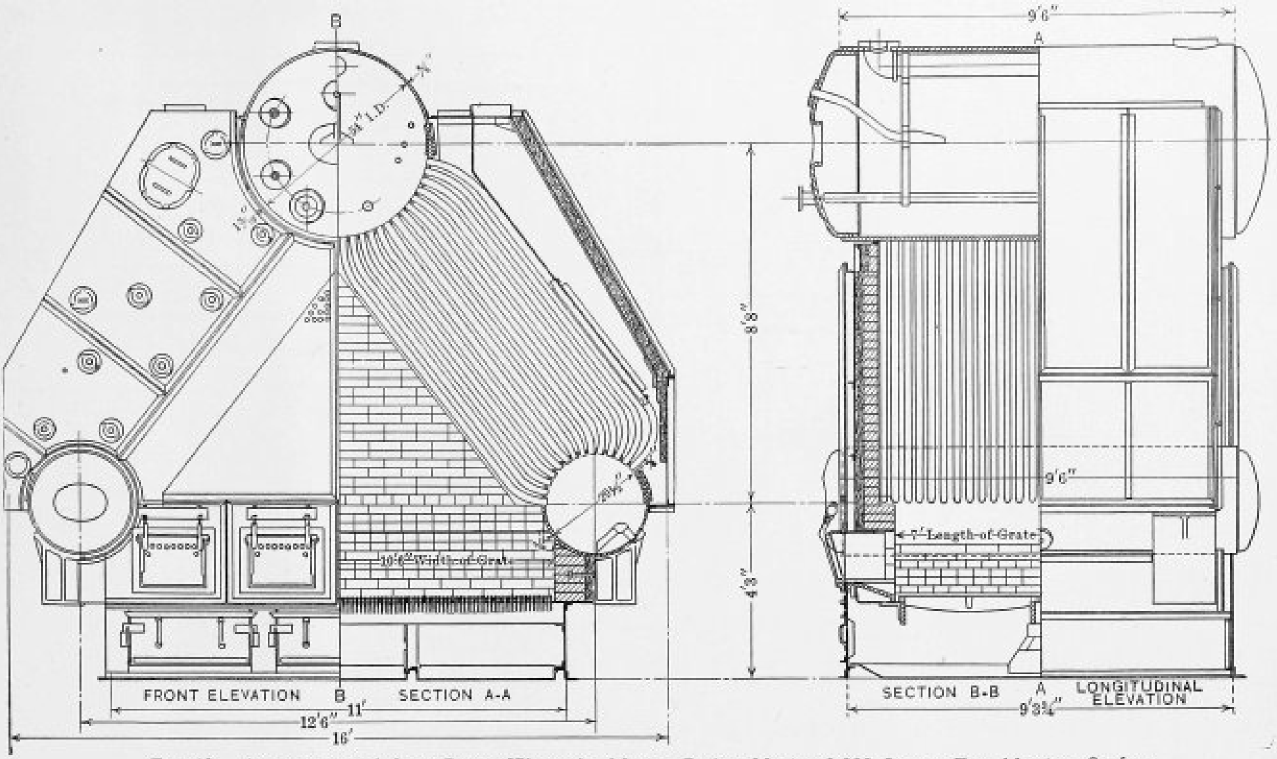



Fig. 12.—Arrangement of Scott Patent Watertube Marine Boiler, Having 3,000 Square Feet Heating Surface

of furnace volume, the short gas passage through tubes and the larger lower drum sheet over the fire, where scale deposits and causes rapid burning out of this sheet. This boiler has not proved successful in marine service, especially when oil-fired, and is now being replaced by boilers of the cross-drum, horizontal, straight-tube, watertube type.

### Results Obtained with Watertube Boilers

The watertube marine boiler, as shown by the various designs being built and operated by the Emergency Fleet, is capable of being built in a great number of different designs. The most successful watertube boilers in the merchant marine are those of the conventional cross-drum, horizontal, straight-tube type. Boilers of this type

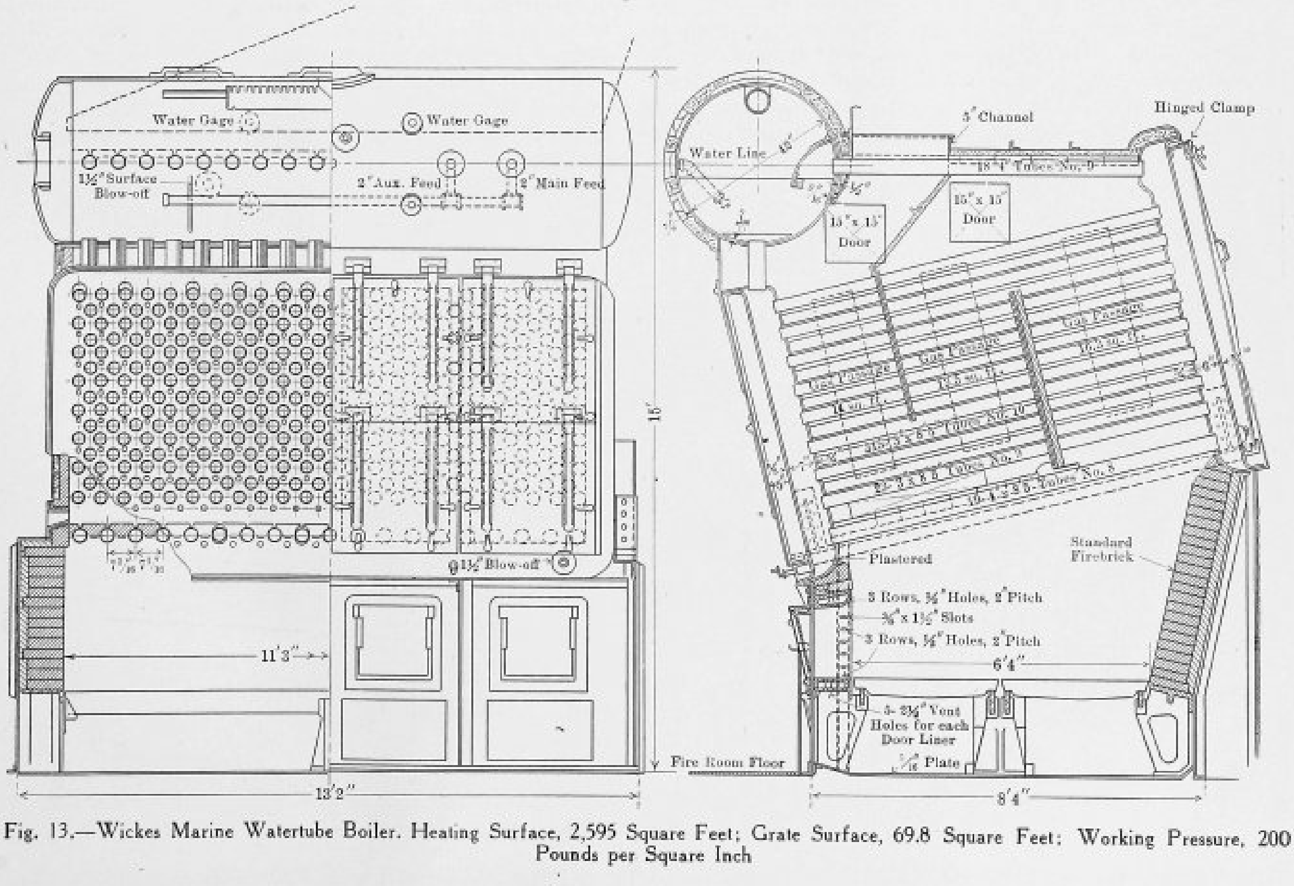



Fig. 13.—Wickes Marine Watertube Boiler. Heating Surface, 2,595 Square Feet; Grate Surface, 69.8 Square Feet; Working Pressure, 200 Pounds per Square Inch

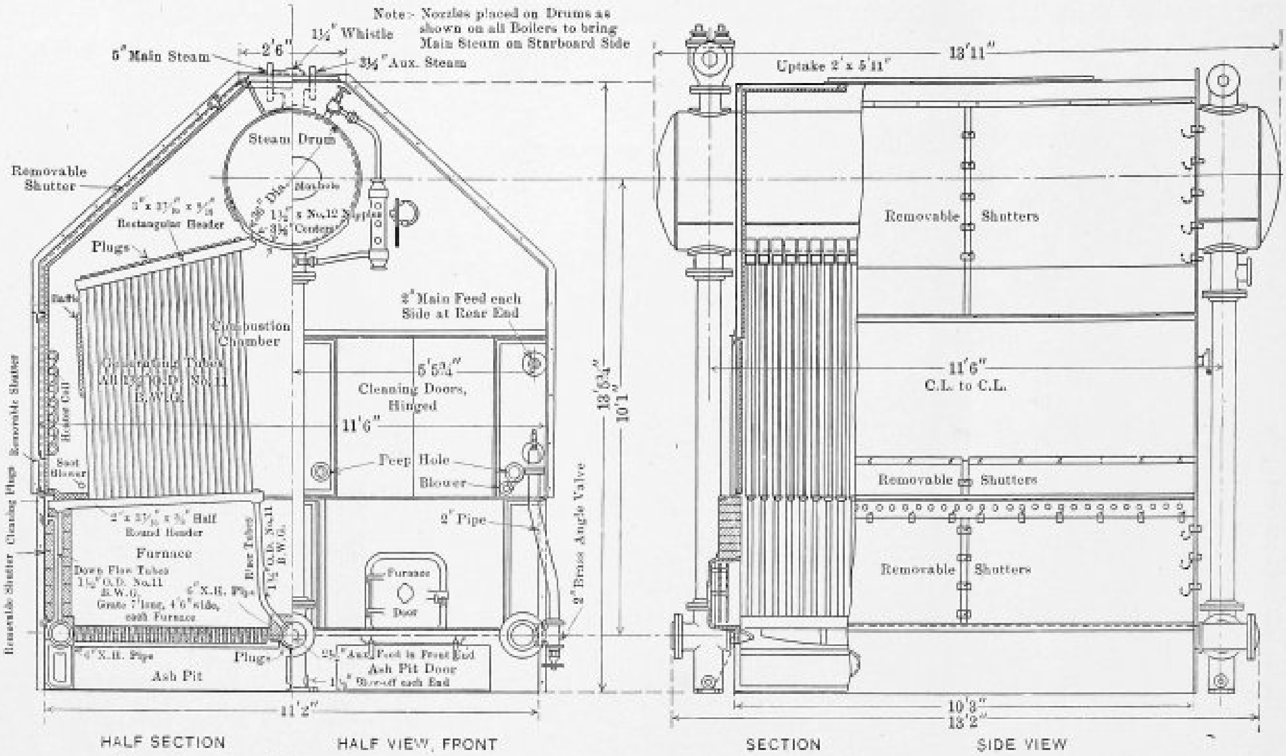



Fig. 14.—Ballin Watertube Boiler Installation Arranged for Use on Vessels of the Emergency Fleet Corporation

built by reliable manufacturers now in service in the Emergency Fleet are giving entire satisfaction as regards reliability, economy, capacity and cost of upkeep. This type of boiler, however, due to the limited water storage and small steam space, requires more careful water tending than the Scotch marine boiler.

With the proper water tending and reasonable care in operation this boiler, when well built, should give satisfactory service for a much longer period of years than the Scotch boiler. Owing to its rapid, well defined circulation it is more likely to prime when salted, due to a leaky condenser or improper operation of the evaporator, than the Scotch boiler, with its larger body of water and defective circulation. If the tubes are kept clean internally there will be practically no boiler repairs excepting the necessary renewal from time to time of the furnace brickwork.

The majority of these boilers are not fitted with sufficient furnace insulation to keep the steel casings reasonably cool. This is a result of trying to adapt naval practice in merchant marine work where weight is not so important. With the proper furnace insulation, such as is installed in the Foster boiler, the furnace steel casing temperatures will not exceed that found with well-insulated Scotch boilers.

The curved-tube, three-drum watertube boilers are in the majority of cases giving good service. These boilers, however, also suffer from lack of sufficient insulation of the steel casings.

Radical departures from these two standard watertube

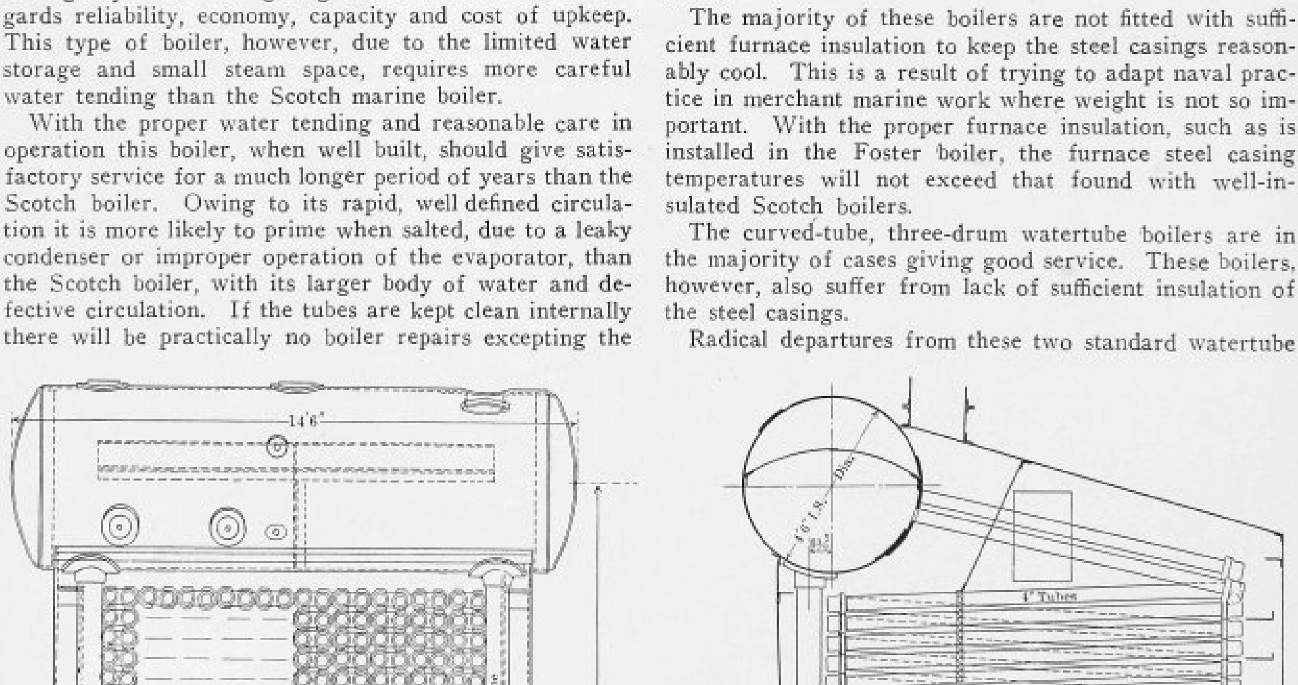



Fig. 15.—Craig Boiler. 2,000 Square Feet Heating Surface

types have not so far proved satisfactory and in most cases are being replaced by boilers of the cross-drum, horizontal, straight-tube types.

### The Engine-Room Force

Engineers for the vast number of new ships are necessarily made up largely of men who formerly did not have any marine experience. A great number of these men were trained in land plants and are accustomed to operate watertube boilers and turbines under conditions which are more severe on the boiler than those ordinarily found in marine use. In land practice the water very often has large quantities of scale-forming material which deposits in the tubes and the steam demands fluctuate over a considerable range, whereas in marine use the boilers operate under a practically steady steam demand and with good feed water. Therefore, these engineers have had little or no difficulty with the watertube boiler at sea. They have, however, been used to feed water regulators in land plants for watertube boilers, and these regulators will also be used in marine service in the future.

There have been a great number of tests made of various types of watertube marine boilers. To date no comparative tests by trained experts and similar test equipment have been made of the Scotch marine boiler, therefore the comparison for economy and capacity of these two types under test conditions is not available. The shipowner, however, is interested in the comparative reliability, economy and capacity of the boilers when operated under marine conditions at sea and not in test conditions for a short period under expert management.

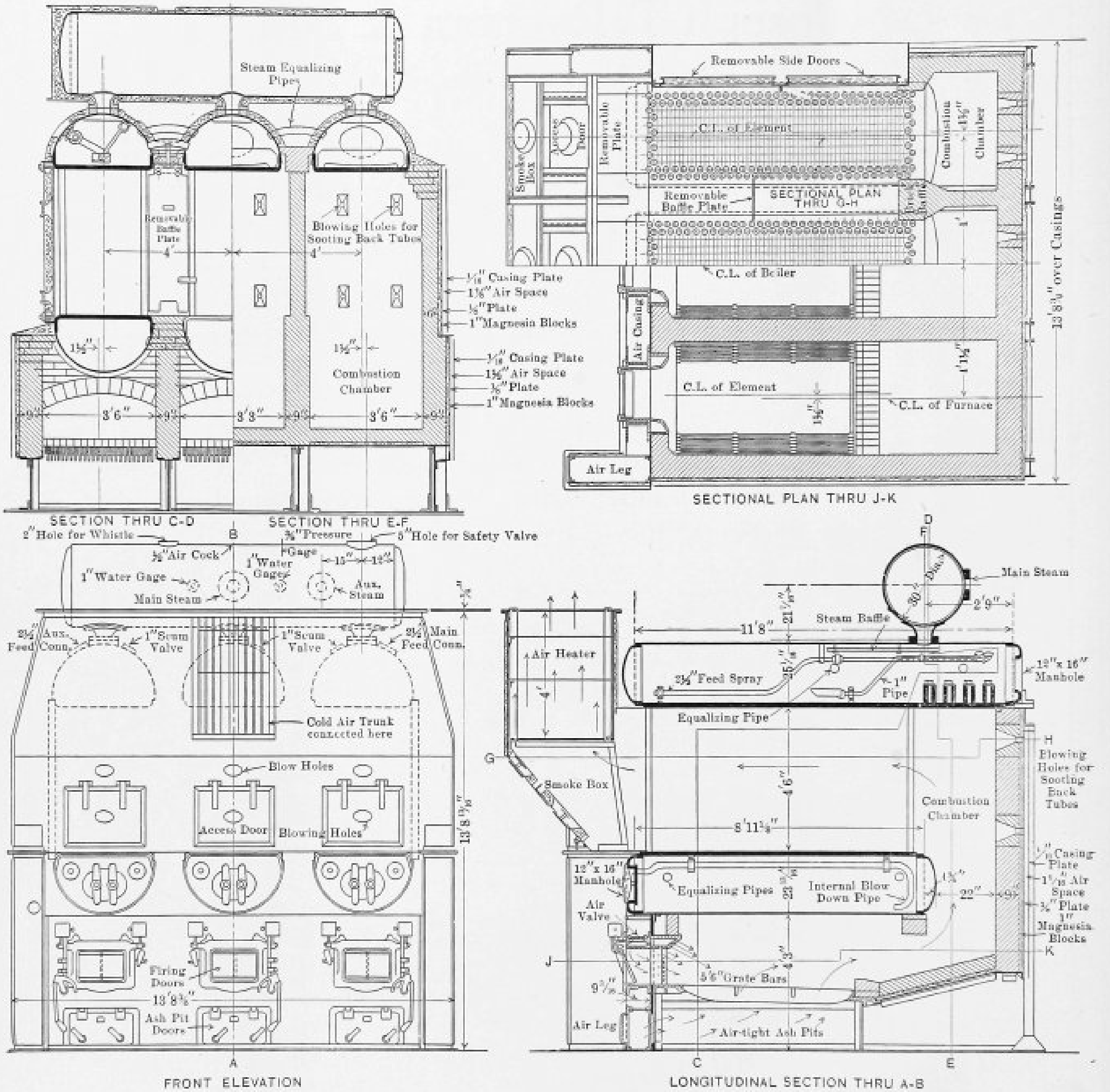



Fig. 16.—Arrangement of Standard Three-Element Marine Type Howden Boiler with Hot Air Forced Draft

### Comparative Results

The experience of the various navies and isolated cases in the merchant marine have shown that under similar conditions at sea the watertube boiler is approximately 10 percent more economical in fuel on both short and long voyages. This is due to the longer gas passages, proper arrangement of baffles and larger furnaces for good combustion only possible with the watertube design. The capacity of the watertube boiler, as shown by the navy, is so vastly in excess of the Scotch boiler that no comparison is possible on this point. In recent naval tests a specially prepared express type of watertube boiler has been tested at a capacity of over 22 pounds evaporation per square foot heating surface. It is evident that the requirements of the merchant marine do not call for any capacity that would be detrimental to the reliability, length of life or economy of the watertube boiler. To insure a long life it is customary to operate watertube boilers in the merchant marine at an evaporation of approximately 5 pounds per square foot heating surface.

The repairs on watertube boilers are very much less than those on Scotch boilers and usually consist of furnace brickwork and grate repairs, when burning coal, or furnace brickwork when burning oil. In either case an occasional renewing of the lower row of tubes may be necessary if the boiler is not cleaned internally. All these repairs can be made by the ship's crew. In the case of Scotch boilers the repairs, such as calking, welding and scaling of the boilers internally, are not usually made by the crew, but by outside help.

The first cost of the Scotch boiler for 210 pounds working pressure, not including the necessary heated forced draft equipment and waste heat type superheater required for its economical operation, is, at present prices, from $9 to $10 per square foot of heating surface. The first cost of the cross-drum, straight-tube watertube type boiler for 225 pounds working pressure, complete with all fittings, is less than $6 per square foot heating surface. This relative difference in price is approximately the same as the relative difference in weight.

The Scotch marine boiler, however, is well known by the older type of marine men, and is preferred on account of its reliability when properly and carefully operated.

During the next few years, when this record has been more definitely established, it is evident that the merchant marine will follow the navy and use the watertube type of boiler for the major portion of its ships. The Scotch marine boiler will be used, though at a decreasing rate, for a number of years owing to its past record for reliability.

# How to Design and Lay Out a Boiler—XVI

### Types of Flanged Nozzles Adopted in Boiler Work—Calculating Special Stud Bolts for Fastening Boiler Fittings

BY WILLIAM C. STROTT*

Alternative to the screwed flange just cited, flanged nozzles are extensively employed. Of these, there are two types, and the most generally adopted design, due probably to its lower cost, is illustrated in Fig. 58.

The lower flange of these nozzles must also be calked steam-tight against the boiler shell, and, although steel castings are ordinarily ductile enough to permit of this operation, it is, nevertheless, an excellent plan to interpose a calking strip of ⅛-inch thick steel plate between the flange and the boiler plate, and calk this strip instead of the casting.

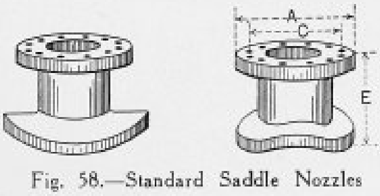


Fig. 58.—Standard Saddle Nozzles

In the better grades of work these straight nozzles are objectionable. The channel through which the steam is drawn is very abrupt; a flaring body, however, provides for quiet withdrawal of the steam, and this feature is met in the form of nozzle illustrated in Fig. 59.

CAST STEEL NOZZLES FOR STEAM PRESSURES UP TO 125 POUNDS

Dimensions for Single, Double or Staggered Riveting

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Size of Nozzle................Inches | 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 |
| A—Diameter of Flat Flange....Inches | 6 | 7 | 7½ | 8½ | 9 | 9¼ | 10 |
| Number of Bolts in Flat Flange...... | 4 | 4 | 4 | 4 | 8 | 8 | 8 |
| Size of Bolts.................Inches | ⅝ | ⅝ | ⅝ | ⅝ | ⅝ | ¾ | ¾ |
| C—Bolt Circle.................Inches | 4¾ | 5½ | 6 | 7 | 7½ | 7¾ | 8½ |
| E—Height, Face to Face......Inches | 7½ | 7½ | 7½ | 7½ | 7½ | 8 | 8 |
| Smallest Diameter can be applied to ........................Inches | 8⅝ | 8⅝ | 8⅝ | 8⅝ | 8⅝ | 8⅝ | 8⅝ |
| Size of Nozzle................Inches | 6 | 7 | 8 | 9 | 10 | 12 | |
| A—Diameter of Flat Flange... Inches | 11 | 12½ | 13½ | 15 | 16 | 19 | |
| Number of Bolts in Flat Flange...... | 8 | 8 | 8 | 12 | 12 | 12 | |
| Size of Bolts.................Inches | ¾ | ¾ | ¾ | ¾ | ⅞ | ⅞ | |
| C—Bolt Circle.................Inches | 9½ | 10¾ | 11¾ | 13¼ | 14¼ | 17 | |
| E—Height, Face to Face......Inches | 8½ | 9 | 9½ | 10 | 11 | 12 | |
| Smallest Diameter can be applied to ........................Inches | 9⅝ | 10¾ | 12¾ | 14 | 15 | 16 | |

CAST STEEL NOZZLES FOR STEAM PRESSURES UP TO 250 POUNDS

Dimensions for Single, Double or Staggered Riveting

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Size of Nozzle....Inches | 2 | 2½ | 3 | 3½ | 4 | 4½ | 5 | 6 | 7 | 8 |
| A—Diam. of Flat Flange | 6½ | 7½ | 8¼ | 9 | 10 | 10½ | 11 | 12½ | 14 | 15 |
| No. of Bolts in Flange.. | 4 | 4 | 8 | 8 | 8 | 8 | 8 | 12 | 12 | 12 |
| Size of Bolts.....Inches | ⅝ | ¾ | ¾ | ¾ | ¾ | ¾ | ¾ | ¾ | ⅞ | ⅞ |
| C—Bolt Circle...Inches | 5 | 5¾ | 6⅝ | 7¼ | 7⅞ | 8½ | 9¼ | 10⅜ | 11⅞ | 13 |
| E—Height, Face to Face. | 7½ | 7½ | 7½ | 7½ | 7½ | 8 | 8 | 8½ | 9 | 9½ |
| Smallest Diameter can be applied to.....Inches | 8⅝ | 8⅝ | 8⅝ | 9⅝ | 10¼ | 12¾ | 14 | 14 | 15 | 16 |
| Size of Nozzle....Inches | 9 | 10 | 12 | 14 | 15 | 16 | 18 | 20 | 22 | 24 |
| A—Diam. of Flat Flange | 16¼ | 17½ | 20½ | 23 | 24½ | 25½ | 28 | 30½ | 33 | 36 |
| No. of Bolts in Flange.. | 12 | 16 | 16 | 20 | 20 | 20 | 24 | 24 | 24 | 24 |
| Size of Bolts.....Inches | 1 | 1 | 1⅛ | 1⅛ | 1¼ | 1¼ | 1¼ | 1⅜ | 1½ | 1⅝ |
| C—Bolt Circle...Inches | 14 | 15¼ | 17¾ | 20¼ | 21½ | 22½ | 24¾ | 27 | 29¼ | 32 |
| E—Height, Face to Face. | 10 | 11 | 12 | 13 | 13 | 13½ | 14 | 15 | 15½ | 16 |
| Smallest Diameter can be applied to.....Inches | 18 | 18 | 20 | 24 | 24 | 26 | 30 | 32 | 36 | 36 |

This nozzle is forged from a solid steel billet, without

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

welds, by the American Spiral Pipe Works, Chicago, Ill., and is known to the trade as the Taylor seamless forged steel nozzle. The table in connection with Fig. 59 is re-

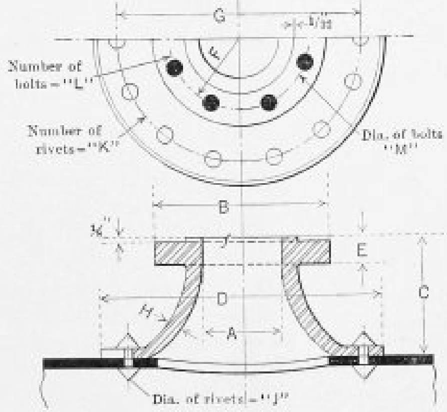



Fig. 59.—Flaring-Type Nozzle Used with Success

| A | B | C | D | E | F | G | H | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1½ | 6 | 5 | 9 | ¾ | 4⅝ | 6 | 11/16 | ⅞ | 10 | 4 | ¾ |
| 2 | 6½ | 5 | 9 | ⅞ | 5 | 6 | 11/16 | ⅞ | 10 | 4 | ¾ |
| 2½ | 7½ | 5 | 13 | 1 | 5⅞ | 9¼ | 9/16 | ⅞ | 12 | 4 | ⅞ |
| 3 | 8¼ | 5 | 13 | 1 | 6⅝ | 9¼ | 9/16 | ⅞ | 12 | 8 | ¾ |
| 3½ | 9 | 6 | 15 | 1⅛ | 7¼ | 10½ | ⅝ | ⅞ | 14 | 8 | ¾ |
| 4 | 10 | 6 | 15 | 1⅛ | 7⅞ | 11¼ | ⅝ | ⅞ | 14 | 8 | ⅞ |
| 4½ | 10½ | 6 | 16 | 1¼ | 8½ | 11½ | ⅝ | ⅞ | 16 | 8 | ⅞ |
| 5 | 11 | 6 | 16 | 1¼ | 9¼ | 12 | ⅝ | 15/16 | 16 | 8 | ⅞ |
| 6 | 12½ | 7 | 17½ | 1¼ | 10⅝ | 13¼ | 11/16 | 15/16 | 18 | 12 | ⅞ |
| 7 | 14 | 7 | 19 | 1 5/16 | 11⅞ | 14½ | 11/16 | 1 | 18 | 12 | 1 |
| 8 | 15 | 7 | 20 | 1⅜ | 13 | 15¼ | ¾ | 1 | 20 | 12 | 1 |

printed from a catalogue issued by that company. The dimensions and drilling of the upper flange conform to the extra heavy 250-pound standard. There is no reason why the form illustrated in Fig. 59 would not make an excellent cast steel nozzle. The metal thickness of the body would then probably be made heavier, not so much to increase the strength as to make a more substantial wooden pattern. Steel castings, when properly annealed to restore homogeneity, are evidently as strong as forged steel. At any rate, when designing castings, metal thicknesses should not be given in sixteenths of an inch, except when the surface is to be machined. Some foundries object to making castings less than ⅝-inch thick, owing to the difficulties in casting.

When head room is at a premium, as in the event of low ceilings, roof trusses or other overhead obstructions, the low type of nozzle must be employed. This form is illustrated in Fig. 60. It is usually made of heavy boiler plate, and is formed by means of dies in a hydraulic flanging press. The notations refer to those previously given

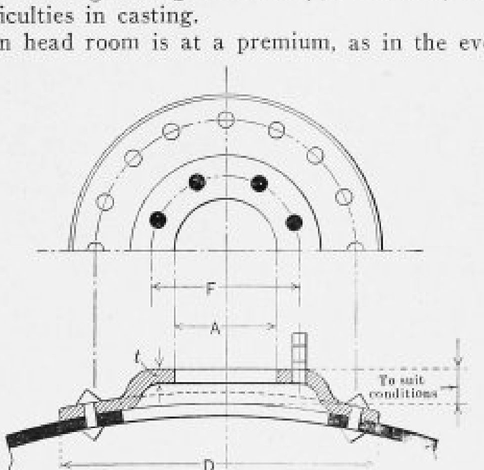



Fig. 60.—Low-Type Nozzle to Be Used in Obstructed Spaces

in connection with Fig. 57, and the same dimensions are applicable for a given size, except for that of *t*, which should have a thickness equal to the diameter of the bolts in the upper flange. This is essential owing to the necessity of employing stud-bolts screwed into the flange. If through-bolts were to be applied to these nozzles they would have to be placed from the inside of the boiler, which is a disadvantage. Furthermore, stud-bolts are never a desirable means of fastening in any kind of apparatus or machinery, as they are a source of breakage, as well as leakage. If a stud-bolt should break inside the body of the plate or casting, it is an exceedingly difficult proposition to remove the "stub." The author has had considerable success with stud-bolts when designed as in Fig. 61.

### Design of Stud-Bolts

The diameter $d$ is the calculated or required size of the stud-bolt, and $D$ is made ⅛ inch larger than the diameter $d$. Now to prevent the stud from breaking below the surface of the tapped hole, a groove is turned in the upper part of the shank so that the diameter at the reduced section is equal to the diameter $d$ of the stud at the root of the thread. It is evident that the weakest part of the stud is then outside of the hole. If breakage occurs, a wrench

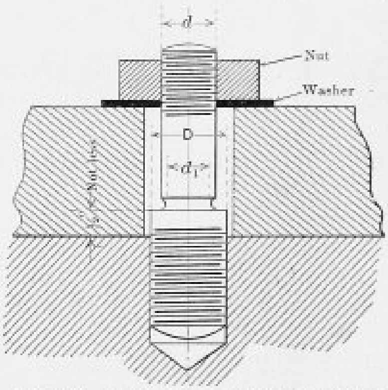



Fig. 61.—Stud Bolt of Special Design

may then be applied to the protruding stub for extracting it.

The dimensions and drilling of the upper flanges of all nozzles must conform to the standards adopted by the American Society of Mechanical Engineers in 1914. All pipe flanges, valves and fittings are now drilled in accordance with these standards, of which there are two, viz., the "low pressure," good for pressures up to 125 pounds per square inch, and the "extra heavy standard" for pressures above 125 pounds and up to 250 pounds per square inch.

For convenience and future reference, Tables 12 and 13 are appended, which require no explanation other than that the bolts are ⅛ inch smaller in diameter than the holes. Flanges coming under the 250-pound standard have a raised face ⅛-inch high and 1/32-inch clear of the bolt holes. This raised face is included in the thickness of the flanges as given in the tables. The raised face receives the gasket and is for the purpose of allowing the latter to become fully effective before the edges of the two flanges being bolted together have a chance to spring.

In reviewing the various forms of nozzles and flanges previously illustrated, it might be well to state that the ordinary cast-nozzle in Fig. 58 is the only form in which the rivets cannot be machine-driven—that is, on the hydraulic "Bull Riveter"—owing to the interference offered by the upper flange. Of course, the bottom flange could be made large enough to overcome this difficulty, but in resorting to this we are obliged to locate the rivets so far from the body of the nozzle as to weaken the construction. That is another feature of the flared nozzle of Fig. 59. At any rate, the designer should be careful, when detailing drawings for these straight patterns, to make the lower flange of such diameter that the rivets may be properly "bucked up" for driving them from the inside by means of the air gun without undue interference between the "dollie bar" and the upper flange.

TABLE 12—DRILLING TEMPLATE FOR STANDARD AND LOW PRESSURE—125 No. STANDARD

| SIZE | Diameter Flanges | Thickness Flanges | Number of Holes | Size of Holes | Bolt Circle | Size of Gaskets |
|---|---|---|---|---|---|---|
| 1 | 4 | 7/16 | 4 | ½ | 3 | 1 x 2½ |
| 1¼ | 4½ | ½ | 4 | ½ | 3⅜ | 1¼x 2⅞ |
| 1½ | 5 | 9/16 | 4 | ⅝ | 3⅞ | 1½x 3¼ |
| 2 | 6 | ⅝ | 4 | ¾ | 4¾ | 2 x 4 |
| 2½ | 7 | 11/16 | 4 | ¾ | 5½ | 2½x 4¾ |
| 3 | 7½ | ¾ | 4 | ¾ | 6 | 3 x 5¼ |
| 3½ | 8½ | 13/16 | 4 | ¾ | 7 | 3½x 6¼ |
| 4 | 9 | 15/16 | 8 | ¾ | 7½ | 4 x 6¾ |
| 4½ | 9¼ | 15/16 | 8 | ⅞ | 7¾ | 4½x 6⅞ |
| 5 | 10 | 15/16 | 8 | ⅞ | 8½ | 5 x 7⅝ |
| 6 | 11 | 1 | 8 | ⅞ | 9½ | 6 x 8⅝ |
| 7 | 12½ | 1 1/16 | 8 | ⅞ | 10¾ | 7 x 9⅞ |
| 8 | 13½ | 1⅛ | 8 | ⅞ | 11¾ | 8 x10⅞ |
| 9 | 15 | 1⅛ | 12 | ⅞ | 13¼ | 9 x12⅜ |
| 10 | 16 | 1 3/16 | 12 | 1 | 14¼ | 10 x13¼ |
| 12 | 19 | 1¼ | 12 | 1 | 17 | 12 x16 |
| 14 | 21 | 1⅜ | 12 | 1⅛ | 18¾ | 14 x17⅝ |
| 15 | 22¼ | 1⅜ | 16 | 1⅛ | 20 | 15 x18⅞ |
| 16 | 23½ | 1 7/16 | 16 | 1⅛ | 21¼ | 16 x20⅛ |
| 18 | 25 | 1 9/16 | 16 | 1¼ | 22¾ | 18 x21½ |
| 20 | 27½ | 1 11/16 | 20 | 1¼ | 25 | 20 x23¾ |
| 22 | 29½ | 1 13/16 | 20 | 1⅜ | 27¼ | 22 x25⅞ |
| 24 | 32 | 1⅞ | 20 | 1⅜ | 29½ | 24 x28⅛ |
| 26 | 34¼ | 2 | 24 | 1⅜ | 31¾ | 26 x30⅛ |
| 28 | 36½ | 2 1/16 | 28 | 1⅜ | 34 | 28 x32⅝ |
| 30 | 38¾ | 2⅛ | 28 | 1½ | 36 | 30 x34½ |
| 32 | 41¾ | 2¼ | 28 | 1⅝ | 38½ | 32 x36⅞ |
| 34 | 43¾ | 2 5/16 | 32 | 1⅝ | 40½ | 34 x38⅞ |
| 36 | 46 | 2⅜ | 32 | 1⅝ | 42¾ | 36 x41⅛ |
| 38 | 48¾ | 2⅜ | 32 | 1⅝ | 45¼ | 38 x43⅛ |
| 40 | 50¾ | 2½ | 36 | 1⅝ | 47¼ | 40 x45½ |
| 42 | 53 | 2⅝ | 36 | 1⅝ | 49½ | 42 x47¾ |
| 44 | 55¼ | 2⅝ | 40 | 1⅝ | 51¾ | 44 x50 |
| 46 | 57¼ | 2 11/16 | 40 | 1⅝ | 53¾ | 46 x52 |
| 48 | 59½ | 2¾ | 44 | 1⅝ | 56 | 48 x54¼ |
| 50 | 61¾ | 2¾ | 44 | 1⅞ | 58¼ | 50 x56⅜ |
| 52 | 64 | 2⅞ | 44 | 1⅞ | 60½ | 52 x58⅝ |
| 54 | 66¼ | 3 | 44 | 1⅞ | 62¾ | 54 x60⅞ |
| 56 | 68¾ | 3 | 48 | 1⅞ | 65 | 56 x63⅛ |
| 58 | 71 | 3⅛ | 48 | 1⅞ | 67¼ | 58 x65⅜ |
| 60 | 73 | 3⅛ | 52 | 1⅞ | 69¼ | 60 x67⅜ |
| 62 | 75¾ | 3¼ | 52 | 2 | 71¾ | 62 x69¾ |
| 64 | 78 | 3¼ | 52 | 2 | 74 | 64 x72 |
| 66 | 80 | 3⅜ | 52 | 2 | 76 | 66 x74 |
| 68 | 82¼ | 3⅜ | 56 | 2 | 78¼ | 68 x76¼ |
| 70 | 84½ | 3½ | 56 | 2 | 80½ | 70 x78½ |
| 72 | 86½ | 3½ | 60 | 2 | 82½ | 72 x80½ |
| 74 | 88½ | 3⅝ | 60 | 2 | 84½ | 74 x82½ |
| 76 | 90¾ | 3⅝ | 60 | 2 | 86½ | 76 x84½ |
| 78 | 93 | 3¾ | 60 | 2⅛ | 88¾ | 78 x86⅝ |
| 80 | 95¼ | 3¾ | 60 | 2⅛ | 91 | 80 x88⅞ |
| 82 | 97½ | 3⅞ | 60 | 2⅛ | 93¼ | 82 x91⅛ |
| 84 | 99¾ | 3⅞ | 64 | 2⅛ | 95½ | 84 x93⅜ |
| 86 | 102 | 4 | 64 | 2⅛ | 97¾ | 86 x95⅝ |
| 88 | 104¼ | 4 | 68 | 2⅛ | 100 | 88 x97⅞ |
| 90 | 106½ | 4⅛ | 68 | 2¼ | 102¼ | 90 x100 |
| 92 | 108¾ | 4⅛ | 68 | 2¼ | 104½ | 92 x102¼ |
| 94 | 111 | 4¼ | 68 | 2¼ | 106¾ | 94 x104 |
| 96 | 113¼ | 4¼ | 68 | 2⅜ | 108½ | 96 x106⅛ |
| 98 | 115½ | 4⅜ | 68 | 2⅜ | 110¾ | 98 x108⅜ |
| 100 | 117¾ | 4⅜ | 68 | 2⅜ | 113 | 100 x110⅝ |

NOTE:—All bolt holes to straddle center lines.

REINFORCING HOLES IN SHELL

In conclusion to the subject of boiler nozzles and flanges it should be clear to the student by this time that such appliances riveted to a boiler are a necessity, first, for the purpose of thoroughly reinforcing the metal around the hole in the shell and, second, to provide a connection for the piping.

TABLE 13—DRILLING TEMPLATE FOR EXTRA HEAVY PRESSURE—250 No. STANDARD

| SIZE | Diameter Flanges | Thickness Flanges | Number of Holes | Size of Holes | Bolt Circle | Size of Gaskets |
|---|---|---|---|---|---|---|
| 1 | 4½ | 11/16 | 4 | ⅝ | 3¼ | 1 x 2⅝ |
| 1¼ | 5 | ¾ | 4 | ⅝ | 3¾ | 1¼x 3⅛ |
| 1½ | 6 | 13/16 | 4 | ¾ | 4½ | 1½x 3⅞ |
| 2 | 6½ | ⅞ | 4 | ¾ | 5 | 2 x 4¼ |
| 2½ | 7½ | 1 | 4 | ⅞ | 5⅞ | 2½x 5 |
| 3 | 8¼ | 1⅛ | 8 | ⅞ | 6⅝ | 3 x 5¾ |
| 3½ | 9 | 1 3/16 | 8 | ⅞ | 7¼ | 3½x 6⅜ |
| 4 | 10 | 1¼ | 8 | ⅞ | 7⅞ | 4 x 7 |
| 4½ | 10½ | 1 5/16 | 8 | ⅞ | 8½ | 4½x 7⅝ |
| 5 | 11 | 1⅜ | 8 | ⅞ | 9¼ | 5 x 8⅜ |
| 6 | 12½ | 1 7/16 | 12 | ⅞ | 10⅝ | 6 x 9¾ |
| 7 | 14 | 1½ | 12 | 1 | 11⅞ | 7 x10⅞ |
| 8 | 15 | 1⅝ | 12 | 1 | 13 | 8 x12 |
| 9 | 16¼ | 1¾ | 12 | 1⅛ | 14 | 9 x12⅞ |
| 10 | 17½ | 1⅞ | 16 | 1⅛ | 15¼ | 10 x14⅛ |
| 12 | 20½ | 2 | 16 | 1¼ | 17¾ | 12 x16½ |
| 14 | 23 | 2⅛ | 20 | 1¼ | 20¼ | 13¾x19 |
| 15 | 24½ | 2 3/16 | 20 | 1⅜ | 21½ | 14¼x20⅛ |
| 16 | 25½ | 2¼ | 20 | 1⅜ | 22½ | 15¼x21⅛ |
| 18 | 28 | 2⅜ | 24 | 1⅜ | 24¾ | 17¼x23⅜ |
| 20 | 30½ | 2½ | 24 | 1⅜ | 27 | 19¼x25½ |
| 22 | 33 | 2⅝ | 24 | 1⅝ | 29¼ | 21¼x27⅝ |
| 24 | 36 | 2¾ | 24 | 1⅞ | 32 | 23¼x30¼ |
| 26 | 38¼ | 2 13/16 | 28 | 1¾ | 34½ | 25¼x32¾ |
| 28 | 40¾ | 2 15/16 | 28 | 1¾ | 37 | 27¼x35¼ |
| 30 | 43 | 3 | 28 | 1⅞ | 39¼ | 29¼x37⅜ |
| 32 | 45¼ | 3⅛ | 28 | 2 | 41½ | 31¼x39½ |
| 34 | 47½ | 3¼ | 28 | 2 | 43½ | 33¼x41½ |
| 36 | 50 | 3⅜ | 32 | 2 | 46 | 35¼x44 |
| 38 | 52¼ | 3 7/16 | 32 | 2 | 48 | 37¼x46 |
| 40 | 54½ | 3 9/16 | 36 | 2 | 50¼ | 39¼x48¼ |
| 42 | 57 | 3 11/16 | 36 | 2 | 52¾ | 41¼x50¾ |
| 44 | 59¼ | 3¾ | 36 | 2⅛ | 55 | 43¼x52⅞ |
| 46 | 61½ | 3⅞ | 40 | 2⅛ | 57¼ | 45¼x55⅛ |
| 48 | 65 | 4 | 40 | 2⅛ | 60¾ | 47¼x58⅝ |

Instead of nozzles or flanges, plain reinforcing pads may be riveted to the shell. These pads are threaded to a certain minimum depth, found necessary for a tight pipe joint.

*(To be continued.)*

# A.S.M.E. Boiler Code

**Preliminary Report on Rules for the Construction of Unfired-Pressure Vessels—Safety Appliances Installed—Foundations for Vessels**

Work on the section of the Boiler Code of the American Society of Mechanical Engineers, to be designated as Part I, Section IV, was begun in April, 1919. The following report is the result of careful study by the committee, who will be interested in any discussions on the matter that may come to their attention through the Secretary of the Boiler Code Committee, 29 West 39th street, New York City.

## Part I—Section IV

The vessels to which the rules apply are divided into two classes:

Class A.—Vessels for containing liquids above the atmospheric boiling point, inflammable substances, or any gas, and limited in size to those over 6 inches in diameter, more than 1.5 cubic feet in volume and carrying over 15 pounds pressure per square inch.

Class B.—Vessels for containing liquids, the temperatures of which are under control so as to be below atmospheric boiling point and limited in size to those over 9 inches in diameter, more than 4 cubic feet in volume and carrying over 30 pounds pressure per square inch, but not to exceed 100 pounds pressure per square inch. For pressures over 100 pounds per square inch the rules for Class A vessels apply.

These vessels may be constructed of any metal complying with the following rules:

The maximum allowable working stress used in any of the metals selected shall be determined by the following formula:

For Class A vessels:

$S = 0.0125\,E\,(e + 8)$, but not more than $0.4\,E$.

For Class B vessels:

$S = 0.0125\,E\,(e + 16)$, but not more than $0.65\,E$.

Where $S$ = Maximum allowable working tension stress, pounds per square inch.

$E$ = Elastic limit of material used.

$e$ = Elongation of material used, in percent, in 8 inches.

Working stress in rivets in single shear shall be taken as 80 percent of $S$.

Working stress in rivets in double shear shall be double that of single shear.

Staybolt values for allowable stress per square inch of net section shall be taken as follows:

When $e$ is not over 10 percent = 60 percent of $S$.
When $e$ is from 10 to 20 percent = 70 percent of $S$.
When $e$ is over 20 percent = 80 percent of $S$.

Class A vessels may be constructed of materials specified in the A. S. M. E. Boiler Code (Edition of 1918), in which case the formula above given need not be used.

Class A vessels shall be built in accordance with the rules of construction, which apply, of the A. S. M. E. Boiler Code (Edition of 1918), except paragraph 186, which shall read as follows: The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 65 percent of the tensile strength of the plate.

and paragraphs 269 to 328, inclusive.

Class B vessels may be constructed of material specified in the A. S. M. E. Boiler Code (Edition of 1918), in which case the formula above need not be used.

For Class B vessels, steel of untested tank quality may be used, assuming the tensile properties below:

| | |
|---|---|
| Tensile strength, pounds per square inch..... | 48,000 |
| Yield point, pounds per square inch......... | 25,000 |
| Elongation in 8 inches ..................... | 20 percent |

All Class B vessels shall be constructed in accordance with the rules of construction, which apply, of the A. S. M. E. Boiler Code (Edition of 1918), with the following exceptions:

Paragraph 180—change $FS = 4$.

Paragraph 186—rewrite as follows:

The ultimate strength of a joint which has been properly welded by the forging process shall be taken as 65 percent of the tensile strength of the plate. The ultimate strength of a joint which has been properly welded by the autogenous process may be used in Class B pressure vessels only and shall be taken as 50 percent of the tensile strength of the plate.

Paragraph 187—change 36 inches to 48 inches.

Paragraph 188—change 36 inches to 48 inches.

Paragraph 190—omit entirely.

Paragraph 195—change formula as follows:

$$t = \frac{5 \times P \times L}{2 \times TS}.$$

Paragraph 210—holes may be punched full size.

Paragraph 253—rewrite as follows:

All rivet holes may be punched full size.

Paragraph 254—omit entirely.

Paragraph 256—omit entirely.

Paragraph 257—rewrite as follows:

Calking shall be done with a round-nosed tool.

Paragraph 262—rewrite as follows:

Manhole plates may be of wrought steel, steel castings or of cast iron.

Paragraph 263—omit entirely.

Paragraphs 269-328—omit entirely.

No drain or blow-off shall be less than ¾-inch pipe size.

### Safety Appliances

All pressure vessels shall be provided with such relieving, indicating and controlling devices as the industry in which they are employed or use to which they may be put shall require to insure their safe operation. All such devices shall be so located and installed that they cannot possibly be rendered inoperative. The relieving capacity of safety valves shall be such as to prevent a rise of pressure in the vessel of more than 6 percent above the maximum allowable working pressure.

### Supports

All vessels must be so supported as to equally distribute the stresses arising from the weight of the vessel and contents. Class A vessels must be so arranged that the entire interior and exterior of the vessel may be thoroughly inspected. In the case of vertical vessels, the bottom head, if dished, of cylindrical vessels must be with the pressure on the concave side to insure complete drainage.

(Paragraph 325) Lugs or brackets, when used to support a vessel of any type, shall be properly fitted to the surfaces to which they are attached. The shearing and crushing stresses on steel or iron rivets used for attaching the lugs or brackets shall not exceed 8 percent of the strength given in paragraphs 15 and 16 of the Boiler Code.

### Corrosive Chemicals

All pressure vessels which are to contain substances having a corrosive action upon the metal of which vessel is constructed should be designed for a pressure in excess of that which it is to carry to safeguard against early rejection.

Class A vessels shall be stamped in accordance with the A. S. M. E. Boiler Code (Edition of 1918), paragraphs 331-332.

Class B vessels shall be stamped in accordance with the A. S. M. E. Boiler Code (Edition of 1918), paragraphs 376 and 377.

{A. S. M. E.}
{B}

### Location of Stamps

Location of tank manufacturer's stamps to be as follows: Plain cylindrical tanks and all other tanks not of a steam boiler type shall have at least one stamp, all stamps to be plainly visible when the tank is completed. On a tank with a manhole, said stamps shall be close to the manhole opening; on a tank without a manhole, close to the handhole; and on a tank without either a manhole or handhole, in a conspicuous place.

The tank builder's stamp shall not be covered by insulating or other material.

## Correction

In the December issue of THE BOILER MAKER an error occurred in the article "How to Design and Lay Out a Boiler—XIV."

The typical solution for formula (19) at the bottom of page 360 gave the value of $t$ as 0.55 inch. When the factor of safety was introduced, the result for $t$ should have been 1½ inches instead of 3.8 inches.

Leo F. Sauerbier has been appointed superintendent of the New York Machine & Plate Company, Jersey City, N. J.

# The Boiler Maker

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E. L. SUMNER, Secretary
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L. S. BLODGETT, Associate Editor

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The section of the A. S. M. E. Boiler Code dealing with the requirements for the construction of unfired pressure vessels, the preliminary report of which is published in this issue of The Boiler Maker, is the first attempt ever made to establish a standard for this important work, which is more or less connected with the boiler-making industry.

So much effort has been put into compiling the material by the sub-committee of the Boiler Code Committee that the members deserve a very great deal of credit for the valuable results of their research. Members of the American Society of Mechanical Engineers and everyone else interested in the matters dealt with in the report should study it carefully, with the object of offering suggestions to the committee for revising or amplifying its provisions before it is presented to the Society for final approval.

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The annual report of the chief of the Bureau of Locomotive Inspection points out several very important ways in which serious railroad accidents might be prevented. The greater number of casualties caused by the failure of the locomotive and its appurtenances may be charged directly to the rupture of some part of the boiler.

Sections of the report and descriptions of some of the worst accidents due to boiler failures published in this issue of The Boiler Maker indicate just how vital the work of good construction and inspection are to the safety of the traveling public. By far the greatest cause for boiler explosions is low water, and, as the report points out, the failure of welded seams in nearly every case contributed to the increased number of deaths from the accidents.

The recommendations for limiting the use of autogenous welding in boilers, that have been made in connection with the report, certainly deserve consideration, if by the elimination of the practice a decrease in locomotive and other boiler disasters will result. However, welding has its field in boiler work and will continue to develop in spite of the accidents for which it is in part responsible, if various precautions are taken to insure the proper design of welded parts, the use of good materials and workmanship and an adequate check on all these factors by competent inspectors.

The fact that so many shops have used the torch in the construction of locomotive boilers, without any failures whatever, would seem to indicate that the trouble does not lie entirely with the system. If the readers of The Boiler Maker will express an opinion in the matter and tell some of their experiences in connection with the use of autogenous welding, the suggestions will prove useful in avoiding a repetition of locomotive accidents from boiler failures.

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Increasing production and developing personal efficiency in the shops are offered as the great cure for the difficult living problems, as they exist at present.

If a plant is conducted according to modern methods of accounting and systematizing, and the amount of material produced by a given working force is low, the only way it can be brought up is to offer some inducement for the men to work harder. By adopting short cuts and eliminating wastes of time, energy and material the same results may be reached in production without the heart-breaking labor that goes with lack of training.

Personal efficiency means nothing more nor less than accomplishing these savings and doing the best work in the easiest possible way. If a professional efficiency engineer discovers anything new in the way of conserving time and energy in any line of work, the men connected with the performance of that work should take advantage of the discoveries and make them their own if possible.

It is true that a man must work at his bench or his lathe day after day to be entirely familiar with the workings of a plant, and only a little instruction is needed to make him realize the part he plays in the scheme of production and how he can increase his efficiency and earning power by co-operating with the management of the plant. The inauguration of such a scheme of efficiency instruction must come from the management, and sufficient inducement made for the men to give it a real trial.

The quicker all hands concerned realize that modern industry must be conducted for the mutual benefit of the men and the management, so much the sooner will our every-day existence become less of a problem than it is now.

---

Due to the confidential nature of the discussions at the January 8 meeting of the American Boiler Manufacturers' Association in New York, it will not be possible to publish a complete record of the proceedings in The Boiler Maker.

The meeting was mainly devoted to an investigation of the methods employed by the various companies represented in the association to determine the overhead charges used in their accounting. The cost system questionnaires which had been sent to all the members some time before the meeting had, in most cases, been answered fully and so made possible an extended comparison of the methods actually in use.

# Engineering Specialties for Boiler Making

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

## Boiler Tube Cleaning

Too much importance cannot be given the matter of tube cleaning in obtaining a high efficiency of boiler operation. There are various ways of cleaning tubes, but

Fig. 1.—Roto Tube Cleaner With the Type A. D. Motor in Use

mechanical cleaners have been particularly useful in accomplishing satisfactory results.

Various cleaners produced by the Roto Company of Hartford, Conn., include air, steam and water-drive types. It is claimed that with the type A.D., having a positive balanced motor which replaces the usual water turbine drive, a set of tubes may be cleaned in a much shorter time than formerly required, at the same time eliminating any chance of injury to the tubes. Where an air com-

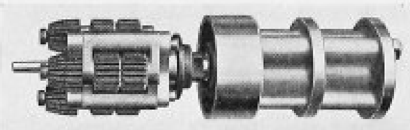


Fig. 2.—Roto Air or Steam-Drive Cleaner for Straight Tubes

pressor is available to supply the driving force, operating costs may be cut considerably. When steam is used, little inconvenience is experienced except in confined spaces.

The cleaners are equipped with positive-acting rotary engines. The cylinder bore of the engine, across which a single balanced blade fits in all positions, is not of the circular form ordinarily used in rotary engines. A single blade is used instead of the double or split type blade to reduce wear and friction, as well as to obtain a better balance. The driving force of the motor is similar to that of a piston engine, but turns over at nearly the speed of a turbine. In the case of the Roto cleaners, the motors are balanced, double-acting and self-starting.

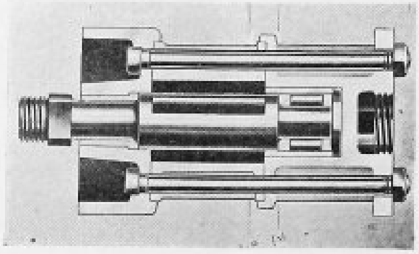


Fig. 3.—Sectional View of Special Motor

Hardened steel rings keep the casing straight, up to size and a correct fit for the boiler tubes after long service. These protecting rings prevent the cutters from wedging or sticking in the tubes and the consequent wearing to a taper form or becoming undersized, and so failing to function properly.

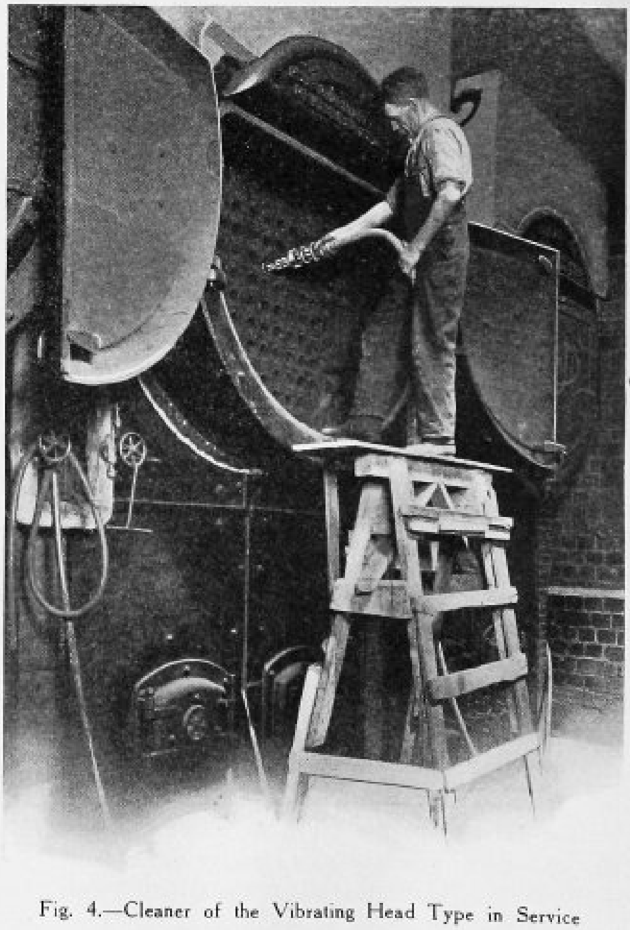


Fig. 4.—Cleaner of the Vibrating Head Type in Service

## New Machine for Drilling Staybolts

A special five-spindle drilling machine has recently been developed and is at present controlled by J. B. Hasty, Box 166, San Bernardino, Cal. The machine is designed for drilling tell-tale holes in locomotive boiler staybolts.

It is equipped with pneumatic feed, the air being admitted to the cylinders by means of a three-way valve.

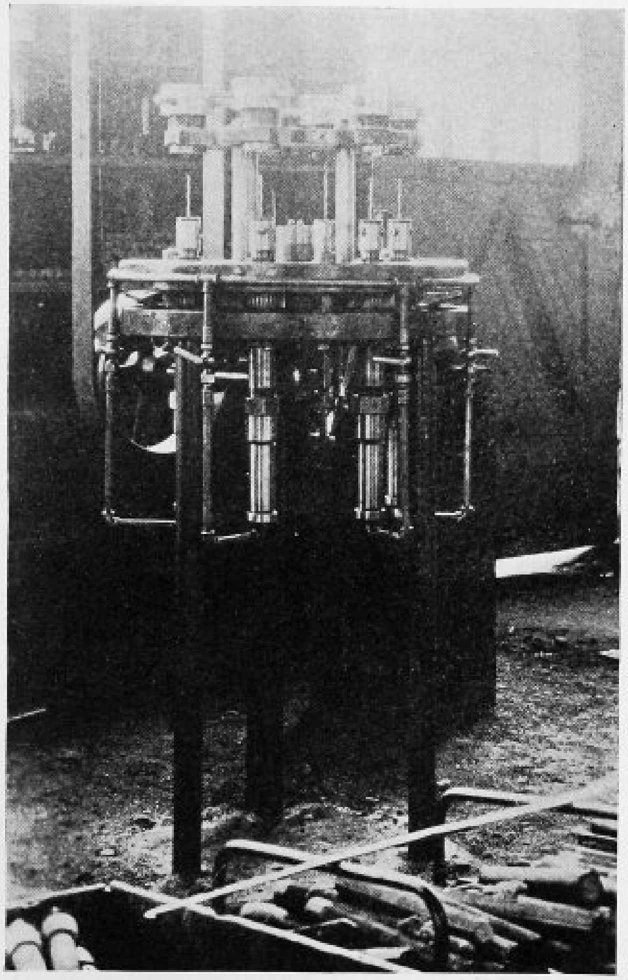


Fig. 1.—Special Five-Spindle Drilling Machine for Drilling Telltale Holes in Staybolts

When entering the cylinders the air forces the drill up into the bolt, allowing chips to drop out, thus eliminating drill breakage. When the valve is placed in the release position the spindles drop down to the frame very quickly. The chucks for clamping the staybolts are self-centered and take all sizes of bolts. It is claimed that the capacity of the machines is 75 bolts per hour with a hole 1½ inches deep, and 25 bolts per hour with an 8-inch hole.

## Lead Burning Outfits

The Davis-Bournonville Company, Jersey City, N. J., has developed several new lead burning outfits to utilize city gas, acetylene and hydrogen in combination with oxygen in the burners.

When designed to burn city gas, the apparatus includes the torch, bench-control block with needle regulating valves, hose, oxygen cylinder with special pressure regulator and gage and city gas connection through a Connolly flash back. The latter is required to prevent air or oxygen being forced back into the gas pipe in case the torch orifice should be accidentally choked. A warning whistle indicates when the water seal has been broken by a flash back.

The second outfit is the D-B lead burner's torch, bench control, hose and special regulator equipment with acetylene and oxygen supplies. The acetylene is made on the spot by a Davis-Bournonville portable flare light generator.

The third type includes the lead burner's torch, bench control, hose-regulator equipment and oxygen and hydrogen supplies compressed in cylinders, each cylinder being provided with a special pressure reducer and gage.

## PERSONAL

Frederick William Renshaw, president of the Globe Seamless Steel Tubes Company, Chicago, Ill., died February 1, of pneumonia at his home in Evanston, Ill. Mr. Renshaw was born in Chicago February 26, 1880. He was a graduate of Harvard Preparatory School and Sheffield Scientific School.

All standard sizes of rivet sets are being manufactured by The Ward Tool & Forging Company, Latrobe, Penn. The company is also prepared to supply special rivet sets according to any specification. Punches, dies, reamers and other tools for structural iron workers, boiler makers and shipbuilders are also available from this company.

The following appointments of sales representatives have been made by the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio.

New York, Chas. Hubbard & Company, 81 Fulton street; Chicago, Warren Corning & Company, Transportation building; St. Louis, Certes Supply Company, Frisco building; Atlanta, Spalding & Small, 1010 Hurt building; Philadelphia, Read-Rittenhouse Company, 1234 Commercial Trust building; San Francisco, Berger-Carter Company, 10th and Mission streets; Seattle, A. M. Castle & Company, of Washington; Boston, Austin & Doten, 102 North street.

Announcement has recently been made of the incorporation of the Conradson Machine Tool Company, of Green Bay, Wis., with C. M. Conradson as president. The new concern is associated with Joseph T. Ryerson & Son, Chisago, Ill., who will market the complete output of the new plant, consisting of plain and universal milling machines, selective head lathes, planers and radial drills. Special attention will be devoted by the company to the development of machinery for heavy-duty production.

The initial unit of the new plant comprises a machine shop and erecting bay, a power house, heating plant and office building. A 10-ton Pawling and Harnischfeger crane serves the erecting bay. The machine shop equipment consists chiefly of individual motor-driven machines, including Ryerson-Conradson planers, selective head lathes, milling machines, radial drills, etc., Brown and Sharpe and Heald grinders, Brown and Sharpe, and Bilgram and Fellows gear-cutting machines. Gages and micrometers in the small tool equipment are of Johannson make.

After the general development of Joseph T. Ryerson and Son as selling representatives for a period of seventy-five years, expansions have been made in the machinery division of their business during the last few years. Steel and machinery warehouses of this company are located in Chicago, St. Louis, Detroit, Buffalo and New York, with district offices in all of the larger cities. Foreign selling organizations are maintained in European countries, as well as in other parts of the world.

# 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.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Determining Joint Efficiency and Allowable Working Pressure on Lap Joint

Q.—In connection with some recent work I had to do in retubing boilers, I should like information on a matter that came to my attention at that time. The accompanying sketch is clear enough for a practised eye to read. I wanted to take off the plate and put it on with butt straps inside and out, as it was originally, but, to my surprise, the boiler inspector passed it and said it was safe.

I am far from satisfied with this. As you will notice, the plate was too short, and so he simply plugged up the rivet holes where the plates didn't overlap, above and below. At its best now it is only a double-riveted seam. I want an honest opinion on this. I consider this unsafe working at 130 pounds per square inch. I would give it about 55 pounds. I will await your answer through our valuable paper and any explanations from our different readers. J. H.

A.—The calculations given herewith on your riveted joint problem bear out your contention that the riveted joint is entirely too weak to withstand a working pressure of 130 pounds per square inch when the diameter of the boiler equals 60 inches and the plate thickness is 3/8 inch.

To ascertain the weakest section or part of the joint, it will be necessary to consider the different ways the joint may fail, and on the strength of the weakest part is based the maximum pressure allowed on the seam.

Referring to the sketch Fig. 1, the joint is a double-riveted lap joint with the rivets spaced opposite each other, all rivets being in single shear.

We will first consider the strength of the plate between the plugged holes in the shell of the boiler. In the calculations the following factors will be used:

*TS* = 55,000 pounds per square inch, tensile strength of plate.
44,000 pounds shearing strength of rivets per square inch.
3/8 inch = the plate thickness.
13/16 inch = diameter of rivets after driving.

Strength of solid plate section in outer row of rivets = 5.5 × 3/8 × 55,000 = 113,437.5 pounds.

Strength of net plate section in the 5½-inch pitch = (5½ — 13/16) × 3/8 × 55,000 = 96,679.7 pounds.

(*B*) Strength of net plate section between rivets in the inner rows = (2¼ — 13/16) × 3/8 × 55,000 = 29,648.44 pounds.

(*C*) Strength of solid plate section in inner row of rivets = 2¼ × 3/8 × 55,000 = 46,406.25 pounds.

(*D*) Strength of two rivets in single shear = 0.5185 × 2 × 44,000 = 45,628 pounds.

Decimal 0.5185 equals the area of a 13/16-inch rivet hole, which may be found in a table of circumferences and areas of circles. By calculation it is determined in the following way:

$$\frac{13^2}{16} \times 0.7854 = 0.8125 \times 0.8125 \times 0.7854 = 0.51849, \text{ say } 0.5185.$$

By dividing the result found in *B* and *D* by that of *C*, the efficiency of these parts as compared with the solid plate section is determined. The smallest efficiency is then used in this case for finding the allowable pressure on the joint.

$$\frac{B}{C} = 29{,}648.44 \div 46{,}406.25 = 0.638,$$ that is, 63.8 percent the efficiency of the net plate section as calculated to resist breaking of the plate along the inner rows of rivets.

$$\frac{D}{C} = 45{,}628 \div 46{,}405.25 = 0.983,$$ that is, 98.3 percent the efficiency of rivets to resist shearing.

The calculations show the rivets to be stronger than the net plate section, and that the pitch of rivets is too small. Therefore, the joint is a poor design.

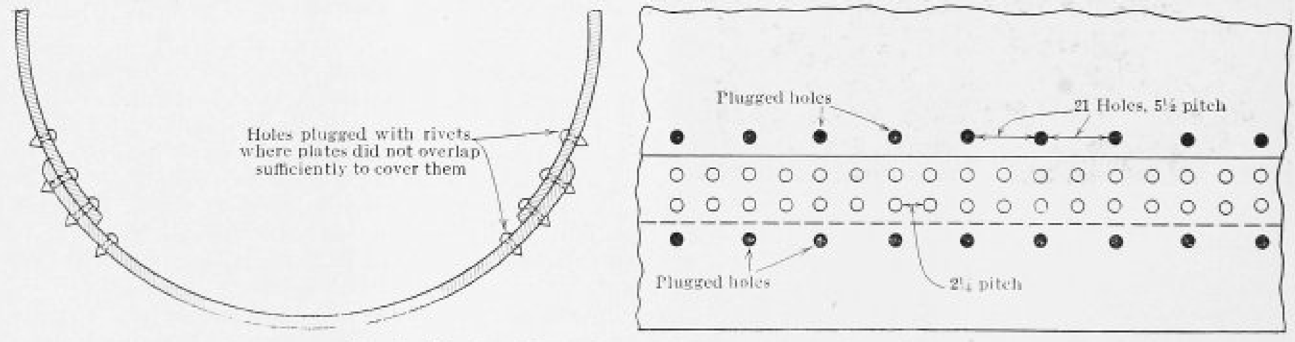



Fig. 1.—Details of Lap Joint with Useless Holes Plugged

The allowable working pressure on the joint may be determined by the formula:

$$\frac{TS \times t \times E}{R \times F} = P,$$

in which:
*P* = allowable working pressure.
*E* = smallest efficiency of joint.
*TS* = tensile strength of plate, pounds per square inch.
*t* = plate thickness in inches.
*R* = radius of smallest shell course, inches.
*F* = factor of safety.

Using 5 as a factor of safety, the values already given and substituting them in the formula, we have:

$$\frac{55{,}000 \times 3/8 \times 0.638}{30 \times 5} = 87.72 \text{ pounds pressure on the joint.}$$

## Saddle Nozzles

Q.—The writer desires information concerning cast iron, cast steel and malleable iron saddle nozzles, more particularly the thickness of bodies, the thickness and diameter of rivet flanges, and the height of the nozzle. The bolt flange dimensions can be readily obtained from various catalogues listing pipe flanges. The nozzles to be designed for standard, medium and extra heavy duty. C. E. L.

A.—The information that you desire on cast steel, iron and malleable iron saddle nozzles can be secured definitely from the manufacturers, such as Crane & Company, Chicago, Ill. For the thickness of cast iron nozzles the following formula is given:

$$T = \frac{D \times P}{4{,}000} + 0.5.$$

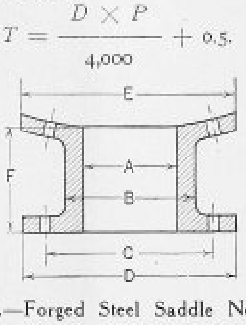



Fig. 1.—Forged Steel Saddle Nozzles

Where:

$T$ = thickness of metal in inches.
$D$ = internal diameter of nozzle in inches.
$P$ = pressure in pounds per square inch.

The thickness of the upper flange = $1.3 \times T$.

The thickness of the lower flange = 40 to 50 percent greater than the thickness so found up to 1½ inches.

In the accompanying table are given the dimensions for several cast iron and cast steel nozzles. The reference letters in the table correspond with those in the figure.

Cast iron, cast steel and malleable iron are not recommended for boiler nozzle saddles. Forged steel has

| | Inches | Inches | Inches |
|---|---|---|---|
| $A$ | 4 | 5 | 6 |
| $B$ | 6 | 7 | 8 |
| $C$ | 8½ | 9½ | 10½ |
| $D$ | 11 | 12 | 13 |
| $E$ | 10 | 11 | 12 |
| $F$ | 6 | 6 | 6 |

many advantages over the castings, being many times stronger, lighter and can be fitted and calked without the use of liners. These nozzles are fabricated in standard sizes, ranging from 1½ inches to 8 inches in diameter. For further particulars on the forged steel nozzles, inquire of Joseph T. Ryerson & Son, Chicago, Ill., or Scully Steel and Iron Company, Chicago, Ill.

## Boiler Inspectors' Examinations

Q.—Have been wanting to take an examination for government locomotive boiler inspector, but the Civil Service tells me that the examination is combined with that of general locomotive inspector. As I know very little about the machine side of a locomotive, I am unable to take the examination.

Are there any examinations held for boiler inspectors? I would also like to have the names of some boiler insurance companies who hire inspectors.

How would you start to make a report of inspection of some boiler? A.

A.—Examinations for the position of boiler inspector are held by the large cities and states. The United States Steam Boat Supervisors require their inspectors to pass a civil service examination, which pertains to boats, engines, boilers and appurtenances. Inspectors of locomotive boilers for railroads must have several years' experience as locomotive firemen before they are qualified to take the civil service examination. The examinations cover a wide range of subjects relative to mechanics, engines, boilers, boiler accessories, locomotive firing and general mechanical subjects.

Report forms are furnished inspectors for their work, as their reports must cover fully the condition of the boilers inspected, and recommendations on repairs required for putting damaged boilers in a safe working condition.

There are a number of boiler insurance companies, those of prominence being the Hartford Insurance Company, Hartford, Conn.; New York Casualty Company, New York City, and Travelers Insurance Company, New York City.

## Factor of Safety-Cracks in Lap Seams

Q.—(1.) What factor of safety would you advocate on second-hand lap seam boilers?

(2.) Would you differentiate between boilers whose shells are exposed to the products of combustion and those that are not?

(3.) Would you consider the drums of Stirling, Babcock & Wilcox, Badenhausen, Parker watertube, Heine watertube and Franklin watertube as exposed to the products of combustion?

(4.) With what frequency do you consider that there are hidden lap seam cracks in lap seam boilers?

(5.) The Rules of the Industrial Accident Commission call for a factor of safety of at least 5.5 on lap seam boilers, and the second dealers have formed an association and may go to court and try and get the factor of safety cut down. Therefore, we would be pleased to hear from any authorities on these questions. F. A. P.

### Factor of Safety on Second-Hand Boilers

A.—According to the A. S. M. E. Code on existing installations, Part II, paragraph 381; second-hand boilers, by which are meant boilers where both the ownership and location are to be changed, shall have a factor of safety of at least 5.5, by the formula paragraph 378, one year after these rules become effective, unless constructed in accordance with the rules contained in Part I, when the factor shall be at least 5.

This covers boilers having shells exposed to the products of combustion and those that are not.

The drums of the Stirling, Babcock & Wilcox, Badenhausen, Parker, Heine and Franklin watertube boilers are partially exposed to the products of combustion.

### Fire Cracks in Lap Seams

*Fire cracks* and lap fractures occur frequently in externally fired lap seam boilers and occur also in internally fired boilers. Such fractures extend from the rivet holes to the edge of the plate, and are usually due to punching the holes in the plate or too excessive use of the drift pin. Sometimes these cracks extend into the body of the plate, in which case they may prove dangerous. To stop fractures of this kind from extending into the plate, a hole is drilled at the end of the crack and a rivet called a stop rivet is driven in place. Where there are a number of such cracks the cracked part should be removed and properly patched.

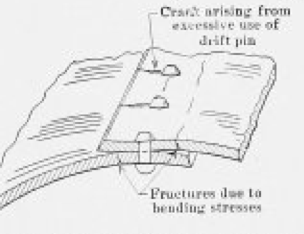



Fig. 1.—Fractures From Excessive Use of Drift Pin

Lap fractures also arise in between rivets as shown in Fig. 1. Such cracks arise from either a damaged plate or from an indirect pull and bending action on the lap seams. Owing to the form of the lap and that of the shell after rolling, the shell is out of round at the joint.

When an indirect pull is exerted on the seam, spreading occurs, and leaking. The resulting bending action sets up stresses which finally produce cracks on the inside of the joint between rivets or on the outside lap under the overlapping plates.

At first small cracks occur, but as the operation continues and corrosion sets in a dangerous condition arises.

## Transition Pieces Intersecting Cylindrical Pipe Off Center

Q.—How are the patterns for the connection shown in the end view of accompanying sketch developed? O. J.

A.—To handle this problem, the triangulation method of laying out can be applied to advantage. The view shown to the right of the end view represents the transition piece when looking at the side of the pipe. The part joining the cylinder has a curved form at the top with straight sides running into the circular opening. One-half of the view is divided into a number of triangular sections, and in the end view corresponding sections are located, by projecting first the points 1-2-3-4, etc., from the circle to the line 1-7 in the end view. From points 1-2-3-4-*y*-*x*-*a* lines are drawn to intersect the circle in the end view as illustrated. Connect the respective points, which is advisable in order to follow the steps involved in constructing the triangles and in laying off the pattern.

Construction of the triangles for the pattern development is as follows: Use the solid and dotted line 1 to 1, 2 to 2, 3 to 3, 1 to 2, 2 to 3, 3 to 4, etc., of the side view as base lines, laying them off on the vertical lines drawn from points 1-2-3-4-*y*-*x* and *a* of the circle, shown in the end view. The hypotenuses are the required true lengths for constructing the pattern.

In this case the pattern is made in one piece, but, if

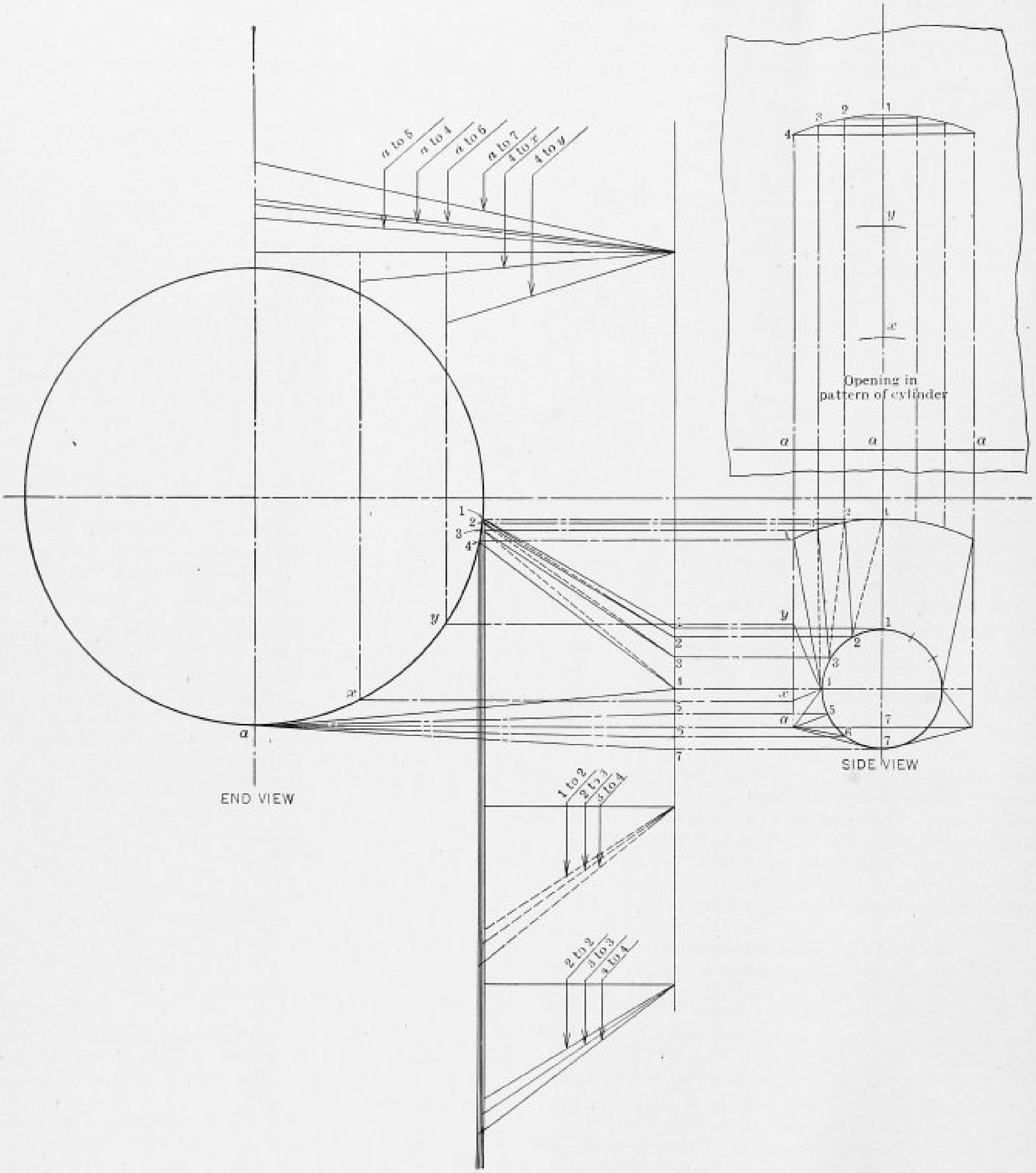



Fig. 1.—Development of Transition Pieces Intersecting a Cylindrical Pipe Off Center

desired, smaller sections of plate may be used up. Lay off the center line 1-1 equal to the line 1-1 of the end view. The arc length 1 to 2, 2 to 3 and 3 to 4 at the large end

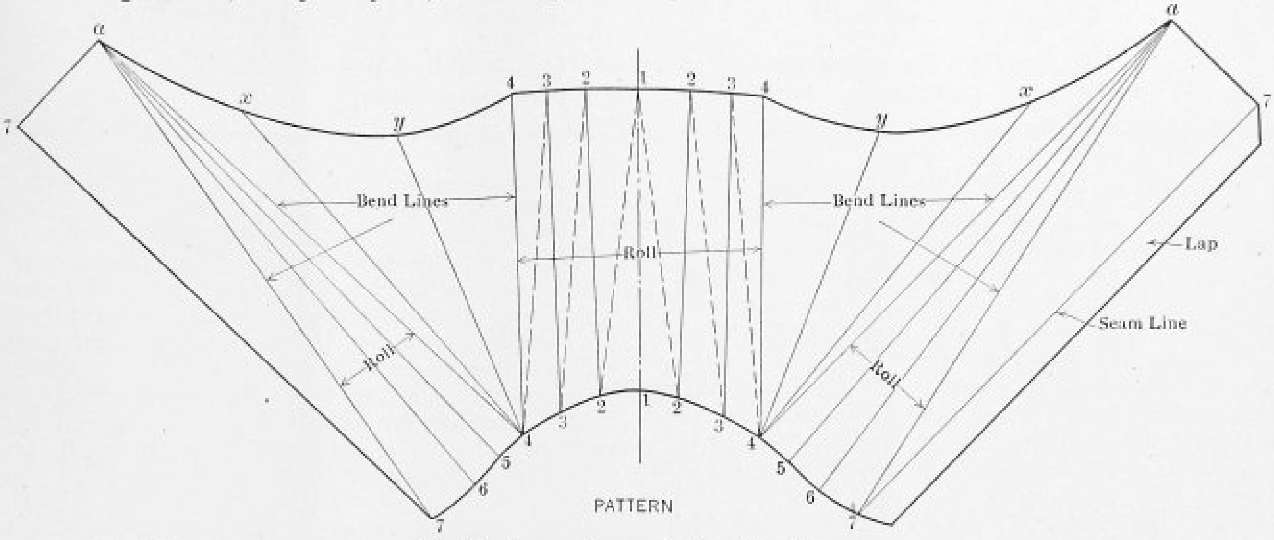



Fig. 2.—Pattern Layout of Transition Pieces

equals the arcs 1-2, 2-3 and 3-4 of the development for the opening in the pattern of the cylinder. Arc 1 to 2, 2 to 3, etc., on the small end are equal to those of the circle of the side view. Arc lengths 4 to *y*, *y* to *x*, *x* to *a* of the pattern are transferred from the end view. The triangles being numbered, it is now a simple matter to arrange the true lengths in their proper position in the pattern.

The shape for the opening in pattern of the cylinder is produced by first laying off the centerline *a*-1, and at right angles to it draw the line *a-a-a*. From the side view project lines from the points 1-2-3-4 parallel with the centerline *a*-1.

From line *a-a-a* as a base line (which also represents the shape of the connection at the bottom of the pipe joint) lay off the distances *a*-1, *a*-2, *a*-3 and *a*-4 equal to the arc lengths from *a* to 1, *a* to 2, *a* to 3, *a* to 4, inclusive of the end view.

## Compressed Air Problems

Q.—In using compressed air, is it necessary that at intervals the pipe line be so full of water that it is impossible to run the machines? If it acts this way, does the fault lie with the engineer or with the compressor? A great deal of time is often lost when water does get in the pipes by shutting down to blow out the line. After this the machine must be oiled up, coupled and started again.

Is it possible to have "dry air"? F. S.

A.—Air taken from the atmosphere contains moisture; the amount of moisture in the air depends on the temperature of the air and its pressure.

Compressing air raises its temperature, and in expanding it the temperature is lowered; the result in the first case is an increased air pressure, and in the latter a decreased air pressure. In compressing free air or atmospheric air, the moisture in the air absorbs to a certain extent the heat arising from the compression. This is an advantage. When the temperature of compressed air falls below the point of saturation, the moisture in the air is precipitated and the degree of saturation is the ratio of the moisture in a given volume of air to the amount of moisture required for saturation of the same volume of air at the same temperature and pressure. Free air contains approximately 25 percent of the moisture necessary for complete saturation.

Atmospheric pressure is due to the weight of the air. At sea level the air pressure is 14.7 pounds per square inch. The pressure decreases as the altitude increases. The temperature and pressure of the air are factors entering into the compression of air, which cannot be treated briefly.

There are two classes of compressors, viz., *wet* and *dry*. In the *wet* type cold water is employed directly in the cylinder of the compressor to abstract the heat which arises from compressing the air. In the *dry* type cold water is introduced in water jackets that surround the cylinder. The dry compressor form is used principally in the United States.

The piping should be either cast or wrought iron. All joints should be carefully made to insure tight connections. Sleeve couplings or cast iron flanges should be employed for joining pipe lengths of wrought iron pipes. All pipes placed under the ground or floorings should be so arranged as to be accessible for inspection and repairing. Pipes should be laid so that there are no low points in the line. In long lines sloping uniformly, provision should be made at the low end to remove the water that accumulates in the line. All bends or turns should be as large as possible, as sharp-curved pipes increase the resistance to the flow of air.

## BOOK REVIEW

A 64-page illustrated book giving in detail the beginnings of railroad transportation between Boston and Lowell, Mass., in 1830 has recently been made available under the title of "The Boston and Lowell Railroad, The Nashua and Lowell Railroad and The Salem and Lowell Railroad," by Francis B. C. Bradlee, the Essex Institute, Salem, Mass. This is a companion book to that on the Eastern Railroad by the same author, published in 1917. Much interesting matter relating to the early rolling stock, time-tables and other features of the road is included, as well as the names of many of the officials connected with the enterprise. The relation of the railroad to steamboat operation is told in full, and the successive additions to the system of other lines down to the present complicated network of the Boston and Maine Railroad is shown. The tables of statistics regarding locomotives, cars, the cost of different parts of the system, income and expense, which are appended, will be found of value. As in the case of the preceding book, the illustrations have been made a feature. The price of this book is $1.50.

# Letters from Practical Boiler Makers

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

## New Steam-Wagon Boiler

The problem that confronts the designer of a steam wagon for use in England is almost entirely one of weight saving. The production of a workable wagon is comparatively simple; the production of one that will be within the legal axle-loads when loaded is difficult.

The principal item that permits of novelty and ingenuity in design is the boiler. The chassis and engine have probably been reduced to the lowest limits that they will reach for some time. At any rate, the two common types of wagon, the under-type and the over-type, are now fairly standard. Only in the boiler does any variation appear, and therein a great deal is to be found.

The latest, and one of the most ingenious, is illustrated above. The design is due to the manager of the traction department of Messrs. Robey and Company, Ltd., of Lincoln, England, who can justly claim, for his years, an unrivalled experience in the manufacture and use of road vehicles, since he has been so engaged since his early youth. He is known, too, as the designer of the Clayton 110-horsepower chain tractor, the most powerful tractor of its kind ever built.

The novelty in the boiler now under consideration lies in its low weight per square foot of heating surface and its cheapness in construction.

In view of the diversity of opinion as to the proper form of box for combustion, it is interesting to note the constricted area in the upper region of this one and to learn that its performance has given the fullest satisfaction, even when run on coke.

It will be noticed that the chief saving in the cost of manufacture lies in the elimination of firebox stays. The firebox is circular in plan and is pressed in two pieces, which are riveted together with butt straps. Screwed stays are thus abolished, an economy of material is made, and a good many rivets are done away with. Further, there are no longitudinal stays in the barrel. The front tube plate above the tubes is stiffened and the back plate of the firebox is self-supporting.

Another interesting feature of the design, which is not inherently a boiler detail, is the carriage of the crankshaft on a large spindle which passes through the steam space above the firebox. The customary way of carrying the crankshaft is by extending the side sheets of the firebox casing upwards and bolting the bearings thereto. These extensions, known in England as horn plates, are thus abolished and the crank shaft rests on the fixed shaft mentioned above. A considerable economy in the arrangement of the engine results.

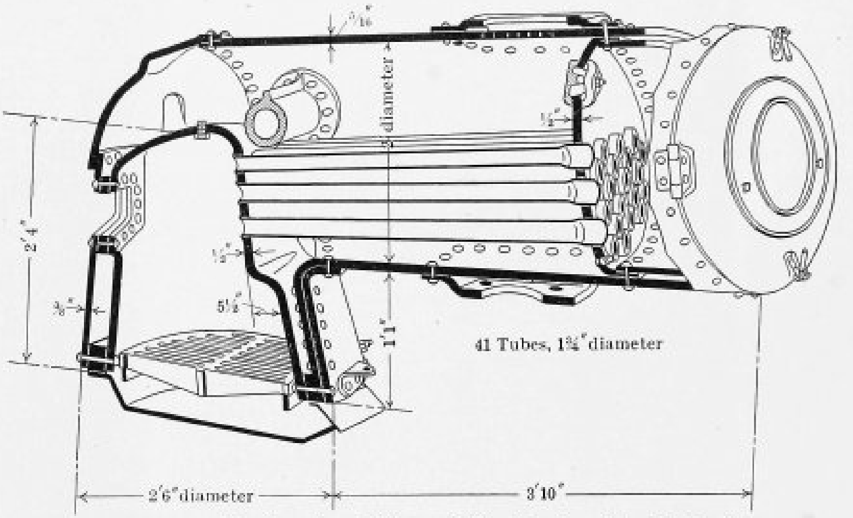



Fig. 1.—Steam-Wagon Boiler Developed in England

The cylinder is bolted, as usual, onto the seating that is to be seen on the top of the barrel.

The weight of the boiler in working order is 1,500 pounds and the heating surface and grate area are 74 square feet and 3 square feet respectively.

London, England. Charles Russell.

## Layout of Plates for Egg Buoy

The accompanying drawing illustrates the method of developing the plates for making an egg buoy, which is generally used for marking the position of wrecks or other temporary obstructions to the fairway in navigable channels and rivers.

First draw an arc through the center of the thickness of the shell plate, producing this arc to intersect the center-line at point *a*, as in Fig. 1. Mark off any convenient numbers of points on this arc, as *b*, *c*, *d* and *e*; it is not necessary to have the points equally spaced. Draw circles equal to the diameters at each of the chosen points, as in Fig. 2, and if the buoy is to be made with three plates in the circumference, draw lines 120 degrees apart to indicate the circumferential width of the plates between center-lines of rivets. If four plates were to be used, these lines would be 90 degrees apart.

Next, with *ab*, *ac*, *ad* and *ae*, as measured along the arc *ae* in Fig. 1, as radii, draw circles as in Fig. 3. Step off on each of these last arcs in Fig. 3 the length of the respective circles between the 120-degree lines in Fig. 2 and join the points so fixed by a curve. This curve will be the centerline of the rivets, and by drawing another

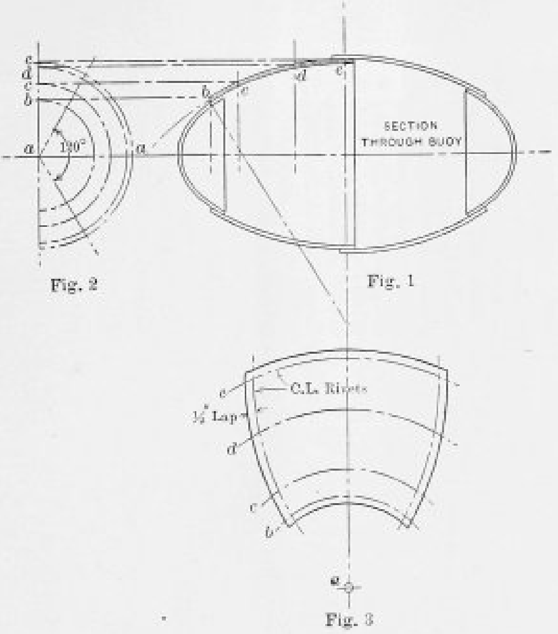



Fig. 1.—Method of Developing Plates for Egg Buoy

line parallel to this line at a distance equal to one-half of the lap the plate is completed.

The proof of this construction is that the distance from *a* in Fig. 1 to points *b, c, d* and *e* is obviously equal all the way around the buoy, and therefore on the flat plate will be circular with radii, equal to the lengths *ab, ac, ad* and *ae*, as in Fig. 3.

The width of the plate measured along the arcs in Fig. 3 is, of course, the length between the 120-degree lines measured along the circle, equal to the diameter of the buoy at the point in question.

## Staybolt Structure

Having noticed an article in the August issue of The Boiler Maker entitled "Staybolt Notes and Suggestions," kindly allow me a small space in your valuable magazine for a few remarks on this subject.

Two methods have been stated for reducing the diameters of vertical stays. Which is the better method? I am of the opinion that it is best to reduce the diameters of vertical stays before threading. This can be done at the blacksmith shop. In the first method mentioned the operator would have to cut the thread the full length of the vertical stays, thus doing work that is uncalled for. In addition, the thread would have to be shaved off and the diameter reduced. That means three separate operations one bolt has to undergo, where one is all that is required in the blacksmith shop.

It is also stated that horizontal stays having continuous threads are very tedious to install. That is quite right. Boiler manufacturers realized that it was not practical to put continuous threads on stays, so the stays with the reduced diameters made their appearance several years ago.

"The brutal method of clipping excess staybolt lengths, or the worse practice of nicking them with a set and breaking them off with a hammer, do not induce good workmanship." They certainly do not, and I am of the opinion that this procedure has been done away with in up-to-date shops.

In this country excess lengths are often clipped by means of a bald cutter and a 6-pound maul. About three blows are struck on the topside of the stay, then it is turned half way around so that both cuts may be opposite each other. Then by means of a piece of pipe a little larger than the diameter of the stay inserted over its entire length the danger of bending is eliminated and a straight bolt ready to be painted up for the next hole is insured. This method is not in vogue at present except in small shops, for modern machinery has done away with the practice.

The article further states that telltale holes may be used to advantage by locating either an electric or an air drill in the center and machining away the excess length. If the length to be machined is not greater than half an inch, would not the cutting torch in the hands of a skillful operator be more practical? Machining off excess lengths of stays was the practice years ago, but has been replaced here by the cutting torch. The stay is annealed during the process of cutting, which makes it easier to drive.

To quote from the article: "It might be well to increase their size (telltale holes) and utilize the hydraulic riveter so that a taper drift can be forced into a 5/16-inch hole, making it ⅜-inch."

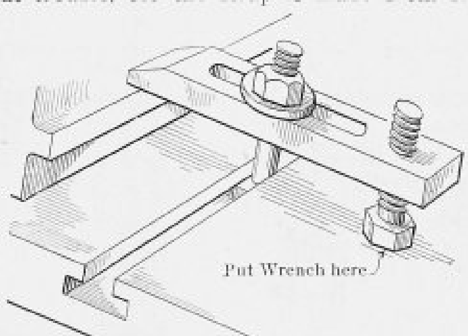
Would it not weaken the bolt by enlarging this hole to ⅜ inch? If it were practical to enlarge the hole to ⅜ inch, I am of the opinion that the air hammer would be the machine to use, as it would be quicker and more economical than the hydraulic riveter.

Most boiler shops nowadays are modern and up to the minute in boiler practice. Their main aim is to outthink the other fellow. To get the work out calls for quite a little mechanical and executive ability.

Youngstown, Ohio. William J. Kelly.

## Unique Machine Strap

Those who operate a drill press or milling machine will appreciate the novel strap that is shown herewith. With the old plain U-shape strap it is always necessary to hunt up blocking to use under the outer end of the strap, and not always can one find just the right thickness of blocking, so washers, etc., have to be hunted up. This strap, designed by a practical shop machinist, does away with that trouble, for the strap is made from steel bar




Strap for Holding Work on Drill Press or Milling Machine

stock with a slot in its center for the regular holding down bolt. A bolt hole is drilled and tapped in the outer end of the strap to take an adjusting bolt. In setting up work, to level up the strap unscrew the bolt.

# Selected Boiler Patents

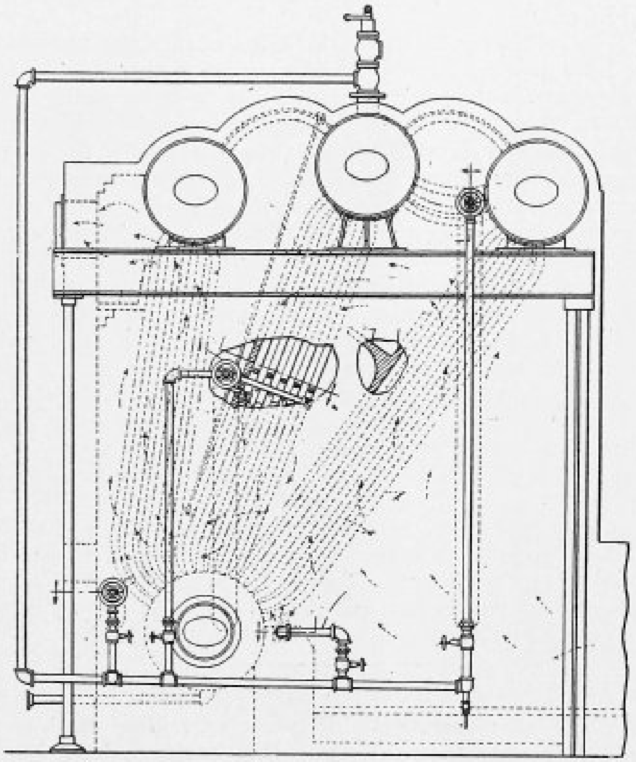
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney, Washington Loan and Trust Building, Washington, D. C.

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

1,317,345. SOOT-BLOWER FOR BOILERS. LEO JNO. BAYER, OF ST. LOUIS, MISSOURI, ASSIGNOR TO BAYER STEAM SOOT BLOWER COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

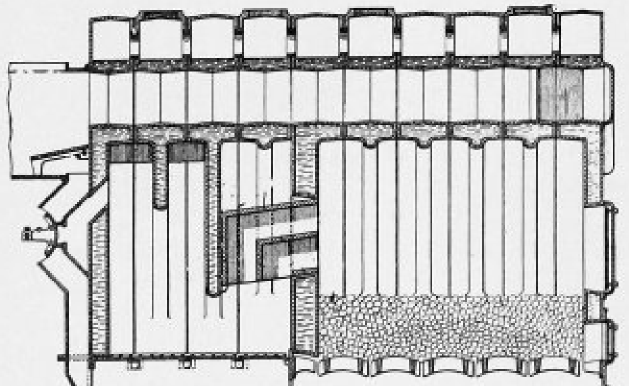
*Claim* 1.—In a boiler of the character described, a jet-pipe provided with peripheral openings, a casing or sleeve surrounding the same and



spaced therefrom and forming an airjacket around the pipe, the casing being provided with vent openings, and a vent-pipe disposed in the jet-pipe having an intake terminal open to the atmosphere through the wall of the jet-pipe at a point beyond or outside the casing, and having a discharge terminal opening through the wall of the jet-pipe into the air-jacket formed by the casing. Two claims.

1,318,123. SMOKELESS BOILER. EDGAR C. WILEY, OF LYNCHBURG, VIRGINIA, ASSIGNOR OF ONE-THIRD TO ERNEST J. F. WILSON, OF LYNCHBURG, VIRGINIA.

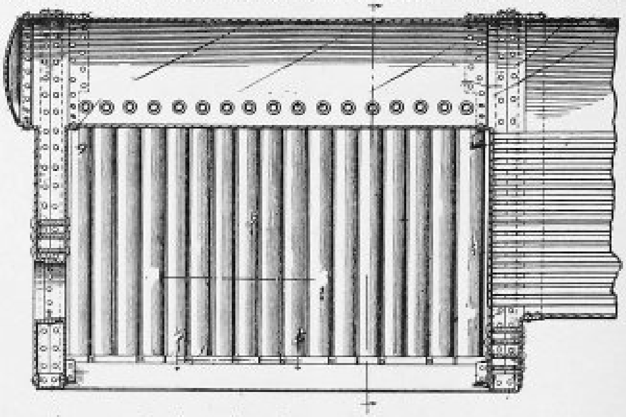
*Claim* 1.—A boiler provided with a bridge wall between the fire chamber and the combustion chamber and having an opening there-through,



and a flue structure for gases of combustion, separate from the bridge wall and passed through the said opening, and having its major portion extended beyond the bridge wall into the combustion chamber and fitting the walls of said opening freely but snugly, said flue structure being angular in form and having a series of angular ducts arranged in horizontal rows, and having a downward slant toward its rear end where it opens into the combustion chamber, whereby it has a normal trend toward the combustion chamber and is held by gravity against liability of falling into the fire chamber, and may be introduced through the opening in the bridge wall and removed therefrom through the fire chamber without requiring any dismantling of the boiler structure. Fifteen claims.

1,320,236. FIREBOX FOR BOILERS. ROBERT JOY, OF OSWEGO, NEW YORK.

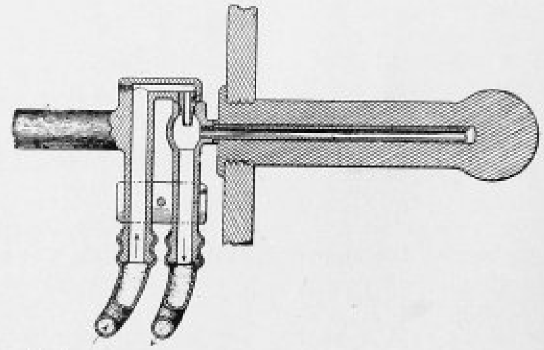
*Claim* 1.—A boiler firebox having a water circulating mud sill, top water circulating means, upright water circulating tubes at their up-



per ends communicating with said means, the lower ends of said tubes having contracted necks opening into said sill, and blocks on said sill fitting and closing the spaces between said necks and protecting the necks against injury from within the fire box. Six claims.

1,317,693. MEANS FOR CLEANING BORES OF STAYBOLTS. JOHN ROGERS FLANNERY AND ETHAN I. DODDS, OF PITTSBURGH, PENNSYLVANIA, ASSIGNORS TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

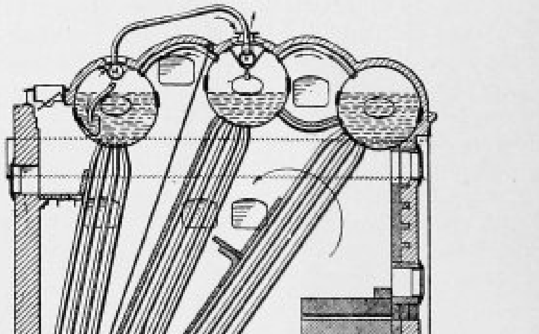
*Claim* 1.—In a cleaning device, the combination of a manually operable head having a suction chamber, and means for creating a suction,



and a tubular boring tool secured to said head and communicating with the suction chamber, the said tool adapted to be entered into a bore open at one end and closed at the other.

1,318,509. WATERTUBE BOILER. JAMES P. SNEDDON, OF BAYONNE, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

*Claim* 1.—A watertube boiler having three transverse steam and water drums connected by banks of tubes to a transverse water cham-



ber, steam and water circulators connecting the steam and water drums, a dry pipe near each end of one of the steam and water drums, a steam collecting pipe in one of the other steam and water drums, and nipples connecting the said dry pipes with said collecting pipe, and a steam outlet connection from said collecting pipe. Three claims.

# THE BOILER MAKER

MARCH, 1920

# Methods of Welding Locomotive Fireboxes

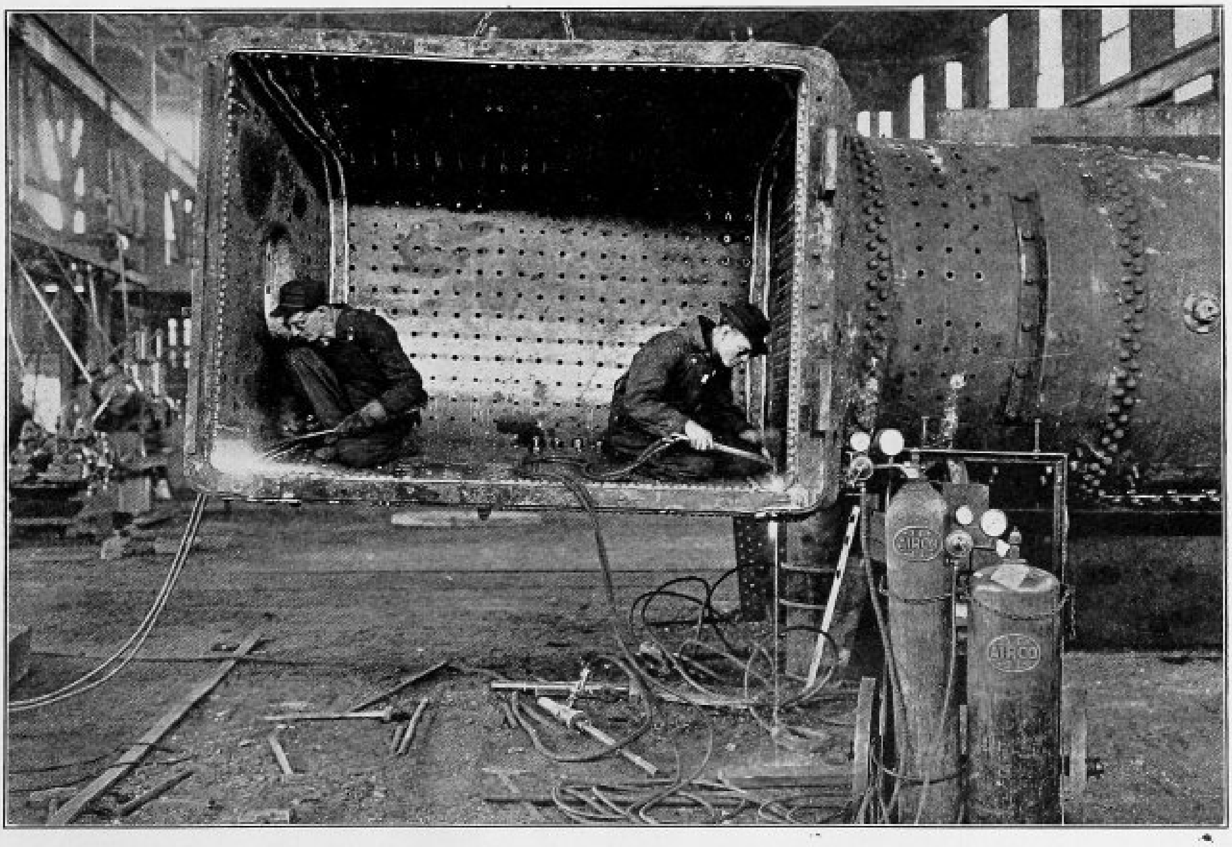
BY GEORGE L. WALKER AND R. T. PEABODY*

*The importance of following the very best practice in the application of autogenous welding to boiler work cannot be over-emphasized. In fact, the future of welding, in so far as it applies to boiler construction, depends on using the best materials and workmanship in such a way that the finished product is safer than if the seams had been riveted. The disastrous accidents cited in the report of the chief inspector of the Bureau of Locomotive Inspection which were in part caused by the failure of welded seams must never be repeated. Thus with the idea of presenting some of the best methods of oxy-acetylene firebox welding, developed by experts, the following instructions are given.*

The prompt action of the Steam Boiler and Flywheel Service Bureau in establishing a definite standard of inspection for welded repairs has done a great deal to prevent the recurrence of past accidents caused by the failure of welded seams. In the future there remains only the education of the men working on the boilers themselves in the best methods of handling the work to ensure the entire elimination of the danger element from welding boiler seams.

The abnormal heat strains to which locomotive fire boxes are subjected cause the gradual development of leaks in riveted joints and finally lead to the laying up of the locomotive repairs. Naturally the attendant losses become of vital importance to the successful operation of a road.

* Members of the engineering department of the Air Reduction Sales Company, New York City.




Welding a Locomotive Firebox at the Seabord Air Line Shops, Portsmouth, Va., by Means of the Oxy-acetylene Torch

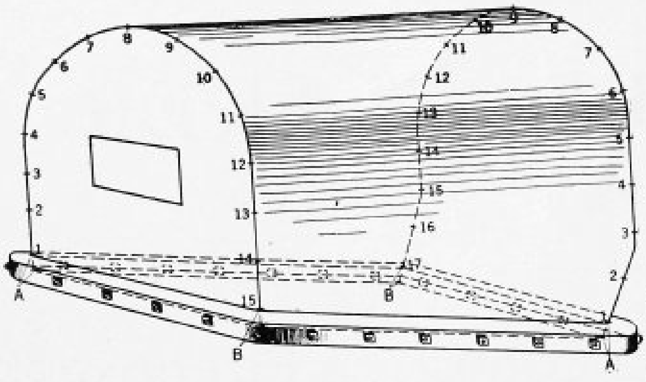


Fig. 1

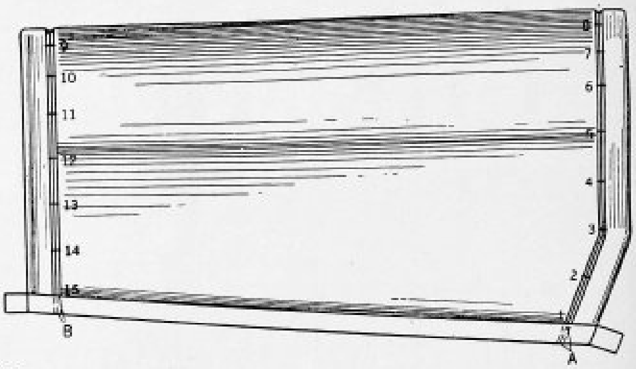


Fig. 2

Oxy-acetylene and electric welding have reduced the length of time required for repairs to a minimum, by eliminating the work required when riveting is done. Increased joint efficiency and tightness, together with greater allowances for expansion, follow the proper application of the process, of course depending on the skill of the operator.

A great many of our readers are no doubt familiar with this phase of oxy-acetylene welding, but as the following

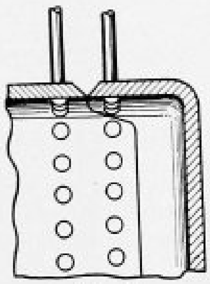


Fig. 3

data are quite clear in dealing with specific repairs in the firebox the information may well be used as a guide to the best welding practice in connection with such repairs.

### Full-Welded Fireboxes

It has been found that the welded joint of a firebox is stronger, more economical, will not leak and has more durable expansion and contraction properties than a riveted seam. Because of this, full welded fireboxes are gradually replacing the old type with riveted seams.

One practical method of carrying out the full welding process of firebox construction is to place the firebox upon the mud ring *AB, AB,* Fig. 1, and bolt it fast.

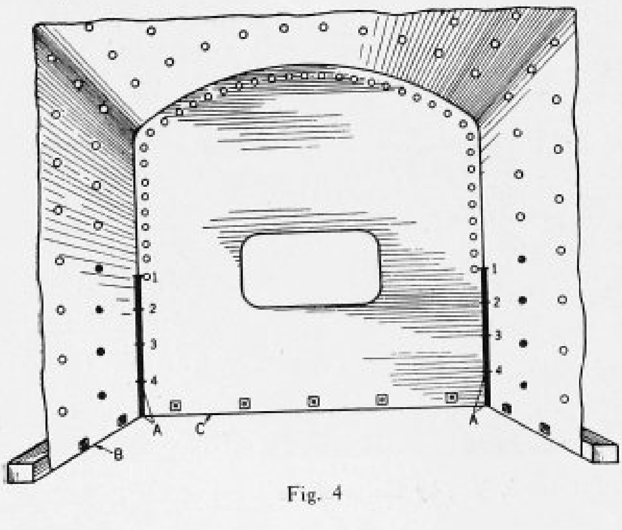


Fig. 4

Prepare to weld the outside, or water side—for example, the flanged flue sheet to the firebox, as shown at Fig. 2—by cutting a bevel of about 45 degrees all the way along its edge from mud ring to mud ring. Now bevel the matched edge of the firebox in like manner. The beveling should be done with a cutting torch set with a number 1 tip. The best practice is to make the flange of the flue and door sheets so as to include a row of radial staybolts, Fig. 3.

Set the firebox so that the weld joint remains open at the bottom, about 3/16 inch, Fig. 3, to allow for expansion, to clinch the welding metal and ensure a perfect weld

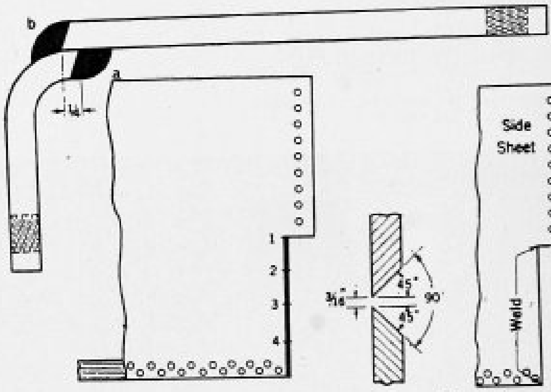



Fig. 5 Fig. 6

through the vee. Start the joint by welding it for about an inch just above the mud ring at 1, Fig. 1, using a 3/16-inch or 1/4-inch welding rod. From a point about 10 inches above the mud ring, weld downward from 2 to 1. Then, continuing the method, weld from 3 to 2, from 4 to 3 and so on. These operations will prevent the spreading of the joint from unequal expansion. Add enough welding rod to raise the surface of the weld about 1/8 inch above the original metal. If practicable, a second welder should follow the outside welder and smooth-flow the joint on the inside while it is red hot. This will be certain to make the joint tight.

Working from the inside, weld the firebox to the mud-ring at the corners *A* and *B*, Fig. 1.

Finally, weld on the door sheet in a similar manner to the flue sheet.

### Semi-Welded Fireboxes

It is not at all times possible or practicable to utilize the full-welded type of firebox construction, so the semi-welded form was developed in which the lower vertical joints of the flue and door sheets are welded to the side

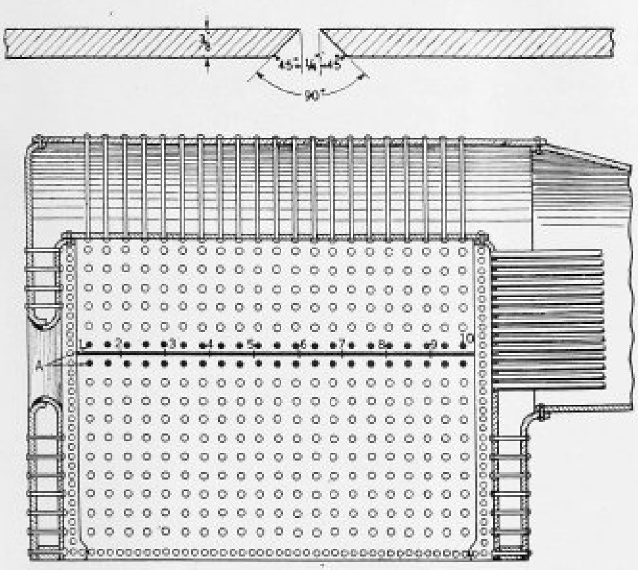



Fig. 7

sheets instead of being fastened with rivets. By this means, riveted joints in the fire zone are avoided, with a consequent elimination of leakage. Oftentimes the welding process is extended to the bottom horizontal joint of the firebox and the mud ring for a distance of about 12 inches from each corner. Here the work may be carried

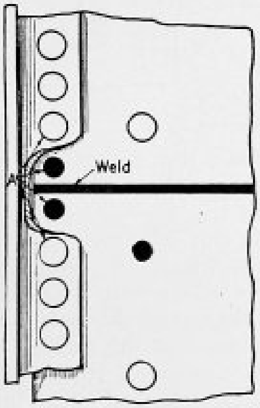



Fig. 8

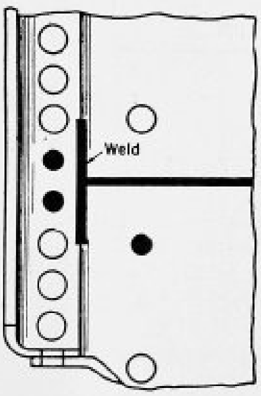



Fig. 9

on by bolting the firebox to the mud ring and riveting the flue and door sheets to the side sheets to within about 36 inches from the mud ring. Omit the rivet holes along the corner joints to be welded from 1 to *A*, Fig. 4. Also leave out temporarily the rivets next to the top of the joint at 1.

Prepare the side sheets as shown in Figs. 5 and 6 by cutting into the flange about ⅝ inch, so that it can be set down flush. Butt the joints and bevel both edges at about 45 degrees on the outside of the firebox. Leave a 3/16-inch opening at the bottom of the vee. Some welders have used a lap weld like that illustrated, but it does not make a strong, tight joint. The butt weld as shown is the best for this work.

Next tack-weld the flange at 1, Fig. 4, starting on the outside at about 10 inches below 1, weld from 2 to 1, then from 3 to 2, and from 4 to 3. Complete the joint by welding on the inside from *A* to 4. Weld the other three corners in like manner.

If a second welder is available, the weld should be flowed on the inside while being made.

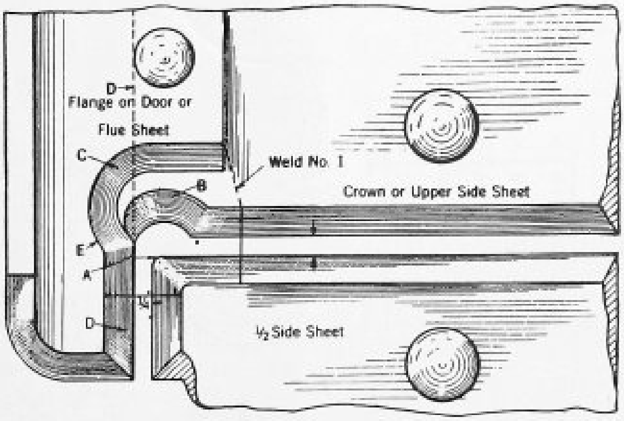



Fig. 10

### Welding Half Side Sheets

When half side sheets are welded along the horizontal joints to the crown sheets and riveted to the mud ring at the bottom and to the door and flue sheets on the sides they are termed semi-welded half side sheets.

The long seams should be welded before the door and flue sheets are set. Bevel the edge of the half sheets and the corresponding edge of the crown sheet as shown in Fig. 7. Screw in the second row of staybolts and bolt the sheet to the mud ring before commencing the welding operation. To avoid delay, however, all of the staybolts except the rows adjacent to the weld may be screwed in and set, and the side sheets riveted to the mud ring before welding.

Weld about 2 inches of the joint at 1, Fig. 7. Then beginning at 2, about 10 inches from 1, weld back to 1, then from 3 to 2, and so on to the end of the joint. The door and flue sheets should next be riveted in.

If the side sheets are to be put in after the door and flue sheets have been set, the flanges of the door and flue sheet should be heated and raised as shown in Fig. 8, in order to allow the part of the joint under the flange to be bevelled.

When new door and flue sheets are put on, the adjacent rivets *A*, Fig. 8, should be left out until the welding is completed.

Fig. 9 shows the practice of welding the end of the long seam when it is desired to change an old riveted joint to a welded one. The vertical weld should be carried to the second rivet each way.

It is sometimes advisable to weld in the three edges of the half side sheet instead of using rivets at the top or sides.

In this case cut out the flange of the door or flue sheet

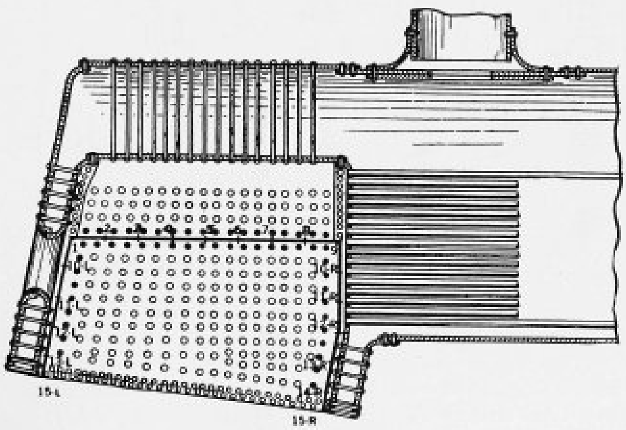


Fig. 11

next to the joint of the crown and half side sheets, as shown at *A* and *D*, Fig. 10. Then bevel the flange, including rivet hole *C*, and set it flush with the half side sheet. Bevel the crown sheet, including the rivet hole *B*.

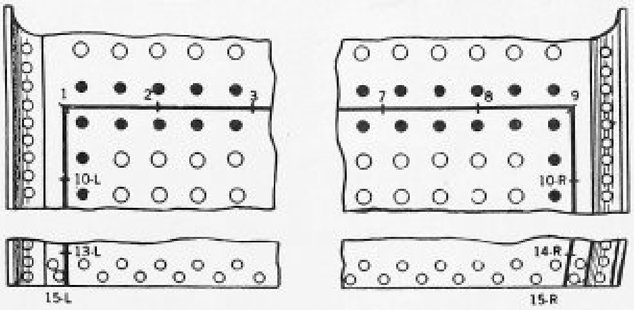


Fig. 12

Set the side sheet so that a ¼-inch space is left at its top and sides, and then bevel these edges. If this sheet is not riveted to the mud ring, bolt it fast. Screw in and set all staybolts except those next to the welds.

Now weld the horizontal seam for about 1 inch at 1, Fig. 11. Then from point 2, about 10 inches from 1, weld back to 1, and from 3 to 2, continuing until the joint is completed. Start about 10 inches down the vertical joint of the door sheet—for example, to 10*L*—and weld up to 1, Fig. 11. Then from 10 inches below 10*L*, at 11*L*, weld back to 10*L*, from 12*L* to 11*L*, and so on to within a few inches of the mud ring.

Weld the flue sheet joint the same way as the door sheet, from 10*R* to 9, Fig. 11, from 11*R* to 10*R*, down nearly to the mud ring. Weld the bottom of the joints to the mud ring at 15*L* and 15*R* last.

When the flanged joints of the door and flue sheets are in good condition, but the rest of the plate needs renewing, a good job may be performed by setting in the half side sheet, as shown in Fig. 12. It should be tacked at 1, then welded from 2 to 1, 3 to 2, and so on, following the practice described above.

## Cracks in Side Sheets

When cracks occur in side sheets between staybolt holes they are not easily welded because of the difficulty of making proper allowances for the expansion of the metal. In fact, if a side sheet has many cracks like those shown in Fig. 13 it would be better to put in a new sheet rather than resort to welding. Much welding of side sheets is being done, however, and the following method may be successfully used when the staybolt holes are to be closed.

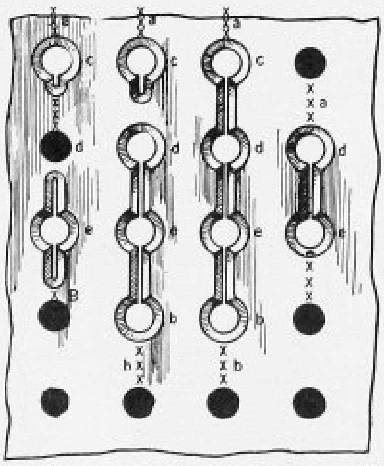


Fig. 13

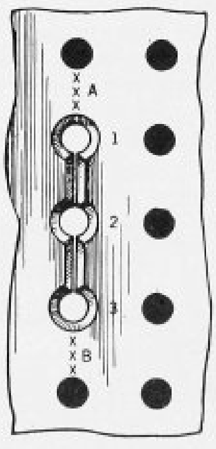


Fig. 14

To weld a crack like that of Fig. 14, bevel the sides of the hole and crack, as shown in Fig. 15.

Prepare for each hole a soft steel disk about 3/16-inch thick and of ¼ inch smaller diameter than the hole. Bevel the edges of the disk, as shown in connection with Figs. 15 and 16. Melt a piece of welding rod to the disk, to serve as a holder, hot-bending the rod.

Place the disk in the hole and melt down the upper edge *a*, Fig. 16, to tack the disk in position. Preheat the metal between the two holes at *xxxA*, Fig. 14, and keep it red hot. Melt off the rod and complete the welding of the disk into the hole. Now allow the hot section *xxxA* to cool with the weld at 1. This provides for uniform shrinkage.

Weld hole 2, Fig. 14, in the same way, and then weld the crack from 2 to 1. Preheat the section *xxxB* when welding the last hole of that line. The weld should be reinforced, as shown by the details in Figs. 15 and 16.

In some cases where it is not practicable to replace a badly cracked side sheet by a new one, or to put on a patch, the welding may be done as follows:

Referring to Fig. 13, preheat the top of the left row of holes at *xxxa*. Then weld in hole *c* of this row. Preheat the area *xxx* down to *d*, as well as that at *xB*. Weld the crack at the bottom of the hole *e* of the first row, then the staybolt hole *c*, the crack at the top of this hole, and finally weld the joint around the head of the staybolt *d*, which is assumed to be in good condition. Reheat the area *xxxa* to relieve the shrinkage strains, and let the job cool down before proceeding with the other rows.

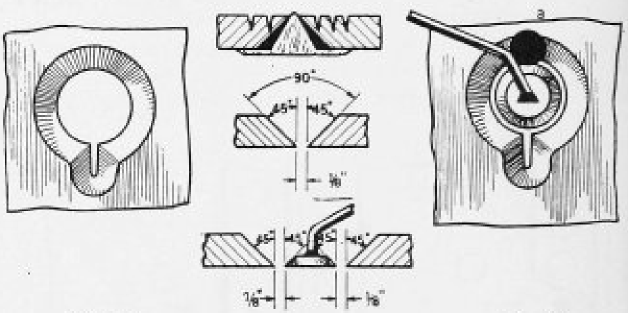


Fig. 15 Fig. 16

Weld the last row on the right next by preheating at *xxxa*, filling the holes at *d* and *e*, and then the crack between them. Reheat the lower part of the row at *xxx* and allow the whole job to cool uniformly. Now weld the second row from the left in the usual way and allow the sheet to cool again. Weld the third row from the left last, which is done in this case because it is the longest continuous crack.

## Door and Flue Sheets

The method to be followed in preparing to weld door and flue sheets is similar to that described for a full-welded firebox as shown in Fig. 17. In the full welding of door and flue sheets, however, the work is done on the outside at all the joints except the one with the crown sheet. That part of the welding is to be done on the water side unless the radial staybolts are in the door sheet, when the welding must be completed from the inside.

The first operation in doing this job is to fit and bolt the door or flue sheet to the mud ring.

Bevel both edges of the vertical joints on the inside, leaving a 3/16-inch opening at the bottom of the vee, Fig.

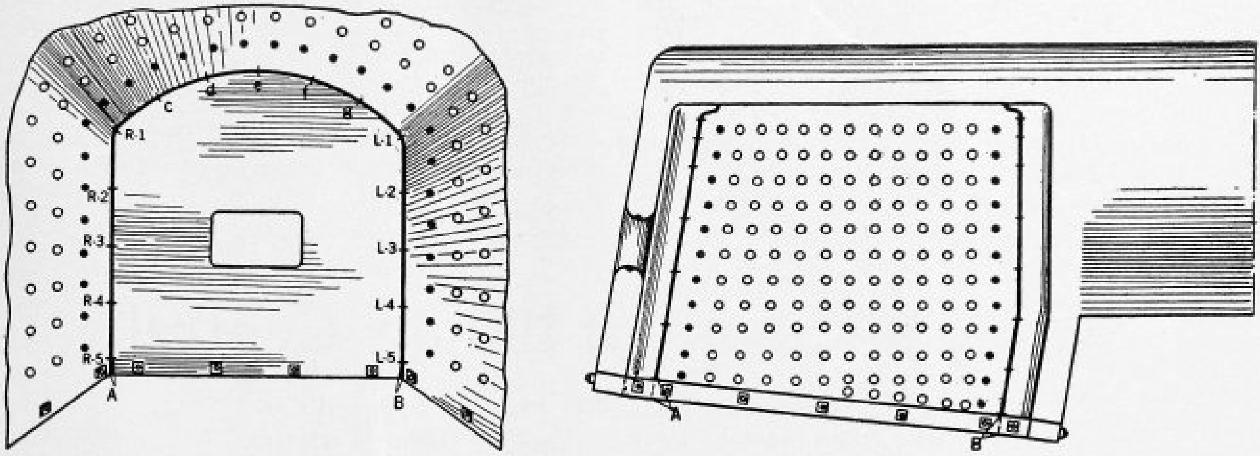



Fig. 17

18. Now bevel the joint with the crown sheet on the outside. The door and flue sheets should be flanged, as shown in Figs. 19, 20 and 21.

Tack-weld the joint for 1 inch at *R1*, Fig. 17. Then drop down about 10 inches and weld from *R2* up to *R1*, from *R3* to *R2*, so continuing to *R5* and welding last on *A* on the mud ring. Assuming that the radial staybolts are not in the door sheet, both the door sheet and the flue

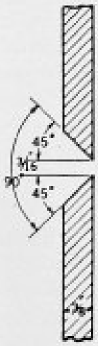



Fig. 18

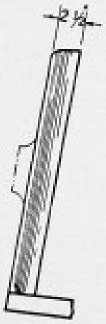


Fig. 19

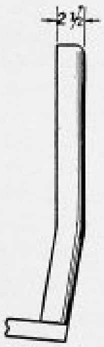


Fig. 20

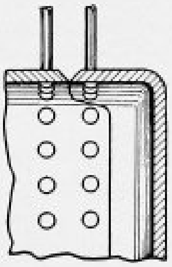


Fig. 21

sheet should be welded on the water side to the crown sheet, starting at *c*, about 10 inches from *R1*, Fig. 17, and welding back to *R1*, from *d* to *c*, *e* to *d*, on over to *L1* and then welding on the inside of the firebox from *L2* up to *L1*, thus welding along until the sheet is finally completed at *B* on the mud ring.

(*To be continued.*)

## Suggestions for Boiler Inspections*

BY C. A. ALLISON

The following instructions are for the annual external and internal inspection of certain types of watertube boilers:

Stop delivering coal to the boiler furnace that is going to be taken out of service.

Burn out the fire in the furnace as quickly as possible and close the damper. When the fire is out, close the boiler stop valve and notice if the auto-stop valve is tight.

Blow all water out of the boiler when the steam is down to 15 pounds.

Blow and clean off all soot from the tubes, superheater and headers.

Take off all handhole plates on the front header and manhole plates on the back of the steam drums. Inspect for leaky handhole plates on the back header; if any are found, remove them and put on new gaskets. All handhole plates on the back header are to be taken off and cleaned every two years.

Inspect the tubes inside the furnace for bags and blisters. If defective tubes are found, cut them out and replace by new ones; mark them when they are inspected.

Inspect all tubes internally for mud or scale. If scale is found, remove the handhole plates on mud drum and use a mechanical cleaner to remove the scale from the tubes.

Inspect the steam drums and water columns, and if scale or mud are found, wash out, clean and scrape.

Inspect the superheater and its connections to the steam drums, also inspect the baffle plates of the feedwater distributor and the dry-pipe for the outlet of steam.

After the scale or mud is removed from the steam drum, inspect the rivets and seams for corrosion, pitting or grooving of the steam-drum plates.

Inspect and clean the side walls, back walls and arches and back connections. If any defective bricks are noticed, have them renewed or repaired.

Inspect the stoker and furnace grates; if defective, repair or renew defective parts.

Take down the steam gage and have it tested to read correctly; mark the date of the test on the gage.

Open the air vent on the steam drum and fill the boiler with water, taking notice while the boiler is being filled of any leaks and marking them.

After the boiler is filled with water up to the top of the steam drum, close the air-vent valve and raise the water pressure to 100 pounds. Then inspect the boiler for any leakage. If there is any leak that cannot be stopped while under a water pressure of 100 pounds, remove the pressure and blow down the water, so as to be able to stop the leak.

After attending to the leak, put the boiler under water pressure again at, say, 100 pounds for a start, inspect the boiler, and if tight at that pressure, raise the pressure to 200 pounds so as to be sure that the boiler is tight.

If the boiler is found to be watertight under 200 pounds pressure, open the blowdown valve and remove the pressure from the boiler, open the vent valve on top of the drum and blow down the water until it shows one inch in the gage glass.

When the work herein outlined is completed, the watch engineer or boiler room engineer is to inspect all apparatus and see that it is ready for service.

* Reprinted from *Power*, December, 1919.

If everything is found to be in proper condition, close all doors, fill the stoker hopper with coal and start a slow fire.

When steam begins to blow from the vent pipe on top of steam drum, close the vent valve and allow the pressure to rise to 20 pounds. When this pressure is obtained, blow out all water from the superheater, close the superheater valve and allow the pressure to rise slowly at a rate not to exceed 50 pounds per hour. It may finally be allowed to rise to within 5 pounds of the working pressure. When this pressure is obtained, open up the boiler stop-valve and connect the steam main and the boiler together.

After the boiler stop-valve is opened up, the boiler is ready for service, and a regular fire is to be maintained in the furnace. The task of external and internal inspection is now completed.

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# McComb Shops of Illinois Central

## Methods of Efficiency Practiced in Plant—Simple and Convenient Labor-Saving Devices Used—Welding Facilities

BY JAMES F. HOBART

During the past year, it was the good fortune of the writer to be able to pay a visit to the McComb, Mississippi, shops of the Illinois Central Railway, and it proved to be a very pleasant and profitable one indeed. Between 150 and 175 locomotives are cared for in these shops, and all the necessary boiler and tank work is done here. Fireboxes are replaced, patches applied—in fact, everything is done save the actual making of new boilers, which is not attempted nor found necessary in these shops.

From one end of the extensive plant to the other, not alone in the boiler shop but in all the other departments as well, the writer found in force and in use exceedingly effective and efficient methods of conserving both material and labor. Seemingly, not a thing went to waste in these shops, not even a pound of scrap metal.

### Economy All Down the Line

It is very evident, even after a short visit to these shops, that the master mind of the superintendent of motive power has organized a system of efficiency and conservation in which he has been most ably seconded by the master mechanic and foreman boiler maker, and undoubtedly by the other department foremen with whom the writer did not come in contact.

Economy and conservation begin with the receipt of a locomotive for repairs and also with the receipt of each and every pound of material. The saving is continued all through the repair of the locomotives. When material is received at this shop it is carefully placed where it will not deteriorate and where it is available for use without undue loss of time or of labor in getting it when needed.

### System of Charges and Credits

Whenever the invoice of any material has been received at the McComb shops it is charged to the shop departments to which the material in question may belong. Every dollar paid for labor is also charged to the department which used that labor, and after the "box score" has been made at the end of the month, too large expenditures of either material or labor as compared with the work turned out by that department are classed as "errors." If this happens in the boiler shop the foreman has an excellent opportunity to display his talent for making explanations and excuses as to WHY the work cost more than it should have cost.

This matter is carried out very fully indeed, and, for instance, the boiler shop which is charged with every pound of material which goes to that shop is also credited with every pound of scrap which is turned in. The system works about as follows: The storekeeper charges to the boiler shop each bit of material delivered, either upon invoice or upon orders issued to the men by the boiler shop foreman.

It is a hard-and-fast rule in this shop that a man cannot get even a single rivet from the storekeeper without delivering therefor an official order duly made out and signed by the shop foreman or, in his absence, by the assistant foreman. This rule is ironclad and it is in effect all the time! On the other hand, every pound of scrap which the shop disposes of is taken over by the storekeeper, and he gives to the shop returning such scrap due credit at the market price then prevailing. This seems a just method and one which is not thought of by some shops.

### Storing New and Old Material

Whenever any new material is received at the boiler shop it is at once deposited in the place set aside for such material. When any scrap comes from a locomotive during the overhauling work or repairs, scrap material is also at once placed where it is easily accessible, in full view, and remains there until everything possible has been used again or is condemned as utterly unfit for further use, then it is turned over to the storekeeper and removed from the boiler shop premises.

When a locomotive is stripped preparatory to repairs either to firebox or to any other section, the pipe shop takes care of the removal and replacing of all pipe. The pipe shop, adjacent and auxiliary to the boiler shop, also handles the thin sheet metal work. When a locomotive is stripped of its piping, everything in that line is at once placed upon trestle stands in the yard, where pipes may be readily seen and gotten at.

These trestles are made with A-frame heads, about seven feet high, and the heads are joined together by means of ribs of hard wood in which stout pins have been placed at frequent intervals. The pipes are hung upon the pins, being sprawled over the twelve feet length of the trestle, thus disposing of the material in a manner which enables the workmen to select in the least possible time any piece wanted which may be used again.

### Rack for Boiler Tubes

A shed with a watertight roof and side walls—except the front, which is open—is devoted entirely to the storage of tubes. All the new ones and the best of the used tubes are stored in the shed, while the older tubes—those of little or of doubtful value, which are not yet condemned to the scrap pile—are piled in the rear of the tube shed upon runways, which keep the tubes well up from Mississippi clay soil.

A section of the tube shed consists of 3-inch by 6-inch scantlings erected in bays about four feet from each other. The scantlings in each bay were placed with the flat side toward each other and from 15 inches to 24 inches apart, according to the size of tubes to be stored in each compartment.

Holes were bored in the scantlings, through which old boiler tubes, about 2 inches in diameter, were slipped.

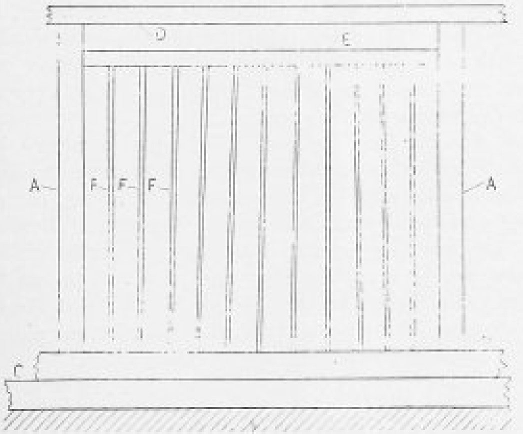

Fig. 1.—Rack for Tender Tank Sheets

The distance between tubes was equal to the distance between the scantlings through which the tubes passed, so as to leave compartments about square for the reception of the stored tubes. The tube storage rack was, the writer noticed, made large enough to receive all the various sizes of steam pipes, as well as the assortment of boiler tubes. In addition, there were also a few compartments in the shed in which were stored the several sizes of angles and other steel shapes used in the shop.

### Storing Steel Plates

The steel plates used for tender and firebox repairs were stored in a similar manner. In fact, an addition to the tube shed was used for plate storage, the same roof covering both depositories. Some idea of the manner of storing steel plate may be obtained from Fig. 1, which is a diagram of the front of that portion of the shed devoted to the storage of thin sheets for tanks of locomotive tenders.

In Fig. 1 two posts of the shed are represented at *AA*, and these and similar ones extend at intervals of about 4 feet entirely across the shed. The sills *B* are spaced to a corresponding distance, each supported upon a solid foundation wall *C*. The timber shown at *D* is one of the plates of the shed, but other timbers are used to tie together the posts of the interior bends across the building.

Timber *E* is cut in between posts *AA* at a height which will accommodate the length of old tubes which must be used at *FFF*, between which the sheets of steel are inserted. The distance between tubes *FF* varies from eight inches to twelve, but the narrower spaces predominate. It requires a little time and patience to slide the sheets endwise into the spaces between the old tubes, but once in there, any sheet in the entire lot becomes instantly available and can be removed in a very few minutes.

### Firebox Plate Storage

Heavier sheets, those intended for firebox renewal, are stored in another shed. Tube sheets and circular heads, already flanged and bumped, are also stored in the heavy plate shed. The plates and heads are all placed in a vertical position, and instead of being retained thus by old boiler tubes, stout pieces of T-iron are employed something as shown by Fig. 2.

In this plate rack the stout T-irons *HHH* are placed upright in solid concrete walls which project a few inches above the surface of the shed floor, which is of natural earth. The vertical T-beams are placed about four feet apart, and the distance between the tees, *HHH*, varies from 6 to 12 inches, accordingly as the spaces are to be used for the reception of plates or of heads already fabricated.

A neat "dodge" was noticed for preventing the wearing away of the concrete *I* by the impact of the plates which would be dragged or thrown against the concrete. All undue wasting away was entirely prevented by the placing upon the wall on each bent thereof a steel plate about 3/16-inch thick, as shown at *J*, the plate being mortised for the reception of the T-shapes *HH*.

The writer has the idea that plates *J* were prepared in advance, before T-shapes *HH* were put in place, and that *J* was used as a template for locating the T's accurately; also, that another strip *J* was slipped temporarily over the tops of *HH* during the placing of concrete wall *I*. Be that as it may, the scheme forms one of the best arrangements for heavy plate storage which the writer has as yet come across. Where such an arrangement could be erected in a large building, with a traveling crane overhead, the storage conditions certainly would be ideal.

Unfortunately, however, these shops were in existence before the traveling crane had reached its present state of development, and the shop must depend upon negro muscle for the handling of plate and other material, although swing-cranes are freely used in the shops.

### A Fine Welding Plant

This shop is equipped with one of the finest welding outfits the writer has as yet come across in any shop. Both oxy-acetylene and electric methods are used and a large room is arranged for welding alone, and no other operations are permitted to be carried on therein. Like most southern shops, the welding room is largely out of doors. In fact, the entire boiler shop consists of a large open shed, well roofed, but open on all sides save where it adjoins the forging shop.

A space about 20 feet square was partitioned off from the rest of the boiler shop, beaded sheathing set up to a

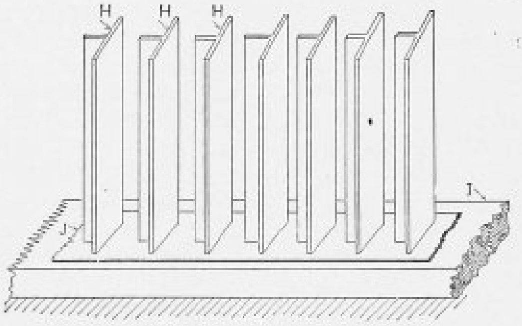

Fig. 2.—Heavy Plate Rack

height of about six feet, then on top of the partition thus made stout slats carried up for another six or eight feet, thus permitting plenty of light and air to enter, but excluding the human element to the extent of a twelve-foot climb.

The six feet of tight sheathing at the bottom of the partitions served to cut off the glare of the electric arc from the rest of the boiler shop, and that such is a necessity is fast being found out by every user of electric welding, for the welding arc certainly does no good to the eye exposed to it.

### Welding-Room Equipment

A portable electric welding machine has been provided and placed upon a four-wheeled truck which was normally

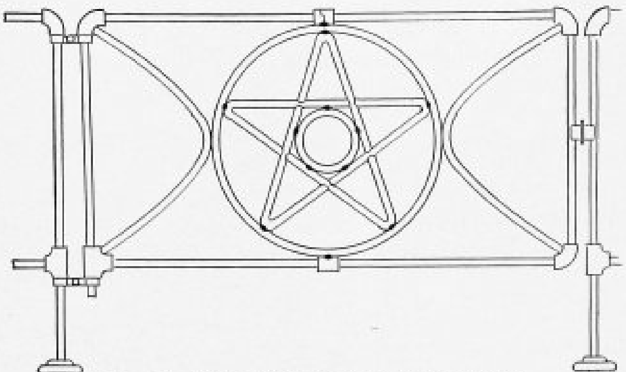

Fig. 3.—Office Gate Designed for the Shop

kept upon a plank platform in one corner of the welding room. For use in the round house or machine shop, the machine upon its truck would be hauled to the work and immediately returned again to its berth after the work had been completed. The machine was not left lying around the shop wherever a job might have been done.

Oxy-acetylene welding and cutting apparatus was also to be found in the welding room, the gas tanks neatly mounted upon two-wheel trucks of great portability. A well-made work bench in one side of the room was furnished with a very strong and heavy vise—large enough for round-house work.

A forge several feet square stood very prominently in the middle of the room. It had been built up about 24 inches from the floor, the top surrounded by a steel band several inches wide and the top of the forge, inside of the band, paved with fire-brick.

Upon this forge the necessary preheating of cast iron and aluminum was done, and all cast iron work, after welding, was heated upon the forge, well covered with fire-bricks and asbestos, and the casting permitted to remain there until cold, thereby undergoing an annealing process.

The cutting torch is used a great deal in these shops. When a locomotive tender comes in to have its tank sheets patched, the cutting torch makes very short work of stripping off the old sheets, also of fastening new ones in place. Oxy-acetylene has heretofore been used largely in pressure boiler work, but since the recent advent of the electric machine all pressure work will be welded by the electric arc, which is also used very largely for restoring wasted places in rods and other steel parts. As one machinist aptly expressed himself: "I've worked in this shop for forty years and they never had a 'putting-on' tool like that before!"

### A Bit of Good Welding Work

A gate made of pipe and fittings for an office railing in the master mechanic's department shows a clever use of the welding torch and indicates unlimited possibilities in that direction. Fig. 3 shows so plainly the manner in which this gate was designed and made up that no detailed description is necessary. It was made of 1½-inch pipe. The hinges were made of flat bar steel bolt-clamped to the floor-fastened post and fitted loose upon the gate end.

The fastening was a spring device, forged by one of the smiths in the shop. The pipes were bent in the pipe department of the boiler shop upon a very simple pipe-bending rig devised by the foreman of that department (pipe and sheet metal). The pipe bender consisted of a metal plate about 2 inches thick and 3 feet long by about 2 feet wide. A heavy sheave about 7 inches in diameter was mounted upon a journal fixed near the center of the plate. The rest of the plate on all sides of the sheave was drilled full of holes about 1¼ inches in diameter and spaced about 3 inches on centers.

A turned pin, made to fit snugly in these holes, could be placed near to or far from the sheave, as desired, and a pipe bent by pulling it around either the sheave or the pin as the sharpness of bend required. For very short bends the pipe would be heated.

The pipe-bending jig was fixed upon a heavy bench just outside the shop and two pipe vises were attached to the bench, one vise for pipe up to 2½ inches, the other having a capacity up to 6 inches in diameter. These vises were direct-acting, operated by an obsolete steam-brake cylinder acting upon the long end of a two-to-one lever, the pipe grip being fastened to the short arm of the lever. With 80 pounds air pressure in the cylinder, no pipe ever slipped or twisted while in either of the vises.

### Air Reservoir "Turn-Buckle" Tool

The foreman of the pipe shop, having to place and remove all the air reservoirs from the boilers to be repaired, found it a costly job to handle the running board reservoirs by man power, the work of placing an 800-pound reservoir under the running board of a locomotive requiring hours of time and as many men as could get around the work.

By use of the little windlass shown by Fig. 4, two colored laborers were able quickly to handle the largest tank. The body of the tool *K* was made of 2½-inch pipe, the handles *L* of 1¼-inch black steel. The holes were for the purpose of inserting eye-bolts to which the hoisting ropes were attached. The hole used for this purpose depended upon the length of the tank or reservoir to be handled.

Two frames, containing the bearings in which handles *LL* could revolve, had been forged from heavy black bar steel. These bearing brackets were made to hook over the back edge of the running board and fasten to the front edge by means of a single clamp-bolt to each bracket. Eye-bolts were also attached to the running board at the back edge, two ropes from the two eye-bolts were carried down to the reservoir upon the floor, passed around it, and back up to the eye bolts in holes *MM*, and made fast.

By turning handles *LL*, the ropes were wound up around pipe *K*, the reservoir came easily up to place beneath the running board and was fastened there while the laborers held handles *LL*. The device saved a good deal of time in the handling of the locomotive air reservoirs which might be located under the running boards.

### Air in the Welding Room

It should have been stated that compressed air had been piped into the welding room and hose connections made

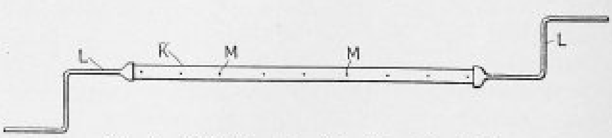


Fig. 4.—Windlass for Handling Air Tanks

thereto for the attachment of "air guns" whenever castings needed to be chipped preparatory to being welded. The welding room was also found to be equipped with ample lockers for clothing and supplies, and in one corner a wash sink with running water has been erected.

The welder managed the floor of his room to his satisfaction. The clay was excavated about two feet deep, gravel put in and well rammed, then several inches of fine sand, provided for sand-box purposes, was spread over the gravel. The smith shop furnaces are heated with fuel oil, of which the welder requisitioned a supply and used it for oiling the sand with which the floor of his room had been covered. The oiled sand would not take fire and it packed very hard and dustless, forming an ideal shop floor.

# How to Design and Lay Out a Boiler—XVII

### Reinforcing the Shell at Pipe Joints—Computing for Feed-Pipe Connections—Location of Feed Water Discharge

BY WILLIAM C. STROTT*

The following table, reprinted from the A. S. M. E. Code, gives the minimum number of pipe threads and the least thicknesses of metal required to give that number of threads:

TABLE 14
MINIMUM NUMBER OF PIPE THREADS FOR CONNECTIONS TO BOILERS

| Size of pipe connection, inches....... | 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 inches......... | 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, inches............ | 0.348 | 0.435 | 0.875 | 1 | 1.25 | 1.5 | 1.625 |

It would appear from this table that, in order to meet these requirements, the only thing necessary would be to rivet a circular steel plate at the point where the pipe is to be screwed into the boiler and then drill and tap a hole clear through both reinforcing and boiler plate, to receive the pipe. This assumption is entirely correct and is the most economical method to pursue, whenever possible. It should be noted that the thickness of the doubling plate is made at least equal to the difference between the depth of thread required by Table 14 and the thickness of the boiler plate. In the case of flat surfaces similar to the heads of our boiler, this construction may be satisfactorily employed, but when dealing with curved surfaces it is in the majority of cases altogether impractical, as will be seen from an examination of Fig. 62.

The dimensions indicated by $x$ represent the maximum depth of perfect thread obtainable. It is best determined by laying out a section of the shell to full or at least half size and measuring the depth of thread available.

In this way the proper thickness of reinforcing plate may also be determined. If desired, two thinner plates, one on each side of the shell, may be applied if a single thickness presents too clumsy an appearance. However, if appearance has any bearing on the proposition at all, the reinforcing pad may be placed on the inside, in which case no calking would be necessary and the application of three or four rivets to hold the pad securely in place would be sufficient. It should be borne in mind that in no case may the thickness of a single reinforcing plate or their combined thicknesses, if two are applied, be less than that of the shell.

### Cutting Threads in Boiler Flanges

In most boiler shops, when threads are thus to be cut in work of large size, the holes must be drilled, reamed and tapped by means of hand tools, and when these are over 2-inch pipe size it is a difficult process to tap the hole absolutely straight. The result is that when the plant is being piped, the pipes extending from the boiler are crooked. It is conceivable how difficult it would be to get steam-tight pipe connections to the boiler under such conditions.

The threads in boiler flanges, however, are cut in a lathe absolutely perpendicular to the face of the flange, and in the case of the flanged nozzles the surface of the upper flange is accurately planed to lie parallel with both centerlines of the boiler. The ultimate effect is obvious,

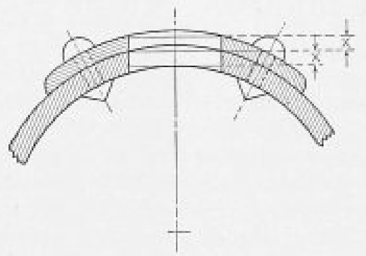


Fig. 62.—Impractical Method of Riveting Curved Surfaces

and the foregoing discussion should have demonstrated to the student when each individual form of construction is best applied.

### Feed-Pipe Connections

We are now sufficiently enlightened on the subject just completed to warrant our proceeding with the actual pipe connections on our boiler.

The feed pipe should be of ample size, at least large enough to supply sufficient water to the boiler when the latter is forced to 150 percent of its rated capacity. One boiler horsepower is equivalent to the evaporation in one hour of 34.5 pounds of water when at the boiling point (212 degrees F.) into steam at the same temperature. This statement should serve to clear up the matter for those who never could fathom the time-worn phrase which ran something like this: "One boiler horsepower is equivalent to the evaporation of 34.5 pounds of water per hour, from and at 212 degrees."

A boiler of the size we are designing is commercially rated at 150 horsepower. The weight of water which this boiler should be expected to evaporate per hour under normal conditions is, therefore, 150 $\times$ 34.5, or 5,175 pounds. In order to provide for a 50 percent overload capacity, we shall figure on a total of 1.50 $\times$ 5,175, or approximately 7,800 pounds water per hour.

Water should not be forced into a boiler at a higher

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.

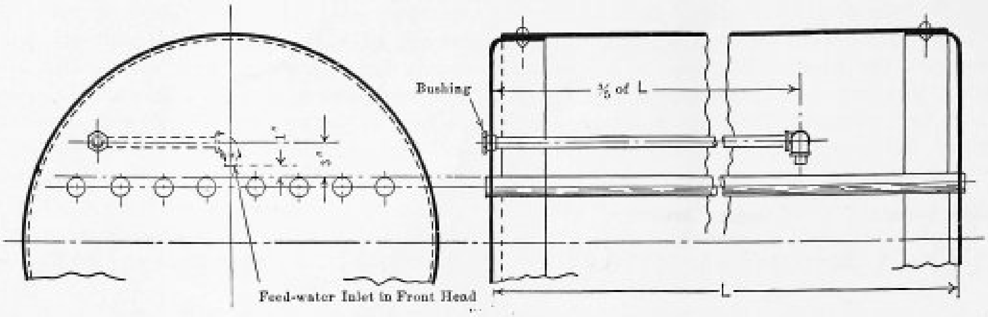


Fig. 63.—Feed Water Inlet Located in the Front Head

velocity than 1.5 to 2 feet per second. The fundamental formula for the flow of water is:

$$(23) \qquad v = \frac{Q}{a},$$

in which:

$v$ = velocity of discharge in feet per second.
$Q$ = volume of water discharged in cubic feet per second.
$a$ = cross-sectional area of orifice at outlet.

One cubic foot of water weighs 62.5 pounds, whence the value of $Q$ in our example becomes:

$$\frac{1}{3{,}600} \times \frac{7{,}800}{62.5}, \text{ or } 0.0347 \text{ cubic feet per second.}$$

Substituting figures for letters in formula (23), we have:

$$2 = \frac{0.0347}{a}, \text{ or}$$

$2a = 0.0347$, whence
$a = 0.01735$ square feet, which is equal to $144 \times 0.01735$, or 2.5 square inches.

By referring to a table of dimensions of standard steel or wrought iron pipe (National Tube Company or Crane Company hand-books), we find that the nearest commercial pipe size giving this required internal area is 2 inches. Although a 1½-inch pipe would probably suffice, it is best when applying formula (23) to any particular problem, and the result for $a$ falls very closely on the internal area of a certain pipe size, to be on the safe side and use the next larger diameter. No factors such as friction and length of pipe have been provided in the formula, but the maximum velocity has been kept quite low to usually give satisfactory results. The percentage of overload capacity is also a factor, and 50 percent is ordinarily quite a large allowance, 25 percent ordinarily being sufficient.

### Feed Water Inlet

The feed water must enter either the front head or the top of the shell, very near to the front end of the boiler. In either case it should discharge about three-fifths the length of the tubes from the front end. The two alternate methods are illustrated in Fig. 63 and Fig. 64 respectively.

Some means must be provided for connecting this internal feed pipe to the source of supply. This is the purpose of the bushings indicated in Figs. 63 and 64. An enlarged detail of these bushings is also given in Fig. 65

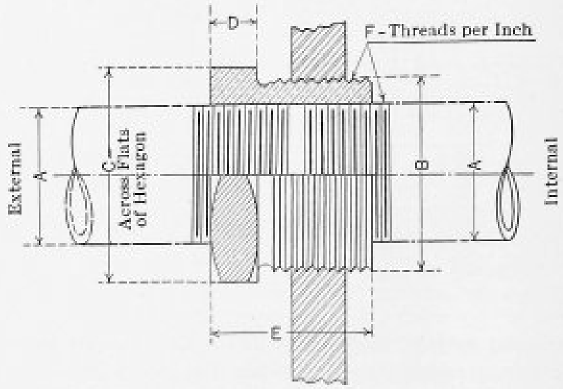


Fig. 65.—Bushing at Connection of Internal Feed Pipe to Source of Supply

The drawing Fig. 65 clearly shows that, in addition to having an outside thread (corresponding to a standard pipe tap) by which they are screwed into the boiler plate, they are also tapped internally from each end. The bushing thus forms an effective coupling for the external and internal feed pipes. Notice the hexagonal collar necessary on the external portion of the bushing, which permits the application of a pipe wrench for screwing it tightly into place. Table 14, in connection with Fig. 65, gives the dimensions of heavy boiler bushings. They may be made of cast steel; but bronze or brass is to be preferred, as the latter material resists corrosion much better. In specifying the size of bushings it is customary to give the internal pipe size first, and then the size of pipe tap in the boiler plate. For a 1½-inch feed pipe we would specify

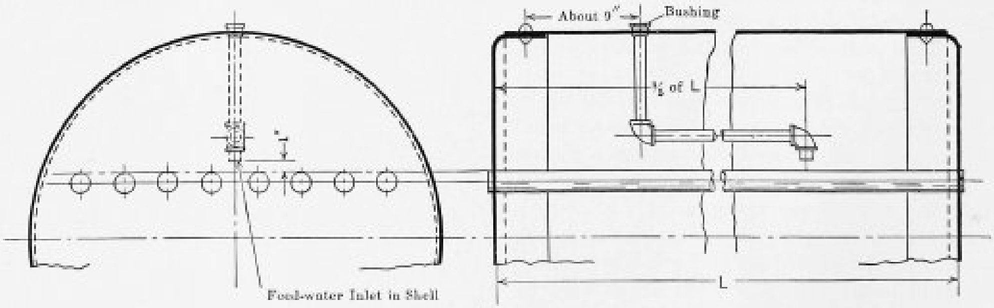


Fig. 64.—Feed Water Inlet Located in top of Shell Near Front Head

(according to Table 14) a 1½-inch by 2-inch bushing, since dimension *B* is the outside diameter of a 2-inch pipe.

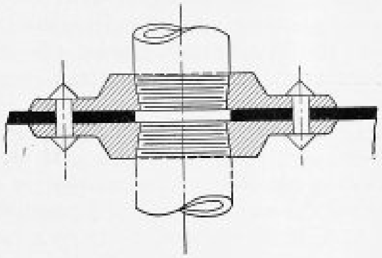

Fig. 66.—Forged or Cast Steel Pipe Flanges Substituted for Bushings

### SIZE OF BOILER BUSHINGS

It should be noted that these boiler bushings are considerably heavier than the standard pipe bushings, which latter should only be employed when it is desired to reduce a tapped hole to accommodate a pipe of smaller size.

TABLE 15
PROPORTIONS OF STANDARD FEED PIPE BUSHINGS, ALL DIMENSIONS IN INCHES

| Nominal Size of Feed Pipe Inches. | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| ¾ | 1.050 | 1.66 | 1¾ | ⅝ | 1¼ | 11½ | 14 |
| 1 | 1.315 | 1.900 | 2 | ¾ | 1½ | 11½ | 11½ |
| 1¼ | 1.660 | 2.375 | 2½ | ¾ | 1¾ | 11½ | 11½ |
| 1½ | 1.900 | 2.375 | 2½ | ¾ | 1¾ | 11½ | 11½ |
| 2 | 2.375 | 2.875 | 3 | ⅞ | 2¼ | 8 | 11½ |
| 2½ | 2.875 | 3.500 | 3¾ | 1 | 2¾ | 8 | 8 |

Instead of boiler bushings for connecting feed piping to steam boilers, two forged or cast steel pipe flanges may be substituted, as shown in Fig. 66. This method is inconvenient when applied to the front head, since, due to the large size of these riveted flanges, interference with the pads of the diagonal braces will be encountered. For a shell feed pipe connection, this construction is to be much preferred; but when a bushing is used in the shell a reinforcement must usually be riveted to the inside or outside of the shell plate, as previously explained in connection with Table 14 bearing on pipe threads in curved plates.

### FEED WATER CONNECTION IN FRONT HEAD

The feed water connection, when placed in the front head, may be located at either the right or left side. The exact location should be specified by the purchaser's engineer. If the boiler is set singly, either position will usually be satisfactory, but preferably on the side nearest the source of water supply. If two or more boilers are set in a battery, then half should be piped up on the left and the others on the right side, as such an arrangement presents a balanced and pleasing appearance. There appears to be no reason why a feed pipe cannot enter the front head in the center, unless it be the objection to having the pipe interposed in the path of the furnace gases which may attack and destroy the pipe in the course of time.

Now with reference to the internal feed pipe itself. This may be of standard steel or wrought pipe, but, as usual for such purposes, brass makes the more lasting job. Due to the corrosive action of water on iron or steel, internal feed pipes made of that material require frequent renewal. It should be borne in mind that feed water shall not discharge in a steam boiler in close proximity to the shell or on riveted joints. It is the aim always to discharge the water at the coolest part of the boiler, since the temperature of the feed water is considerably lower than the boiler plate. If comparatively cold water is discharged against a portion of a hot plate, the latter will be instantly chilled and unequal expansion and contraction of the material will be set up, resulting in injury to the boiler. Probably more explosions have occurred from pumping cold water into an overheated boiler than from any other cause.

As was previously stated, the internal feed pipe must be carried three-fifths of the length of the tubes, towards the rear of the boiler. The purpose of this long pipe is very effective in preheating the incoming water to very nearly the temperature of the water and steam within the boiler. Although most steam power plants are equipped with an auxiliary feed water heating apparatus, the addition of the internal feed pipe is an essential device, in case of a shut-down of the regular heating equipment.

Boilers 36 inches in diameter and under do not require internal feed pipes, but it is good practice in these small boilers to make the connection on the top of the shell a little over half the length of the boiler from the front end. A short pipe extending from the inside of the shell should discharge the water about 1 inch above the top of the tubes.

### POINT OF FEED WATER DISCHARGE

Figs. 63 and 64 also show how the water should be discharged below the lowest safe water line, and at a point between the central banks of tubes. This is conveniently accomplished by means of an elbow as shown. The A. S. M. E. Code further requires that the ends of internal feed pipes shall be open the full size of the pipe. This ruling evidently prohibits the use of special feed water spraying devices designed to heat the feed water by spraying it, through the medium of a perforated pipe or other device, into the steam space of the boiler. The employment of such appliances not only results in the generation of "wet" steam, but also, due to their complex design, they readily become clogged up with scale and rust and make it difficult to discharge water into the boiler as rapidly as may be required. The feed water pipe inside the boiler must be well supported, so that it may lie horizontal and not drag on its connection to the bushing. Pipe hangers made of 1½ by ⅜-inch steel, as illustrated in Fig. 67 (a) and (b), and riveted to the boiler shell, are quite substantial. Fig. 67 (a) shows how to apply this hanger to the longitudinal pipe, and (b) to the cross pipe. Care should be taken when locating these hangers that same will not interfere with braces, openings in the shell, or riveted joints.

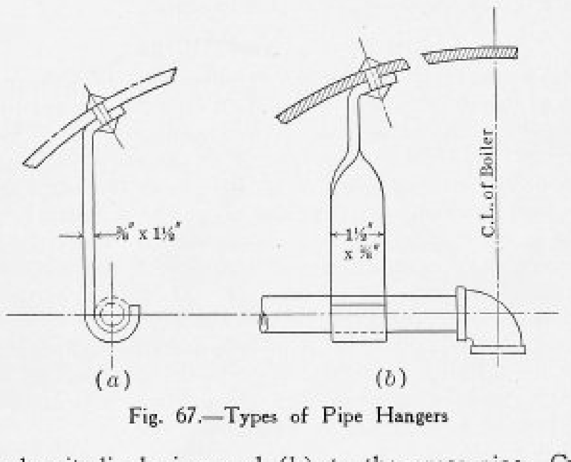


Fig. 67.—Types of Pipe Hangers

(*To be continued.*)

## Interpretations of the A. S. M. E. Boiler Code

Great numbers of questions on the interpretations of sections of the Boiler Code of the American Society of Mechanical Engineers are being constantly referred to the Boiler Code Committee. The final decisions in these cases are important, for they state clearly the meaning the Code intended to convey when first drawn up.

The procedure to be followed when asking questions on the Boiler Code consists in sending a written inquiry to the secretary of the committee, who supplies copies of it to all the members. An interpretation in the form of a reply is passed on at the regular meeting of the members of this committee. The final decision is submitted to the council of the American Society of Mechanical Engineers for approval, after which it is issued to the inquirer and published in the journal of the society.

Some of the more important decisions passed at a recent meeting of the Boiler Code Committee are published below, in the form of questions and answers:

### Wrought Iron Material

Will wrought iron material made by the puddling process be acceptable under the Boiler Code Rules for use in superheated construction where the requirements in the Code specify wrought steel or cast steel?

Where the Boiler Code specifies wrought steel or cast steel for superheater construction, the intent was to prohibit the use of cast iron. It is also the opinion of the committee that puddled wrought iron that will meet the requirements in the specifications for wrought iron in the Code will be a suitable material.

In the case of a watertube boiler of the water-leg type, using large tapered connections from the rear header to the drum, is it permissible to weld the flanged edges of the water-leg sheets instead of butt-strapping them, and also the longitudinal joint of the tapered connection piece if it is amply braced crosswise by staybolts? These welded joints would not be under tension, as the staybolts take all of the pressure load and the possibility of breakage of these staybolts is negligible.

It is the opinion of the committee that this cannot be done and comply with the requirements of the Code. The safety of the structure may be dependent upon the weld to the extent that the interior stresses in the weld, which would be relieved if rupture should take place, may throw suddenly upon the nearest staybolts excess stresses, which might cause the staybolts to fail in series.

### Limiting Staybolt Pitch

Is it necessary, under the requirements of paragraph 186 of the Boiler Code, where door-hole flanges are to be welded and the stress due to the steam pressure is to be carried by the adjacent staybolts, to consider any limitation on the staybolt pitch to secure proper distribution of the load from the door-hole flanges to the staybolts?

It is the opinion of the Committee that, under the requirements of paragraph 186, the door-hole flanges of the furnace and exterior sheets may be joined by autogenous welding, provided these sheets are stayed or otherwise supported around the door-hole opening, and provided that the distance from the flange to the surrounding row of stays or other supports does not exceed the permissible staybolt pitch, according to paragraph 199.

Can a vertical firetube boiler be constructed with an unstayed furnace from 36 to 38 inches in diameter with butt-strap longitudinal seams as required in paragraph 239 of the Boiler Code?

It was not the intent of the Boiler Code that the requirements for longitudinal seams of furnaces between 36 and 38 inches inside diameter should apply to the unstayed furnaces of vertical firetube boilers. Such furnaces over 36 inches inside diameter should be fully staybolted, as it is necessary to use lap-riveted longitudinal seams in this type of furnace. Butt-strap seams may be used only in horizontal furnaces where the seams can be placed below the grate.

Will a specially constructed water gage with an automatic valve-closing device, arranged to be operated by a balanced pressure attachment depending for action upon the breakage of the water glass, be considered under the rules of the A. S. M. E. Boiler Code as an automatic water gage, in which the automatic shut-off valves must conform to the requirement of paragraph 427?

It is the opinion of the Committee that the requirements of paragraphs 292 and 427 of the Boiler Code apply specifically to automatic shut-off valves on water gages and not to exterior automatic devices which may be provided to close the valves. If the automatic closing device is not incorporated into the construction of the shut-off valves, the requirements of these paragraphs do not apply.

### Hot Water Boilers

*a.* In large hot water heating boilers which, under the requirements of paragraph 335 of the Boiler Code, must be constructed under the requirements for power boilers, is it necessary that such requirements as covered in paragraphs 291 and 315 shall apply?

*b.* Was it the intent of paragraph 349 of the Boiler Code to cover the possible contingency of the necessity of a water relief valve discharging steam, provided the boiling point has been passed, by the bursting of the diaphragm, thereby increasing the capacity of the water relief valve?

*c.* Would it be assumed that the safety of the structure would be dependent upon the strength of a weld made in a header of a Hawley down-draft furnace attached to the shell by means of pipe connections from each header, and could such a header be welded and a patch strap then applied over the top of the weld, to take the strain of a joint which is in tension?

*a.* It is the intent of the requirement in paragraph 335 that only such portions of the rules for power boilers shall apply to hot water boilers as refer specifically to constructional details. The requirements for some of the fittings and trimmings for steam power boilers are obviously not applicable, so that in such cases the rules for hot water heating boilers shall apply.

*b.* It was not the intent of paragraph 349 that the diaphragm of a water relief valve should break after the valve opens.

*c.* It is the opinion of the Committee that this is a question of repairing boilers. The Code gives certain recommendations in regard to the use of autogenous welding for repairs, but does not deal with the general subject of repairing, which must, in each case, be taken up with the local state or municipal inspectors.

Is it allowable under the requirements of the A. S. M. E. Boiler Code to fit a high-pressure steam boiler with a 4-inch blow-off connection, in case it is to be used initially for low-pressure steam service, or will it be necessary under the requirements of paragraph 308 to apply two or more 2½-inch blow-off connections for the return connections to the boiler?

It is the opinion of the Committee that the boiler could be fitted with the 4-inch blow-off connection when in use for hot-water heating and, when converted to a steam boiler, a reducing fitting could be used at the 4-inch opening to reduce to the pipe size necessary for the blow-off connection.

Is the requirement of paragraph 185 of the Boiler Code, relative to planing down the girth joint, applicable to a special type of boiler formed of an horizontal return tubular shell with a watertube element over which the gases pass before coming in contact with the horizontal return tubular shell?

Paragraph 185 applies only to horizontal return tubular boilers and does not apply to a combination design of fire and watertube boiler as described. In such a boiler the girth joints are not as directly exposed to the heat of the fire as in the case of the horizontal return tubular type of boiler.

What is the stress allowable under the requirements of the Boiler Code for unwelded solid stays more than 20 diameters in length?

It is the opinion of the Committee that the stress should be that given in item *c* in Table 5 of the Boiler Code, which is 9,500 pounds where the lengths between supports do not exceed 120 diameters.

### Stresses in Stays and Staybolts

*a*. Is it the intention that Table 5 of the Boiler Code, which specifies the maximum allowable stresses for stays and staybolts, shall apply to iron as well as steel stays? Are sub-items *a*, *c* and *e* supposed to apply to iron as well as to steel?

*b*. Is it assumed by the Boiler Code Committee that an ordinary expanded boiler tube has no holding power in the tube shell whatever? What holding power is a beaded tube or a welded tube supposed to have?

*a*. Items *a* and *c* of Table 5 apply to iron as well as steel, but in accordance with the requirement of paragraph 4, item *e* applies only to iron.

*b*. It is the opinion of the Committee that tubes which are merely expanded in the tube sheets have a large initial holding power. However, under practical conditions of operation, where the seating of the tube in the sheet is disturbed, the holding power of tubes so attached is different. It was for this reason that the Code requires either beading, flaring or welding in of the tubes. There have been many tests made on the holding power of tubes, the results of which may be found in technical literature and handbooks.

What form of test will be required for the shell of a miniature boiler formed by the cupping and hot-drawing process from a sheet of firebox plate which meets the requirements of the Boiler Code? It is believed that the specifying of firebox boiler plate steel and subjecting each finished cupped and hot-drawn shell to an hydrostatic test, using the formula $P = 32{,}000t/D$, and the flattening test of a coupon cut from each cupped and drawn piece, this flattening test to go to 5 times the wall thickness, would be sufficient guarantee of the finished material and would be a far more representative and better test than taking tests from the material before the cupping and hot-drawing operations.

It is the opinion of the Committee that if the firebox plate material from which the boiler shell is formed meets the requirements of the boiler plate specifications of the Code, and if the shell is properly annealed after drawing, it may be considered as having met the requirements of the rules in the Boiler Code. The Boiler Code Committee has been informed that for proper annealing the shell should be subjected to a temperature of 1,550 degrees F.

Is it the intent of paragraph 25 of the Boiler Code that chemical limits for carbon are applicable only to firebox plate and not to flange plate?

The specification for boiler plate steel in the Code, which is in conformity with the similar specification of the American Society for Testing Materials, does not specify any chemical limits for carbon in steel plate of the flange grade.

## Protecting Boiler Drums from Over-Heating*

A bulged spot on a boiler shell is not an uncommon occurrence. We associate it usually with the fire sheets of horizontal tubular boilers, the crown sheet of locomotive boilers, and in general with the furnace tops of internally fired boilers. The cause may be either shortness of water or an accumulation of oil, mud or scale. When a steel plate or a steel tube is exposed to the hot products of combustion on one side, and is covered with water on the other side in a well-designed boiler, heat is transmitted from the hot gases and from the radiating fuel bed through the metal to the water at a sufficiently rapid rate to keep the temperature of the metal well below the range at which it begins to lose its strength and become soft and plastic. If, however, some substance comes between the metal and the water which cannot remove the heat from the metal as fast as it is received from the fire and the hot gases, the metal becomes gradually hotter till a point is reached at which it is no longer able to withstand the stresses imposed by the steam pressure within the boiler and the plate or tube swells out into a bulge. If the bulged metal continues to receive heat at a faster rate than it can dispose of it, the bulge increases in size and the metal wall gets thinner and thinner until it ruptures at the weakest point.

### Common Causes for Bulging

There are many different conditions which may result in a bulged spot in a boiler, and, since the portion of the boiler directly exposed to the action of the flame and combustion products is usually below the normal water line, we are apt to look for this condition only at such points. The most common cause for bulges below the normal water line of a boiler is, of course, a deposit of some sort of heat-resisting material on the water side of the metal. This may be an oil film or it may be a deposit of mud or scale matter from the boiler water. In either case if it provides sufficient hindrance to the flow of heat a bulge will result. Another common cause for the bulging and rupturing of boilers is found in some abnormal working condition which permits the water line to become dangerously low. Under these circumstances as soon as steam and not water covers the surface of metal exposed directly on the opposite side to the heat of the products of combustion, overheating of the metal, which will result in bulging and rupture, is likely to start, because heat cannot flow as readily through a metal and into steam as it can flow through the same metal and into water.

### Superheating Surface

To be sure, superheaters are made in various ways with special provisions for the rapid absorption of heat by the steam and for considerable reserve strength to resist the tendencies to bulge on the part of the metal, in which heat can be safely and profitably transmitted directly from the hot gases to steam through metal. It is also true that a properly designed vertical firetube boiler may have a portion of the upper end of the tubes exposed on the one side to the steam and on the other to hot gases with no serious results. In general, however, a portion of a shell or drum of a boiler, whether of the firetube or

* Reprinted from *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company.

watertube type, which is exposed to combustion products on one side and is not covered by water on the other side is apt to prove troublesome, if not dangerous.

### Three-Pass Setting

Formerly it was common in some parts of the country to return the gases from an ordinary horizontal return tubular boiler from the front end after they had passed through the tubes directly back across the top of the boiler in a brick flue of which the upper surface of the boiler shell was a floor, to a stack connection at the back. This arrangement has been known locally as a three-pass setting. It probably succeeded in running without serious injury to the boiler (when it did so succeed) chiefly because the gases were pretty well cooled before they emerged from the tubes at the front end, and also because as the boiler shell formed the bottom of the third pass it must inevitably become heavily blanketed with soot and fine ash in an exceedingly short time. Soot and ash are rather better insulators to heat flow than many forms of pipe covering, and so the top of the shell usually became protected with soot. When it is remembered that if soot enough was deposited on the boiler top to protect the shell plates there would certainly be enough of it to practically prevent any possible economy through the additional absorption of heat from gases by the steam. Also, since the supposed extra absorption of heat was the only reason for providing the extra gas pass, a matter of some expense and much inconvenience, as such a pass greatly complicates the provision of proper and accessible manholes and the location of a safety valve close to the boiler shell, there is no great difficulty in seeing why its use is rapidly declining even in the regions where it had become a nearly standard method of installing boilers.

### The Protection of Boiler Drums

When horizontal tubular boilers are set, care is taken that the brick work of the settings shall come close enough to the boiler shell so that the joints can be tightly packed with asbestos rope. The line at which the brick setting and the shell are joined through this packed joint is about where a horizontal plane through the horizontal diameter of the head would cut the shell, and this is several inches below the usual working water line. In the event of low water, several rows of tubes would be exposed to the fire before any unprotected portion of the shell comes in contact with hot gases. However, in some sorts of watertube boilers the settings are so arranged that parts of the space open to the gases are in contact with portions of the surface of steam drum, which are not always covered with water on the steam side. This condition may be aggravated at times of heavy load by the fact that the water line is not uniform throughout all parts of a watertube boiler, but may rise, due to the effect of the rapid circulation in some of the tubes and drums or in some portion of the boiler, only to correspondingly fall at other points. The amount of this rise and fall varies with the rapidity of the circulation and the load on the boiler. A further condition to be reckoned with is the fact that, although where the rate of combustion is moderate and the furnace conditions good, combustion may be completed long before the gases reach the relatively out-of-the-way corners where the shell surface is exposed above the water line. Still under overload conditions, or with poor firing, an entirely different set of circumstances may arise.

### Secondary Combustion

It is not uncommon for a portion of the fuel bed to give off combustible gas in a solid stream at a rapid rate. This solid stream may easily pass through a considerable part of the combustion space without burning. It will do this, for example, if it is not properly mixed with air; for gas cannot burn without air, no matter how hot the surroundings. If such a stream of hot combustible gas gets up into the corners of the setting and there finds air which is perhaps leaking through small cracks in the brick or tile, it will often burst into flame and burn strongly at these points, notwithstanding that it has come a long way from the main part of the fire. Such burning of combustible gas when boilers are being forced on coming in contact with air is the thing which is occasionally seen as a flame at the top of the stack, especially in the case of gas retorts and foundry cupolas, and is known as secondary combustion. It should be clear that if secondary combustion occurs in a corner of a boiler setting alongside of a portion of the boiler shell and above the water line, serious and perhaps dangerous bulging of the shell is the result to be expected, probably also followed by a more or less violent rupture. Indeed, such a rupture might easily be sudden and large enough to start a boiler explosion, for, once released, there would be abundant energy stored in the hot water and steam within the boiler to continue the destruction.

### The Obvious Cure

In any case, even if the rupture were a small one resulting only in the gradual release of the steam from the boiler, the accident would prove inconvenient and expensive. The means for preventing such accidents is simple and should be obvious. It consists merely in carefully studying the setting of a boiler to see if it is possible that the water line in ordinary operation can drop low enough to expose portions of the shell unprotected by water to the gases. If this is possible the setting should be changed immediately so that this contact will become impossible.

## Boiler Explosions

In the article "Locomotive Disasters of 1919," published in the February BOILER MAKER, which contains statistics from the eighth annual report of the Chief Inspector of Locomotives, the statement appeared that the fatalities from boiler explosion between the years 1908 and 1919, increased 25 percent. This percentage should have been 21.9 percent instead of 25 percent, and took place between the years 1918 and 1919.

Twenty-five percent of all fatalities were due to the failure of some part of the locomotive boiler, including such items as flue and plug failures as well as explosions. Of this increase 21.9 percent was due to boiler explosions alone.

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The government director of sales announces that 200 Decapod locomotives will be offered for sale by the Chief of Engineers, United States Army. These locomotives are now in service on American railroads, gage and coupling devices having been altered to the standards of domestic lines. They are to be sold by informal bids and negotiations. Bids will be received by the Office, Chief of Engineers, Room 2707 Munitions Bldg., Washington, D. C., until 3:00 P. M. Wednesday, March 10, 1920.

Upon the collapse of the Imperial Russian Government, and during an extreme demand for steam locomotives in 1918, the War Department bought these engines and since January, 1918, they have been in service in the United States. They were built for service on 5-foot gage track and to strictly Russian railroad standards. They can be altered for operation on either 4 foot 8½-inch or 5-foot gage track.

# Boiler Explosions in Great Britain*

*In Great Britain, as in the United States, the examinations of boiler explosions have in many instances been in the hands of men competent in other lines than boiler construction. The value of adequate, scientific investigations of boiler failures is only now being generally recognized as the one great means of preventing future accidents. When the weaknesses of construction are discovered, they can easily be eliminated, and it seems rather strange that this self-evident fact should be so difficult to impress on the legislative minds of various countries.*

It may be taken in round numbers that some seventy to eighty boiler explosions occur per year in the United Kingdom. Each one is a full-scale destructive experiment from which a great deal of useful information might be obtained. In many cases the cause of the failure is obvious and common; in others it is obscure and rare; but, whether it belongs to one classification or to the other, its instructional value is not diminished, for in the former case it provides a warning to boiler users, and in the latter it gives instruction to boiler makers. In these circumstances there can be no question that full advantage should be taken of these accidents.

We learn more from failures than from successes, and the close scientific investigation of the reasons of such events would put us in the possession of information that often can only be uncertainly obtained by laboratory tests.

### Accidental Explosions

It may be said that accidental boiler explosions labor under the disadvantage that the conditions are not prescribed, and hence that doubts about their relative values may exist. To this contention we reply that careful analysis and examination by qualified men seldom fails to define the conditions, and that when they have been defined it rarely remains impossible to indicate the cause of the failure. Mysterious boiler explosions have become a thing of the past. When the full facts are known the mysteries disappear as certainly as those surrounding the appearance of oil on the ceilings of a Norfolk rectory. But we must be warned against falling into a trap for the unwary.

It is a mistake to say because no boiler explosions are mysterious that therefore the explanations of their occurence are always simple. It is just as futile and childish to report that a boiler exploded from excess of pressure as it is to say that a man died from lack of breath. If the existence of excessive pressure cannot be proved, then it is our clear duty to seek other causes—defective design, existing weakness, and so on—and not to shelter behind an all-embracing phrase.

### Failures from Excess Pressure

In a sense every boiler explosion is due to excess pressure, for if there were no pressure the boiler would not burst, but the pressure may still be no more than the vessel should be able to withstand, and a more detailed cause must be looked for. If every boiler explosion were looked upon as a scientific experiment, we could by examination acquire a mass of information of a kind that would be sought vainly in other ways.

### Classification of Explosions

Recognizing the instructional value of explosions, the Manchester Steam Users' Association for many years classified failures of the kind, and drew from them all the information it could. In 1882 an act was passed which placed in the hands of the Board of Trade the power to hold official inquiries into accidents associated with the boilers of steam vessels. It was hoped that the Board would recognize the scientific importance of the work, and that it would so conduct its investigations and so make its reports that the fullest technical information should be won and circulated. These hopes have not been regularly fulfilled. A preliminary examination is indeed made by expert representatives from the Board, but the inquiry itself is conducted before a commissioner, and that commissioner is nowadays always a lawyer.

It is, under the terms of the act, the Board of Trade's duty to indicate the cause of the explosion and to apportion the blame for its occurrence. Now it cannot be expected, on the one hand, that a lawyer will take a deep interest in the technical questions that arise; but, on the other hand, the fixing of responsibility is precisely one of those matters in which he is trained and by which he is attracted. The result, as might be expected, is that scientific problems receive scant attention, while the weighing of the evidence that will fix responsibility receives a great deal. In the circumstances we fear this course is inevitable. The commissioner has power to fine the guilty parties—technically by ordering them to pay a portion of the cost of the inquiry—and as long as that is a part of his duties the sifting of the human evidence will occupy his chief attention.

### Scientific Study of Explosions

It cannot but be a matter for regret that the scientific lessons of explosions should be lost, and we regard with sympathy the plea to which Mr. Stromeyer returns in his report this year that a permanent expert should be appointed by the Board of Trade to examine boiler explosions from their technical aspect. Under the act, competent and independent engineers practically conversant with the manufacture of boilers are to be appointed by the Board of Trade to investigate boiler explosions. It is not easy to find men with the necessary qualifications, and the method followed by the Board—that of sending its surveyors in rotation—weakens rather than increases the probability that the necessary knowledge will be acquired.

What is wanted is closer specialization. It might be well to appoint a single, or possibly two or three, surveyors for explosions, whose duty it would be to investigate accidents as completely as possible, so that every particle of useful information might be derived from them. They would in time acquire a volume of experience that would make their reports of great technical value, and they would so affect the inquiries that the legal aspects would not be permitted, as now, to dwarf and obscure the scientific.

### Boiler Experts Needed

"Little," wrote Mr. Stromeyer in his report of 1912, "is gained by the present system, but much time and money is wasted. Surely with about 100 explosions per annum

* From *The Engineer*, January 23, 1920.

sufficient work could be found for one man possessed of a good college training and suitable practical experience to investigate these cases and to report on them with such clearness that formal inquiries need not be held; or, if an occasional one were found to be necessary, he would be the most fitting man to conduct it. The money which would then be saved on expensive formal inquiries might very advantageously be spent by the expert who makes the inquiries on occasional interesting tests, for these are very badly wanted in this country."

Since the passing of the Act of 1882, something like 2,400 explosions have been inquired into by the Board of Trade. We may safely assume that the larger—by far the larger—proportion of those accidents were brought about by simple, obvious and familiar causes; but there remains a percentage of failures that are out of the ordinary run. Can it honestly be said that all the information, all the technical knowledge, that might be drawn from those accidents has been drawn? Mr. Stromeyer holds that it has not, and we are disposed to agree with him, and we do not think it ever will be drawn as long as the commissioner is a lawyer and his assessors not men especially qualified for the task.

Important as it may be to apportion blame and punish the wrong-doer, we cannot for one instant admit that this duty is so paramount that it ought to be allowed to override technical and scientific considerations. The intention of the act was to find out the cause of accidents; the effect of it, as practised, is to impose petty fines on individuals. Until the intention is restored in practice we cannot expect it to get the full value from the full-scale experiments which boiler explosions present.

## Simplifying the Elbow

BY PHIL. NESSER

There are many ways to lay out elbows, and every layerout claims the way employed by himself is the best. That is because he has learned that way and it seems the easiest to him. Some are very good ones. We have noticed them from time to time in THE BOILER MAKER, but the method given herewith has never been disclosed, being the invention of the writer. It is the result of years of experience, as simplicity comes after one is familiar with certain work.

Fig. 1 is the side elevation of the first section of a four-piece 90-degree elbow, in which *A-B* is the base line, *A-O* the inner radius, *O-B* the diameter and *A-g* the miter line. The rule for finding the angle of the miter line for any elbow, without figuring, is as follows: Divide the arc of the elbow into one less spaces than there are to be pieces in the elbow and bisect the angle formed by one space. In Fig. 1 the arc is 90 degrees. This is divided into 3 spaces, 1, 2 and 3 spaced from the point *O* on the base line. Next bisect the angle *O-A-1* by taking the radius *X*, scribing arcs to intersect upon line *A-g* (the space *O-1* could be used as radius *X*), then draw a line through *A* and the interesection of the arcs as *A-g*. This then is the miter line for a four-piece 90-degree elbow.

But for the one who uses figures, there is a chance to save all this drawing, and by having a chart of factors for this purpose, we can find the rise of the miter line, and we can get along without Fig. 1 entirely, just so we understand the principle and have that in mind to work from. Just to illustrate we have drawn a semi-circle, with *O-B* as the diameter, divided it into six equal parts, dropping a perpendicular line to the base line, through each division. Continue to draw perpendiculars between the base and the miter line, locating points *a-b-c*, etc., on the miter line. It will be found that the perpendiculars *c*, *d* and *e* will cut the diameter of the circle into four equal parts, and that the other points *b* and *f* strike upon the base line, a distance equal to .067 times the diameter of the circle, measured in toward the center from points *O* and *B* upon the base line. This .067 is a factor to be used for finding the horizontal distance between the two outer perpendiculars when the circle has been divided into twelve parts (but we used a semi-circle, dividing it into 6 parts and that is the same) when multiplied by the diameter.

One way that the pattern could be laid out is shown by Fig. 2. After having found the angle of the miter line, take 3.1416 times the diameter upon a line, as 12 to 12 in Fig. 2. The distance *O-a* in Fig. 1 (which could have been found by multiplying the inner radius, 10 inches, by .2679, which makes 2.679 inches) is measured on each end from points 12 and 12 to *a* and *a*, the line *a-a* is then drawn horizontally and parallel to line 12-12.

Next the difference between the length of line *O-a* and of line *B-g*, Fig. 1, could be found by multiplying the diameter, 20 inches, by .2679, which makes 5.358 inches,

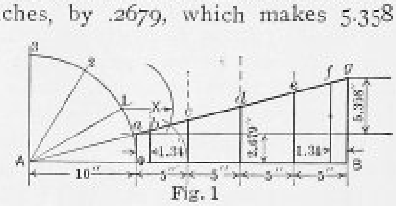


Fig. 1

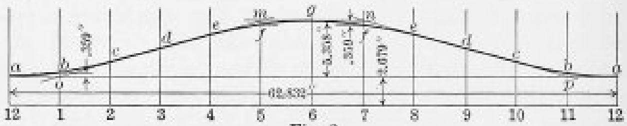


Fig. 2

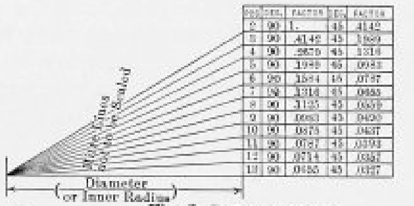



Fig. 3 ELBOW CHART

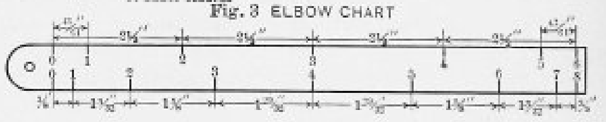


Fig. 4

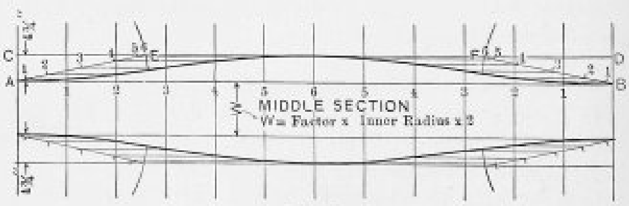


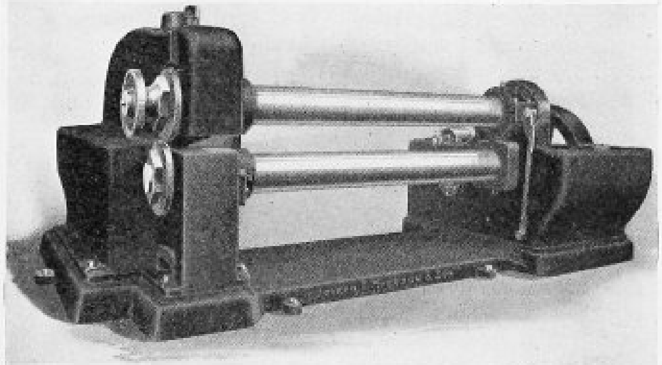

Fig. 5

Method of Simplifying Elbow Developments

the line 12-12 being divided into 12 equal parts and a perpendicular line drawn through each division, 1, 2, 3, etc.

From line *a-a*, Fig. 2, take, on line 6, 5.358 inches to *g* and draw a horizontal line through *g* locating *m* and *n* upon lines 5 and 7 respectively. Points *o* and *p* are located on lines 1 and 11 by the line *a-a*. Next draw a line from *O* to *m*, and a line from *n* to *p*, locating points *c*, *d* and *e*, upon lines 2, 3, 4, 10, 9 and 8. The points *b* and *f* are located by taking .067 times 5.358 and measuring down

# Special Shearing Equipment For The Boiler Shop

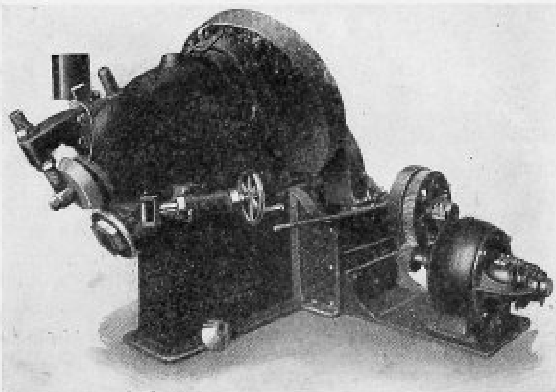


## Lennox Rotary Splitting Shear

### Housing Type

This machine is designed for straight shearing of sheets and plates, but will also cut round, square or flat bars of a diameter or thickness corresponding to the capacity of the tool for plates. The blades are milled, making them self-feeding, and are reversible. The main frame is offset so that plates of any length may be split without distortion. The extended upper shaft carries a hold-down wheel to guide the plate and prevent it from tipping. This, together with the enclosed form cutter shaft which operates as a rest, materially assists the operator and makes unnecessary the use of a hoist and an extra helper.

Machines are made in regular sizes of 4, 6 and 8 feet between housings. Special sizes can be furnished to order.



## The Lennox Rotary Bevel Shear

The Lennox Rotary Bevel Shear has long been recognized as a necessary part of the equipment of the modern boiler and tank shop, at the present time there being in use several thousand of these machines, embracing practically all of the principal boiler, tank, railroad, car and shipbuilding plants of the world.

This machine will bevel all of the irregular and curved sheets usually required in boiler and tank construction. It will bevel-shear in-and-out curves of segments, angles, and such difficult work as boiler heads after flanging, manhole saddles, dome sheets, and in addition will handle straight work in a small proportion of the time in which it can be done by hand or on a plate planer.

## JOSEPH T. RYERSON & SON

**MACHINERY**

CHICAGO ST. LOUIS DETROIT BUFFALO NEW YORK from *m* and *n*, and up from *o and p*, in Fig. 2. This makes .359 inch, as marked.

The pattern has thus been made without the use of Fig. 1, but the figure had to be made to make it plain, and only after we have mastered the principle can we get along without it.

Trace a line through the points thus found and get the miter line, then if more holes are required, the base line could be re-divided, carrying the perpendiculars to the miter line which has been drawn.

Considering that the reader is familiar with the foregoing, we will go a few steps further toward "simplifying the elbow" by giving a chart as Fig. 3 for finding the miter line by calculation.

The line *A-B* in Fig. 3 represents the diameter of the pipe. The number in the left-hand column is the number of pieces in the elbow. In the next column to the right is 90, which means 90 degrees, and next to that is the factor to be used to calculate the rise of the miter line, as the distance marked 5.358 inches in Fig. 2. As we were making a four-piece elbow in Fig. 2, let us go over the work again using the table. Find 4 in the left-hand column. The factor after 90 degrees is .2679. This must be multiplied by the diameter, and 20 times .2679 makes 5.358 inches, the rise of the miter line in one diameter length. Then to figure the length of the line 12-*a*, Fig. 2, we use the same factor and multiply by the inner radius. As 10 times .2679 makes 2.679, that is the distance between 12-12 and *a-a* vertically, Fig. 2. The rest has been explained before.

Next, refer to Fig. 4, which is a graduated scale, which might be called an elbow layerout. It is oddly graduated, made of 1/8 steel, 1 1/4 inches wide. The numbered graduations are copied from the baseline of a 10-inch semicircle. The edge numbered 0 to 6 was copied from the baseline when the semicircle was divided into 6 equal spaces, and perpendiculars drawn through each division and carried to the baseline. The edge numbered 0 to 8 was made the same, excepting that the semicircle was divided into 8 equal parts instead of 6 as before. These graduations are scratched in with a scratch-awl. The numbers are stamped in with stencils, then a hole is punched in one end in order to hang it up when not in use.

The other side of the scale is also graduated, having 10 numbers on one edge and 14 on the other, having been copied from the baseline of a 10-inch semicircle as explained above for the 6 and 8 divisions. This would take in nearly all the common number of holes, for we can use the 6 numbered edge for elbows having 12, 24, 36, etc., holes, and all multiples of 12, by subdividing the 12 spaces after the miter line has been drawn. We can use the 8 numbered edge for 16, 32, 48, etc., holes the 10 numbered edge for 20, 40, 60, etc., holes, and the 14 numbered edge for 28, 56, 84, etc., holes.

Now suppose we had to make an elbow, of pipe, 30 inches diameter, 1/4 steel. When considering thickness, we usually add one thickness to the diameter for outside sections or take off one thickness from the diameter (before multiplying by 3.1416) for sections fitting inside. In making Fig. 5 we considered an outside section. Multiplying 30 1/4 by 3.1416, we get 95.0338, or 95 1/32. In that distance we could space 24 holes. About 4 inches apart would do for furnace pipes.

The next thing is the number of pieces. If we use 6, look for 6 in the left-hand column of Fig. 3. After 6 and 90 degrees we find the factor .1584. We then take 30 times .1584, which will make 4.75 or 4 3/4 inches, the rise of the miter line. Draw line *A-B*, Fig. 5, set off 95 1/32 inches from *A* to *B*; and as we are going to use 24 spaces, divide *A-B* into 12 equal spaces for the present.

On each of the divisions erect a perpendicular, set off on each end 4 3/4 inches, locating points *C* and *D*. Draw line *C-D* parallel to *A-B*, then set dividers to 10 inches, then with *A* as a center scribe to intersect upon line *C-D*. With *B* as a center scribe to intersect line *C-D*, locating points *E* and *F* upon line *C-D*, Fig. 5.

Draw a line from *A* to *E* and one from *B* to *F*, then take the elbow scale and copy the graduations from the 6 numbered edge upon the lines *A-B* and *B-F*, numbering them with 1-2-3, etc., as shown. The divisions on line *A-B* are also numbered, as shown, then lines are drawn as, 1-1, 2-2, 3-3, etc. Make each line intersect a like numbered perpendicular line, then trace a line through the interesections, making the curved miter line.

To avoid confusion the spaces are not subdivided, but to make it known it was mentioned here.

Fig. 5 shows only the miter line developed, as it is unnecessary to repeat the explanation of Fig. 2 with regard to the inner radius. For middle sections, of course, we double across the center on each line, so we could multiply the factor by the inner radius, then the result again by 2, to get the length of the shortest perpendicular in a middle section, and the operations repeated on the other side of the pattern.

It is hoped that the above explanation has been made plain enough to be understood, as it will be of use to all those who can "get on" to it and make use of it.

## OBITUARY

Bartholomew Scannell, Sr., one of the pioneers in the boiler-making industry of Lowell, Mass., died of influenza at his home in that city, February 20.

He came to this country from Ireland with his parents at an early age, and after living a few years in Hallowell, Me., moved to Lawrence, Mass., in which vicinity he spent the remainder of his life.

When quite young he entered the employ of the J. C. Hadley Company of Lawrence, Mass., at that time the largest manufacturers of steam boilers and engines in the country. After serving an apprenticeship in this company he entered the employ of the Stewart Boiler Works of Worcester, Mass., where he assumed the position of superintendent.

In 1875, with David M. Dillon as a partner, Mr. Scannell opened a boiler shop in Fitchburg, Mass., the first that had been conducted there. Five years later with Dennis Wholey as a partner he began his career in Lowell by opening a boiler shop which became an immediate success. In 1900 the partnership was dissolved, and the company continued under the name of the Scannell Boiler Works. This business was conducted by Mr. Scannell up to the time of his illness.

In his business associations he always played a most prominent part, and was, at the time of his death, vice-president of the New England Boiler Manufacturers' Association and a charter member of the American Boiler Manufacturers' Association.

James F. Flannery, chairman of the board of the Vanadium Steel Company, died at his home in Pittsburgh, Pa., March 6, at the age of 66 years. With his brother, Joseph Flannery, who died last month, he developed the vanadium process of steel manufacture. It is interesting to note that he began life as a newsboy, as have so many of the old-school captains of industry.

# The Boiler Maker

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H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.
L. S. BLODGETT, Associate Editor

Branch Office
Boston, Mass., 294 Washington street, S. I. CARPENTER.


One of the first problems confronting the railroads, now that control has gone back to the owners, is that of replacement of equipment. Rolling stock and particularly locomotives are badly in need of immediate attention. Domestic orders have come in during the past two weeks for about 200 locomotives. There is every indication that this number will be increased very rapidly until service on the roads has become normal once more.

What policy will be adopted for work in the railroad shops during this rebuilding programme is still in doubt, but there would seem to be an excellent opportunity for establishing equitable working conditions and correcting the faults of the shop system as operated by the Railroad Administration.

One change particularly advocated, and one which will serve to render the efforts of efficient workers not without effect, is the re-establishment of some form of the piece-work system. Under its operation there is some inducement for turning out good work and lots of it. The man who by training and experience is capable of the best efforts has been handicapped for the past two or three years by the necessity of waiting for the slower worker. A flat rate basis of pay, with very few exceptions, tends to slow up work until it is carried on at the pace set by the men with the least training.

Such changes as are made in the existing shop conditions must come gradually and after very careful consideration of the bearing that they will have on future development of the industry.

The attitude that will be taken in this matter by the men and the management is still in doubt, but because of the fact that benefits will be mutual there should be no difficulty in establishing a satisfactory working system.

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Are the improved facilities, materials, equipment and organization with which the industries have to work accomplishing the increase in quantity and the improvement in quality of finished products that they should? As compared with production in the old days, the gain has been remarkable, but it has not been sufficient to balance the other changes that have occurred in the past few years.

The bearing that workmanship has on production is well expressed by one of our correspondents, who compares conditions in the past with those of the present:

"Workmanship is much more than skilled work; it involves process, method, resource and material. Considering how inferior in many respects past resources were, the results achieved were creditable. To obtain results at all involved compensations, rectification and adjustment at every stage by every individual concerned, but the result was none the less inferior. The skill needed was largely employed in overcoming preventable difficulty and inherent shortcoming, which modern methods cut out; that is to say, that, as everywhere else, the individual skill required was directly in proportion to the inferiority of the work.

"There are now better materials, better and more specialized machines, better methods, better organization, greater realization of underlying principles; in the case of boilers: higher pressures, thicker plates, different design, new conception. The revolution of the past two decades is extraordinary; more is yet to come.

"This all improves workmanship while it minimizes skill—skill of craft that is, the individual manipulation processes formerly evident. It is useless to confound skill and workmanship or to mistake the one for the other.

"Skill is the product of individual hardship; workmanship the product of well-organized and specialized industry.

"There is still skill, but not of the same type; the skill involved is in the co-ordination of process, detail, method, research—taking nothing for granted, analyzing every detail, and in terms of economic fact giving an infinitely better product at a lessened cost.

"It is the present contention that both quality and quantity have made simultaneous strides in boiler making, and by present standards past practice was inferior in all respects. It is the survival of past practice when better is available which needs condemnation, for the skill of the old-timer being absent, to continue his methods is to invite disaster.

"There is little need to point to the evidence as to past inferior workmanship (not skill) when this has been applied to the new era of higher pressures and better but more easily damaged material. It has been proved in these pages.

"Refinement and exactitude, together with revised process and new ideas, are essentially modern in a universal sense. The more the necessity of these sinks into the consciousness of the boiler exponent, the better for his outlook and the retention of his craft.

"One thing is certain, that among the most progressive are some of the older generation. They are young enough to learn, and that is the only youth that matters."

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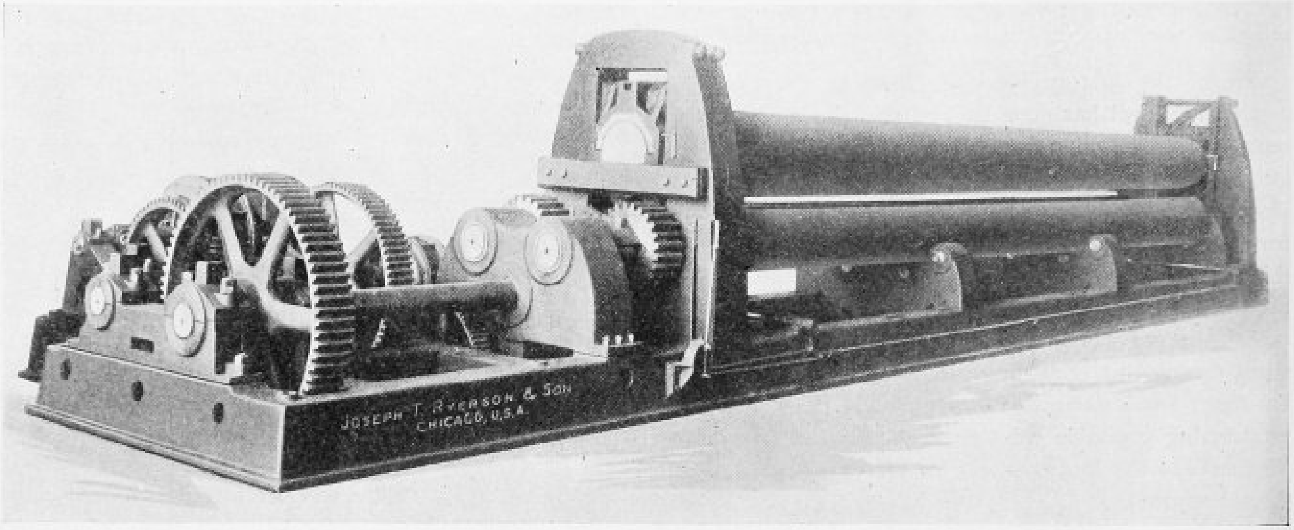
The Executive Committee of the American Boiler Manufacturers' Association announces that the annual convention will be held May 31 to June 2, at French Lick Springs Hotel, French Lick, Indiana.

# Engineering Specialties for Boiler Making

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

### New Type Bending Rolls

One of the largest plate bending rolls built in the Central States has just been installed by the General American Tank Car Corporation, East Chicago, Ind. This machine was sold by Joseph T. Ryerson & Son, and built by Kling Bros. Engineering Works of Chicago.




One of the Largest Plate Bending Rolls in the Central States

The machine is provided throughout with cut teeth, steel gears, and all bearings are bronze bushed. In the past it has been the custom to build heavy machinery of this kind with cast gears and either babbitted bearings or bearings directly on cast iron. The machine measures 34 feet 2 inches between housings, and has a capacity for bending ¾-inch mild steel plates. The top roll is 29 inches in diameter and weighs about 40 tons. The bottom rolls are 21 inches in diameter and have two roller supports. The rolls are mounted on a rigid cast iron sub-base and have independent motors for the main drive and for the power adjustment of the top roll.

### Staybolt Chuck

A new reversible staybolt chuck is being manufactured by the Lovejoy Tool Works of Chicago. The chuck is furnished with either a square or a Morse taper shank and is reversible, so that the bolt may be backed out when necessary without removing the chuck from it.

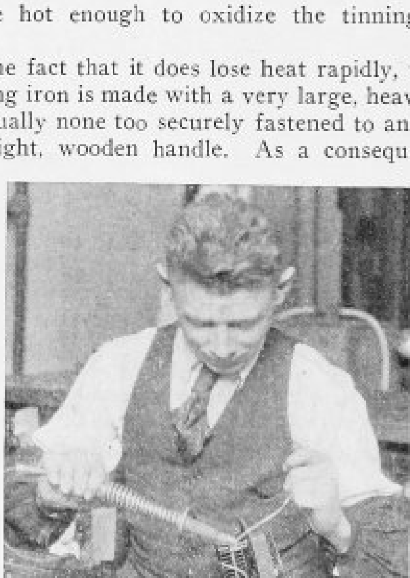
It is claimed that the chuck will grip and turn a round staybolt either threaded or blank without necessitating squaring the ends. Three sizes are available for staybolts, ranging from ¾ inch to 1¼ inches in diameter.

### Advantages of Electric Soldering Iron

The electric soldering iron, when compared to the type heated in a gas flame or fuel-burning muffle, exhibits improvements, both in operation and convenience, which should make its adoption in shops where soldering is carried on a matter of serious consideration.

The ordinary type iron is, as a rule, anything but economical, either from the standpoint of time or of material. It requires continual reheating, since it chills very quickly from radiation, and nearly every time it is reheated the tinning is destroyed. The electric iron, on the other hand, once heated remains hot as long as it is needed, but does not become hot enough to oxidize the tinning or the copper.

Due to the fact that it does lose heat rapidly, the average soldering iron is made with a very large, heavy copper element, usually none too securely fastened to an iron rod having a light, wooden handle. As a consequence, the



Electric Soldering Iron in Use on Electrical Apparatus

iron is hard to use because of its lack of balance. For working in corners or narrow places, a skilled operator is required to manipulate it with any degree of success.

To overcome this awkwardness, the General Electric Company, Schenectady, N. Y., has developed an electric iron having a heavy spiral wire handle, which allows a certain degree of flexibility, while giving the iron a good balance and a firm connection to the copper.

A Special Feature of the Electric Soldering Iron Is Its Flexible Handle

Other features of the gas-heated iron make it more or less undesirable, and among these is the fire risk. Gas flames are subject to blowing back and exploding.

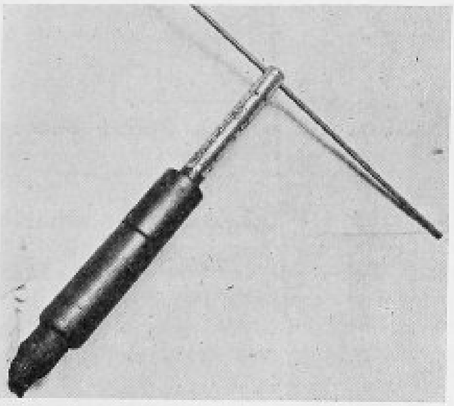
The average fuel-burning muffle is at best smoky, inconvenient and far from economical. There is always danger of the iron rolling off a bench if laid down for a minute and starting a fire.

The electric iron can be quickly attached to any lighting circuit and a constant heat is assured. The spiral handle is expanded into a guard ring where it joins the tip, so that the heated part of the iron is raised when the iron is not in use. This feature removes the fire hazard.

## Convenient Electrode Holder

A patent has recently been allowed to L. A. Eckenrode, Park avenue, Chambersburg, Penn., on an electrode holder that eliminates the usual spring clip of such devices.

It is claimed that the holder cannot be injured by accidental contact. In practice one member of the holder rotates on the other, actuating a plunger against the electrode. A quarter turn of the handle is sufficient to clamp the rod in place, so that springs are not needed. The cable connection is also of special design.



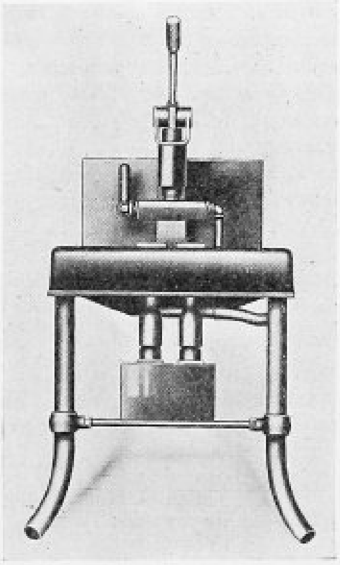
Electrode Holder Eliminates Spring Clip

Further information of this device is available at the above address.

## Electric Rivet-Heating Forge Developed

A new electric rivet-heating forge is being produced by the United States Electric Company, New London, Conn. It is intended for use in shipyards, boiler shops and in connection with steel structural work—in fact, wherever it is necessary to use hot rivets from ¾ inch to 1¼ inches in diameter. It is stated that for these sizes from 7 to 15 seconds is required to attain the proper heat.

The electrodes of this heater are arranged to heat two rivets at a time, and about four rivets are supplied a minute at the proper heat and free from scale. The pan of the forge is designed to hold a keg of rivets. These are fed to the machine by hand. The conductor is operated by means of a foot or hand lever which brings the electrode in contact with the point of the rivet. When the rivet is adequately heated the pressure on the lever is released.



Electric Rivet Heating Device

The forge may be supplied with a set of electrodes and twenty foot leads to be used in heating loose rivets in place, after which they may be driven up tight.

Equipments are available in all sizes and for use with 110 and 220 volts alternating current.

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The American Chain Company, Inc., of Bridgeport, Conn., has purchased the control of the Page Steel and Wire Company, with mills at Monessen, Pa., and Adrian, Mich.

It is the intention of the American Chain Company to continue the business of the Page Steel and Wire Company as heretofore, taking only the surplus products of its plants, which consist of open hearth furnaces, rolling mills, wire mills, as well as fence factories.

The new officers elected under the reorganization of the company are: Walter B. Lashar, president; William T. Morris, vice-president; Wilmot F. Wheeler, treasurer; John E. Carr, assistant treasurer, and William M. Wheeler, secretary. E. C. Sattley, general manager of the Page Steel and Wire Company, will continue in that capacity, with offices in Pittsburgh, Pa.

The American Chain Company has its general sales offices in the Grand Central Terminal building, New York City, and district sales offices in Chicago, Boston, Philadelphia, San Francisco, Portland and Pittsburgh.

# 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.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Allowable Stresses in Double-Riveted Butt Joint

Q.—Please indicate the safe working stresses in a longitudinal seam, when the diameter of the boiler is 60 inches, the plate thickness 3/8 inch, rivet diameters 13/16 inch, and the pitch 3 1/16 inches. J. P. K.

A.—Paragraph 413 of the A. S. M. E. Code gives all the calculations governing this problem. The pitch should be greater than 3 1/16 inches in order to obtain a high efficiency of the joint.

A. S. M. E. Code, Paragraph 413—Example: Butt and double strap joint, double-riveted:

$A$ = strength of solid plates $= P \times t \times TS$,
$B$ = strength of plate between rivet holes in the outer row $= (P - d)\, t \times TS$,
$C$ = shearing strength of two rivets in double shear, plus the shearing strength of one rivet in single shear $= N \times S \times a + n \times s \times a$,
$D$ = strength of plate between rivet holes in the second row, plus the shearing strength of one rivet in single shear in the outer row $= (P - 2d)\, t \times TS + n \times s \times a$,
$E$ = strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of one rivet in the outer row $= (P - 2d)\, t \times TS + d \times b \times c$,
$F$ = crushing strength of plate in front of two rivets, plus the crushing of butt strap in front of one rivet $= N \times d \times t \times c + n \times d \times b \times c$,
$G$ = crushing strength of plate in front of two rivets, plus the shearing strength of one rivet in single shear $= N \times d \times t \times c + n \times s \times a$,
$H$ = strength of butt straps between rivet holes in the inner row $= (P - 2nd)\, 2b \times TS$. This method of failure is not possible for thicknesses of butt straps required by these rules, and the computation need only be made for old boilers in which thin butt straps have been used. For this reason this method of failure will not be considered in other joints.

Divide $B$, $C$, $D$, $E$, $F$, $G$ or $H$ (whichever is the least) by $A$, and the quotient will be the efficiency of a butt and double strap joint, double-riveted.

$TS$ = 55,000 pounds per square inch,
$t$ = 3/8 inch = 0.375 inch,
$b$ = 5/16 inch = 0.3125 inch,
$P$ = 4 7/8 inch = 4.875 inch,
$d$ = 13/16 inch = 0.875 inch,
$a$ = 0.6013 per square inch,
$s$ = 44,000 pounds per square inch,
$S$ = 88,000 pounds per square inch,
$c$ = 95,000 pounds per square inch.

Number of rivets in single shear in a unit length of joint = 1.

Number of rivets in double shear in a unit length of joint = 2.

$A = 4.875 \times 0.375 \times 55{,}000 = 100{,}547$,
$B = (4.875 - 0.875)\, 0.375 \times 55{,}000 = 82{,}500$,
$C = 2 \times 88{,}000 \times 0.6013 + 1 \times 44{,}000 \times 0.6013 = 132{,}286$,
$D = (4.875 - 2 \times 0.875)\, 0.375 \times 55{,}000 + 1 \times 44{,}000 \times 0.6013 = 90{,}910$,
$E = (4.875 - 2 \times 0.875)\, 0.375 \times 55{,}000 + 0.3125 \times 95{,}000 = 90{,}429$,
$F = 2 \times 0.875 \times 0.375 \times 95{,}000 + 0.875 \times 0.3125 \times 95{,}000 = 88{,}320$,
$G = 2 \times 0.875 \times 0.375 \times 95{,}000 + 1 \times 44{,}000 \times 0.6013 = 88{,}800$.

$$\frac{82{,}500\ (B)}{100{,}547\ (A)} = 0.820 = \text{efficiency of joint.}$$

$A$ = cross sectional area of rivet after driving,
$s$ = shearing strength of rivet in single shear, pounds per square inch,
$S$ = shearing strength of rivet in double shear, pounds per square inch,
$c$ = crushing strength of mild steel, pounds per square inch.

The allowable working pressure based on the joint efficiency of 82 percent, using a factor of safety of 4, is determined as follows:

$$\frac{TS \times t \times 2 \times E}{D \times F} = P,$$

in which

$P$ = allowable working pressure in pounds per square inch,
$TS$ = tensile strength of plate in pounds per square inch,
$t$ = thickness of plate in inches,
$E$ = efficiency of joint,
$D$ = diameter of boiler,
$F$ = factor of safety.

Using values in the formula, we have:

$$\frac{55{,}000 \times 3/8 \times 2 \times .82}{60 \times 4} = 140.9 \text{ pounds allowable working pressure.}$$

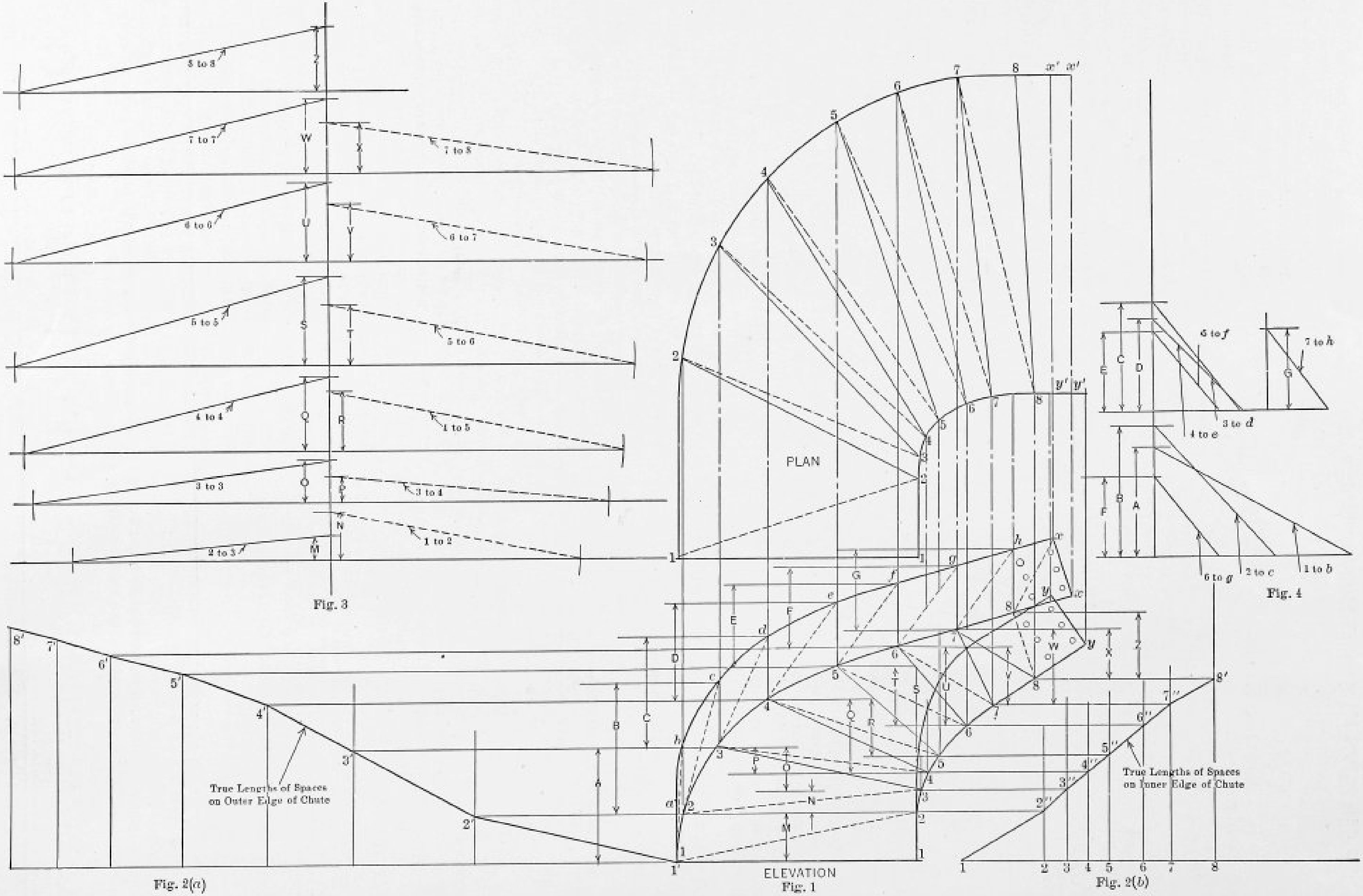
### Construction of a Spiral Chute

Q.—What is the easiest and quickest way of laying out and developing the inclined, curved, steel chute with the sides and inclination of the dimensions indicated on Fig. 1? J. B. C.

A.—The layout of the chute may be made in the following manner:

The shape of this chute is such that only an approximate development can be made. The draftsman in designing the chute evidently drew the curves in to suit the eye, and not according to any geometrical method. An example of how this may be done will be shown later.

In this problem the curved outlines and sides are foreshortened, and the triangulation method is used in the layout. From the curves in the plan Fig. 1 draw vertical projectors to intersect the corresponding curves in the elevation, thus locating the points 1-2-3-4-5, etc. Connect these points on the inner and outer curves with straight lines. The true lengths of these lines are then found by developing the right-angled triangles as shown to the




Details of Layout for Construction of Spiral Chute left of the plan in Fig. 3. The heights of the right-angled triangles are found in the elevation and are shown at *M-N-O-P-Q-R-S-T-U-V-W* and *Z*, and their bases are taken from the plan from 1 to 2, 2 to 3, 3 to 4, etc., for the dotted lines and from 1 to 1, 2 to 2, 3 to 3, etc., for the solid lines.

As the curved edges of the chute are foreshortened, it is necessary to find also the true arc lengths. This may be done as shown at Fig. 2 (a) and Fig. 2 (b). The base lengths in these views on the horizontal lines equal the arc lengths of the curved edges of the chute plan view. Vertical projectors are drawn from these points and from the corresponding points on the edges in the elevation; horizontal projectors are extended to intersect the vertical lines at Fig. 2 (a) and Fig. 2 (b). Straight lines connecting the points 1 to 2, 2 to 3, 3 to 4, etc., in these views closely approximate the required arc lengths.

With these data the pattern for the bottom of the chute can now be laid off, as shown in Figs. 5 and 6, for the bottom of the chute and for the outer side. The lines and spaces being numbered, the development should be understood without further explanation.

Fig. 7 illustrates another method of developing a spiral chute and also gives the projections as they appear in a plan view and elevation. In this case the spiral is considered to be formed on the outside of a cone and to taper from a larger to a smaller width, having sides that are straight. The cone is laid off as in the two views, and a number of horizontal planes passed through it, as shown at *a-a, b-b, c-c, d-d, etc.* Their shape in plan are circles. Radial lines *x'-f, x'-h, g'-x* are drawn in the plan intersecting at 1-2-3, etc., which locate points on the inner spiral. These points are projected vertically to intersect the lines *a-a, b-b*, etc., in the elevation at 1'-2'-3', locating the points for the spiral in this view. On the extended lines *x'*-1, *x'*-2, *x'*-3, etc., in the plan, lay off the widths of the chute, as from *a* to *a*, 1 to 1, 2 to 2, etc., these lengths being made to suit the conditions.

Complete the elevation and make the depth of the sides at *a*-1 equal to the desired length. The vertical lengths from points 1"-2"-3" and 4" all equal the distance *a*-1 and are also shown in the view in their true length.

The dotted diagonals to the left of the elevation are the true lengths of the lines for the pattern layouts of the base and the strip for the outer side. The bases are taken from the plan and the heights from the elevation. As the distance between the lines *a-a, b-b*, etc., in the elevation are the same, the heights for the triangles are all equal for the bottom of the chute. The arc lengths on the inside of the chute are laid off to the right of the elevation, and the development is clearly shown in the view. The arc lengths *e-f, f-g, g-h and h*-4 are taken from the plan. Having there data, the patterns can now be laid off by assembling the triangulation lines.

Another method of showing the projections of the chute is to develop it about the outline of a cylinder making a quarter turn. The pattern layout is found in the same manner as in the previous figures.

## Fusible Plug in Vertical Boiler

Q.—I have one vertical tubular boiler which has a fusible plug in one of the tubes. Will you please let me know how it is fixed in and if it can be removed without taking out the tube? The Government rules require it to be cleaned every three months. T. B.

A.—When a fusible plug is employed in a vertical boiler it is the usual practice to screw the plug into ne of the tubes in the outer row at about 2 inches below the lowest gage cock. If a hand hole plate is not provided so that an inspection and renewal of the plug can be made, it will be necessary to remove the tube.

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## Rule Governing Spacing of Crowfoot Braces

Q.—Will you kindly explain paragraph 203 of the A. S. M. E. Code where it refers to "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 braces to the head shall be determined by the formula in paragraph 199, using 160 for the value of *C*." Does this mean the distance from the edge of the head to the center of the rivets? J. H.

A.—Regarding paragraph 203 of the A. S. M. E. Code, the following explanation is offered:

The maximum distance between the centerline of the rivets of the braces, which run parallel with the curvature of the shell, shall be determined in accordance with the formula given in paragraph 199.

The formula in paragraph 199 is:

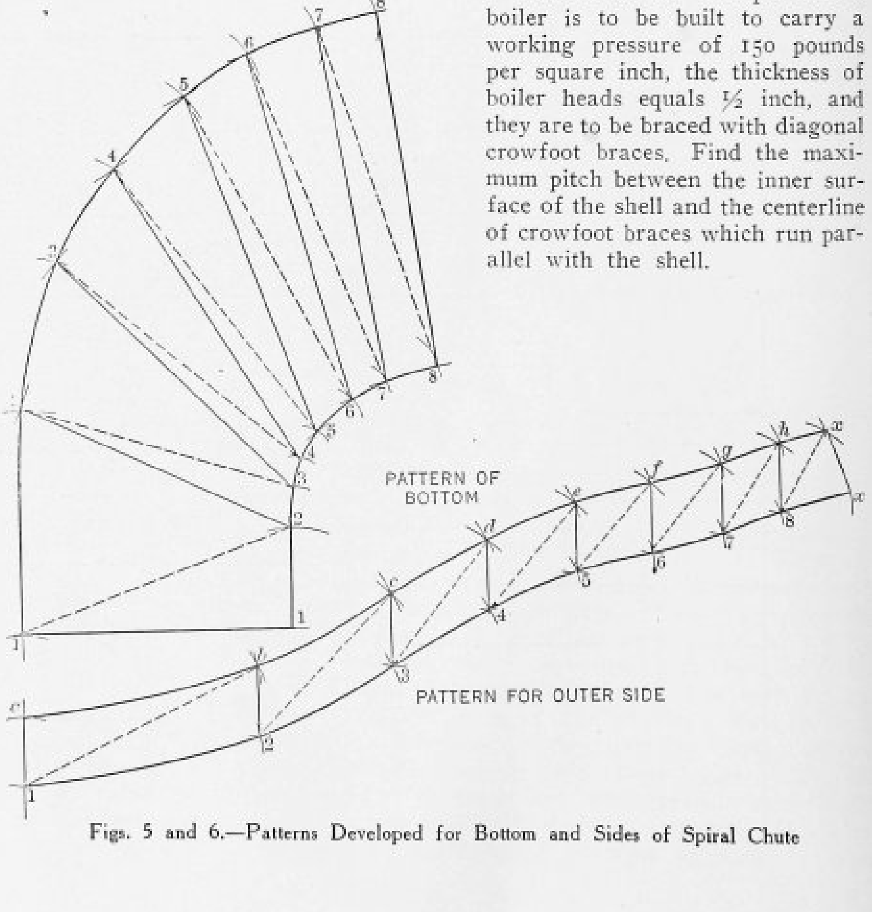
$$P = C \times \frac{t^2}{p^2},$$

in which:

$P$ = allowable working pressure in pounds per square inch.
$C$ = constant.
$t$ = thickness of plate in sixteenths of an inch.
$p$ = maximum pitch in inches.

This formula is transformed so as to find the maximum pitch when the plate thickness, working pressure and the method of bracing is known.

Consider as an example that a boiler is to be built to carry a working pressure of 150 pounds per square inch, the thickness of boiler heads equals ½ inch, and they are to be braced with diagonal crowfoot braces. Find the maximum pitch between the inner surface of the shell and the centerline of crowfoot braces which run parallel with the shell.




Figs. 5 and 6.—Patterns Developed for Bottom and Sides of Spiral Chute

Using the value of 160 for the constant called for, and transferring the formula, we have:

$$p = \sqrt{\frac{160 \times 8^2}{150}} = 8.3 \text{ inches maximum pitch.}$$

The figure 8 used in the calculation is the numerator of the fraction which expresses the plate thickness in sixteenths of an inch.

John H. Harris has been appointed superintendent of the boiler shop at the Ames Iron Works, Oswego, N. Y., to replace Thomas McNamara, who has resigned to accept a similar position with the Titusville Iron Works, Titusville, Pa.

The Chicago Pneumatic Tool Company on January 21 and 22 held a general conference of executives, plant and branch managers and salesmen at its Detroit plant, Second avenue and Amsterdam street, on the occasion of the formal opening of a large five-story addition.

At this conference the expansion programme of the company for 1920 was outlined, calling for largely increased production not only at Detroit but at the five other American plants of the company. It was reported that much of the proposed increase in production was already absorbed by orders for future deliveries.

The work of the nation-wide chain of service stations which the company has opened and supplied with complete stocks of spare parts, machinery and tools, and provided also with facilities for handling territorial repairs for users of the company's products, was also outlined in detail.

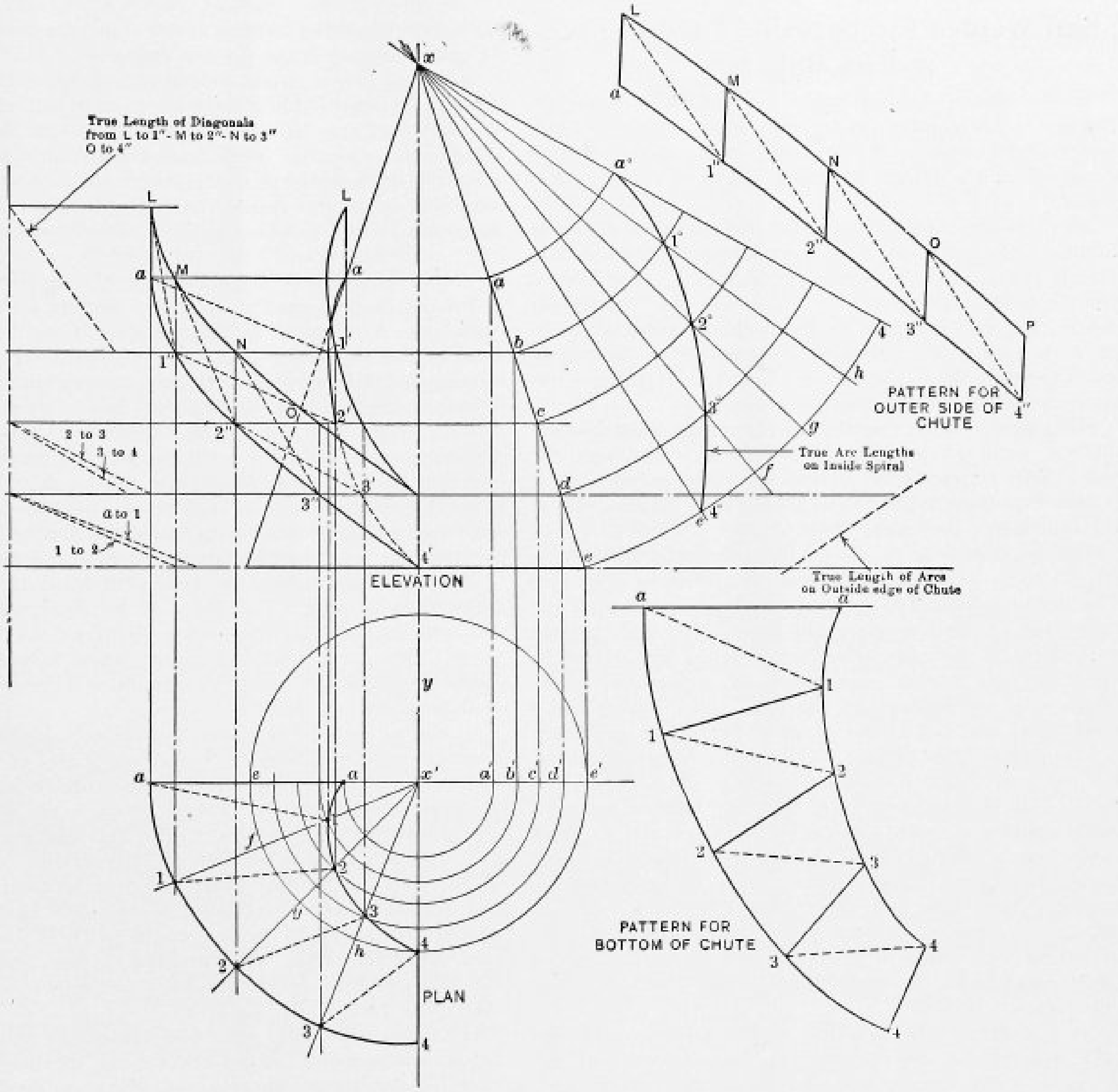



Fig. 7.—Alternative Method of Laying Out Chute

## PERSONAL

William F. Brady has resigned his position as superintendent of the boiler shop of the Edward Renneburg & Sons Company, Baltimore, Md., to become superintendent of the tank and stack department of the Erie City Iron Works, Erie, Pa.

H A.. Lacerda, for some time past connected with the boiler inspection departments of the Federal Shipbuilding Company, Kearny, N. J., and the Morse Dry Dock & Repair Company, Brooklyn, N. Y., has assumed his former connections with the Erie Railroad in the shops at Jersey City ,N. J.

# Letters from Practical Boiler Makers

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

## Shall Welded Fireboxes Be Used in Locomotive Boilers?

In the Eighth Annual Report of the Chief Inspector, Bureau of Locomotive Inspection, to the Interstate Commerce Commission are several very interesting illustrated examples of the effects of boiler failures caused by low water.

It is apparent from the report that welded seams in fireboxes are not given a very good recommendation. In almost every case the welded firebox seams are blamed for the greater force of the explosions. If there is not some improvement made in the welding process as applied to locomotive boilers, it will only be a short time until the Interstate Commerce Commission will put restrictions on the use of welded seams.

Some people claim that the oxy-acetylene torch and the electric welding apparatus saved the day and won the war. This statement may be exaggerated a little, but it is true that these types of equipment kept locomotives on the road when they were badly needed.

The oxy-acetylene torch and the arc welder have come to stay. So have welded seams and seamless fireboxes. The welding torch and welding machine are in their infancy, but are fast coming to the front. The main trouble with the work done on welded seams is the lack of skilled operators and proper supervision of welders in boiler shops and roundhouses by practical boiler makers who understand the seriousness of poor welding in fireboxes.

The demand for skilled welders was so great during the war period that it was impossible to obtain first-class men. This left an opening so that any man or boy who could operate a torch was called a welder and in most cases put at skilled work, which only expert welders should have been doing. Boilers were being welded by men and boys who had never seen a boiler before. It takes some time to become an expert welder, and only expert welders should be permitted to work on locomotive boilers, and under the supervision of the boiler foreman or an expert welder.

As a general rule, practical boiler makers make the best welders for boiler work, as they understand the stress the welds are subjected to, the effect of contraction and expansion of different parts of the boiler on the welds, and the seriousness of a boiler failure. The inexperienced welder thinks all there is to welding is to fill in the space between the plates with metal and the job is all right.

### Precautions in Welding

The skilled welder is very particular to have the sheets beveled correctly, free from dirt, scale and grease, and that every particle of metal is properly fused to every other particle. The unskilled welder lays the material in the opening in chunks, makes a big showing, and is then considered a fast man by certain individuals unfamiliar with the work, but not by the practical boiler maker who has had experience in welding.

Such a welder should not be permitted to weld in a locomotive or any other boiler. The writer has had a number of welders under his supervision and can truthfully say the skilled welders are few and far between, and in great demand at the present time.

Seamless fireboxes and welded firebox seams have come to stay, but the welding must be done by skilled men or the welds will not hold. Welded firebox seams have been used in our shops for a number of years, and if they are properly made by good welders who know their business they will never give trouble. In fact, welded seams eliminate many of the troubles we have had with riveted seams.

### Welding on Southern Pacific Lines

I have been connected with the Southern Pacific for some time, handling all kinds of engines, from the 8-wheel type to the Mallet compound freight and passenger type, running on all kinds of water, both in mountain and valley service. We first started welding the calking edges of firebox seams, then welding over the riveted seams. This did not prove successful, as there was too much iron in the fire. Seams would bag down and crack open at the weld almost invariably. This kind of a job, however, will hold fairly well on side seams below the fire line, but will not hold on the crown seams of fire door and flue sheets.

We then tried cutting the seams off back of the rivet holes, then welding. This job does better on side seams, but will not hold on the crown seams of the fire door sheet. This fact became apparent when several of the seams bagged down and gave considerable trouble on installations we had made.

In one case we were having trouble with Mallet freight engines; could not keep riveted crown seams of fire door sheet from leaking. To overcome the trouble we cut out a patch, eliminating the riveted crown seam altogether. The patch was cut out between the first and second rows of crown bolts, down between the second and third rows of staybolts on the door sheet and over between the first and second rows of staybolts in the side sheets. We changed the radius in the heel of the patch to four inches, eliminating the riveted seam and flat surface, and brought the welds in between the staybolts and crown bolts, thus taking the load off the weld.

If a patch is properly fitted and welded, the trouble with crown seams will be at an end. Some of these patches have been in service three years, and none of the welds have cracked open or given the least bit of trouble. Only the highly skilled welders are permitted to do this class of work. Low water has never occurred in any of these engines, so it is difficult to say what the effect might be on the seams.

### Disastrous Explosion

A number of years ago, before welded seams were heard of, a very violent locomotive boiler explosion occurred on the Southern Pacific Railroad. The locomotive was one of the largest then in service with a wagon-top boiler, having a dome set over the firebox, an outside wrapper sheet ⅝-inch thick, a back head of ¾-inch material, a throat sheet of ¾ inch, a crown sheet ½ inch, flue sheet ½ inch, fire door and side sheets ⅜ inch. The inside firebox was built up of five pieces; the crown sheet was riveted to the side sheets, to which were also fastened a flue sheet and door sheet. An outside shell was riveted to the back head with a single row of 7/8-inch rivets. The firebox was riveted to the barrel at the connection with a double row of rivets.

At the time of the accident the engine crew had just boarded the locomotive, which was standing on a siding. The engineer, firemen and coal passer were all killed by the explosion, which blew the firebox completely out, tearing the flue sheet seams at the rivet holes on top and ripping the plate loose about half way down the side seams of the flue sheet. The crown seams of the fire door sheet at the top held, although the rivet holes were elongated from the strain on the crown sheet. The firebox was blown down over and between the journals of the driving wheels. The outside wrapper sheets were torn loose at the rivet holes on the back head and throat sheet and folded up over the dome, while the back head was also blown up and folded over the dome. The outside firebox was ripped away at the connection of the boiler above the throat sheet, as was also the taper course and sheet. The only rivets holding were those at the top of the shell. The outside firebox landed about 250 feet ahead of the locomotive and to the right of the track.

The riveted seams did not in any way check the force of the explosion—in fact, if this firebox had been constructed with welded seams it is doubtful if the explosion would have been so violent.

I am very much in favor of the welded firebox seam, but do not believe in using a torch to build up pitted or rusted-out plates or worn and rusted-out mudring corners.

I would like to hear an expression of opinion on welded firebox seams from practical boiler makers and some of their experiences and successes in this work.

Roseville, Cal. H. A. Patrick.

## "Pointing Off" When Using the Slide Rule

The hardest thing for a beginner to learn about the operation of a slide rule is to keep track of his decimal point.

The method used in long-hand, of starting at the right and point off to the left, will not work at all on a slide rule, as the entire number of figures is not always known, due to the fact that the average rule can be read to only three or four places.

The following rule does not take into consideration the figures to the right of the decimal point except in the case of fractions. It is very simple and is so short that it can be marked on the back of your slide rule and therefore does not even have to be memorized.

It is:

| | | |
|---|---|---|
| Sum of the Characteristics | <—— Multiplication ——> | Sum of the Characteristics minus 1 |
| Difference of the Characteristics | <—— Division ——> | Difference of the Characteristics plus 1 |

The arrow indicating the direction the slide is pointing.

The characteristic of a whole number is the number of digits to the left of the decimal point. Thus the characteristic of 25.74 is plus 2. The characteristic of a fraction is the number of zeros between the decimal point and the first significant figure. Thus .2574 has a characteristic of plus or minus 0, for there are no digits to the left of the decimal point and there are no zeros between the decimal point and the first significant figure, while .0002574 has a characteristic of minus 3, for there are three zeros between the decimal point and 2, the first significant figure.

When the sum or the difference of the characteristics of two figures is to be obtained, it should always be the algebraic sum. Thus, 2 plus (minus 3) equals minus 1, or 2 minus (minus 3) equals plus 5.

Take, for example, 25.74 × .0682. The characteristic of 25.74 is plus 2, and that of .0682 is minus 1. The slide extends to the left, and, as this is multiplication, it should be the sum of the characteristics. Hence, plus 2 plus (minus 1) equals plus 1, which means that the answer will contain one digit to the left of the decimal point or 1.76.

Suppose that this had been division, that is, 25.74 divided by .0682, the characteristics of both members remain the same. The slide still extends to the left, but as this is division it is the difference of the characteristics, or plus 2 minus (minus 1) equals plus 3, and the answer becomes 377.4.

Take another example of multiplication: .1268 × 71.5. The slide extends to the right so the rule says sum of the characteristics minus 1. The characteristic of .1268 is 0, and that of 71.5 is plus 2. The sum is plus 2 plus 0 equals plus 2, but it is the sum minus 1, or plus 2 minus 1 equals plus 1, and the answer is 9.06.

Another example of division: .00925 divided by 12.5. The characteristic of .00925 is minus 2, and that of 12.5 is plus 2. The slide extends to the right, and, as this is division, the rule says the difference of the characteristics plus 1, or minus 2 plus (minus 2) equals minus 4, but it is the difference plus 1, or minus 4 plus 1 equals minus 3 and the answer is .00074.

Any number of examples might be given, but as these four cover every possible use of the rule the reader is left to practice with examples of his own manufacture.

Jacksonville, Fla. B. W. Manier.

## Preparing and Welding

With the oxy-acetylene torch being used so frequently nowadays, especially in the repairing of boilers, every boiler maker should know how to prepare sheets for the welder. It is a fact, however, that some do not yet know the proper method.

I will try to explain the procedure of preparing sheets for welding for the benefit of those who do not know how, and if anyone finds this little bit of advice useful I will feel that my task has not been in vain.

Nothing is more disgusting and tiring to a welder than to be working on a patch or new sheet that butts together at one point and at another spreads half an inch or more, or to have one place beveled too much and another place with no bevel at all.

We all know that it is hard to get just the same opening and bevel on a seam that runs the entire length of a firebox, but still some jobs that are turned over to the welder could be improved upon quite easily. Often the welder is worried as he gazes at some jobs that are given to him to weld, yet he goes at them with a smile, knowing that the responsibility rests upon his shoulders.

### Distance Between Sheets

The proper distance between the sheets, in the writer's opinion, should never be less than 1/8 inch or more than 1/4 inch. With an opening less than 1/8 inch the welder will have difficulty in penetrating to the full depth of the seam, and with an opening greater than 1/4 inch there will be a large gap to fill up, which is always difficult, especially if the welder is not an experienced man.

Each sheet should be beveled to the same angle (about a 45-degree angle is proper), and when the sheets are placed in position they should form a "V" making a 90-degree angle.

The beginner or inexperienced welder should not attempt to weld in a patch or new sheet until he has had several weeks' experience with the torch, for, if he can do fairly good work in a few days, he will probably tire before the job is half done and become careless, in which event the job will suffer. (Most railroads require six months' experience before they will allow a welder to work on a boiler.)

DANGER OF IMPROPER HEATING

There are several difficulties which the beginner must learn to overcome. The chief trouble with many apprentices is that they are afraid of getting the pieces they are welding too hot. As a result, they fail to get them hot enough to weld.

A beginner may think he is having good success, but after the weld he has completed cools a little he will find that it has broken loose from one of the sheets, much to his disgust.

The beginner will find it difficult to keep the metal where he wants it, and some of it will get away from him in spite of all he can do. This will tend to make him nervous and uneasy, but he should endeavor all the harder to try to control the metal.

It is more or less hard for the beginner to keep the proper flame. It is well for him to make adjustments often to see that he is holding a neutral flame. It is a common occurrence to see a weld, produced by a beginner, that looks burnt and faulty due to an improper flame.

It will be found hard to work the torch and filler rod in the proper manner at first, but this will come naturally in a short time.

There is so much for the beginner to watch that he often becomes bewildered; but he should keep his mind cool, as he will find that it is impossible to keep his body so.

If the person takes a liking to the trade he will soon emerge from the apprentice stage and advance slowly into the class of skilled welders. He will be surprised at himself as each difficulty which seemed to bother him so much at the beginning is mastered and overcome.

Above all things, no matter how good you may become, a man should always remember that he is never too old to learn something and should always endeavor to do a little better and not throw aside an opportunity to help the advance of the art of welding.

The welding torch can be used to advantage on boilers as a heater in laying up sheets, cutting off staybolts and many other small jobs. A small area can be heated quickly without heating up the entire firebox. This last not only saves the boiler maker a lot of trouble, but lengthens the life of the sheets.

It is better to finish a job, in the writer's opinion, when once it is started, than to let it cool and then finish it, as the expansion and contraction is more even and does not put so many undue strains upon the weld.

Denver, Colo. ARTHUR MALET.

## Increasing Locomotive Safety

Many attempts have been made to reduce the possibilities of locomotive boiler explosions because of low water, with varying degrees of success.

The following boiler installation has certain advantages in accomplishing this result by permitting the collapse of a number of tubes, inserted under the crown sheet, before the danger point of the boiler has been reached. At first glance the arrangement seems rather impracticable, but a long series of tests has proven it to act, invariably, before the crown sheet gets overheated.

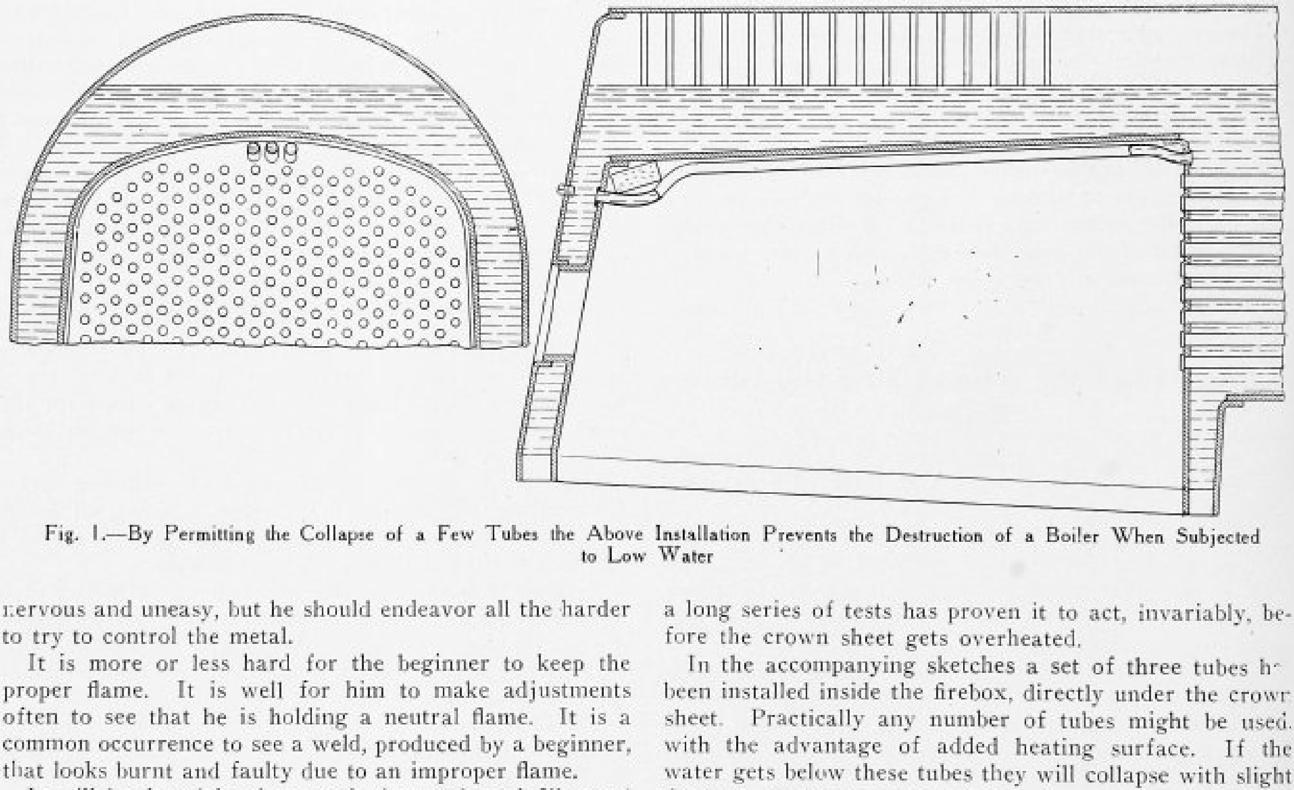


Fig. 1.—By Permitting the Collapse of a Few Tubes the Above Installation Prevents the Destruction of a Boiler When Subjected to Low Water

In the accompanying sketches a set of three tubes have been installed inside the firebox, directly under the crown sheet. Practically any number of tubes might be used. with the advantage of added heating surface. If the water gets below these tubes they will collapse with slight damage. It has been found that the water can fall 3 to 5 inches below the crown sheet before the boiler is endangered.

Wallace, Idaho. VICTOR HANSEN.

## Calculating Tube Sheets

Under the heading of "Tube Sheet Calculations" on page 22 of the January issue of THE BOILER MAKER, the area of the rectangular space above the manhole was not determined in calculating the area to be stayed. The unstayed distance supported by the flange was given as 3 inches.

Paragraph 214 of the 1918 edition of the A. S. M. E. Boiler Code reads: The area of a segment of a head to be stayed shall be the area enclosed by lines drawn 2 inches from the tubes and a distance *d* from the shell. The value of *d* used may be the larger of the following values:

(1) $d$ = the outer radius of the flange, not exceeding 8 times the thickness of the head.

$$(2)\ d = \frac{5 \times T}{\sqrt{P}},$$

where:

$d$ = unstayed distance from the shell in inches.
$T$ = thickness of head in sixteenths of an inch.
$P$ = maximum allowable working pressure in pounds per square inch.

Substituting values as shown on page 23 in Fig. 1 of the January BOILER MAKER, we have:

$$\frac{5 \times 8}{\sqrt{100}} = 4 \text{ inches, unstayed distance supported by flange.}$$

Paragraph 217 of the A. S. M. E. Boiler Code reads: The net area to be stayed in a segment of a head may be determined by the following formula:

$$\frac{4\,(H-d-2)^2}{3}\sqrt{\frac{2\,(R-d)}{(H-d-2)} - 0.608} = \text{area of segment.}$$

where:

$H$ = distance from tubes to shell, inches.
$d$ = distance given by formula in paragraph 214.
$R$ = radius of boiler head, inches.

Substituting values as shown on page 23 in Fig. 1 of the January issue, we have:

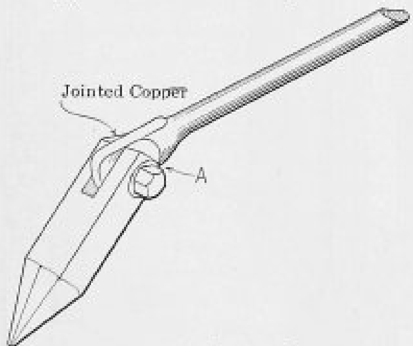
$$\frac{4\,(13-4-2)^2}{3}\sqrt{\frac{2\,(27-4)}{(13-4-2)} - 0.608} = 159 \text{ square inches, area of segment.}$$

The area of the rectangular space shown over the manhole in Fig. 1 is $12.5 \times 2.75 = 34.375 + 159 = 193.375$ square inches area below tubes. Because the manhole and flange meet the requirements of paragraph 218, this area may be reduced by 100 square inches. Then we have $193.375 - 100 = 93.375$ square inches, say 94 square inches area to be stayed. According to paragraph 216, it may readily be determined, if it is necessary to stay the segments as shown in Figs. 2 and 3, page 23 of the January issue.

Olean, N. Y. F. R. BURLINGAME.

## Jointed Soldering Copper

After having done work with a straight regular type of soldering copper that required me nearly to stand on my head to get at it, I hit upon the idea shown in the drawing, that of making a jointed soldering copper that could be used at any convenient angle. To make it was a simple task. The regular straight handle was cut off next to the copper and its end forged out thin and flat.




Convenient Soldering Copper

The end of the copper was then slotted to take the flattened end of the handle, a hole having been drilled in it to take the clamping bolt *A*. This tool is worth many times the old straight type. W.

## BOOK REVIEW

PARALLEL TABLES OF SLOPES AND RISES. Constantine K. Smoley. Size 4½ inches by 7 inches. Pages, 173. Illustrations, 33. New York and London. D. Van Nostrand Company. Price, $3.00 net.

This book is a compilation of parallel tables of slopes and rises in combination with diagrams and other tables useful to bridge and structural engineers, draftsmen, checkers, template makers, and for school instruction purposes. The work is essentially an extension of the author's "Smoley's Tables."

The calculations required in the preparation of structural drawings may be divided into two distinctive parts. In the first place the dimensions and bevels of the members of the frames must be determined. For this part of the work the "Parallel Tables of Logarithms and Squares" are used. When they are completed, there remain the layout of the joints and the determination of the dimensions of the material. The Tables and Diagrams of Slopes and Rises will be found well adapted to this because in all the joints the bevels are known. In addition the tables may often be used for the computation of the main dimensions of the frames, particularly when the frame is given with the bevels.

"The Tables of Slopes and Rises" is really a collection of about 200 tables, the tabulation for each bevel being a complete work in itself, and the entire set of tables contains more than 100,000 solutions of right triangles.

## BUSINESS NOTES

William R. Gummere, who for a numbe rof years represented the Independent Pneumatic Tool Company in Cleveland, Ohio, has again become affiliated with that company. Mr. Gummere will be connected with the Pittsburgh branch, which is under the management of Harry F. Finney.

The Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has announced the appointment of Alexander Taylor, for many years manager of works, as assistant to the vice-president, to have general charge of production, stocks and stores. R. I. Wilson has been promoted from the position of general superintendent to works manager of the East Pittsburgh plant. E. R. Norris has been appointed director of works equipment, in charge of machinery, tools and methods in the various plants. C. B. Auel has been made manager of the Employees' Service Departmeint.

The Champion Rivet Company, Cleveland, Ohio, announces the appointment of George W. Denyven, of Boston, as New England agent. Mr. Denyven has been identified with the iron and steel industry in its various branches. His first experience in boiler work was obtained with Edward Kendall & Sons, Cambridge, Mass. Later, in South Africa, he was employed as a boiler maker and inspector by the Central South Africa Railroad. For a few years he traveled through Australia, New Zealand, Honolulu, and then to San Francisco, where he located in the boiler shops of the Santa Fe Railroad. At different periods he has been connected with the Pacific Hardware & Steel Company; A. C. Harvey Company, Boston, Mass., and during recent years with E. P. Sanderson Company, Cambridge, Mass., whom he will continue to represent in connection with the Parkesburg Iron Company, Parkesburg, Pa.; Rome Iron Mills, New York; The Pollak Steel Company, Cincinnati, Ohio; The Locomotive Firebox Company, Chicago, Ill., and the Champion Rivet Company. The Boston offices are at 141 Milk street.

# Selected Boiler Patents

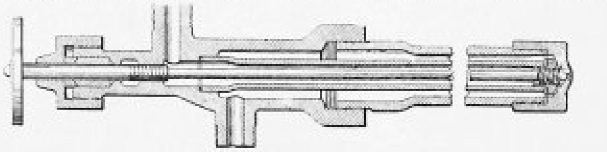
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,326,488. FUEL-OIL BURNER FOR BOILERS. JOSEPH O. FISHER, OF WASHINGTON, D. C.

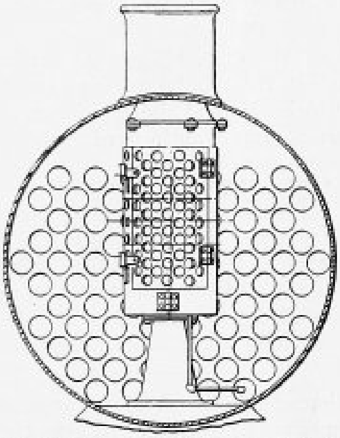
*Claim* 1.—In an oil burner for boilers the combination of an outer sleeve; an inner sleeve spaced from said outer sleeve to form an inlet



passage; a valve stem in said inner sleeve forming an exit passage; a burner tip provided with a fuel delivery port associated with said outer hollow member provided with straight and tangentially arranged passages hollow member provided with straight and tangentially arranged passages surrounding said valve, forming a chamber with which said tangential passages communicate, and in which the oil may receive a high rotational velocity and forming a return passage for the oil between said chamber and said exit passage, substantially as described. Three claims.

1,326,486. LOCOMOTIVE DRAFT APPLIANCE. VON G. FERGUSON, OF FAIRBURY, NEB.

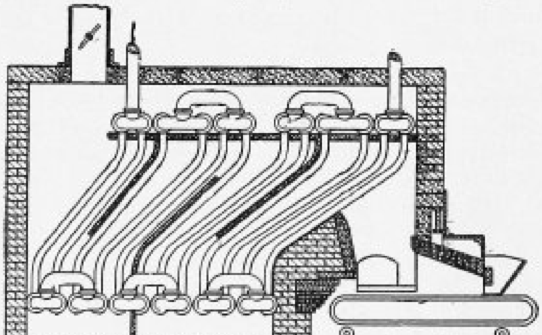
*Claim* 1.—In a locomotive boiler provided with an end smoke chamber, exhaust nozzle and smokestack in co-operative relation with the smoke



chamber, a standpipe connected with the exhaust nozzle and having its upper end disposed to discharge into the smokestack, a damper ring adjustable vertically on the standpipe and a casing inclosing the standpipe and having openings in its sides for the passage of products of combustion. Two claims.

1,327,032. SUPERHEATER. EDWARD A. GEOGHEGAN, OF CHICAGO, ILL., ASSIGNOR TO MILTON KRAEMER AND EDWARD J. TALBOTT, TRUSTEES.

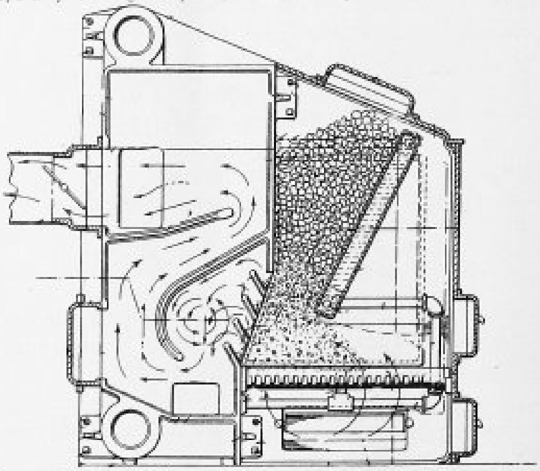
*Claim* 1.—In an apparatus of the class described, a furnace chamber, a fire-grate therein, a fire-wall behind said grate, an intake return-bend header tube above said fire-grate, a series of succeeding return-bend



header tubes on the plane of and behind said intake header, a fire-baffle under said headers, vertical return-bend pipe connections connecting said return-bend headers in alternate pairs, so that the last header becomes a discharge header, a series of return-bend tube headers under the first-named headers and behind said fire-wall, vertical return-bend pipe connections connecting said lower headers in alternate pairs in staggered relation to said upper headers, inclined superheater tubes connecting the first and succeeding upper headers with the first and succeeding lower headers, and inclined baffles adapted to cause fire-gas to travel a zigzag course through said furnace chamber, substantially as set forth.

1,326,621. BOILER. CHARLES B. THOMPSON, OF NORTH TONAWANDA, N. Y., ASSIGNOR TO THOMPSON HEATER CORPORATION, OF BUFFALO, N. Y., A CORPORATION OF NEW YORK.

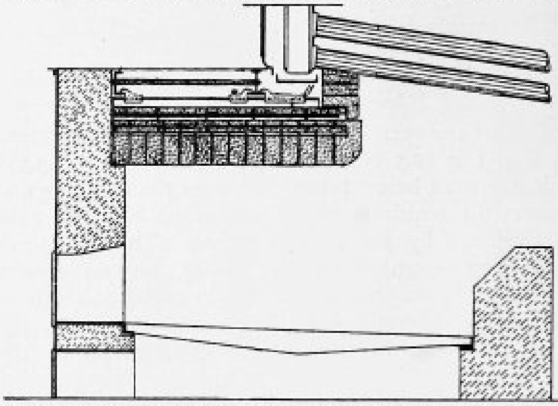
*Claim* 1.—A boiler comprising a boiler part and a furnace part, means for separably uniting the parts, the furnace part comprising a grate and



a fuel magazine, the boiler part being provided in its lower portion with flue openings leading into the combustion zone of the furnace part, and comprising flues and a plurality of louvers arranged in the openings between the said parts. Eighteen claims.

1,326,752. FURNACE ARCH FOR BOILERS. MICHAEL LIPTAK, OF MINNEAPOLIS, MINN.

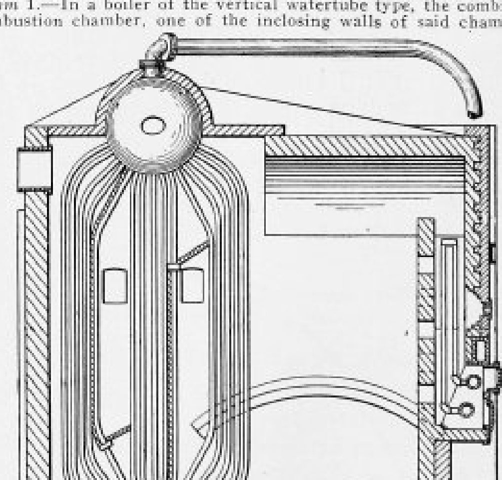
*Claim* 1.—A fire arch for furnaces comprising hanger blocks supported



in an upper layer, and underfacing blocks interlocked to and detachably hung from said hanger blocks and forming a lower layer to be exposed to the flames. Eleven claims.

1,326,203. BOILER. GEORGE T. LADD, OF PITTSBURGH, PA.

*Claim* 1.—In a boiler of the vertical watertube type, the combination of a combustion chamber, one of the inclosing walls of said chamber being




provided with a pocket provided with openings into the combustion chamber permitting of the flow of products of combustion from the combustion chamber down through the pocket and back into the combustion chamber, and a superheater arranged in said pocket. Two claims.

# The Boiler Maker

APRIL, 1920

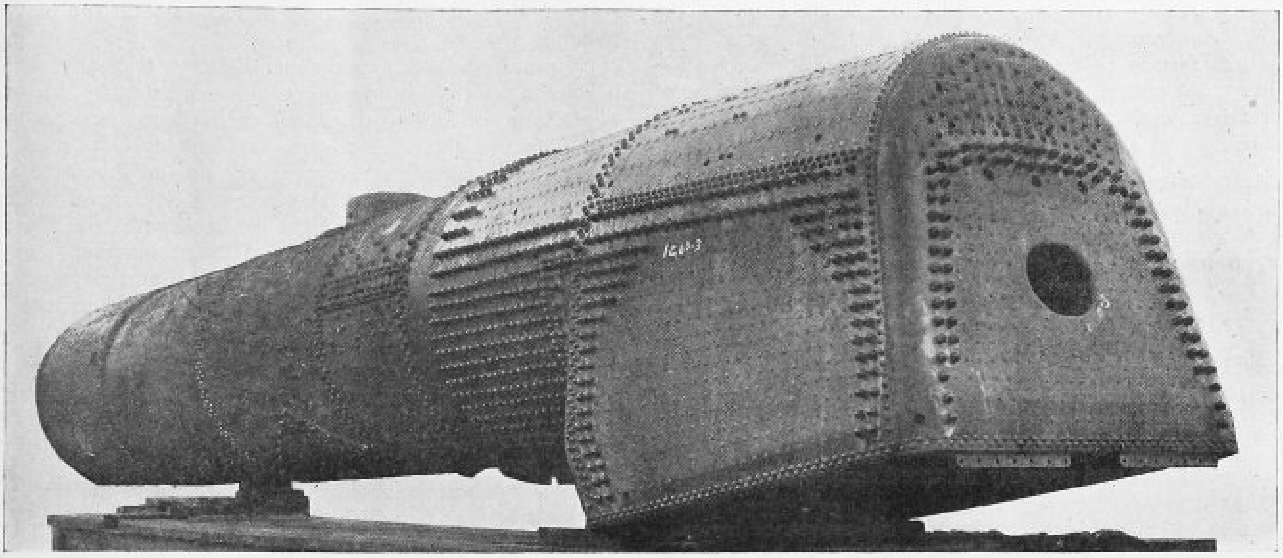



Fig. 1.—Standardized Boiler for Class 2662 C S 448 Locomotive Built for the United States Railroad Administration

# Scientific Development of Locomotive Boilers

BY JOHN E. MUHLFELD

*The following abstracts, taken from a paper read before the annual meeting of the American Society of Mechanical Engineers, indicate the lines along which the steam locomotive of the future must advance in order to hold its place in the transportation field. Great strides have already been made in overcoming the defects of present locomotive boiler design, but the possibilities for improvement are still very great.*

Steam railroads, to be successful, must, through executive foresight and engineering progressiveness, respect the same law of additions and betterments that applies to other profitable industries and which demands continuous modernization of plant and equipment in order to effectively and economically meet the necessity for greater production and speed by means and methods that will result in the least possible artificial age being capitalized in the improvements when installed.

Marked progress has been made in the development of the steam locomotive as the result of superior engineering ability, and the results have in many respects been exceedingly effective. This progress, however, has been confined largely to an increase in size, weight, evaporating capacity and hauling-power; and, while the general use of superheaters and firebox baffle walls during the past ten years has substantially assisted in improving sustained boiler capacity and increasing thermal efficiency, as well as in keeping the steam locomotive in advance of the electric locomotive, the opportunity for further improvement in thermal and machine efficiency and to reduce smoke, cinders, sparks and noise is untold.

The desiderata in a steam locomotive may be summed up as: a reasonable first cost; maximum capacity for the service within roadway weight, curvature and clearance requirements; ability to handle the heaviest gross tonnage practicable at the highest permissible speed; positive control of mechanical operation; economy as regards fuel and water consumption and repairs; minimum manual labor for road and terminal handling; construction of the least number of parts, and capacity to perform continuous mileage without failure.

Modern types of steam locomotives fulfill quite satisfactorily all of these requirements with the exception of wastefulness in fuel, water and steam consumption, as may be gathered from the fact that the thermal efficiencies now obtained are only from 50 to 65 percent at the boiler, from 60 to 75 percent for the combined boiler and superheater, and from 4 to 6 percent at the drawbar. These as compared with thermal efficiencies of from 3 to 5 percent at the drawbar of an electric locomotive, 18 to 19 percent at the switchboard of a modern steam-electric central power station, 25 to 30 percent for internal combustion engines, and 40 to 45 percent as claimed for the full range of from one-quarter to full load for combination internal combustion and steam motors.

The increase in the first cost and in the cost for labor, fuel, material and supplies for operation and maintenance of the steam locomotive has been most marked during the past ten years, particularly since the war. It is now being operated and maintained by highly paid enginemen and mechanics, with high-priced materials and supplies, and the machine and its performance must be brought up to a more respectable basis of engineering efficiency if it is to be perpetuated.

The supporting data of this paper, which apply to the United States, present the reasons why the general improvement of the steam locomotive should embrace the following changes which, it may be opportune to here state, are now being embodied in the design, specification and construction of a new type of locomotive, the first of which it is planned to have in regular service in 1920 on a prominent and progressive Eastern railroad:

*a.* Steam at a pressure of about 350 pounds per square inch to be employed, superheated about 300 degrees F.

*b.* Improved boiler, furnace and front-end design and appliances.

*c.* Greater percentage of adhesive to total weight, and a lower factor of adhesion.

*d.* More efficient methods of combustion.

*e.* Use of exhaust steam heater and flue gas economizer for boiler feedwater.

*f.* Better steam distribution and utilization.

*g.* Reduced cylinder clearances and back pressure.

*h.* Lighter and properly balanced reciprocating and revolving parts.

*i.* Lower heat, frictional and wind-resistance losses.

*j.* Improved safety and time-, fuel- and labor-saving devices.

TABLE 1.—STEAM LOCOMOTIVES IN THE UNITED STATES

| Item | Total Number | Tractive Power, Average Pounds | Weight on Drivers, Average Pounds |
|---|---|---|---|
| Single-expansion cylinders..... | 61,336 | 30,500 | 135,000 |
| Two-cylinder compound....... | 500 | 32,000 | 145,000 |
| Four-cylinder compound....... | 1,300 | 33,000 | 148,000 |
| Mallett articulated compound.. | 1,750 | 79,000 | 350,000 |

## EXISTING STEAM LOCOMOTIVES

The steam locomotive stock in the United States on the railroads formerly under the control of the United States Railroad Administration may be stated as follows:

| | |
|---|---|
| Number of locomotives, total...................... | 64,886 |
| Number equipped with coal stokers............ | 4,010 |
| Number equipped with fuel oil................. | 3,358 |
| Number equipped with coal fired by hand........ | 57,518 |
| Number equipped with superheaters................ | 24,242 |
| Number equipped with firebrick baffle walls.......... | 34,824 |
| Tractive power, average pounds..................... | 35,100 |

This total locomotive stock may be divided approximately as shown in Table 1.

During the month of June, 1919, the cost per mile of service from these locomotives averaged as follows, the total of $1.071 comparing with $0.974 for June, 1918:

| | |
|---|---|
| Fuel ............................................. | $0.391 |
| Repairs .......................................... | 0.361 |
| Enginemen ........................................ | 0.196 |
| Enginehouse expenses .............................. | 0.088 |
| Other supplies .................................... | 0.035 |
| | $1.071 |

Assuming a total of 2,000,000,000 locomotive-miles per annum, at this average cost the locomotive service would represent a total expenditure of $2,142,000,000, or over $33,000 annually per locomotive.

## BOILER FEEDWATER

No item in the operation and maintenance of steam locomotives contributes to greater unnecessary cost than boiler feedwater containing excessive incrusting, corrosive and foaming elements. The use of such water not only results in continual delays and expense for washing, rinsing and blowing out, but also in premature repairs and renewals of boiler and firebox sheets, flues, tubes, seams, staybolts, valve and cylinder parts, and superheater elements, due to pitting, grooving, corrosion, incrustation, overheating or priming, all of which increase the fuel, water and lubricant consumption and cause continual and otherwise avoidable delays and expense in the movement of traffic.

Observations and experiments indicate that any scale porous to water has little effect on boiler economy. However, such scale when dried out or hardened next to the metal by the expulsion of the carbonic acid, as usually occurs when boilers are forced, will not only become an excellent heat insulator and cause a heat loss of about 10 percent when 1/8 inch thick, but it exposes the sheets and staybolts to overheating and "mud burning," with resulting leakage and shopping for repairs and cleaning.

In the preparation of recent data on the expense resulting from bad water supplied to steam locomotives on eight divisions of a large Eastern trunk line, the cost averaged $1,000 per locomotive per annum for fuel, repairs, time out of service and boiler washing, with specific cases of mud burning costing as high as $400 for repairs and time out of service only.

In view of the increasing size of locomotive boilers and the high ratings to which they are subjected, the importance of purifying unsuitable water to prevent incrustation, corrosion, leakage and burning, as well as to eliminate delays and cost for cleaning, repairing and extra fuel consumed, cannot be overestimated, and until the many existing conditions of this kind are corrected, neither the existing nor improved steam locomotives can be expected to render satisfactory and economical service.

## BOILER FEEDWATER PURIFYING

When an adequate and suitable supply of boiler feedwater cannot be obtained from the usual sources, then the proper treatment of the available unsuitable water becomes necessary by settling, filtration, chemical treatment in treating plants, supply tanks or tenders; or, in the case of suspended matter and carbonates, by partial purification in a combination open and closed type of exhaust steam feedwater heater on the locomotive.

While the supplying of suitable natural or treated boiler water to the locomotive tender is the most satisfactory and economical method, in the absence of such the tender treatment or feedwater purification method will be an improvement over feeding the raw water into the boiler without treatment or attempting to treat it in the boiler.

## COMBUSTION

As a matter of historical interest, the following data are presented as taken from a copy of the report made November 21, 1854, by Captain George B. McClellan, Corps of Engineers, to Jefferson Davis, Secretary of War, on the Baltimore and Ohio, Pennsylvania Central, Virginia Central, Massachusetts Western, Boston and Worcester, Boston and Providence, Boston and Maine, Boston and Lowell, and Burlington and Rutland railroads:

"On the Boston and Maine Railway a load of 170.5 tons (gross, exclusive of engine and tender—net tons of 2,000 pounds) was drawn 74 miles at a velocity of 14.5 miles per hour, and the average of six trips gave as a result that 10.59 pounds of anthracite evaporates 7.48 gallons (1 cubic foot) of water (5.88 pounds of water per pound of coal). The trip with Cumberland coal indicated that 9.19 pounds of it will evaporate 7.48 gallons of water (6.78 pounds of water per pound of coal).

"The average waste of steam while engines are at rest, stopping on the road, steaming up, etc., is one-third of the whole amount generated."

Comparing the foregoing figures of 65 years ago with the average saturated steam locomotive performance of today it will be noted that little improvement has been made in the average road service.

The locomotive fuel bill for the year 1918 was approximately $750,000,000, and while full recognition is given to the fact that from 25 to 50 percent of the available energy in the fuel is still needlessly wasted and that present methods of mechanically firing, as compared with the average hand firing, and burning coal on grates or in retorts increase this waste, but little has been accomplished in regulating combustion so that this loss may be reduced.

The capacity of the average steam locomotive boiler is dependent upon the activity, temperature and radiation of combustion, which in turn are usually controlled by the limitations of combustion when fuel is burned on grates, the furnace volume and evaporating surfaces, the length of the boiler flues, tubes and baffle wall arrangement, and the draft, and not so much upon the inability of the evaporating and superheating surfaces to absorb the heat.

The combustion rate generally follows the increase in draft until about 100 pounds of bituminous and about 50 pounds of anthracite coal are burned per square foot of grate area. After this the additional coal supplied is not effectively consumed, due to the difficulty in supplying sufficient air, uniformly distributed, through the grates and fuel bed to oxidize the fixed carbon and volatile matter in process of combustion without a large excess of air such as obtains when forcing takes places, and it becomes necessary to open the fire door so that combustion can be completed by the admission of air above the fuel bed.

TABLE 2.—COMPARATIVE TESTS OF A STOKER-FIRED MIKADO-TYPE LOCOMOTIVE USING DIFFERENT SIZES AND KINDS OF COAL

| Item | Test No. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|
| 1 | Coal, kind | Bituminous | Bituminous | Bituminous | Bituminous |
| 2 | Coal, class | Gas | Gas | Soft | Soft |
| 3 | Coal, grade | Nut, pea and slack | Slack | Run-of-mine | Screenings |
| 4 | Coal, moisture, percent | 1.23 | 1.57 | 0.75 | 0.81 |
| 5 | Coal, volatile, percent | 36.47 | 35.74 | 18.17 | 17.52 |
| 6 | Coal, fixed carbon, percent | 53.94 | 52.78 | 69.07 | 70.06 |
| 7 | Coal, ash, percent | 8.36 | 9.91 | 12.01 | 11.61 |
| 8 | Coal, sulphur, percent | 2.59 | 3.30 | 3.33 | 2.31 |
| 9 | Coal, B.t.u. (calorimeter) | 13,910 | 13,790 | 13,880 | 13,970 |
| 10 | Total miles run | 505 | 505 | 505 | 505 |
| 11 | Kind of firing | Stoker | Stoker | Stoker | Stoker |
| 12 | Coal per average drawbar horsepower-hour, pounds | 3.74 | 4.19 | 4.14 | 4.89 |
| 13 | Boiler efficiency, percent | 46.6 | 41.9 | 46.1 | 38.0 |
| 14 | Relative pounds of coal fired, percent | 100 | 111.87 | 110.54 | 130.56 |
| 15 | Relative cost of coal, percent | 100 | 102.14 | 123.58 | 143.64 |

The greatest loss in heat is that due to the heat carried off in the stack gases, sparks and cinders, which usually results in a smokebox temperature of from 500 to 750 degrees F. for the best practice. Adding to this the heat losses due to combustible in ash, vapors of combustion, carbon monoxide and otherwise, leaves an average of from 25 to 40 percent of the heat in the fuel as fired unabsorbed by the boiler and superheater.

Where locomotives are worked at from 25 to 35 percent cut-off and hand-fired, with a thermal efficiency of about 65 percent for the combined boiler and superheater, the heat balance will be approximately as follows in Table 3.

However, at high rates of boiler capacity and draft, when stoker-fired coal is burned on grates the front end and stack cinder and spark losses will run as high as from 12 to 25 percent, the carbon monoxide from 2 to 7 percent, and the unburned fuel from 10 to 35 percent.

With the best hand firing, when using dry bituminous coal averaging 14,400 British thermal units and 60 percent fixed carbon, 32 percent volatile and 8 percent ash, the relative fuel weights will vary from 2.8 to 3.4 per indicated horsepower hour for locomotives of 500 to 2,500 horsepower respectively.

As compared with hand firing, stoker firing will result in an increase of from 10 to 25 percent in the fuel fired, while if the same coal be pulverized and burned in suspension there will be a decrease of from 15 to 25 percent in the amount of fuel fired.

As the locomotive firebox, which in the best practice represents only from 7 to 10 percent of the total boiler evaporating surface, must generate all and absorb from 30 to 40 percent of the heat energy that is converted into drawbar horsepower, the fuel effectively consumed, not fired, is the measure of work done. Therefore the largest permissible combination of firebox and combustion chamber volume, heating surface and grate area should be provided and equipped with an arrangement of firebrick baffle walls placed on water-circulating supports in a manner to produce long flame travel, high firebox tem-

TABLE 3.—HEAT BALANCE FOR BOILER AND SUPERHEATER

| | Percent |
|---|---|
| Heat absorbed by boiler | 55 |
| Heat absorbed by superheater | 10 |
| Heat loss in smokebox gases | 14 |
| Heat loss in cinders | 8 |
| Heat loss in vapors of combustion | 4 |
| Heat loss in combustible in ash | 3 |
| Heat loss in carbon monoxide | 2 |
| Heat loss in radiation and unaccounted for | 4 |
| Total | 100 |

The future of the steam locomotive has been a topic for frequent discussion, particularly since the electrification of the main line of the Baltimore and Ohio Railroad through the city of Baltimore in 1895.

Little attention was given to improving its efficiency until the tunnel, bridge and track clearance and weight limitations and the rising costs for fuel and labor made it necessary to find means to increase capacity and economy, since which time the compound, Mallet articulated, and superheated steam types of locomotives have been generally adopted, although the working steam pressures, due to the continuation of the existing type of boiler, have remained relatively low, with a few extreme cases of from 225 to 250 pounds.

The scientific factors are now being considered in the design and development of a new, high-powered freight locomotive for the purpose of substantially increasing the average thermal efficiency, as well as the maximum and sustained drawbar pull and horsepower per unit of weight, all of which are at present limited by the capacity of the generally adopted boiler superheater.

perature and the maximum radiant heat for absorption by the surrounding water.

With the usual limitations in firebox volume, too much importance cannot be placed on the arrangement of heat-absorbing and radiating walls for the purpose of flame and radiant heat propagation. Carefully conducted tests have shown that the best results are obtained from solid firebrick baffle walls and that the unburned gas, coal dust, spark, cinder and smoke losses are reduced with an increase in their length and gas-passage arrangement, and a saving of from 10 to 15 percent in bituminous coal as fired is effected.

The greatest difficulty in controlling combustion occurs at high horsepowers and long cut-offs, where grates are used, and for the best results the air openings should be equal to about 50 percent and those in the ashpans to about 15 percent of the total grate area so that firebox temperatures of from 2,000 to 2,500 degrees F. can be obtained and the unburned solid fuel, carbon monoxide and excess air over the fuel bed reduced to the minimum.

### Factors Influencing Combustion

Other important factors influencing combustion, as well as evaporation and superheating, that should receive consideration are: The ratios of length to diameter of boiler flues and tubes and the spacing between them; the distribution of gas area between boiler flues and tubes; the effect of closed superheater dampers on firebox draft when the locomotive is not using steam; the free passage of gases through the front end by the elimination of unnecessary baffles, steam pipes and superheater parts; the arrangement of the exhaust stand and nozzle to change the form of the exhaust jet and produce greater entrainment of gases and improved co-ordination of exhaust jet and stack.

As with dry pulverized coal of 12,430 British thermal units value, an average boiler efficiency of 69.2 percent at 1,080 boiler horsepower and an average combined boiler and superheater efficiency of 78.1 percent at 1,220 boiler horsepower, with an equivalent evaporation averaging 42,100 pounds of water per hour from and at 212 degrees F., has already been obtained on a Mikado simple-cylinder type of locomtive hauling fast freight trains over a 113-mile division, the possibilities for reducing the steam locomotive fuel consumption are practically unlimited and much remains to be done in this direction by good hand firing, through a combination of the fireman's eyes, brain and brawn, provided the thermal efficiency of the modern locomotive at the drawbar is brought up to where it can and should be.

### Boiler Water Circulation

Water is practically a non-conductor of heat, but expands when heated above 39 degrees F. and rises due to its relatively lower specific gravity. Unimpeded circulation will therefore increase its ability to take up heat, maintain greater uniformity of temperature throughout the boiler, and decrease the liability of incrustation of heat-absorbing surfaces and of priming.

In designing a boiler it is extremely desirable to secure the most rapid circulation practicable, as with high combustion rates and temperatures and the abnormal state and behavior of the water film in contact with the heating surfaces, the load on the firebox sheets is very intense, the conduction rate averaging from 75,000 to 100,000 British thermal units per square foot of evaporating surface per hour.

Therefore, in order to avoid resistance to heat transfer, with resultant overheating of metal and reduced efficiency, a relatively high velocity of circulation and at least a rate of 125 feet per minute in the most sluggish locality is very essential.

The average locomotive boiler, with its combination of cylindrical and box shell, water legs, staybolts and rods, flues, tubes and generally irregular design of water spaces, does not present ideal water-circulation possibilities, but the enlarging of contracted spaces, increasing of water-leg, flue and tube clearances, and provision of suitable outlets from choked water pockets will not only reduce the resistance to the "slip" of the steam bubbles through the water, but will enable the accelerated action of the former to increase the velocity of the latter and thereby improve general circulation and heat transfer results.

*(To be continued.)*

# Oxy-Acetylene Work in the Railroad Shop*

BY W. L. BEAN†

Methods of handling and applying oxy-acetylene in railroad work should, however, be scrutinized and properly supervised, if the results are to match up with the rapidly mounting expenditures necessary daily, and monthly, and yearly, to carry on the work. The process depends on two gases, acetylene and oxygen, a few facts with respect to each being as follows:

### Acetylene

Acetylene is generated by chemical reaction between water and calcium carbide, and is a gas of remarkable qualities. Briefly, its most outstanding characteristic, and the one which puts it head and shoulders above all other commercial gases, is its high carbon content, which is 99.2 percent of its total weight, and which gives such a high flame temperature, especially when burned with pure oxygen. Furthermore, the endothermic nature of acetylene further increases the flame temperature. It is this characteristic which prevents the common gases, such as ordinary illuminating gas, natural gas, benzine, gasoline, kerosene, pintsch and blau gases, etc., from competing with acetylene for welding any metals but those with low fusing temperatures, and from cutting steel or iron with greatest economy.

Comparative temperatures, attained by burning acetylene and other gases in air, are shown in the tabulation:

| | | |
|---|---|---|
| (1) | Alcohol | 3,092 degrees F. |
| (2) | Marsh gas | 3,362 degrees F. |
| (3) | Hydrogen | 3,542 degrees F. |
| (4) | Coal gas | 3,542 degrees F. |
| (5) | Water gas | 3,632 degrees F. |
| (6) | Acetylene | 4,652 degrees F. |

Naturally, when the flames are supported by oxygen instead of air, the temperatures attained are much higher, for instance:

| | |
|---|---|
| Coal gas burned in oxygen | 3,960 degrees F. |
| Hydrogen burned in oxygen | 4,388 degrees F. |
| Acetylene burned in oxygen | 6,300 degrees F. |

* From a paper read before the New England Railroad Club.

† Mechanical assistant, New York, New Haven & Hartford Railroad, New Haven, Conn.

From which we note also that acetylene burned in air gives a higher flame temperature than either coal gas or hydrogen burned in oxygen. This shows that a welder has an extremely hot flame to handle—a temperature that is a good deal higher than the fusing point of the metal that he is welding, and consequently success depends on the skill of the operator in being able to fuse metals without burning them.

### The Flame

The oxy-acetylene welding flame is composed of two portions, a small inner or so-called cone, which attains a temperature of approximately 6,300 degrees F., is produced by the combustion of oxygen supplied to the blow-pipe, uniting with the carbon from the acetylene. The products of this initial combustion are free hydrogen and carbon monoxide. The temperature supplied by the cone is too great to permit combustion of these two gases until they have cooled off. Therefore, they pass out from the cone until they meet the atmosphere, where they cool and unite with atmospheric oxygen, to form water vapor and carbon dioxide, respectively. The burning of the hydrogen to create water vapor is at about 3,600 degrees F. and they go to form $CO_2$ at about 2,300 degrees F.

This is of particular importance in welding alloys or metals like copper, which oxidize pretty rapidly, and it is one feature that stands out in favor of the oxy-acetylene flame as compared with the electric process, because the electric process has, of course, the advantage of a great deal less heat involved, which reduces contraction stresses, but at the same time the metal in the electric weld is not protected from the atmospheric oxygen as it is in this case. The outer, cooler, enveloping flame acts as a shroud, which keeps the atmospheric oxygen from uniting with the metal being welded, thereby performing a valuable work. The products of the combustion, which forms the cone, viz.: H and CO, have strong affinities for oxygen, thereby assisting in preventing any excess of oxygen from uniting with the metals.

Examination of hundreds of test specimens and likewise hundreds of observations of welding operations shows that the great majority of blowpipe operators underheat the body metal, that is, the piece being welded; and, on the contrary, they overheat the wire or filler metal. An operator who plays the small cone directly on the filler wire is burning it. He cannot do otherwise. Such a workman invariably runs the burnt metal upon the underheated surface of the piece he is trying to weld, and gets an adhesion, but not a weld. He has, as a result, a combination of two weak elements; viz.: burned metal attached by surface adhesion to the body metal.

This point cannot be too strongly emphasized, as it is the cause of more inferior welds than any other one thing. The skilled operator works the end of his filler wire in a puddle of metal, agitating the molten metal and thereby distributing the heat. Also, he constantly moves his welding cone so as not to overheat the molten metal and so as to permit moving the wire through the latter without the wire encoutering the welding jet. The welding cone should approximate, in its movements, a half circular arc. The welding wire should be melted by heat from the puddle metal plus radiated heat from the cone, but never by being enveloped by the latter.

### Oxygen

As stated in the beginning, the development of the oxy-acetylene process was retarded by the high price of oxygen. In 1910, oxygen was commonly sold at from four to six cents per cubic foot and was still largely produced by the potassium chlorate process. The big possibilities commercially, however, stimulated production and a cheaper chemical process using bleach powder and some other re-agents, had a short life, the cost being about 2½ cents per cubic foot. The electrolytic and liquid air processes, however, control the market at present, and are likely to continue, especially the latter.

In 1912, the price of oxygen had dropped to about two to two and one-quarter cents per cubic foot, in quantities, and now most railroads buy it for one and one-half cents or slightly less. Therefore it is one article of importance which has decreased in price during the period of the war, and as it is the item of largest expense in welding, especially in cutting operations, railroads have better opportunity than ever before to make large and profitable utility of the process. It is true that carbide has increased in price, and so has labor, but not more than like items entering into costs of doing work or reclaiming materials by other methods.

### Apparatus

Naturally with the development of the process there comes opportunity for refinement in the selection of apparatus to suit given conditions, and the ultimate results depend on the choice made.

For oxy-acetylene operations in small shops or for temporary work at remote points, compressed acetylene in portable cylinders is best adapted to the work; but in large shops, where a relatively large amount of work is done regularly within a restricted area, full advantage should be taken of the economies of stationary apparatus, connected to a pipe system. Experience indicates that railroad shop installations of oxy-acetylene equipment should consist of stationary instead of portable apparatus when the volume of welding and cutting requires the services of two or more operators regularly.

Compressed acetylene costs 1½ to 2 cents per cubic foot, f. o. b. charging station. Freight or express charges must be borne by the railroad both on the filled and empty drums, whereas, in using a generator, the cost per cubic foot is ¾ to 1 cent per cubic foot, depending on carbide price, and there is no expense for transportation except in one direction, and also there is less weight to be handled per foot of gas delivered by the generator as compared to the compressed acetylene. Also the slowness of releasing the compressed, or dissolved gas, especially on heavy work, causes operators to set cylinders aside as empty when they still retain from 10 to 20 percent of the nominal gas charge. This is especially true in cold weather. This feature, of course, raises the cost of the gas per actual cubic foot delivered to the blowpipe. The cost is also affected by the admixture of varying amounts of acetone to the discharged gas. Acetone, by reducing the flame temperature, requires the burning of more acetylene to do a given amount of welding than is needed when acetylene, free from acetone, is taken directly from the generator. These several features combined produce an actual cost for compressed acetylene of 2½ cents to 3 cents per cubic foot.

Aside from the above considerations, there remain a number of matters concerning ease and efficiency of operation. When the acetylene generator is installed, it delivers a continuous supply of gas to a shop through a pipe line at a constant pressure, thereby eliminating the need of regulators or reducing valves which have the following disadvantages:

(a) First cost; (b) maintenance cost; and (c) time required for adjusting pressure and for connecting and disconnecting from cylinders.

Under the constant supply system, the operator is at once relieved of all concern as to gas supply, since the handling of cylinders from the storehouse to shop and back again, and from job to job, is eliminated. He is also not concerned with regulating the gas pressure, as that is done by the generator, and he need not, and, in fact, cannot, change the pressure. That cuts out the regulator expense and annoyance. In fact, the operator has his hose and blowpipe and can move from job to job without any more apparatus to carry or adjust than in the case of a man using an air hammer supplied by a pipe line.

Blowpipes are carefully designed by manufacturers and should not be altered by railroad shop men. If orifices are changed, the proportion of mixing oxygen and acetylene is disturbed with consequent effect on combustion. In this connection it is important to point out the need for using gas pressures and welding and cutting nozzles suitable for the heaviness of the work done. The average railroad shop worker, and that includes foremen, generally assumes that if a little is good, a whole lot more is better, and so one can daily observe operators welding thin plates with cones big enough for a locomotive frame job, or cutting an ash pan sheet, with 75 pound oxygen pressure instead of 25 pounds. Likewise, in using a cutting blowpipe, two large nozzles are used. When one cuts ⅜-inch plate with 75 pounds oxygen pressure and a nozzle to match that pressure, fully two-thirds of the oxygen is absolutely wasted and the cost increased at the rate of $4.00 to $6.00 per hour of operation.

Money is being wasted in everybody's railroad shop, especially on cutting, by using nozzles and pressures that are too great for the job, and a lot of alleged savings are going by the board on that account. They are only imaginary. There must be education and real supervision along these lines, or else the volume of poor and at the same time expensive work cuts down the benefits deplorably below what they should reasonably be.

### Welding Accessories

It is unwise to equip a shop with high grade oxy-acetylene apparatus and then give welders common iron to use as "filler" metal, or to set them to welding a gray iron casting with scrap packing rings for "filler." The different metal parts of a locomotive vary greatly in their chemical and physical characteristics, and likewise those characteristics usually change more or less when the metals are heated to a welding temperature. On that account "filler" metals and fluxes designed to produce metal in the weld as nearly as possible of the right make-up should be used.

Charcoal iron wire of great purity is best for firebox work, and no flux is needed, but it is not the best practice to weld a cast steel mud ring with that metal, which has 48,000 pounds of tensile strength, when the mud ring steel probably has a strength of from 60,000 to 75,000 pounds per square inch. It is better to use on such work a "filler" of proper carbon content to give the weld high tensile strength, and to be otherwise specially adapted to the work.

It is not sufficient to use a "filler" of the same grade as the metal to be welded, or to use one which might seem even better in quality than the object to be welded. For example, any cast iron to be found on a locomotive, no matter how good it may be for the purpose it was made, does not make a good "filler" on a casting where it is important to get a clean, strong weld, which works well under a tool. The reason is, that on cast iron work a special alloy "filler" iron containing from three to four times as much silicon as is found in ordinary foundry casting, is needed. The excess silicon replaces that of the welded casting, oxidized in the making of the weld, and since the silicon controls to a large extent the proportion of combined and free carbon in the casting, it cannot be removed without hardness resulting.

A great many railroad shops have indiffenent results in welding cast iron, because they don't take the proper care in pre-heating and annealing. It is necessary on a cylinder job, for instance, or any job of any magnitude, where the casting has any complication to it, or any great mass, to heat it slowly, and weld it, and then let it cool slowly. It may be necessary even to let the job stand from forty-eight to sixty hours covered up from the air to let it gradually cool down. If the work be so handled, by means of a boring bar or a facing tool, it can be machined as nicely as any casting that was ever made. But if that job is allowed to cool rapidly not only does warping result, but the material gets as hard as flint. Foremen as a general rule are too anxious to hurry the job, not so much in the welding itself as in getting ready and in letting the work cool down slowly afterwards.

Oxy-acetylene welding, to be carried on with the best of success, must include the use of "fillers" and fluxes specially compounded to meet the needs of the different metals to be welded. This applies to all forms of iron and steel, forgings, plates, shapes and castings; and to copper, brass and aluminum.

### Selection and Instruction of Welders

The use of pure gases, efficient blowpipes, and proper fillers and fluxes does not insure good welds unless operators are competent. Probably more failures of welds have resulted from unskilled and unintelligent craftsmanship than from any other one cause.

Not all proposed operations of welding are possible or advisable, but when men of some mechanical skill and knowledge of the metals and the demands which service will place on the weld, are given correct and sufficient instruction, a great variety of jobs can be done successfully from every standpoint. On account of the fact that results in welding are very greatly dependent on the skill of the operator, and because the welds can vary even more in actual structure than in external appearance, it is necessary to place blowpipes in the hands of men who have a knowledge of that particular piece being welded, as to its physical nature and the service to which it is to be subjected. Moreover, men who can be successfully instructed in the elementary chemistry of the subject will have a finer appreciation of the need for careful blowpipe regulation, the preparation of the work, the use of fluxes, the application of suitable special filler materials, the effects of expansion and contraction, and all other details which have to do with the efficiency and economy of the operation.

And right here let it be said that a man who is erratic, who feels well to-day and will make a good weld, but who to-morrow feels "rotten," won't make a successful welder. In the first place, it is a routine job, that requires generally a phlegmatic disposition, more or less, to make a high-grade welder. The man who is impulsive and quick-tempered does not make a reliable welder. Men who are intelligent, who take a natural pride in workmanship, who are uniform in disposition, who are anxious to become proficient, should be the ones entrusted with the blowpipe, and the additional wages which such men command will prove a most excellent investment.

# Lubrication of Air Compressors*

BY H. V. CONRAD†

Satisfactory lubrication of air compressor cylinders is attained by securing (1) the reduction of friction to a minimum, and (2) elimination of carbonization of the oil as far as possible.

For the proper reduction of friction, the oil chosen should have sufficient body to sustain the weight of the moving parts and to form a seal between the piston rings and the cylinder walls, and still not absorb excessive power in the overcoming of the viscosity of the oil itself.

The objections to air cylinder oils which allow more than the very slight amount of carbonization which appears unavoidable are, of course, well known, but may be briefly stated for the purpose of clarifying what follows:

Carbonization of the oil allows the accumulation of deposits of carbon which are sticky in the early stages of their formation, but hard and flinty later. Such deposits accumulate on the cylinder valves, in the cylinder passages, in the pipes and eventually in the air receiver.

Sticking or partial closing of the valves and their consequent failure to act properly is probably the chief objection to this action from the standpoint of the efficient operation of the compressor.

The formation of excessive carbon deposits is apt to be due to any one or more of the following causes:

1. The ill-advised use of some oil, such as a steam cylinder oil, which easily decomposes in the heat of the air cylinder.
2. The use of oils of too great a viscosity—commonly referred to as "too heavy oils." These do not atomize readily, and therefore remain too long upon the hot cylinder walls, etc., thus baking down to sticky carbon deposits.
3. The use of too great quantities of oil, which has the same effect as the use of too heavy an oil as far as the carbonization is concerned.
4. The failure to provide a proper screen over the air intake of the compressor, thus allowing free entrance of dangerous dust (especially coal dust).

The objections to this carbonization, aside from the sticking of air valves and choking of the air passages, is the menace of fire entailed by carbon deposits. Carbon particles torn loose from them may become incandescent from causes which could not be anticipated by the compressor manufacturer. If such incandescent carbon particles should happen to come in contact with "oil vapor" given off by the lubricating oil, a fire might possibly be started whose menace would be small or large, depending upon how much carbon had been allowed to accumulate in the compressor and piping to the receiver. If these are kept properly cleansed at all times, there should never be a time of any danger.

This oil vapor is given off from a lubricating oil at a certain temperature called its "flash point," just as steam arises from water at a certain point.

### Heat of Air Compression

The selection of an air cylinder lubricant is, of course, governed to a considerable extent by a knowledge of the cylinder temperature it must withstand. Knowing the air pressures, the corresponding temperatures are ascertained fairly accurately, as shown in Table 1.

This table gives the final temperature in the cylinder at the end of the compression stroke for single stage, also for two stage (or compound) compression when the free air entering the cylinder is 60 degrees F.

TABLE 1—Cylinder Temperatures at End of Piston Stroke

| Air Compressed to | Final Temperature Single Stage | Final Temperature Two Stage |
|---|---|---|
| 10 pounds gage | 145 degrees F | |
| 20 pounds gage | 207 degrees F | |
| 30 pounds gage | 255 degrees F | |
| 40 pounds gage | 302 degrees F | |
| 50 pounds gage | 339 degrees F | 188 degrees F. |
| 60 pounds gage | 375 degrees F | 203 degrees F. |
| 70 pounds gage | 405 degrees F | 214 degrees F. |
| 80 pounds gage | 432 degrees F | 224 degrees F. |
| 90 pounds gage | 459 degrees F | 234 degrees F |
| 100 pounds gage | 485 degrees F | 243 degrees F. |
| 110 pounds gage | 507 degrees F | 250 degrees F. |
| 120 pounds gage | 529 degrees F | 257 degrees F. |
| 130 pounds gage | 550 degrees F | 265 degrees F. |
| 140 pounds gage | 570 degrees F | 272 degrees F. |
| 150 pounds gage | 589 degrees F | 279 degrees F. |
| 200 pounds gage | 672 degrees F | 309 degrees F |
| 250 pounds gage | 749 degrees F | 331 degrees F |

Variations from these temperatures will occur in actual practice due to water-jacketed air cylinders and radiation, tending to lower the temperature at the higher pressures. But at, say, 50 pounds pressure and lower, the heat is likely to be somewhat greater than given by the table, particularly if the compressor is run at high speed and also if it is not water-jacketed.

### Relation of Oil Flash Point to Cylinder Temperature

The natural inference of the reader after noting the temperatures in Table 1 is that he must select an air cylinder oil whose flash point is higher than the maximum temperature apt to be encountered within the air cylinder. As a matter of fact, this is not the case, and it need only be carefully noted that: the study of the air cylinder temperatures is useful mainly in testing lubricating oils to determine their resistance against breaking down into carbon, etc. But such temperatures cannot be taken as limits establishing the highest allowable flash point for a lubricant safe to use in the air cylinders.

### Qualities of Cylinder Lubricating Oils

For average normal conditions, the oil should be a medium-bodied pure mineral oil of the highest quality, not compounded with fixed oils such as animal or vegetable, and should be carefully filtered in the final process of manufacture.

Quite a range of oil composition is permissible for lubricants approved for this work, which are manufactured under the above conditions. Primarily a distinction must be made between those oils having paraffin base as distinguished from those having an asphaltic base.

From a strictly operating standpoint—so it is claimed by some lubricant manufacturers—there is no distinction between these two classes of lubricants as to their desirability as compressor cylinders oils, provided that both have been properly filtered in the process of manufacture to remove the carbon-forming elements. If any carbon should be formed, however, such carbon deposited by the asphaltic base oils is of a light fluffy nature and easily cleaned out, whereas that deposited by the paraffin base oil is very adhesive and characterized by the hard, flinty nature.

### Paraffin Base Lubricating Oils

Merely as a guide to aid the operator in specifying the qualities to be possessed by an air cylinder lubricant



† Mechanical engineer; secretary, Compressed Air Society, New York City.

recommended for average duty, the following table is presented:

TABLE 2—PHYSICAL TESTS OF PARAFFIN BASE OILS

| | Minimum | Average | Maximum |
|---|---|---|---|
| Gravity, Baume.... | 28 to 32 degrees | 25 to 30 degrees | 25 to 27 degrees |
| Flash Point, Open Cup........... | 375 to 400 degrees F. | 400 to 425 degrees F. | 425 to 500 degrees F. |
| Fire............... | 425 to 450 degrees F. | 450 to 475 degrees F. | 475 to 575 degrees F. |
| Viscosity (Staybolt) at 100 degrees F.. | 120 to 180 seconds | 230 to 315 seconds | to 1500 seconds |
| Color............ | Yellowish | Reddish | Dark Red to Green |
| Congealing Point (pour test degrees F.)............ | 20 to 25 degrees F. | 30 degrees F. | 35 to 45 degrees F. |

It is suggested that those oils within the range expressed by the minimum figures be used for light duty of low-pressure and temperatures, while those expressed by maximum figures should be used for high pressures and temperatures.

It is recommended that any paraffin base lubricant intended for use in "all standard air compressors" should meet the physical tests imposed by the average range of figures given in the middle column of the above table. The above wording, "standard air compressors," is to be interpreted as including the following types of machines:

*a.* Low pressure up to 100-pound compressors, which may be either small-sized single-stage units or larger-sized compound machines.

*b.* High-pressure compressors which are constructed with the proper number of stages, so that no excessive temperatures are ever reached.

In other words, this lubricant of average test figures is always recommended unless a compressor manufacturer specifies in his literature that a high flash point oil should be used to meet the conditions peculiar to his machine. It is thus obvious that it is never necessary that a lubricant should possess a flash point as high as 500 degrees unless abnormal conditions of high temperature prevail. Such high flash point oils have an unusual tendency to produce carbon deposits.

### Asphaltic Base Lubricating Oils

This group of oils is considered separately for the reason that the lower limit of gravity stated in the above table, viz., 25 degrees Baume, eliminates this entire group from consideration—which is not the intention of this article.

As a guide for the selection of suitable oil, the following table is given:

TABLE 3—PHYSICAL TESTS OF ASPHALTIC BASE OILS

| | Minimum | Average | Maximum |
|---|---|---|---|
| Gravity, B aume.... | 20-22 degrees F. | 19 .8-21 degrees F. | 19.5-20.5 degrees F. |
| Flash Point, Open Cup........... | 305-325 degrees F. | 315-335 degrees F. | 330-375 degrees F |
| Fire............... | 360-380 degrees F. | 370-400 degrees F. | 385-440 degrees F. |
| Viscosity (Staybolt). at 100 degrees F.. | 175-225 seconds | 275-325 seconds | 475-750 seconds |
| Color............ | Pale Yellow | Pale Yellow | Pale Yellow |
| Congealing Point (pour test)...... | 0 degree F. | —0 degree F. | —0 degree F |

For general all-round use, it is conceded that the recommendations given in Tables 2 and 3 above cover the situation as well as possible, special cases, of course, requiring investigation and special consideration before making recommendations.

The quantity of lubricating oil to feed to the air cylinders of compressors cannot be stated in exact terms, due to the varying viscosity of different oils, the heat of compression and the size of cylinder. It may be stated in general, however, that after the cylinders have acquired smooth and polished surfaces, the quantity should be reduced to the lowest limit to avoid the possibility of the accumulation of carbon and sooty deposits within the system due to excessive use.

The following basis of quantity given in Table 4 is recommended, subject to above modifications for these cylinders or equivalent sizes operating under normal conditions:

TABLE 4—QUANTITY OF AIR CYLINDER LUBRICANT REQUIRED PER 10-HOUR DAY

| Diameter of Cylinder, Inches | Size of Cylinder, Inches | Displacement per Minute Cubic Feet | Piston Speed Feet Per Minute | Square Feet of Cylinder Wall Swept by Piston | Drops Oil per Minute | Drops Oil per 10 Hours | Square Feet Oiled per Drop | Number Pints Oil Required per 10 Hours. |
|---|---|---|---|---|---|---|---|---|
| 8 | 8 x 8 | 120 | 344 | 718 | 1 | 600 | 718 | .0375 |
| 12 | 12 x 12 | 320 | 408 | 1230 | 2 | 1200 | 613 | .0750 |
| 18 | 18 x 18 | 880 | 496 | 2340 | 4 | 2400 | 585 | .1500 |
| 24 | 24 x 24 | 1730 | 550 | 3450 | 6 | 3600 | 575 | .2250 |
| 30 | 30 x 30 | 2940 | 600 | 4700 | 8 | 4800 | 590 | .3000 |
| 36 | 36 x 36 | 4550 | 644 | 6070 | 10 | 6000 | 607 | .3750 |
| 42 | 42 x 42 | 6700 | 696 | 7600 | 12 | 7200 | 633 | .4500 |

Figures of last column are based upon an estimated 16,000 drops per pint of oil at 75 degrees F

It will, of course, be carefully noted and clearly understood that the results in the last column of Table 4 are based upon the assumption that under average conditions of temperature and usual range of oil viscosities a pint of oil will contain an average of about 16,000 drops. It is, of course, understood that these figures are offered merely as an approximate guide and that every individual must exercise his own judgment in modifying them wherever his own particular set of working conditions is unusual.

A leading authority on compressor engineering contributes the following: "The best way to determine the proper amount of lubrication is to take out the valves from time to time and examine the cylinder. All parts should feel that there is oil thereon. If they feel dry, the lubricators should be adjusted to feed a little more oil, whereas if oil lies in the cylinder and its parts show excessive oil thereon, the quantity fed by the lubricators should be reduced. By thus examining the machine a few times, the proper amount of oil can be determined to suit the characteristics of the particular lubricant used and the conditions under which the machine operates." This is a better way to finally determine the quantity of oil required than by adopting without this experimenting any tabulated number of drops.

### Periodical Cleansing of System

The best of lubricating oils will cause the deposit of enough carbon in the compressor system to necessitate the periodical cleansing of it.

For the removal of carbon, the machine operator should confine his efforts to the use of soap suds. A good cleansing solution is made of one part soft soap to fifteen parts water. These suds should take the place of oil for a few hours and be fed into the air cylinders about once a week, either by means of a hand pump or through the regular lubricator at a rate about ten times as rapidly as that of the oil. The cleanliness of the air valves when inspected, as they should be periodically, will indicate whether greater or lesser applications of the soap suds should be made. After using soap suds, open the drain cock of the air receiver, and of the inter-cooler in the case of compound machines, to draw off any accumulated liquid. Oil should be used again for a half hour before shutting down the machine, in order to prevent rusting the cylinder and its fittings. Never use kerosene, gasoline or lighter oils in an air cylinder for any purpose whatever, because of their volatile nature under heated conditions.

### Cleaning Air Receiver and Piping

It often happens that oil, carbon and other foreign matters are deposited in the air discharge lines and air receiver. A practical method of cleaning these is to use a receptacle made of 6-inch pipe set on top of the discharge pipe. If a mixture of one pound of Red Seal Lye and eighteen pounds of water is passed into the discharge line at the rate of 60 or 70 drops per minute while the compressor is running, this will eat out all the accumulation on the surface of the pipe and in the receiver, and if the blow-off valve on receiver is open all of this foreign matter will be discharged therefrom. This cleaning solution can be used every month or two, or depending on how much accumulation there may be in the receiver.

### Steam Cylinder Lubrication

The proper quantity of oil to be fed to steam cylinder is much greater than to air cylinders, due to the constant washing away of the oil by the steam. Approximately four times as much oil will be needed in the steam cylinders as in those for air, subject, of course, to variable local conditions.

Depending on its viscosity, a pint of steam cylinder oil will furnish from 5,000 to 8,000 drops; and, taking an average of about 6,500 drops, and four times as much oil as air cylinders of same size, and working at same piston speeds, as given in Table 3, the recommended amounts to feed the steam cylinders or their equivalents are given in the following:

TABLE 5.—QUANTITY OF OIL FOR STEAM CYLINDER LUBRICATION

| Number Drops per Minute | Size of Cylinder, Inches | Number Pints Oil Required per 10 Hours |
|---|---|---|
| 4 | 8 x 8 | .4 |
| 8 | 12 x 12 | .75 |
| 16 | 18 x 18 | 1.5 |
| 24 | 24 x 24 | 2.25 |
| 32 | 30 x 30 | 3.0 |
| 40 | 36 x 36 | 3.75 |
| 48 | 42 x 42 | 4.5 |

These figures are approximate only and will vary with the steam conditions, the kind of oil used and its method of introduction into the steam, also with the boiler compound carried by the steam into the cylinder.

### Observations on Changing Tested Oils

When the operator of an air compressor succeeds in obtaining lubricating oils that are giving satisfactory results, he should be very cautious about making a change to other grades, particularly if cheapening the cost is advocated by purchasing and sales agents. But if a change is decided on, the performance of the new lubricants should be most carefully checked up before damage can occur to the rubbing surfaces of the compressor, and to see that no increased amount of deposit collects on the inside walls of the air receiver.

The most satisfactory way to get the quickest results is to put up the problem of lubrications to the local experts of any reputable lubricating companies and to be governed by their recommendations, which, however, should be based on the foregoing statement.

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# Australian Locomotive Construction

**Boiler and Superheater Developments Factors in the Progress of Locomotive Design in New South Wales**

The development of the rolling stock of all classes in the state of New South Wales, Australia, is reasonably in harmony with that taking place in the older countries of the world. Although the pace has not been that set in America with respect to the size or hauling capacity of locomotives, the progress of New South Wales compares favorably with that of Great Britain and European countries, even though the business in Australia is only a fractional part of that handled by the former.

The first passenger engine used in the state of New South Wales had a draw-bar pull of 8,192 pounds, while the latest type of locomotive (N. N. Class) passenger engine of today has a draw-bar pull of 27,480 pounds, or 3.55 times the capacity of the first engine used.

The Railway Department constructed its first locomotive, known as Engine No. 10, in 1910.

It has just been mentioned that progress equal to that in the United States has not been achieved in New South Wales, and that fact is not so much due to lack of desire to introduce engines of greater hauling capacity as to the heavy expenditures which must be incurred to permit the use of such engines. The United States started railway construction wisely with a liberal load gage. In the Commonwealth, British practice was introduced and maintained up to a comparatively recent period.

Powerful engines must be of large dimensions, and their introduction can only be effected after a complete reconstruction of many bridges and other fixed structures throughout the State. Progress in this direction has been made during the past few years.

### Lines of Locomotive Development

In the main, there has been no very marked departure in locomotive building from early standards; boilers have grown in size, tubes increased in number, and the number of coupled wheels has been increased. Cylinders have increased in diameter and length, but the materials used have remained practically the same. In what are sometimes regarded as minor details, very marked improvements have been effected in the last decade. Compounding has been tested everywhere and almost everywhere abandoned, but other aids to a reduced coal and water consumption have been adopted with success. Chief among these is the superheater, which was introduced in America and Europe about 1905, though the superheater was actually invented by Archibald Sturrock in the middle of last century while he was the chief mechanical engineer of one of the leading British railroads. He was not able to make a success of it because high flash point cylinder oil was not then known. Further study has so perfected the system that the hauling power of locomotives of a given weight has been increased 10 percent, while coal consumption for hauling that increased load has been decreased by at least 20 percent.

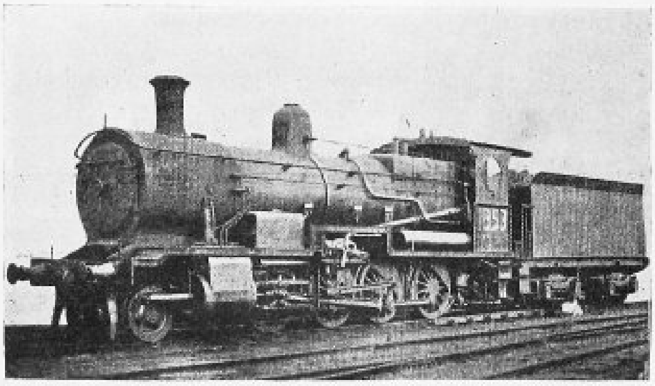

Fig. 1.—"K" Class Locomotive No.1353 of the New South Wales Railway

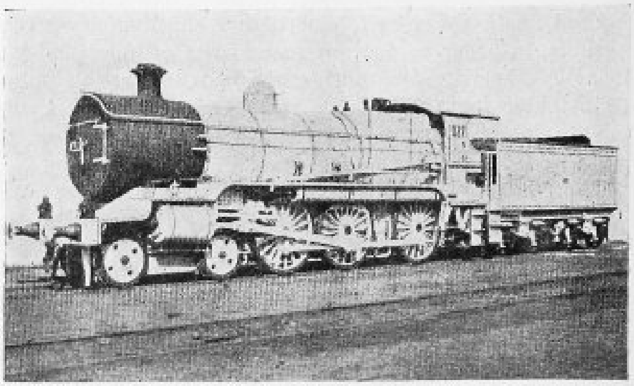

Fig. 2.—Passenger Engine No. 1027 of the "N. N." Class, Latest Type of Australian Locomotive

The first type of superheater tested in this State was the "Schmidt," a type which, including as it did the best principles of several European and American designs, was, just before the war, widely used throughout the world. It had, however, some serious weaknesses, and finally the chief mechanical engineer, E. E. Lucy, designed the "Lucy" superheater, which has now been adopted as standard. A general view of this class of superheater is shown in Fig. 3. The first superheaters of this type were used in service for a period of 2¼ years without requiring any attention or repair, while no others (with one exception) had given more than two months' service without attention.

Another important alteration in the direction of economy has been the introduction of the exhaust injector, which returns heat to the boiler, in the feed water, that was formerly blown into the atmosphere and lost.

A phase of locomotive design to which no very great attention has been given anywhere until recently is the firebox, grate and ashpan, and it may be claimed that New South Wales has now made as great progress in designing these details as has been accomplished in any country.

The "K" type engine is equipped with the improved

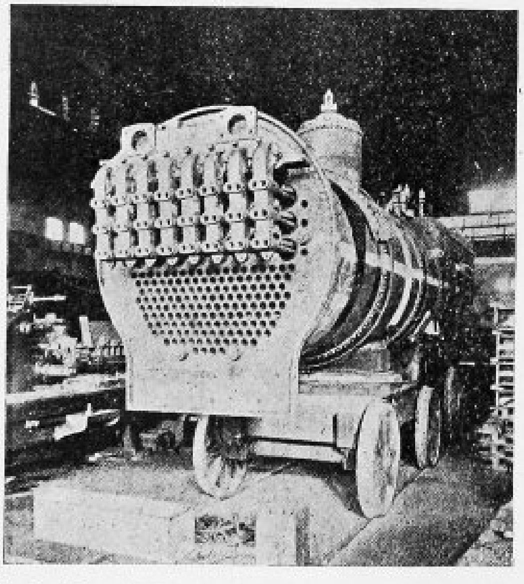

Fig. 3.—"Lucy" Type Superheater, Standard for Australian Locomotives

"Lucy" superheater and a steam circulatory system for the preservation of the superheating elements. The firebox has a grate area of 28.75 square feet, and the total heating surface of the boiler is 2201.7 square feet. An exhaust injector is fitted, as well as a top feed for the water from the injectors flowing into the boiler. This system automatically separates many deleterious elements, which are converted into gas and steam, and therefore discharged through the steam pipe and cylinders into the atmosphere before having an opportunity to do mischief to the inside of the boiler. It is impossible for the enginemen to rock the firebars of this locomotive, and thereby riddle out the ashes and clinkers while coasting down inclines. Such ashes and clinkers are received in the hoppers underneath the ashpan, where they are quenched by water injected through a special apparatus from the tender tank. The introduction of steam to a suitable cylinder then opens the slides at the bottom of these ash hoppers, and the ashes—wetted, quenched and harmless—then drop out on the track or into a pit, as the case may be.

The engine is also fitted with a blow-off cock that can be operated by the driver when running, and so get rid of undesirable qualities of water, scale and mud from the boiler, which would otherwise cause delay to the engine by reason of priming.

The ashes from the smokebox can be ejected at any desired spot by the use of a steam ejector and suitable collecting hoppers situated under the smokebox.

The effect of the developments in Australian locomotive design may best be shown by a comparison of the present work with that done in an earlier year:

In 1897 the coal used totalled 290,199 tons.
In 1918 the coal used totalled 823,673 tons.
In 1897 the water used totalled 429,030,201 gallons.
In 1918 the water used totalled 1,217,718,163 gallons.

In 1918 the goods, ton mileage and passengers carried were each more than four times as great as in 1897, while the coal and water used in 1918 were less than three times the quantities used in the earlier year, showing a saving relative to the business done of over 33 percent.

In April, 1919, the highest record of efficiency yet achieved in the consumption of coal per 1,000 ton-miles was established, the figures being 5,872 ton-miles per ton of coal used over the railways as a whole, compared with an average of 5,697 for the year 1918.

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Charles F. Overly has recently been appointed general manager of sales of the Structural Tool Company, Cleveland, Ohio. He has been connected with the manufacture of pneumatic tools for some time, and was formerly vice-president of the Overly Industrial Tool Company. The new company will manufacture rivet sets, chisel blanks, punches, dies, and pneumatic tool parts. Further information may be obtained from the company on request.

# Methods of Welding Locomotive Fireboxes*

**Patching Firebox Sheets—Methods of Restoring Firebox Edges by Welding—Miscellaneous Suggestions for Facilitating Repairs**

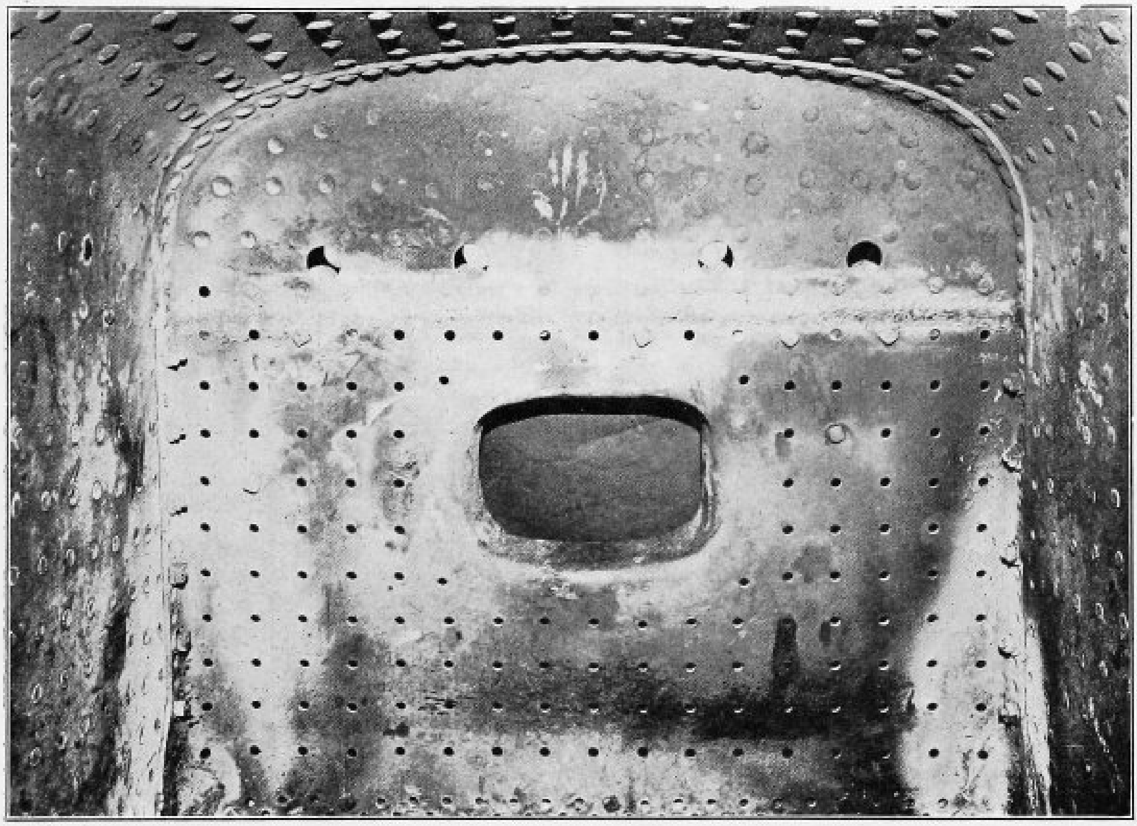
BY GEORGE L. WALKER AND R. T. PEABODY†

The matter of welding on patches to firebox sheets is one of great importance in locomotive repairs. Great care must be taken not to weaken the joints, so the best form of patch to apply is triangular, for in this case the sides do not run parallel with the rivet holes.

For example, in Fig. 22 the patch may be applied by beveling the edges, tack-welding at 1, welding from 1 about 10 inches along the seam to 2, from 3 to 2, and heating each according to the triangle preferred, and closing up the sides. Fig. 26 indicates the proper manner of rounding the corners of patches, using a radius of 3/4 inch.

In preparing all of the joints, use a bevel of about 45 degrees and leave the "V" open about 3/16 inch at the bottom, as shown in Fig. 27.

When the diamond patch of Fig. 28 is used, the welding should be done in the same way as that described for the triangular patches. Expansion must be provided for by the proper preheating and reheating at the ends of the line of the weld.



Appearance of a Properly Welded Firebox Door Sheet

from 4 to 3. After this joint becomes cold, continue the operation of welding from 5 to 4 and from 6 to 5. Preheat as shown at 1 to allow for expansion, then weld from 8 to 1, 7 to 8 and 6 to 7. Preheat again at 6.

Other examples of the application of triangular patches are given in Figs. 23 and 24, where the plate was first bolted to the mud ring, tack-welded at 1, then from 2 to 1, 3 to 2, down to the mud ring at 5. In each case *A* should be welded last. When the weld has become cold, preheat at 1 and weld from 6 to 1, 7 to 6, and down to the mud ring at *A*.

In Fig. 25 the work is first preheated along 1, tack-welded at 1, then welded about 10 inches along the seam to 2. The same manner of completing the welding on of the patch is carried out as in the above instances, by preheating each according to the triangle preferred, and closing up the sides.

### Flue Sheet Patches

Wherever practicable, the triangular patch should be used in repairing flue sheets. The methods of applying the patches might be described as follows, the welding to be done on the water side of the firebox:

Cut the flue sheet as shown in Fig. 29. Weld the bridges at 1, then from 2 back to 1, then from 3 to 2. Next weld the knuckle at 6 from 10 to 6, then at 7, and from 11 to 7. Complete the patch by welding to the flange at 12 and 13.

The patch, Fig. 30, illustrates a deep job which requires less welding to the flange. In Fig. 31 the bridges 1, 2, 3, 4, 5, 6 should be welded successively, remembering to preheat at the end of each row. Weld the patches 7, 8 and

* Continued from the March BOILER MAKER.

† Members of the engineering department of the Air Reduction Sales Company, New York City.

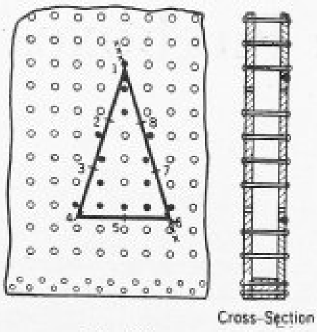


Fig. 22

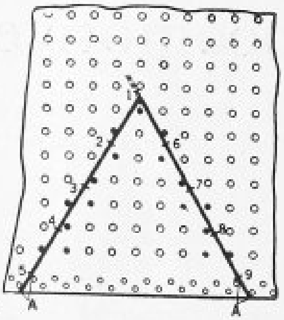


Fig. 23

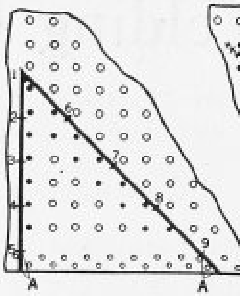


Fig. 24

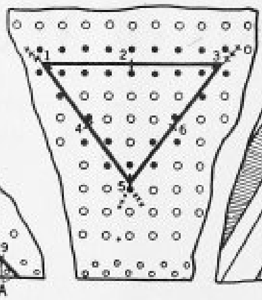


Fig. 25

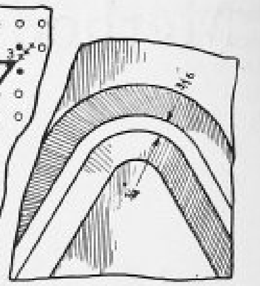


Fig. 26

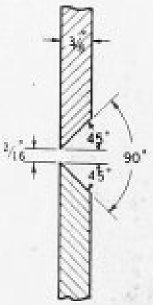


Fig. 27

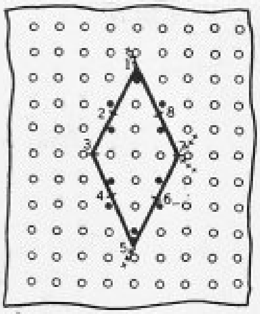


Fig. 28

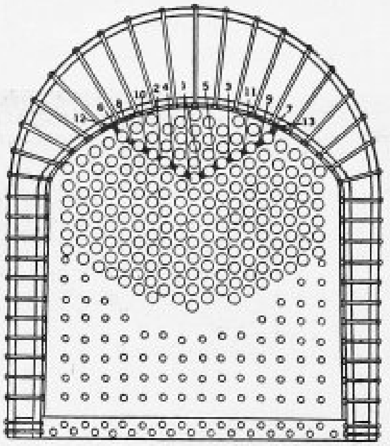


Fig. 29

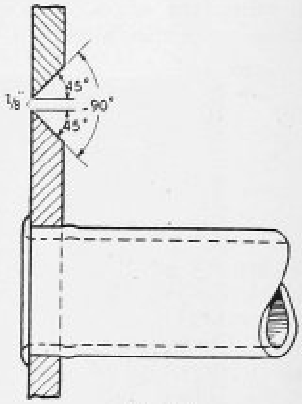


Fig. 32

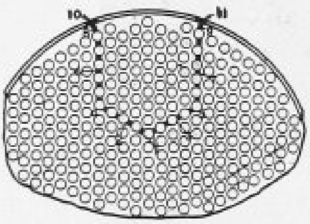


Fig. 30

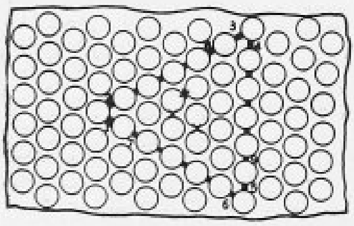


Fig. 31

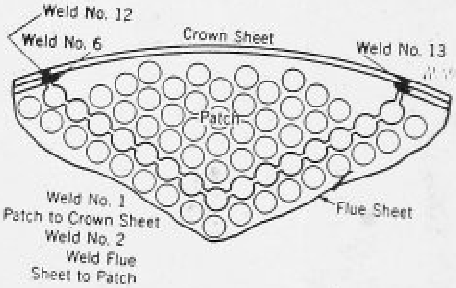


Fig. 33

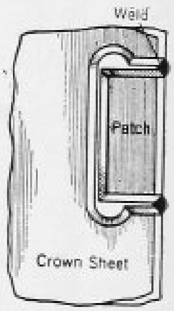


Fig. 34

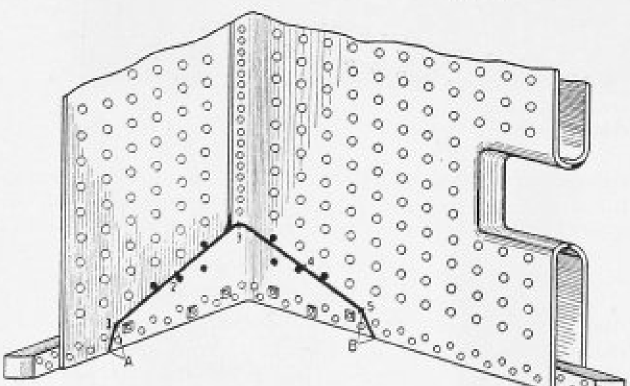


Fig. 35

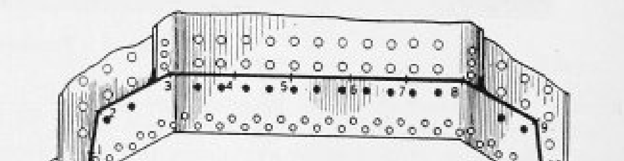


Fig. 36

9 and so on until all the seams are finished. Welds should be butt-jointed as shown in Fig. 32.

When it is desired to weld patches to the crown sheet, Figs. 33 and 34 should be followed.

### Mud Ring Patches

Three methods of patching mud rings have proved to be most serviceable. In each case the rivets adjacent to the weld should be left out.

The first of these examples, Fig. 35, consists in welding from *A* to 1, then from 2 to 1, and from 3 to 2. Care should be taken in making a good weld at 3 where the flange comes. After this, continue from 4 to 3 and on to *B*. The operations for the patch in Fig. 36 are quite similar and do not require description.

When the trouble in Fig. 37 occurs, remove the rivets adjacent to the weld at the mud ring and side sheets, as well as the staybolts that might be affected by the heat. Commence welding at *A*, then along the seam to 3, being particularly careful at the flange. Finally weld along the seam to *B*.

All joints should be bevelled at 45 degrees and welded 3/16 inch at the bottom.

steam and corrosion. The restoration of these edges by building up may be accomplished, as in the case of Fig. 43, by brushing the rust from the edge of the hole and building in the gap from 1 to 2.

If the weld is hammered lightly while red hot the joint

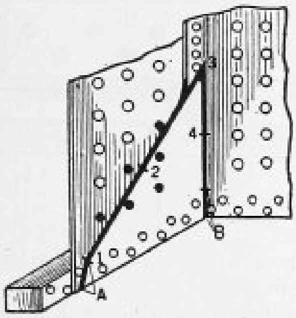


Fig. 37

Fig. 40

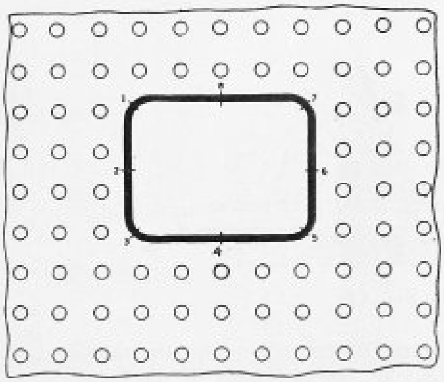


Fig. 41

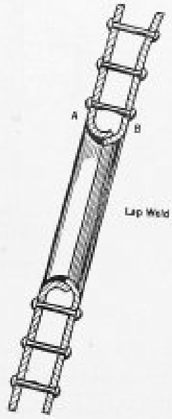


Fig. 42

### Door Collars and Holes

When welding locomotive door collars the door sheet should be made large enough to include a row of staybolts within its area, as shown in Fig. 38.

Bolt the patch in place by screwing in some of the staybolts. Bevel the edges of the weld joint at 45 degrees on the inside of the firebox and tack-weld for about 1 inch at 1 and 5, Fig. 46. Advance about 10 inches to 2 and back-weld to 1. Weld from 3 to 2, 4 to 3, and 5 to 4, continuing from 8 to 1, 7 to 8, 6 to 7 and 5 to 6.

Fig. 39 gives an end sectional view of the welded joint of a door collar.

In the welding of door holes for locomotive fireboxes the butt-weld of Fig. 40 should be used. The work should be done as follows:

Bevel the edges to 45 degrees and leave the bottom of the weld open about 3/16 inch.

Tack at 1, Fig. 41, weld from 2 to 1, 3 to 2, and so on to 5; then from 8 to 1, 7 to 8, 6 to 7, and 5 to 6.

A lap weld like that of Fig. 42 is sometimes used for welding door holes, but it should not be resorted to if the butt weld of Fig. 40 can be made.

will be improved. If the case is similar to that of Fig. 44, where a large gap has been caused by the plate rusting out, the rivets must first be removed and the metal then added from *a* down to the bottom of the sheet to the mud ring.

In welding sheets to a mud ring, Fig. 45, build up the joint between each for about 5 inches above the bottom. Bevel the bottom of this sheet as shown in Figs. 46 and 47.

### Welding Half Door Sheets

There are two methods used to weld in half door sheets of fireboxes. That shown in Fig. 48 is sometimes resorted to, to save time. It is not the best way to do the work, however. This method leaves the old riveted flange on the side sheets. The welding is done by starting at 1, back welding from 2 up to 1, and so on around, ending at *B* on the mud ring. The most serviceable way to do the work is as shown in Fig. 49.

Here the side sheet should be cut to the inner edge of the rivet holes, fitting the door sheet to the edge of the side sheet. Screw in the second row of staybolts and bolt the door sheet to the mud ring.

Then weld the door sheet to the side sheet from a point

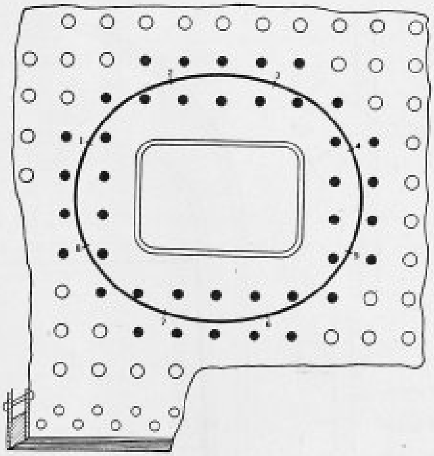


Fig. 38

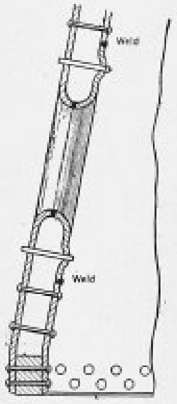


Fig. 39

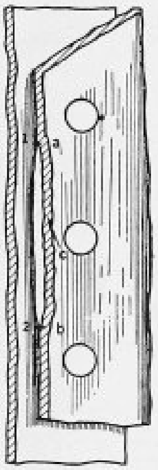


Fig. 43

### Building Up Worn Edges of Fireboxes

The edges of fireboxes become worn and cause leaky joints from excessive calking, erosion from escaping

about 10 inches down, at 2, up to 1, from 3 to 2 and end at *A* on the mud ring.

Back-weld 10 inches from 6 to 1, from 7 to 6 and on around to *B* at the mud ring. The sketch at the left of Fig. 49 shows the style of joint between the door sheet and the side sheet.

In preparing to weld half door sheets above or below

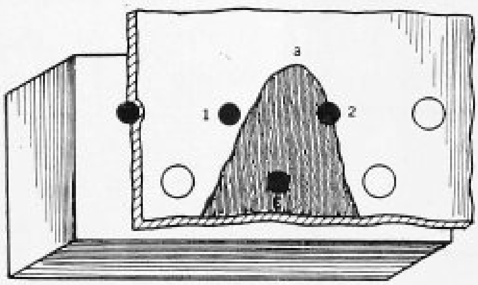


Fig. 44

the doorhole, the sheet should be cut not nearer the doorhole than between the first and second rows of staybolts, as shown in Figs. 50 and 50 A. All the staybolts, except those adjacent to the weld, may be screwed in place. The door sheet should be riveted to the side sheet and mud ring

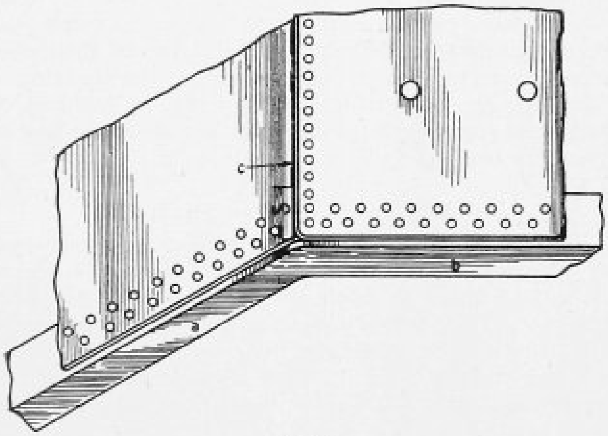


Fig. 45

before welding, and the weld vee formed as in connection with Fig. 50.

Weld the flange at 1, Fig 50, then at a distance of about 10 inches from 1 back-weld from 2 to 1, from 3 to 2 and continue to 8. Details of the end of the weld are illustrated in Fig. 50.

MISCELLANEOUS WELDING REPAIRS

In welding steel beams like those of Figs. 51 and 52,

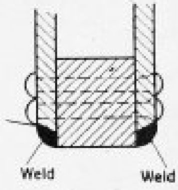



Fig. 46

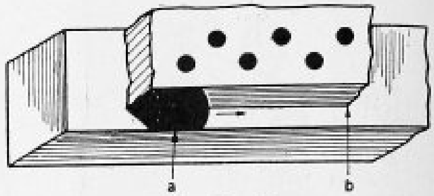


Fig. 47

bevel the web at 45 degrees at one side, if less than 1 inch, as shown at *A*, and the flange at *D*. If over 1 inch, use the double bevel of the detail drawing, making a hole at the junction of the flange and the web *b*. This will make it possible to get a strong weld at this joint. Start to weld the flange at *a* and weld the web last.

Fig. 53 shows the method to be used in welding cracks where expansion must be carefully considered. The best practice is to tack and back-weld. The back-weld jumps should be about 6 inches for ¼-inch plate, 10 inches for ⅜-inch plate, and 12 inches for ½-inch plate. Bevel at 45 degrees and leave the bottom of the "V" open about ⅛ inch. Preheat one end of the crack as shown at *x x a*. If the crack is in a vertical position, tack-weld at the top at 1, then back-weld from 2 to 1, and from 3 to 2. Complete the weld by reheating it red hot at *x x b*. The weld should be made about 2 inches wide at the top and be reinforced about ⅛ inch thicker than the original metal.

Sketches *A* and *B* of Fig. 54 show how patches should be applied to cylindrical shells and tanks. The base of the triangular patch should run with the circumference of the shell.

A weld like that of Sketch *A* should be started at 1 and go to 3 and be allowed to cool. Then from 3 to 5 and cool. Finally from 5 to 1.

The weld of Sketch *B* should be run from 1 to 3 and allowed to cool. Then from 3 to 5 and cool, and from 5 to 1.

To weld locomotive flues, first countersink the fluehole about 3/16-inch deep, as shown in the detail. Extend the

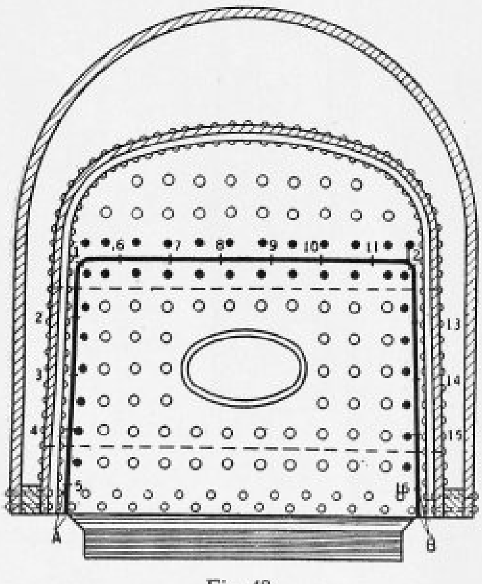
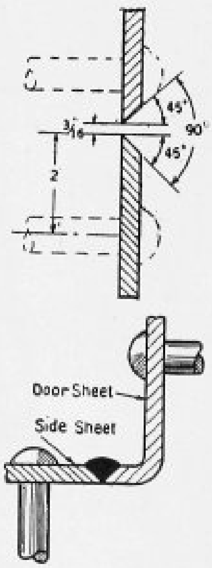


Fig. 48



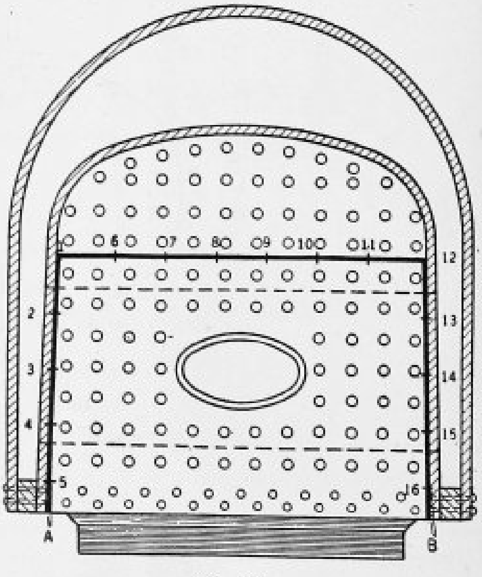



Fig. 49

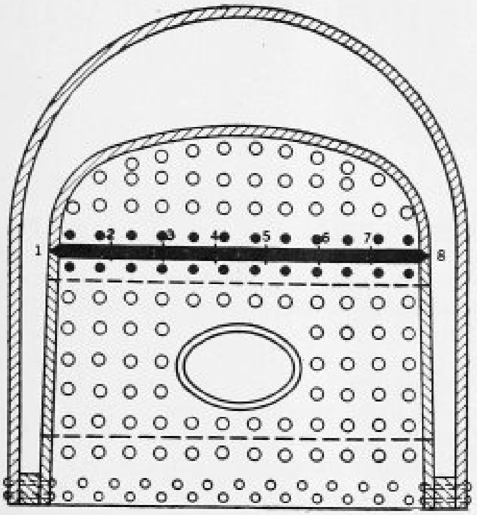
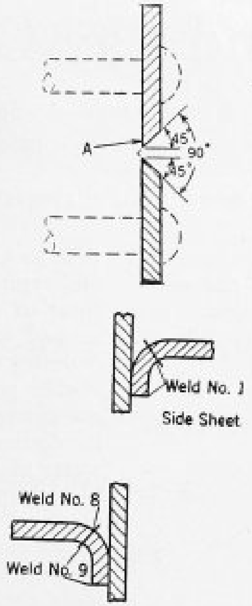


Fig. 50



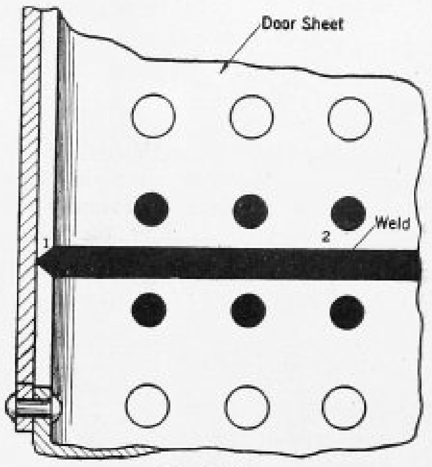




Fig. 50A

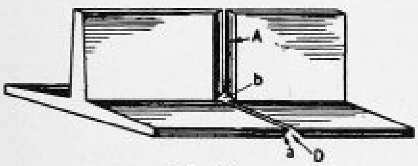



Fig. 51

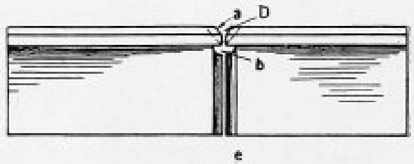



Fig. 52

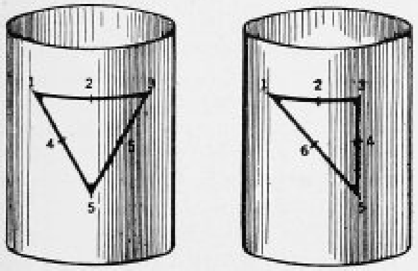


Fig. 54

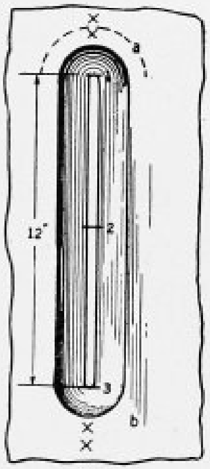
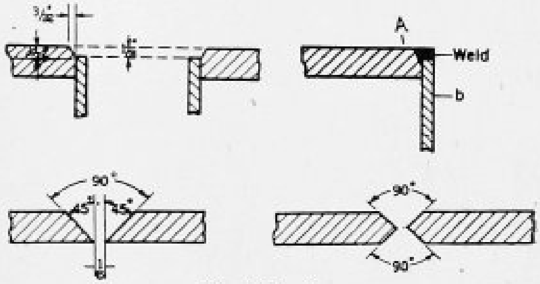



Fig. 53




Bevel Details

flue to within ⅛ inch of the outer surface of the sheet and 1/16 inch beyond the bottom of the countersinking. Leave out the copper ferrules, and expand the flues just enough to fill the flueholes.

Start to weld at the bottom of the hole, and weld around to the top on one side, and then the same way on the other half. Weld the fillet flush with the inside of the flue and the face of the flue sheet.

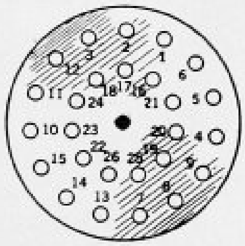


Fig. 55

Fig. 55 shows the order in which the flues should be welded so that unequal expansion may be allowed for. Weld the row of flues 1, 2, 3 and then 4, 5, 6, then 7, 8, 9, and so on to completion.

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Every suggestion and every method that may be practised that will lead to greater competence in the use of the welding and cutting apparatus will serve to very greatly lessen the number of defects that have been traced to lack of training in the art. Every man who keeps himself informed of advances in the use of the torch will improve the general conditions of the welding department in which he works.

Resourcefulness and vision are essentials to success in repair work. The means and method to be followed vary with the job. Repair men employ unusual expedients on unusual jobs, sometimes to avoid costly dismantling and long delays. Vision is required to see opportunities of using the torch to advantage. It reduces the scrap pile to the vanishing point and cuts out many a heavy bill for supplies.

The skilled welder avoids, as much as possible, going back over his work and finishing it. The best welding is progressive welding without ever retracing and correcting defects. Aim to weld so that there are no defects and therefore no necessity of correcting them. It requires heat, gas and time to remelt adding material, and every time it is remelted there is a distinct loss in strength and metal. It is highly important to choose a tip of the correct size which will insure sound work at a rate of progression within the operator's control. If the tip is too small the rate of progression will be so slow that no operator can maintain it. He must necessarily work over and over the same metal. The advantage of the large tip is that the heat lost by radiation is less, proportionately, than with the small tip. The rule then is to choose the largest tip that can be applied successfully by the welder without overheating the metal or working so rapidly that he cannot do the job justice.—*Autogenous Welding.*

# How to Design and Lay Out a Boiler—XVIII

### Position of the Water Glass—Types of Stop Valves and Gage Cocks Used—Computing the Safety Valves

BY WILLIAM C. STROTT*

The water column connections shall now be discussed. A typical arrangement of the piping between the water column and boiler was previously illustrated. No further reference concerning the actual position of

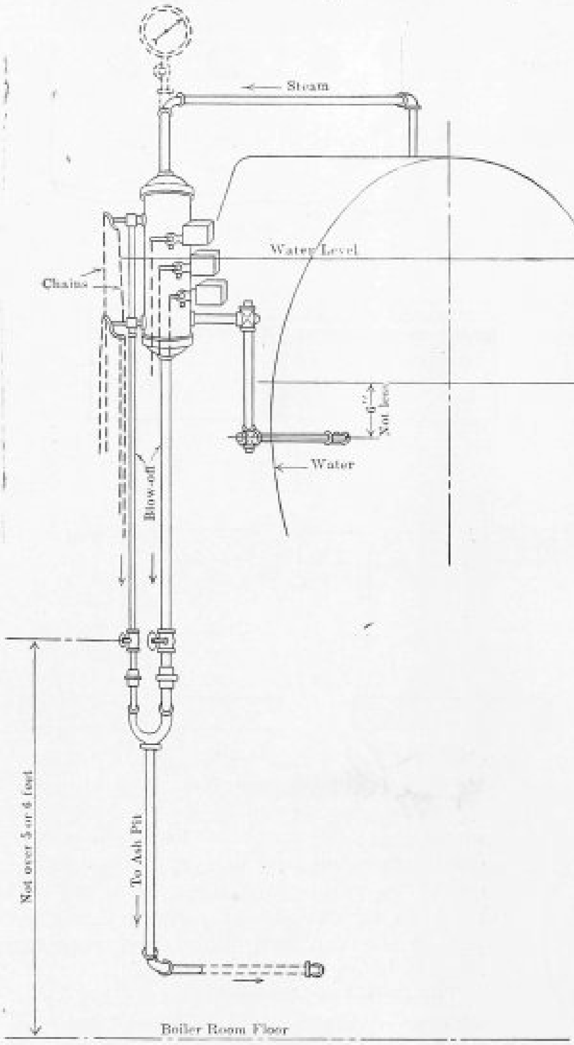



Fig. 68.—Isometric View of Complete Water Column and Piping

the water column with relation to the water in the boiler need now be made, as this matter was thoroughly treated in a previous chapter. In Fig. 68, however, is an isometric view of the complete water column and its piping.

The lower water column pipe must enter the front head, and, since it is through this pipe that the level of the water in the boiler is registered, it should naturally receive its supply from a point where the water in the boiler is the least agitated. This seems to be approximately midway between the bottom of the shell and the top of the tubes. The A. S. M. E. Code requires that it should be located at least 6 inches below the center line of the boiler. The least diameter of pipe allowed is 1 inch, and it *must be of brass,* since we dare take no chances on iron or steel pipe, with its attendant dangers to "rusting shut" at some point and registering a false water level. The corner connections of this piping must be made with brass tees and crosses to facilitate thorough scraping-out without dismantling the piping. The bottom of the water column should be provided with a ¾-inch pipe connection for testing and blowing out scale and sediment. A similar connection is also to be provided at the bottom of the water glass, but need be of only ½-inch pipe. These two lines of pipe must have independent globe valves within reach of the boiler room floor. Below the valves the piping may connect, by means of a special Y-fitting with easy curves, into a common ¾-inch pipe. The latter must discharge into the ash pit under the grates, or else be carried to a hot-well or sewer to prevent danger from scalding the operator.

The water column shall take steam from the upper part of the head or shell at a point where there will be no possibility of water being carried over into the top of the column. The reason that steam must enter the top of the column is to create a neutral pressure, otherwise the pressure in the boiler would force the water to the top of the column, filling the same.

There appears to be a mistaken impression among a great many students (practical firemen, also) that when the water glass is half full the boiler is half full of water also. A study of Fig. 68 should correct this misunderstanding. The water gage glass merely indicates the level of the water in the boiler. It is very evident that the location of the glass with relation to the center line of the boiler must be known in order to determine the exact water content in the boiler. For instance, if the water column attached to a horizontal return tubular boiler is located in accordance with the A. S. M. E. requirements,

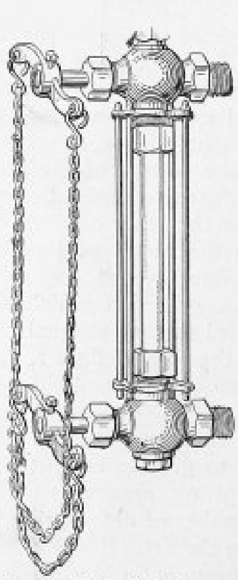
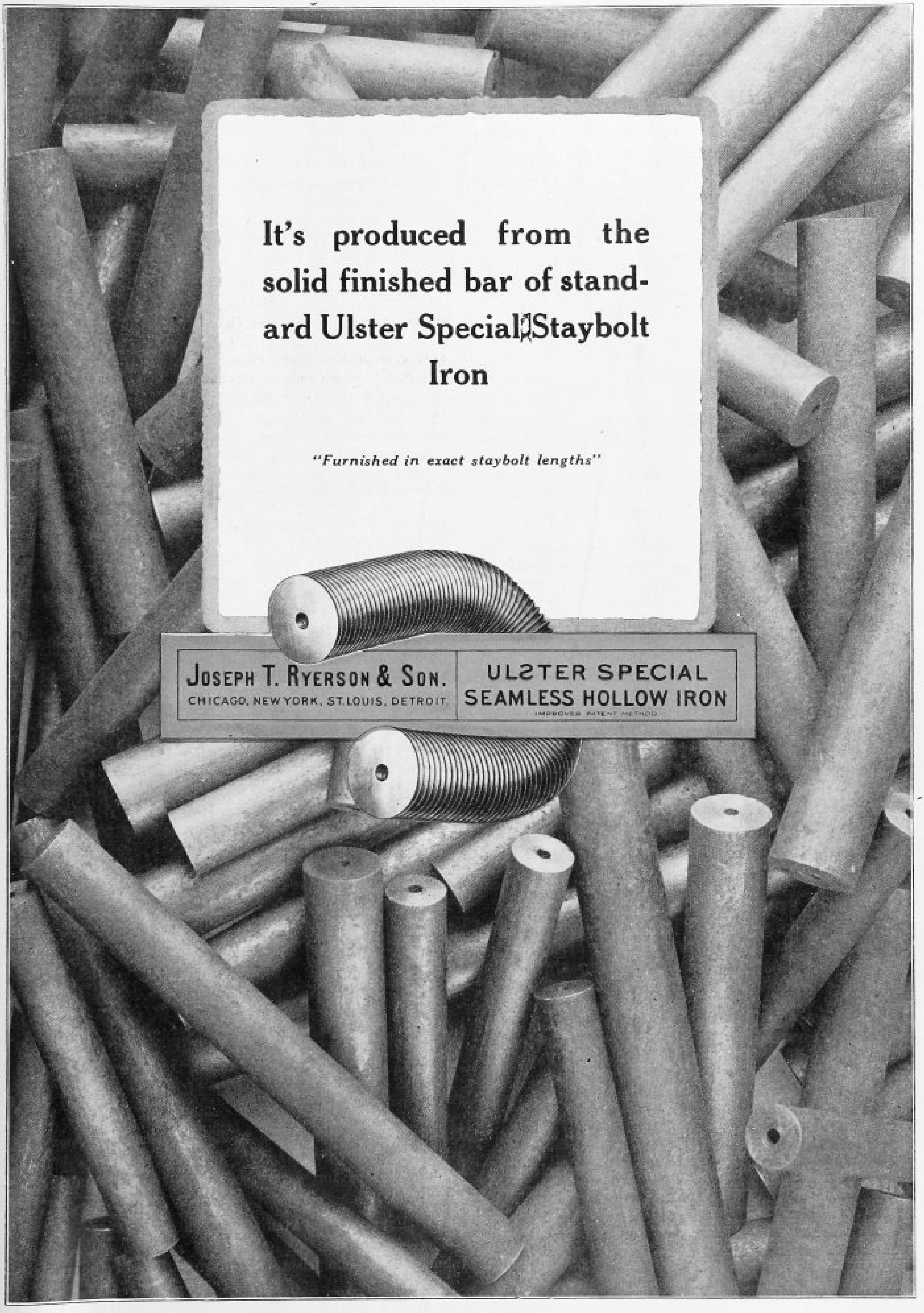


Fig. 69.—"Quick-Closing" Water Glass Cocks

then when the water in the glass stands 2 inches above the lower gland nut we know that the level of the water in the boiler is 4 inches above the top of the tubes.

* Designer, Blaw-Knox Company, Pittsburgh, Pa., formerly boiler designer, Union Iron Works, Erie, Pa.


It's produced from the solid finished bar of standard Ulster Special Staybolt Iron
"Furnished in exact staybolt lengths"
JOSEPH T. RYERSON & SON.
CHICAGO, NEW YORK, ST. LOUIS, DETROIT.
ULSTER SPECIAL
SEAMLESS HOLLOW IRON
IMPROVED PATENT METHOD

The steam piping to the water column may be of iron or steel pipe, and of the same size as the water piping, viz., 1-inch diameter.

### Stop Valves

Stop valves on either the steam or water connections to a water column are not required—in fact, are not recommended—but, if desired, they must be either outside screw and yoke type gate valves or else stop cocks. Illus-

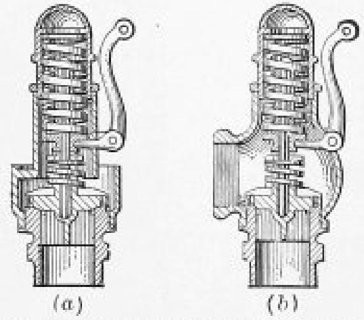


Fig. 70.—Spring-Loaded "Pop" Valves

trations of these valves may be found in any valve manufacturer's catalogue. The valve operating levers or handwheels must be permanently attached to the valve stems and should be locked or sealed open to prevent careless operators from closing the valves. No valves at all is, however, the safest policy. This renders the connection fool-proof.

Particular attention is now called to the valves at the top and bottom of the gage glass. These valves are necessary for shutting off the steam and water in case of breakage of the glass, which may occur from steam pressure or accidentally. The Code prohibits the use of any device intended to automatically close the connections to the gage glass in the event of breakage. Ordinary hand wheels are usually provided for operating these connections, but on account of their distance from the boiler room floor they are inconvenient of access and rather dangerous of operation after an accident.

It is obvious that the scalding steam and water would be blowing onto the operator while attempting to close them. Although chain wheels might be employed, there is nothing as good as the "quick-closing" water glass cocks operated by a chain from the boiler room floor, as indicated in Fig. 68. This form is more clearly illustrated in Fig. 69. Notice also the guards which protect the glass from accidental breakage.

### Type of Gage Cocks Used

The gage cocks attached to the three openings in the body of the water column should also be of the quick-opening and closing type. At one end they are heavily counterweighted, which, under ordinary conditions, keeps them tightly closed. A slight pull on the chain attached to the lever end of the cock opens it instantly. These are known to the trade as "P. B. H." cocks and are manufactured by P. B. Hyatt Company, Philadelphia, Pa. With final reference to the "piping up" of the water column, the Code further states that no steam may be taken from the steam pipe leading to the top of a column, except for the purpose of making a connection to an automatic damper or feed water regulator.

Instead of the elbow just above the water column, a "tee" may be employed and a steam pressure gage screwed into the "tee," as indicated by the dotted lines on Fig. 68. Where large steam gages, say over 5 inches diameter of dial, are required, this is not a good scheme, it being more substantial to attach the steam pressure gage to the top of the boiler front and take steam from the boiler direct through an independent ¼-inch pipe.

### Safety Valves for Power Boilers

Death and destruction in the form of potential energy are stored up in every steam boiler while under pressure. Should the pressure be permitted to exceed that for which the boiler was designed, grave danger of rupture occurs. It is the purpose of the safety valve to relieve the boiler of such danger at the instant that the pressure reaches a specified amount. Safety valves are usually set to blow at not more than 5 pounds above the pressure of the steam employed in operating the plant, and from 5 pounds to 15 pounds *below* the maximum working pressure allowed on the boiler.

The only form of safety valve allowed in connection with power boilers is the spring-loaded "pop" type illustrated in Fig. 70 (a) and (b).

The more generally adopted form shown at (a) has a 45-degree beveled seat. However, the flat-seated valve at (b) is also employed, its discharge capacity being 4 percent greater than the former, on account of the more direct exit for the steam. In the author's opinion, a bevel-seated valve is more easily reground by hand.

The size of the safety valve will now be determined. For this purpose the well-known Napier formula for the outflow of steam into the atmosphere may be employed:

$$W = C\left(\frac{p \times a}{70}\right), \qquad (24)$$

in which:

$W$ = pounds of steam flowing per second.
$p$ = absolute pressure (gage pressure + 14.7 pounds), pounds per square inch.
$a$ = area of orifice in square inches.
$C$ = the coefficient of discharge depending on the shape of the orifice.

Transposing this formula, for "a" we write:

$$a = \frac{70 \times W}{C \times P}. \qquad (24a)$$

It will be recalled during the early part of the discussion on steam domes that our boiler has a steaming capacity of 7,800 pounds per hour at 50 percent overload. This is equivalent to $\frac{7,800}{3,600}$, or approximately 2.2 pounds per second. This value will have to be checked up with the Code, which places the minimum safety valve capacity at 6 pounds of steam per hour per square foot of effective

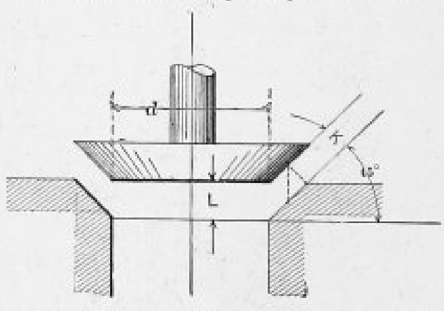


Fig. 71.—Graphic Illustration of the Relation Between the Area of the Valve Seat and the Connection to the Boiler

heating surface for watertube boilers and 5 pounds for all other types.

### Effective Heating Surface of Boilers

The effective heating surface of a horizontal return tubular boiler comprises the internal area of the tubes plus the area of one-half the shell and the net area of half of each tube sheet. For our boiler we calculate the heating surface as follows:

On the shell = ½ (6 × 3.1416 × 17.92), or 169 square feet.
On the heads = [½ (72 × 0.7854)] — [70 ($4^2$ × 0.7854)], or 8 square feet.

Table 16 gives the length of tube per square foot for both external and internal surface of standard boiler tubes from 1 inch to 6 inches diameter inclusive:

TABLE 16.—LENGTH OF TUBE PER SQUARE FOOT

| Outside Diameter | Exterior Surface | Interior Surface |
|---|---|---|
| 1 | 3.819 | 4.715 |
| 1¼ | 3.056 | 3.603 |
| 1½ | 2.547 | 2.916 |
| 1¾ | 2.183 | 2.448 |
| 2 | 1.909 | 2.110 |
| 2¼ | 1.698 | 1.854 |
| 2½ | 1.528 | 1.674 |
| 2¾ | 1.389 | 1.508 |
| 3 | 1.273 | 1.373 |
| 3¼ | 1.175 | 1.269 |
| 3½ | 1.091 | 1.171 |
| 3¾ | 1.018 | 1.088 |
| 4 | .955 | 1.024 |
| 4½ | .849 | .902 |
| 5 | .764 | .812 |
| 6 | .637 | .673 |
| 7 | .546 | .573 |

To find the heating surface of any length of tube, divide the length by the tabular value for the particular size. In our boiler there are 70 tubes, each 17 feet 11 inches long, hence the total tube length is 70 × 17.92, or 1,254 feet. The internal heating surface of the tubes is, therefore,

$$\frac{1{,}254}{1.024} = 1{,}224 \text{ square feet.}$$

The total effective heating surface of the boiler is, therefore, 169 square feet + 8 square feet + 122 square feet + 1,401 square feet.

The minimum steam consumption on which the A. S. M. E. Code figures the safety valve capacity is 1,401 × 5 = 7,005 pounds per hour. Remembering that we had figured on just 795 pounds per hour more than this, our calculations, in so far as steaming capacity is concerned, are evidently well on the safe side.

We may now proceed with the application of the formula (24a).

For safety valves the coefficient $C$ is usually made 0.96. Substituting figures and solving, we get:

$$a = \frac{70 \times 2.2}{0.96 \times 164.7}, \text{ or } 0.974 \text{ square inch.}$$

This is evidently not the area of the connection to the boiler, but is the actual area of the valve orifice when the disk of the valve is lifted from its seat the maximum amount. Fig. 71 graphically illustrates this relation.

Dimension $L$ indicates the lift, and it is obvious that the diameter $d$ at the seat of the valve must be such that the area of the annular opening between the valve disk and its seat, indicated in the sketch by $K$, be not less than found by formula (24a). For convenience we shall arrange the equation thus:

(25) $$a = d \times 3.1416 \times K.$$

The lift $L$ may be made any amount from 0.02 inch to 0.15 inch for any size of valve. For our case we shall assume as a trial 0.10-inch lift. The small dotted triangle indicated in Fig. 71 shows that $K$ is the altitude and $L$ the hypotenuse of a 45-degree right triangle. The value of $K$ is found by multiplying $L$ by 0.70711, which the student will understand if he has a knowledge of plane trigonometry.

Solving for $K$ we get:

$$0.70711 \times 0.10 = 0.0707 \text{ inch.}$$

We may now substitute in formula 24 as follows:

$$0.974 = d \times 3.1416 \times 0.0707.$$

Whence, solving for $d$, we get:

$$d = \frac{0.974}{3.1416 \times 0.0707}, \text{ or } 4.39 \text{ inches.}$$

Since safety valve connections must correspond to standard commercial pipe sizes, we would have to specify a 4½-inch safety valve. If desired, we could use the Code requirement for minimum steam consumption and probably get away with a 4-inch safety valve. It should be realized that 50 percent overload is a great deal—in fact, altogether too much to provide for in a horizontal return tubular boiler. Some *watertube boilers*, however, are capable of developing 200 percent of their rated horsepower for short periods.

### INCREASE IN NUMBER OF VALVES

On further examination of the Code with regard to safety valve regulations, we find that when any boiler requires a safety valve larger than 3 inches, at least two valves shall be provided. The reason for this is that when any boiler is of such power that a safety valve larger than 3 inches is necessary, at least one spare valve must be mounted on the boiler. Either valve will then serve in an emergency, or in the event of the other getting stuck.

There is no restriction, however, to mounting valves of different sizes on one boiler so long as the combined discharging capacity of all the valves is not less than the total calculated amount required.

No safety valve may, however, be larger than 4½ inches, as this is the maximum allowed by the rules.

A further consideration of this matter is necessary because of the fact that the sudden release of pressure afforded by a single valve of large capacity throws a violent shock on the boiler. The instant that the pressure within the boiler is lowered a certain volume of the water is suddenly expanded into steam corresponding to the reduced pressure, and the vibrating effect on the steam generating equipment is similar to that explained in a previous chapter, as when periodically sudden demands for large quantities of steam are made on a boiler. Last, but not least, we may consider the matter in the light of fuel conservation. It is an established fact that the weight of steam dissipated into the atmosphere by a large safety valve is enormous. This represents a loss altogether too frequently reflected in the coal pile.

### SETTING THE VALVES

It is good practice, particularly in the case of high-powered boilers when multiple safety valves are required, to set one of the valves at the pressure at which it is desired to relieve the boiler and set the remaining valves to discharge at a higher pressure. Concerning this, the Code makes certain regulations which are best explained as follows:

Suppose that in a certain boiler, supplying steam to a plant at 175 pounds pressure, four safety valves are to be mounted. We shall further suppose that the maximum working pressure allowed on this boiler is 200 pounds per square inch. Now, one of these valves would probably be set at 180 pounds, thus allowing the pressure to rise not more than 5 pounds above that required to operate the engine or turbine. Although this single valve would not be sufficient to reduce the pressure sufficiently, it is nevertheless an aid and gives the fireman an opportunity to check the draft, thereby decreasing the rate of combustion until the steam pressure drops to normal. With such an arrangement it is evident that the loss of steam is comparatively small as compared with one or two valves of large capacity discharging simultaneously.

Now, then, according to the Code the remaining valves may be set within a range of three percent above the maximum working pressure allowed on the boiler, but the range of setting of all the valves on a boiler shall not exceed ten percent of the highest pressure to which any valve is set. This ruling is clarified in the following paragraph, which, of course, is a continuation of the example we have assumed.

Having set one valve at 180 pounds, we are privileged to set the other three at 3 percent above the maximum working pressure allowed on the boiler, or at 206 pounds. Now the range of setting between the 180-pound valve and the 206-pound valve is 206 — 180, or 26 pounds. But, as 26 pounds is greater than 10 percent of the maximum pressure to which any valve is set, we cannot employ this arrangement. The correct method, in order to comply with the Code, would be to divide the 6 pounds evenly between the three remaining valves, as follows:

Set the second valve at 198 pounds, the third at 199 pounds, and the fourth at 200 pounds. The total range is then 200 — 180, or 20 pounds; and, since 20 pounds is 10 percent of the 200-pound valve, this new arrangement is evidently correct. The student should notice that, had the first valve been set at 179.4 pounds, the maximum setting of any one of the other three could then have been 206 pounds, because the range of increase is 206 — 179.4, or 20.6 pounds, the latter being not in excess of 10 percent of 206 pounds. Having thus thoroughly interpreted the Code on this point, we shall return to the completion of the safety valve requirements for our boiler.

*(To be continued.)*

## Weaknesses of Welded Tanks

BY JOHN S. WATTS

The manufacturers of rectangular-welded tanks are apparently following the same designs for the staying as were used when the tanks were riveted. The result is that the tanks fail by opening the welds at the corners, which soon commence to leak and, not being repairable, have to be scrapped. This gives the welded tank a bad reputation—which it does not deserve, the fault being entirely with the weakness of the bracing.

The weld comes at the point of greatest flexure and strain in the plate, and so the tanks, as they are ordinarily braced, "breathe" to a greater or less extent when the tank is emptied or filled. The strain which this breathing puts on the welded joint can be seen by observing the movement of the side and bottom plates of such a tank in service.

It may be easily understood from such observations why no welded joint will stand the racking strains occurring at the corners and why the welds give way here and start to leak.

Unfortunately, there is no practicable way of repairing a welded joint, and so the whole tank must be scrapped.

The old style tanks with riveted joints were made with an angle bar in the corners, and consequently the deflection of the plate had no serious effect. For this reason the number and fit of the braces was not of such vital importance as it is in the welded work.

A welded tank, however, with the same bracing as was sufficient for a riveted tank will certainly prove defective. The stay is simply a round bar with the ends bent over and made to drop loosely into the holes in the angle bars. Before this stay can take its load, the side of the tank has to bulge outward until the slack is taken up in the holes. Even then the plate will bulge still more between the angle bars, as the span horizontally across the tank is too great, and the stays, being usually spaced about 30 inches apart vertically, support only a narrow strip of plate horizontally across the tank.

This deflection may be observed in any tank undergoing test, so it is not necessary to prove that such a deflection exists by calculating the amount.

This defect may be remedied by fitting a sufficient number of solidly riveted stay bars to hold the plate from deflecting too much.

My opinion is that the plate must be supported by angle bars placed both horizontally and vertically, and the pitch of these angle bars must be such that the stress in the plate, calculated as a beam 1 inch wide and fixed at the ends, whose span is the distance center to center of the angles, must be limited to 16,000 pounds per square inch.

The plate is then actually a square plate fixed around the edges. In these thin plates with a relatively long span the horizontal strip in the center of the square does not derive much, if any, support from the angle bars above and below.

Calculating for a strip 1 inch wide, we have from the formulae for beams fixed at the ends and uniformly loaded:

$$W = \frac{12 \times f \times s}{l},$$

where $W$ = load in pounds = $p \times l$, where $p$ = pressure per square inch.

$f$ = stress = 16,000 pounds.

$s$ = modulus of section = $\frac{t^2}{6}$, where $t$ = thickness of plate.

$l$ = pitch of angle bar stays.

Substituting in above formula, we have:

$$p \times l = \frac{12 \times 16{,}000 \times \frac{t^2}{6}}{l}$$

$$p \times l^2 = \frac{12 \times 16{,}000 \times t^2}{6}$$

$$l^2 = \frac{2 \times 16{,}000 \times t^2}{p}$$

$$= \frac{32{,}000 \times t^2}{p}$$

$$l = \sqrt{\frac{32{,}000 \times t^2}{p}}$$

$$= \sqrt{\frac{32{,}000}{p}} \times t$$

The angle bars should be riveted to the plate with rivets not over 4 inches pitch, and of a diameter sufficient to carry the load due to the pressure at 7,000 pounds stress.

The angle bars need not be large, and can be easily determined by calculating their strength as beams uniformly loaded and fixed at the ends.

The cross stays should be flat bars or angles, riveted

*(Continued on page 119.)*

# The Boiler Maker

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H. L. ALDRICH, President and Treasurer

GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor.
L. S. BLODGETT, Associate Editor

Branch Office
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The locomotive boiler has not by any means reached a point where developments are unnecessary, and if it is to successfully hold its own against the electric locomotive from the point of view of economic operation and maintenance a great deal must be accomplished in the near future.

Rapid strides have been made in overcoming existing difficulties, but the thermal and mechanical efficiencies of new type engines must be higher, and the smoke, cinders, sparks and noise drawbacks of the steam engine must be eliminated to a great extent. New boilers should develop pressures up to 350 pounds, superheated to 300 degrees F.; furnaces and front-end designs should be improved; better methods of heating boiler feed water by the use of the exhaust steam heater and flue-gas economizer should be devised, as well as better distribution and utilization of the steam.

For certain purposes the electric locomotive has its advantages—in the terminals of large cities, especially where the approaches are through tunnels, in the relief of congested districts, and for roads operating in districts where cheap electric power is available because of water-driven generating plants.

There is little danger of a general electrification of the railroads so long as the new construction program now laid out for the shops of the country is followed.

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Business in general has reached the conclusion that the peak of commodity prices has been reached and that the period of reaction is about to commence. In some cases this change is barely apparent and in others—in fact many others—prices have gone higher.

The basis for this idea in the business world is in the high money rates maintained by the Federal Reserve Bank. Other conditions being normal, high rates tend to reduce prices, but supply and demand, factors which in the long run absolutely control economic matters, may not by any stretch of the imagination be considered normal at present.

Construction programs in practically every branch of industry are about three years behind the demand. As long as the supply of raw materials does not accumulate, such materials must be bought at a high market, and the consumer be made to bear the tariff when purchasing the finished article.

In view of conditions one fact is quite certain, that the harder every one works to get over this period, and meet the problems as they occur at least halfway, the sooner may we expect the promised drop in prices.

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In reviewing the causes and results of the present high demand in iron and steel circles, the *Iron Age* states that the violent changes which have occurred in international exchange and the resulting curtailment of our exports to Europe are feared because of the reaction that will probably follow in domestic buying. Iron and steel exporting is a relatively small item as compared to domestic consumption, but the reduction in the volume of general exports indicates a check in business activity. The downward movement in securities is bound to affect business, and may be in part the readjustment demanded by investors, who look for a return which approximates that before the inflation period.

It is reassuring to know that the iron and steel produced are being used almost immediately in consumption, and that practically no reserve stocks are being maintained. This means that unless cancellations become very great there is no danger of even temporary overproduction. With the large volume of unsatisfied demand, any check on existing business will prove to be slight, and simply tend to get the country back into a normal attitude for its work in production.

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At a meeting of the executive committee of the Boiler Makers' Supply Men's Association, held March 30, it was decided that, on account of lack of adequate space, no exhibits would be made in connection with the convention of the Master Boiler Makers' Association this year. Firms desiring to exhibit their product may do so in their rooms. The convention will be held at the Curtis Hotel, Minneapolis, Minn., May 25 to 28 inclusive.

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The National Board of Boiler and Pressure Vessel Inspectors, which was recently formed, has gradually assumed a position of great importance in the field of boiler production and operation.

One function of this board is to co-ordinate and standardize the rules of the code as applied to specific cases. The requirements of a boiler in one state are exactly the same as those in any other of the fifteen states which have adopted the code. When a boiler is passed upon and stamped by the authorities in one place, that stamp and certificate are acceptable wherever the code is enforced. The accurate records of the causes of boiler explosions that are now kept by the board will prove of great value in overcoming defects that might otherwise escape investigation.

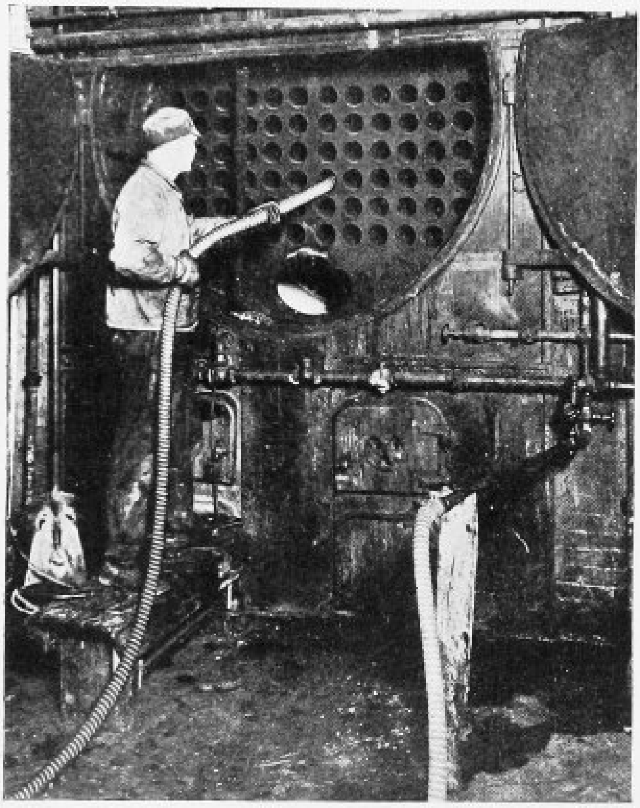
The fact that a working scheme of standardizing boiler requirements is actually in operation is the greatest argument for the rapid adoption of uniform state boiler laws.

# Engineering Specialties for Boiler Making

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

### Air and Steam Drive Boiler Tube Cleaners

From time to time the matter of keeping boilers free of scale is brought to the attention of the industry, particularly after reports of the insurance companies indicate that explosions have been caused either directly or indirectly by the presence of non-conductors of heat on the tube walls. Not only must the tubes be kept clean to prevent possible explosions, but also to maintain every-day operating efficiency.



Steam-Driven Tube Cleaner in Operation

The mechanical means of removing scale has proved itself satisfactory over a long period of service, both from the point of view of economy and of positive action.

Some of the modern turbine-drive cleaners produced by the Lagonda Manufacturing Company, Springfield, Ohio, are typical in construction and operation of the best types of mechanical cleaners. Type No. 79, for example, is designed for use in 3¼-inch curved tubes of watertube boilers, such as the Sterling, Erie City, Maxim and Hyde types. This cleaner is constructed to remove the scale from the bends down to the iron, and, if properly operated, will not stall or have to be forced. The construction of this cleaner for either air or steam drive is such that a high rotative speed is imparted to the drive shaft by the impelling force delivered to four paddles enclosed in an elliptical case. Two of these paddles are always under pressure, so that there is no possibility of the cleaner becoming stalled if it is operated properly. The paddles bear against a hardened steel plate pressed into the main shell, which can be replaced when worn. All wearing parts of the cleaners are high-carbon steel carefully tempered and ground. The rotor and center shaft are of one piece. An air or steam pressure of 80 to 100 pounds is required for most efficient operation, the consumption at this pressure being about 55 cubic feet per minute. The quick-repair head and toggle joint are so arranged that they are most effective in removing scale from bends. Various other cutting heads may be used in combination with the toggle joint if desired.

Type No. 79 Cleaner for Curved Tubes

Type No. 80 Cleaner for Straight Tubes. Type No. 81 Is Similar

Another type of cleaner for straight tubes is also of interest. Nos. 80 and 81, for 3½-inch and 4-inch tubes respectively, are especially adapted for use in the Heine, Babcock and Wilcox, Wickes, McNaull and similar type boilers. They may also be utilized in removing scale from economizer tubes and boiler feed water lines.

The motor in each case is similar to that described for Type No. 79 cleaner. A three-arm, quick-repair head is part of the standard equipment, as well as drill and porcupine heads, which may be used in combination with the toggle joint.

### Power Plant Equipment

In a new leaflet, No. 6, certain of the equipment produced by the Griscom-Russell Company, New York, is described. The "G-R Instantaneous Heater," of the straight tube type, is designed for heating boiler feed water or for supplying hot water for general service. In this case the water passes through the tubes and the steam through the shell. The "Reilly Type D Heater" has a heating surface composed of helical coils of seamless drawn copper tubing. These coils are so arranged in the shell that they are easily accessible for expansion or removal through a large door in the heater. The "Reilly Navy Type Heater," having a steel shell, is built for marine and special land service where light weight is a factor. Other heaters include the "Massillon Open Feed Water Heater," for service requiring this type, and the "Russell Storage Heater," which is particularly useful for land installations, for supplying hot water to office buildings, manufacturing plants and the like.

Oil coolers and heaters include the "Multiwhirl Type," for cooling lubricating or quenching oils, and the "Reilly Oil Heater," designed to preheat fuel oil for use in mechanical oil-burning systems. "Reilly (multiple effect) Evaporators," having a capacity from 10 to 10,000 gallons per hour, may be installed wherever pure distilled water is desired. They are especially useful for boiler feed make-up and ice plant requirements.

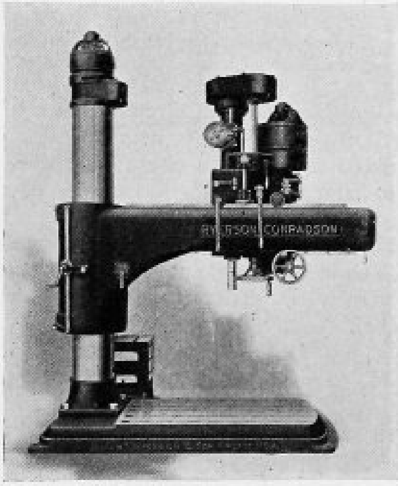
Other devices described include the "Reilly (submerged type) Evaporator," having either a steel shell or a cast iron shell, "Copper Expansion Joints," "Multiscreen Feed Water Filter and Grease Extractor," "Stratton Air Separator," "Bundy Oil Separator," the "Stratton Jr. Oil Separator," and the "Stratton Steam Separator."

Complete descriptions of any of the above devices will be supplied by the Griscom-Russell Company on request.

### High Power Radial Drilling Machine

Among the new machine tools being placed on the market by Joseph T. Ryerson & Son, Chicago, Ill., is the Ryerson-Conradson Twin Motor Driven High Power Plain Radial Drilling Machine.

This machine differs somewhat from the usual design, and drilling, tapping, boring and reaming operations can be performed equally well. The machine has but four




High Power Radial Drilling Machine

shafts and sixteen gears. The spindle and driving shafts are contained in a single cast box of rigid construction. Only spur gears are employed, eliminating bevel gears and the consequent trouble of alinement.

The special features of the machine include a twin-motor drive, one motor being used for driving the spindle and the other for elevating purposes, mounted on the column. All bevel gears and friction clutches for tapping have been eliminated. Because of the box section design of the arm, the usual overhanging head is done away with. In the spindle drive arrangement there are only three gear transformations, which eliminates the numerous bevel gears usually found necessary. In getting rid of these gears, the trouble of alinement has also been avoided. Because of the construction, the tool may be operated on a true radial line with the column. The long bearing surface and double-acting clamping device of the arm on the column reduces all springing and sagging action to a minimum.

## BUSINESS NOTES

The Baird Pneumatic Tool Company, Kansas City, Mo., is at all times interested in receiving correspondence from subscribers to The Boiler Maker relative to boiler problems and the short cuts in overcoming them.

Charles Gitlan, 72 Trinity Place, New York, through his connections with the producers of non-ferrous metals and ores, such as tin, antimony, copper, spelter, lead, tungsten, mercury, etc., is able to carry through negotiations between these producers and possible consumers in the shipyards and boiler shops. The practice of distributing inquiries over the entire market in trying to obtain quantities of these metals is not in general advantageous to the buyer. By keeping closely in touch with market conditions at all times, Mr. Gitlan is able to render valuable service to any plant having requirements of this nature.

A new book which will interest boiler makers has just been published by J. Faessler Manufacturing Company. Its sixty-eight pages include descriptions of a recently developed line of roller expanding and flaring tools for locomotive superheater tubes, locomotive arch tubes and stationary watertube and marine boiler tubes. Special types of expanders are included for Stirling, Babcock and Wilcox, and Heine boilers. These and other Faessler tools are fully described in detail, with the help of some hundreds of half-tone and line illustrations. Copies of the book can be secured from J. Faessler Manufacturing Company, Moberly, Mo.

The Mono Corporation of America, 48 Coal & Iron Exchange, Buffalo, N. Y., announce that they have purchased the entire stock of mono apparatus and accessories from the F. D. Harger Company, Buffalo, N. Y. This includes all rights for the manufacture and sale of their various types of apparatus for the automatic analysis of carbon dioxide, carbon monoxide and other gases. F. D. Harger has not severed his connection with the company, but will serve as general manager of the new corporation. A service and inspection department will be maintained in connection with the laboratory, and erecting engineers will be placed at the disposal of customers in connection with the erection of new work, as well as for carrying on an inspection service for existing installations.

Due to the national growth of the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y., and to the inevitable changes in personnel occurring from time to time, it has been the general policy of the company to advance to responsible positions in the organization those individuals who have proved themselves competent to handle the work of these positions. To develop the men in line for such openings, and to provide instruction for those in the company desiring special training, the Shepard Technical Night School was opened in the fall of 1916.

This plan of education has proven successful, and in the three years and a half of its operation several hundred employees have been given certificates from the school. Such courses as machine shop practice, shop mathematics, machine design, practical electricity, stenography and the like are included in the training.

# 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.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Streaks on Steel Stack

Q.—Last summer we erected a 6-foot by 120-foot steel guyed stack for one of our customers and lined it with a 4½-inch wall of fire-brick, set away from the steel ½ inch. The top of the stack is protected by a hood, placed so that it forms a water shed to prevent rain from getting in on top of the brick lining or between the brick lining and the steel shell.

In putting the brick lining in position, more or less of the fire clay grout naturally splashed or was otherwise thrown against the inside of the steel. Ever since the stack has been erected, at frequent intervals, at points on all sides of the stack and throughout the entire height, with the exception of about 30 feet at the bottom, this clay grout has washed down through the seams on the outside of the stack. This streaking comes at periods of exceptionally warm weather and is independent of rains or bad weather. As we have built any number of stacks and lined them with brick in this same way, some of them having stood for twenty years or more, and not one of them heretofore has streaked as above described, we are unable to account for the present behavior of this particular stack.

Have you or your readers ever had a similar experience, and can you or some of your readers offer any explanation as to why this particular stack should streak in the manner described?

Any information you can give us, either directly or through the columns of your publication, will be greatly appreciated, for which we thank you kindly in advance. R. E. A.

A.—The precipitation of the mortar substance on the outside of the stack, as you state, arises from mortar between the steel and brick portions of the stack. The moisture from this mortar, and also that in the mortar of the stack lining, has worked out between the seams and run to the outside of the stack. The chemicals in lime and cement are soda, ash, potash, magnesia, etc. These readily mix with water and run, causing grayish white streaks. You have noted, no doubt, that in some brick buildings a streaked effect of this kind on certain parts of the building, while other parts are not affected at all. Efflorescence is the name given to this condition, and it appears particularly in buildings located in moist climates. Bricks that have been burnt with coal containing a great amount of sulphur or bricks made of clay containing iron also cause this condition.

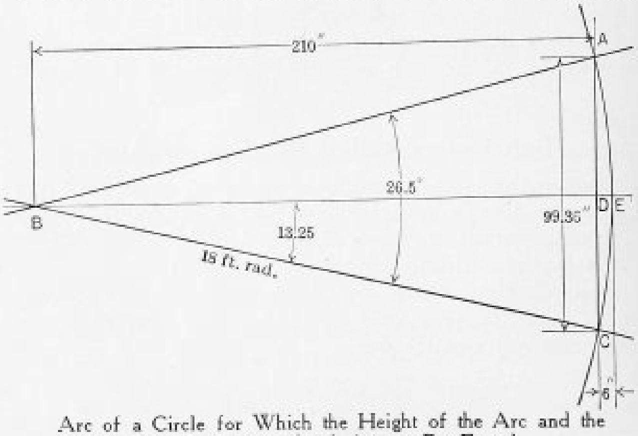
It is possible that when the stack was erected that some of the mortar was splashed on the outside of the steel stack. In damp and rainy weather it would absorb the moisture and the streaked appearance disappear. In dry weather the moisture would evaporate and the streaked effect occur again. If, during the erection of the stack it rained, the mortar on the outside of the bricks and between the steel and brick lining might have run to the outside of the stack.

### Calculations for Camber Template

Q.—The accompanying sketch represents the arc of a circle. If this arc is 100 inches and the radius of the circle 18 feet, what is the height of the arc *A*, also the length of the chord *B*, giving some points as *C*, *D*, *E*, so that a thin strip or batten may be used to draw the circle? W. E. G.

A.—In answer to your inquiry on finding the length and height of the chord of circle, when the arc length and diameter of circle are known, the following is given:

The diameter of the circle, of which the arc is a part, equals $18 \times 2 = 36$ feet; 36 feet reduced to inches equals




Arc of a Circle for Which the Height of the Arc and the Length of the Chord Are to Be Found

$36 \times 12 = 432$ inches. The circumference of the circle equals $3.1416 \times 432 = 1{,}357.17$ inches.

There are 360 degrees in a circle; therefore, in an arc of one inch length the angle in degrees equals $360 \div 1{,}357.17 = 0.265$ degrees.

In 100 inches, the angle $= 0.265 \times 100 = 26.5$ degrees.

The sketch shows the angle at *A-B-C*, and the length of *B-C* equals 216 inches. From these values we can find the length of *D-C*.

$$\text{The sine } B = \frac{DC}{BC} = \text{sine } 13.25 = 0.23.$$

$216 \times 0.23 = 49.68$ inches, length of *CD*.

Length of $AC = 49.68 \times 2 = 99.36$ inches.

Having any two sides of a right angle triangle, the other side can be readily found. In this case, $CD = 49.68$ inches, $BC = 216$ inches. To find length *BD*, apply the following formula:

$$BD = \sqrt{BC^2 - CD^2} = \sqrt{216^2 - 49.68^2} = 210 \text{ inches.}$$

$$DE = 216 - 210 = 6 \text{ inches.}$$

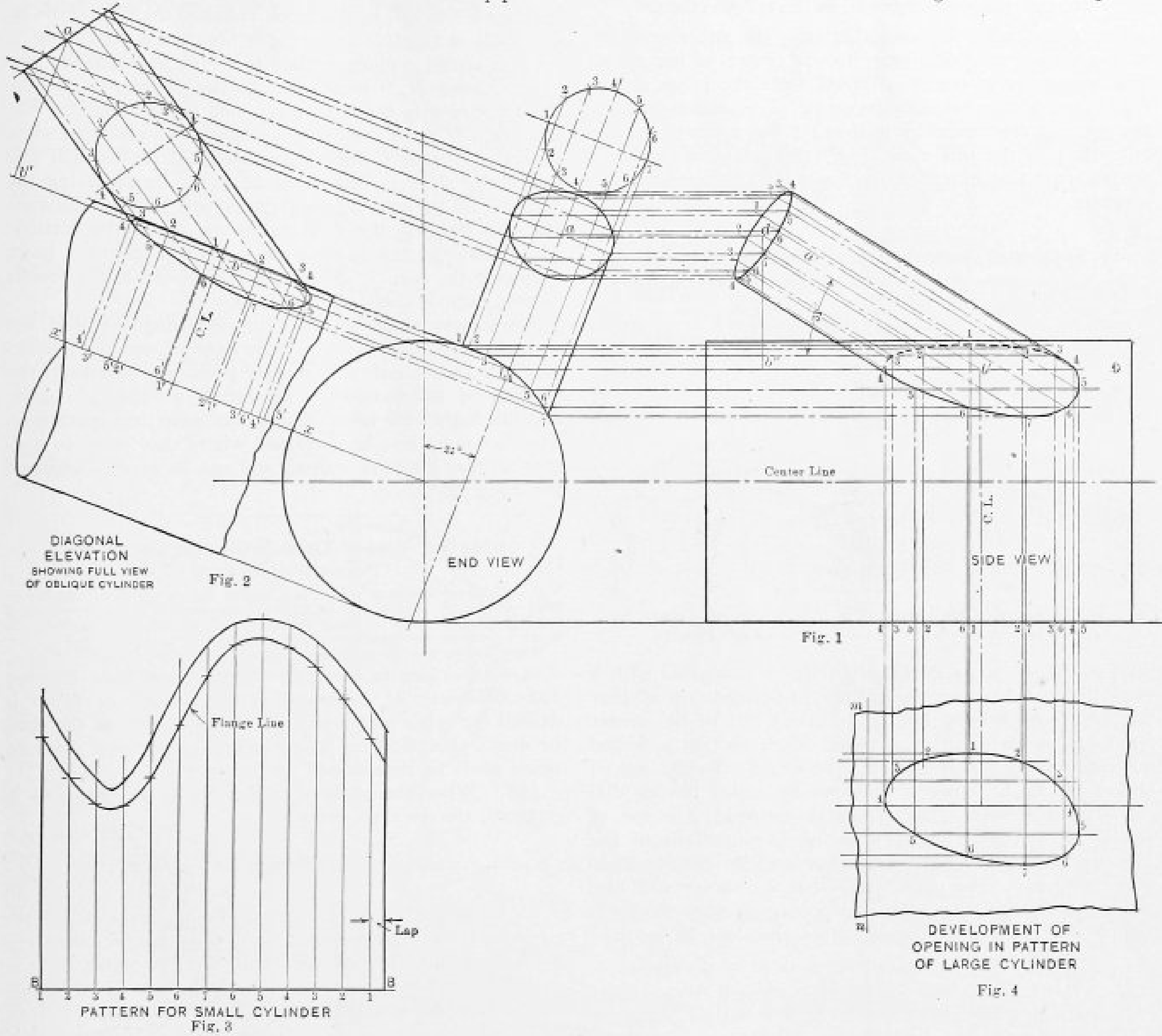
### Development of Patterns for Oblique Pipe Connection

Q.—Given a cylinder tipped to the right 21 degrees and tipped forward 31 degrees, will you please draw three views—front, side and top. J. R. B.

A.—In Fig. 1 draw the centerlines for the end and side views of the two cylinders, laying off the axis of the small cylinder at 21 degrees in the end elevation and 31 degrees in the side elevation. At right angles to *a-b* of the end view lay off a diagonal elevation, in which the true size of the oblique pipe is shown. By working from the full view—that is, the diagonal view, the foreshortened side and end elevations can be constructed. The points *a* and *b* are projected from Fig. 1 at right angles to the axis of the small pipe to Fig. 2. Lay off a section of the large cylinder in this view and construct the right-angled triangle $a'b'b''$. The base $b'b''$ of the triangle equals $b'b''$ of the side elevation, Fig. 1, which is the length measured horizontally between the extremities of the small pipe and

PROJECTION OF SMALL CYLINDER

Project the points on the miter, Fig. 1, to the centerline *x-x* and at right angles to it with the spacing dividers, and from *c* on this line transfer the length between the points




**Development of Views for Oblique Pipe Connections Shown Foreshortened in Plan and Elevation**

indicated on the centerline. The length $a'b'$, Fig. 2, equals the true length of the centerline of the small pipe, and the angle $O$ is the true angle it makes with the large pipe.

Complete the outline of the small pipe and draw its profile, dividing it into a number of equal divisions, as 1, 2, 3, 4, 5, etc. Also draw a profile in the end view for this cylinder and divide its outline into the same number of equal parts. These should be numbered so as to bring the proper relationship between the points in the two views. Draw in the construction lines in these views parallel to the axis of the pipe. From the points of intersection of these lines with the circle, end view, Fig. 1, draw projectors to the diagonal view, Fig. 2, to intersect the corresponding projection lines so indicated. Through these points draw in the curved line, which is the required miter between the pipes. From the upper base of the small pipe, Fig. 2, project the points as shown to develop the elliptical outline for this section in Fig. 1 of the end view. The side view projection of the small cylinder may now be completed.

1-2-3-4, etc., to the centerline of the side view, as shown. The miter in the side view may now be obtained by first drawing projectors from the points 1-2-3-4, etc., on the large circle, end view, parallel with the horizontal centerline of the large cylinder. Then project vertical lines from the points just located on the centerline to intersect the corresponding horizontal ones. Parallel to the axis *a-b* in the side view draw lines from the points on the miter, as from 1-2-3-4-5-6-7. From the elliptical view of the small cylinder, end elevation, project horizontal lines to intersect the projectors produced parallel with *a-b*, side view, thus completing the foreshortened views of the connection.

PATTERN DEVELOPMENT OF SMALL CYLINDER

Draw a stretch-out line *B-B*, Fig. 3, making it equal in length to the circumference of the small pipe. Divide this length into the same number of equal divisions, as in the profile (circle) of the pipe. Erect perpendiculars to *B-B* from these division points and transfer the lengths of the projectors 1-1, 2-2, 3-3, 4-4, etc., of the pipe, Fig. 2, laying them off on the lines in the pattern. Allow for the lap and flange material.

Development of Opening in Large Cylinder

Fig. 4 illustrates this construction. The stretchout line *m-n* is drawn at right angles to the center of the sheet. The spaces on it are transferred from the large circle, Fig. 1, and horizontal lines drawn in. The widths through the opening are found by projecting the points from the miter line of the side view, Fig. 1, to intersect the horizontal projectors extended from *m-n*. This completes the example.

## Sectional Formers for Dishing Heads

Q.—Will you please publish a sketch showing the design of a former for making dished heads. I was in a boiler shop last week where they make heads different from what we do. They say they push the heads through the female die and do not have to strip them. At the present time we make heads on dies and have lots of trouble stripping them from the male die. We make mostly 30-inch, 36-inch and 42-inch heads. V. W.

A.—In Fig. 1 is illustrated a sectional male block for ordinary flanged heads. The block is circular in form

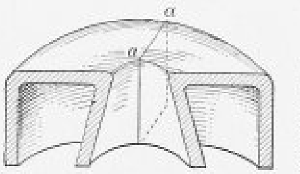



Fig. 1.—Section of Male Former for Flanged Heads

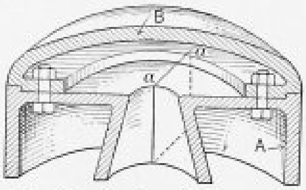



Fig. 2.—Section of Former for Bumped Heads

and cored out so as to make it light as compared with a solid block. Consider the former to be made up of four segments or sections and to be cored out in the center to form the frustum of a cone. Each section is bolted together along the division line as at *a-a*. By the use of liners placed in between the sections, heads having different thicknesses of metal can be formed. The use of liners will cause a slight variation in the shape of the former, but the flanged heads made with the block will be close enough. The cone blocks for the center will also be larger for the corresponding increase in plate thickness of the boiler heads. The segments and cone blocks take

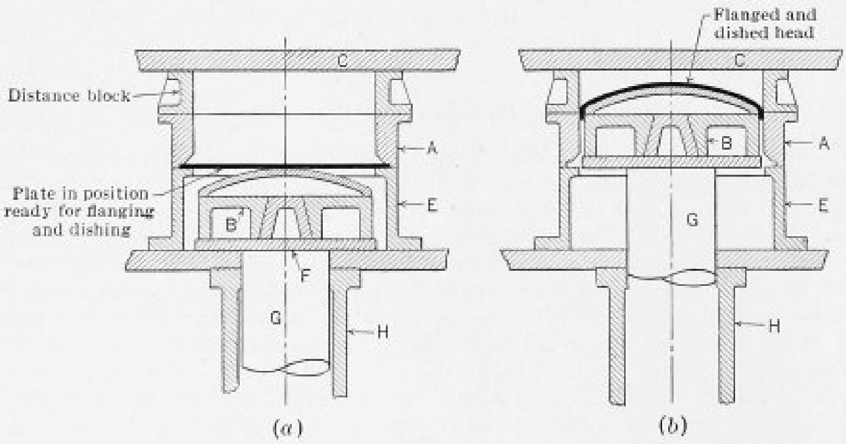



Fig. 3.—Flanging Process of a Dished Head on a Four-Column Hydraulic Press

up a very small amount of room, and are easily assembled.

For bumped heads the bottom block *A*, Fig. 2, may be made sectional, but the upper part *B* for forming the dish is solid, being bolted to the bottom block *A*. The dished former is made to produce only the one curvature, but it can be used for different thicknesses of heads.

Fig. 3 shows the flanging of a dished head on a four-column hydraulic press by means of the sectional former and female block. At (a) the plate is shown in position before flanging and bumping, between the two blocks *A* and *B*. The plate *C* is a base plate to which is bolted a distance block, and to this block is bolted the female die *A*. The table is movable and on it is fastened a grip block *E*. At *F* is shown a plunger plate to which is bolted the sectional former *B*, *F* is attached to the plunger *G* and the clamping or grip block *E* is fastened to the ram *H*. The main ram *H* holds the clamping block *E* in position, while the plunger ram *G* forces the sectional die to dish and flange the plate as illustrated at (b). By releasing the pressure on the ram *G*, the plunger will fall and the cone block in clearing the sectional parts allows the sections of the male former to drop away slightly from the head, following the ram *G*. The head will remain in the female former until it cools, then drop down.

Allowances must be made in designing the dies for clearance between them, to take care of the plate thickness, expansion of the metal, and for upsetting the knuckle of the flanges so as not to produce too great a gathering of the metal during the upsetting operations. The dies must also be machined where they come in contact, so that they are smooth and can be readily adjusted for flanging.

## Staying Water Tube Boiler to Carry 200 Pounds Pressure

Q.—Enclosed herewith please find sketch Fig. 1 of watertube boiler. Will you kindly inform me whether or not such a boiler would need staying between tubes or does the sketch show sufficient staying? Is there a formula for determining the thickness of the outer shell? Steam pressure is 200 pounds per square inch. J. P. Y.

A.—According to the A. S. M. E. Code, Rule Number 192, *Efficiency of Ligament*, when a shell or drum is drilled for tubes in a line parallel to the axis of the shell or drum, the efficiency of the ligament between the tube holes shall be determined as follows:

(b). When the pitch of tube holes on any one row is unequal, the formula is:

$$\frac{p - nd}{p} = \text{efficiency of ligament,}$$

where:

$p$ = unit length of ligament, inches.
$n$ = number of tube holes in length, $p$.

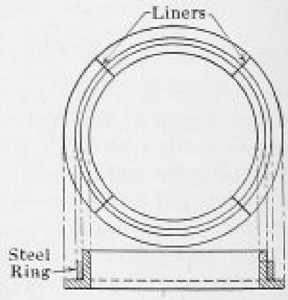



Fig. 4.—Liners Used to Regulate Thickness of Heads

$d$ = diameter of tube holes, inches.

In your example $p = 6\frac{1}{2}$ inches.
$d = 2\ 1/32$ inches.

Using these values in the formula, we have:

$$\frac{6\frac{1}{2} - 2 \times 2\ 1/32}{6\frac{1}{2}} = 0.375, \text{ efficiency of ligament.}$$

Paragraph 180 of the A. S. M. E. Code on the allowable working pressure gives:

The maximum allowable working pressure on the shell of a boiler or drum shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength stamped thereon, as provided for in paragraph 36, the efficiency of the longitudinal joint, or of the ligament between the tube holes in the shell (whichever is the least), the inside diameter of the course, and the factor of safety.

$$\frac{TS \times t \times E}{R \times FS} = \text{maximum allowable working pressure, pounds per square inch}$$

Where:

$TS$ = ultimate tensile strength of plate.

$t$ = minimum thickness of shell plates in weakest course, inches.

$R$ = inside radius of weakest course of the shell or drum.

$FS$ = factor of safety or the ratio of the ultimate strength of the material to the allowable stress. For new construction in the above formula, $FS = 5$.

$E$ = efficiency of longitudinal joint or of ligaments between the tube holes, whichever is the least.

Using 55,000 pounds per square inch tensile strength of the plate and substituting the values already given in the example in the formula, we have:

$$\frac{55{,}000 \times \frac{1}{2} \times 0.375}{30 \times 5} = 68\tfrac{3}{4} \text{ pounds}$$

allowable maximum pressure, if the tube ligament is the weakest part.

The calculation shows the ligament between the tubes to be too weak to carry 200 pounds pressure; therefore, staying is required.

The maximum pitch for the stays in Fig. 2 is 3¼ inches.

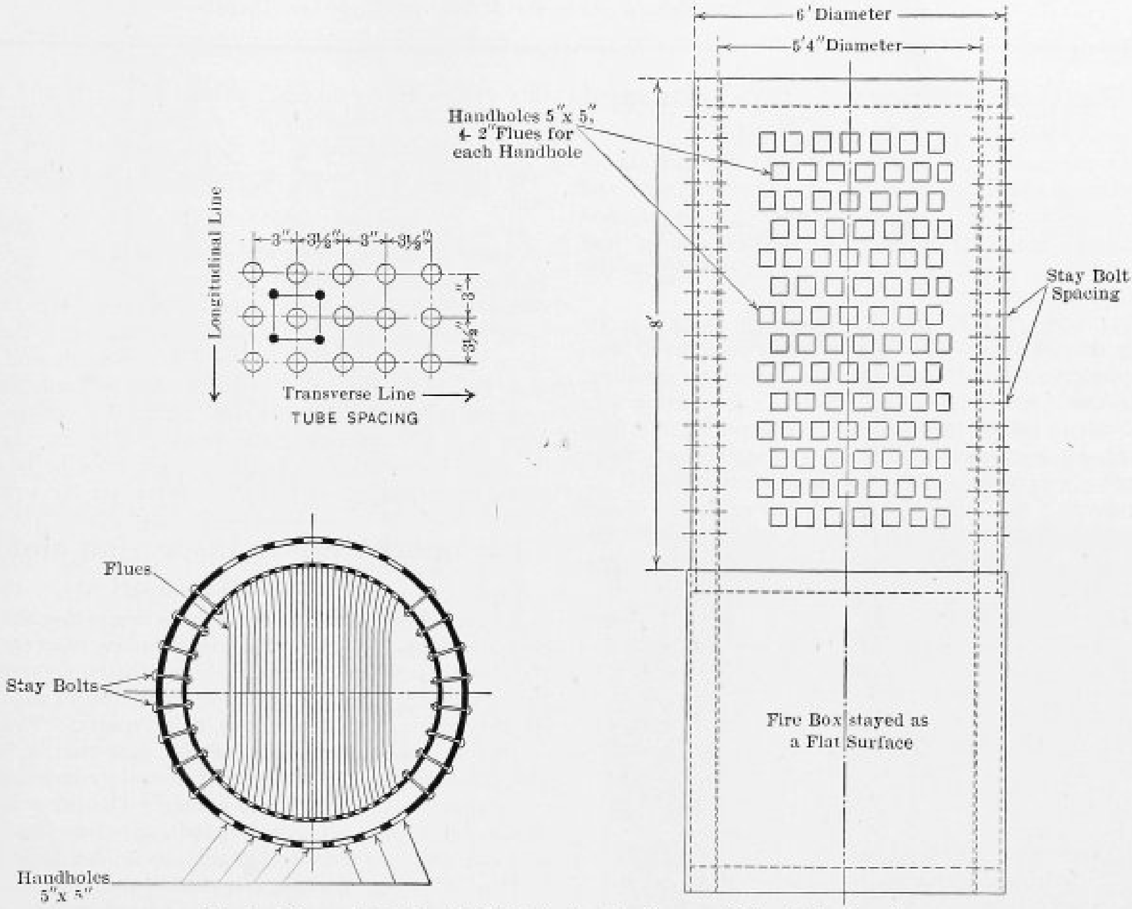



Fig. 1.—Watertube Boiler in Which the Staying Between Tubes Is in Question

In the calculation consider the tube omitted for convenience in this case of determining the diameter of stay required. The area of the stayed surface equals 3¼ × 3¼ = 10.5625 square inches.

10.5625 × 200 = 2,112.5 pounds pressure on the surface.

Tensile strength of staybolt iron = 49,000 pounds per square inch.

Diameter of stay required =

$$\sqrt{\frac{2{,}112.5 \times 5}{49{,}000}} = 0.464 \text{ inches,}$$

say ½ inch at the root of the thread.

The value 5 in the above calculation is the factor of safety.

## Rule to Find Thickness of Plate for Boiler Shells

Multiply the pressure by the factor of safety and this product by the radius of one-half of the inside diameter of the shell, then divide the product so found by tensile strength of plate in pounds per square inch, the quotient is the required plate thickness.

Considering the outer shell to find the required plate thickness, we have:

$$\frac{200 \times 5 \times 36}{55{,}000} = 21/32 \text{ inch, say } \tfrac{3}{4} \text{ inch.}$$

# Letters from Practical Boiler Makers

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

## Flue Rattler Operates Forty-Thousand Hours in Topeka Shops

During the early part of the year 1914 we had an accumulation of about 200,000 dirty flues in the yards and shops of the Santa Fe Railroad system at Topeka, and every official, from the president of the road down, was demanding more speed in turning out the work from the boiler department.

At that time two flue rattlers were in operation for cleaning the tubes; one was a side door perforated shell that depended on the drop of the flues to do the cleaning, and the other was known as a wet chain rattler. In spite of what seemed to be adequate equipment, the flues continued to accumulate until an investment of about $1,000,000 was represented in unusable flues alone.

To overcome the difficulty, a new rattler of the Baird type was installed, and within a few weeks the two other rattlers were scrapped, all of the work being done by the single machine.

For the first nine months after its installation it was operated 24 hours a day, and since that time has been run 16 hours a day, or a total of nearly 40,000 hours without any appreciable outlay for upkeep. One accident, however, caused a short shutdown when a 2-inch bolt was dropped into the gears. This was not serious, however, and the delay did not allow the dirty flues to accumulate.

### Operation of Rattler

The flue rattler accomplishes its work by means of friction. The cleaning chamber is filled with flues nearly to capacity and then rotated at approximately 30 revolutions per minute. A great deal of heat is generated by friction, which cracks the scale while still holding it in the flue. The scale is gradually pulverized, however, until it is nearly as fine as emery dust. The heat removes all the moisture from the resulting lime and makes it a perfect scouring compound. After it has been utilized in this way, it finally becomes powdery in form and finds its escape into the dust rooms at either side of the rattler. The complete cleaning of three hundred flues requires from two to four hours, depending on the hardness of the scale.

It is rather interesting to note that A. M. Baird, the inventor of this rattler, started in the boiler shops of the Illinois Central Railroad at the age of 13 years and served his time there as a boiler maker. He has since been connected in managerial capacities with the Baltimore and Ohio, the Burlington, Cedar Rapids and Northern, the Wabash, the Wisconsin Central and Northern, and the Atchison, Topeka and Santa Fe railroads. In each case his experience has been directly in connection with the boiler shops. At the present time he is actively in charge of the Baird plant. William Keininger.*

## Locomotive Boiler Inspection and the Hydrostatic Test

While talking to a fellow inspector regarding the proper way in which to make out Federal boiler reports, so that they would convey to the authorities the true condition of the boiler inspected, the question arose as to the bearing of the hydrostatic test upon such reports. The writer maintained that, regardless of the fact that a boiler is able to stand the required test, the exact condition of the various parts should be made known. The other inspector contended that a boiler which withstood the hydrostatic test was good all over and should be reported as such.

The following example illustrates the point of difference. Engine 3739 had been in yard service for over one year, making two, sometimes three, turns during the twenty-four hours with an allowable mileage of 75 miles for each turn. At the time she was put into service the tubes were pieced and welded into the tube sheet, patches

* Foreman of the Topeka, Kan., boiler shops of the Atchison, Topeka & Santa Fe Railroads.

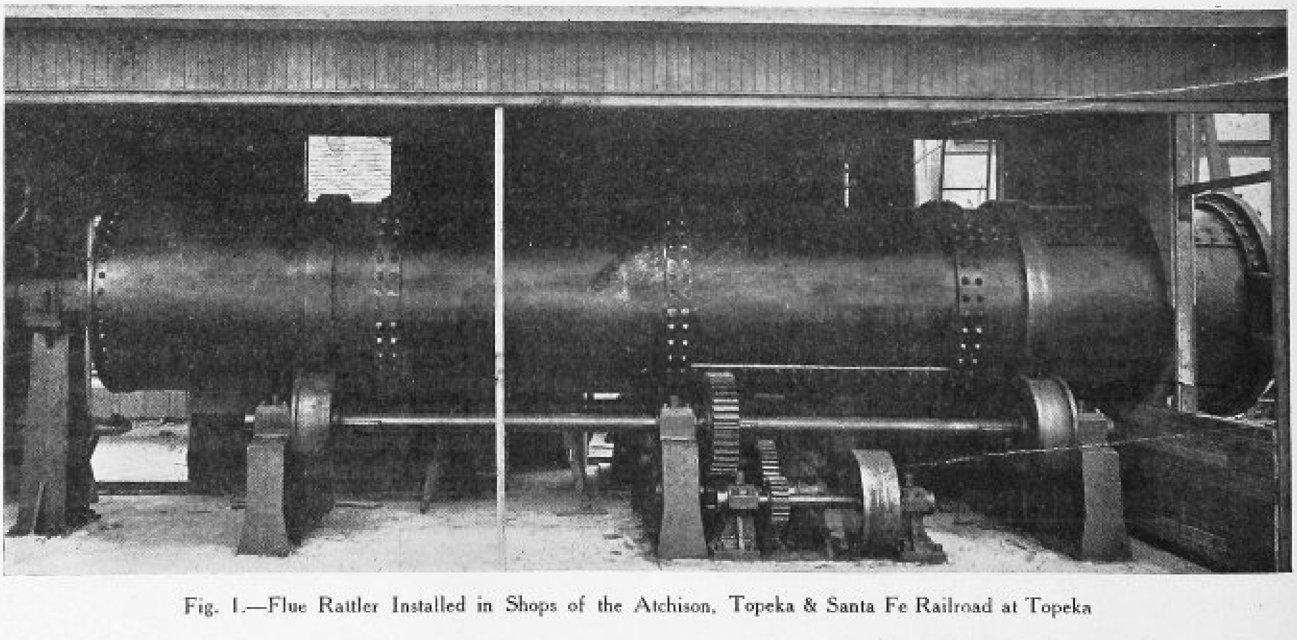


Fig. 1.—Flue Rattler Installed in Shops of the Atchison, Topeka & Santa Fe Railroad at Topeka

inserted in the side sheets and welded in place, cracks in top flange and many small cracks in the bridge of the tube sheet were welded. In fact, the firebox was one mass of welds—all good welds—but welds, nevertheless.

After being in service a short time, cracks began to develop and the old welds let go. At this time the tubes also commenced to crack, some of these extending into the groove formed by the sectional expander. The tubes had to be cut out, and on account of bad water conditions it was necessary to lay the engine up three and sometimes four nights a week for repairs to the firebox. In spite of these evidences of defects, at every monthly test all parts of this boiler were reported in good condition, simply because it was able to stand the hydro test.

The writer has always reported the condition of all parts of the boiler as being in good, fair, poor or bad condition, as the case may be, the object of the report being to keep the Federal authorities informed upon the true condition of boilers in service.

Shortly after our conversation, the same engine was shopped for a general overhaul, which meant putting in new half side sheets, a new tube sheet and renewing a large number of crown bolts. The writer has not been able to find out what the Federal inspectors said when they found this machine in the shop for such extensive repairs, when all the reports for a year past had led them to believe this engine to be in excellent condition.

With a chief inspector on the job who knows his business and visits all points of a great system, the writer fails to understand how any round house inspector can "get away" with such reports, especially after the true condition of the boiler is known at the main shop.

The writer is of the opinion that on a large railway system all boiler inspectors should be called together at some central point and discuss this vital question thoroughly with the chief inspector and some of the motive power officials. There can be no question as to the inadvisability of leaving it to the judgment of the individual to determine the condition of a particular machine.

It would be a good thing for some of the interstate inspectors to get in touch with the roundhouse inspectors, question them upon various points pertaining to the boiler under their supervision, and do it without letting the roundhouse foreman or the inspector know who he is. Some interesting facts may come to light in this way.

While on the subject of inspection, I may state that for some time past at various places it has been the common practice for the inspector, after looking over an engine, to take the oil certificate out of the engine cab to the office. There the new one is written out from the old one, stamped by the notary public and signed by the inspector without being sworn. This is a strong charge, but a true one, for, as one roundhouse inspector said, "I am running this place to suit myself." The results in this instance certainly showed this to be true, for the condition of all the engines in his charge indicated that they were badly in need of some one else's attention.

The writer would like to know to whom the roundhouse boiler inspector is responsible. Is he expected to take orders or receive instructions from the chief inspector? It has recently come to the writer's knowledge that the chief inspector instructed the roundhouse inspector to do a certain thing when making the monthly test, which he did, and the following day rated a good calling down from the roundhouse foreman for doing it. This incident placed the inspector in a bad position and embarrassed him to such an extent that he became indifferent about his work.

We have always believed that an inspector should be independent of the shop foreman, and, as far as his work of inspection is concerned, on an equal footing with the foreman. A position without authority is no position at all, and the inspector becomes nothing more than a buffer between the Federal Government and the motive power department of the road he is working for.

Much as been said in these pages about the boiler inspector (Federal and insurance), but very little about the true inspector who lacking the higher education to qualify him for one of these high positions is doing a work that calls for good judgment and quick decision, equal to that of the high-class men.

The writer trusts that this may catch the eye of some one higher up, and that the ball may be started rolling for better conditions for the roundhouse inspector.

Wilkinsburg, Pa. Flex Ible.

## The Use of Graphite in Cleaning Boilers

Very little has ever been written on the use of graphite as a boiler compound. In most cases where the material has been used to prevent the formation of hard scale, the records kept of the results are not satisfactory.

The action of graphite in a boiler is purely mechanical,

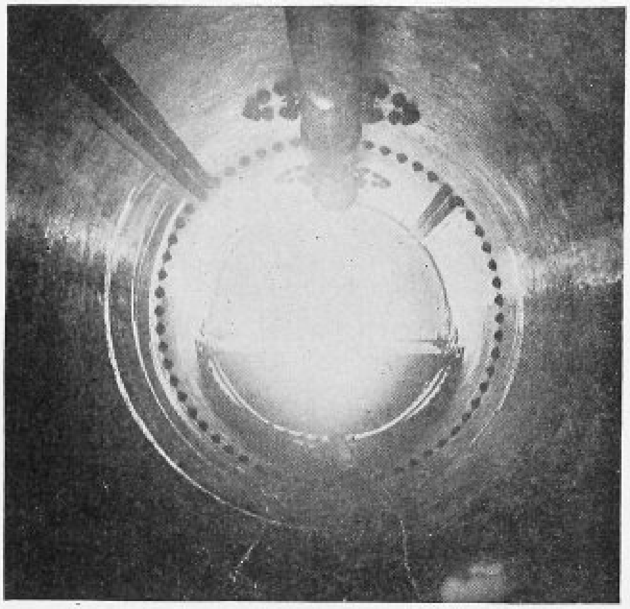


Fig. 1.—Interior of a Boiler Cleaned with Flake Graphite

since it is inert at ordinary temperatures, and so unable to combine with the scale formation.

The action and effect of graphite in boilers is summed up in the following extracts from the "Production of Graphite in 1914," published by the Department of the Interior, Washington, D. C.:

"The two uses of graphite that seem to have shown the greatest gains recently are its application to automobile lubrication and its use as a preparation to loosen boiler scale. The effect of graphite in boilers is mechanical, not chemical. Being mechanical, it cannot injure the iron of the boilers or affect the quality of the boiler water. It does not prevent the formation of scale, but the fine graphite particles, by mixing with the scale during its formation, render it soft and crumbly and prevent it from adhering strongly to the boiler. It can then be easily removed. It is said, moreover, that graphite is efficient in loosening old scale, the graphite particles working into the pores and between the scale and the boiler."

It might be added that the scale loosened by this penetration of the graphite may be more easily rapped off or removed with regular cleaning tools. If the scale is very hard and thick, however, it may take three or four months before the graphite has any apparent effect. After it has once been removed, scale does not so easily adhere to the metal again as long as the graphite treatment is continued.

Various forms of graphite are available, but it has been found that the flake or crystalline form is superior to the amorphous or powder form for treating boiler water, because of the fact that the flakes will be distributed more evenly over the surfaces of the shell and tubes and become more permanently attached to the metal. The powder variety of graphite has a little tendency to form into a paste or muddy mass when put into the water.

## New Design Washout Plug

The modern locomotive is equipped with many ingenious appliances, and, although in general there is no comparison between the machines of today and those of thirty-five years ago, some of the fittings have been developed

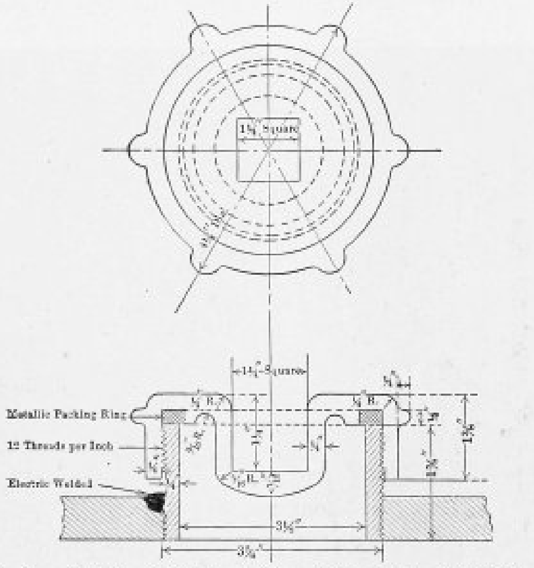



Fig. 1.—Details of Washout Plug Designed to Overcome Present Defects

little beyond their original stage. One of the devices which has never been improved upon to any great extent is the washout plug. It might safely be said that the plug now in use is the same design which has been fitted on locomotive boilers since Alexander Stephens invented the locomotive in 1826. This statement would seem to imply that the plug occupies a minor place and is of little importance, but such is not the case.

The Interstate Commerce Commission has emphasized the necessity of developing a plug of new design which will adequately meet the requirements of the law. The laws of the commission are very specific in their statement that all washout plugs must be removed from the boiler when it is washed, and that they must be free from leaks and at all times maintained in a safe and serviceable condition.

To meet the requirements of the Interstate Commerce Commission, the writers have designed a washout plug which is strictly mechanical in its design and construction, economic in its first application and subsequent upkeep. The details of this plug may be of interest to the readers of The Boiler Maker, as it represents an attempt to develop this rather neglected item of locomotive equipment. Fig. 1 shows an arch tube plug which may either be welded or screwed into the boiler plate. Other methods of installation may be used in which the

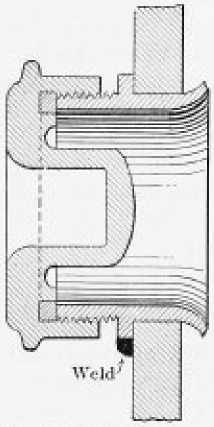



Fig. 2.—Modification of Washout Plug

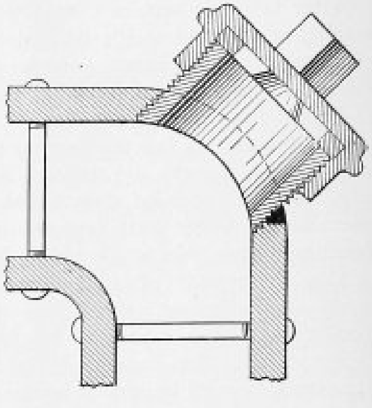


Fig. 3.—Washout Plug as Applied to the Mudring Corner

plug may be rolled into the boiler plate and prossered, with or without being welded around the collar outside. Whichever system of installation is used, all the plugs in the boiler must be applied in a similar manner, with the exception of the corner mudring plug. The design and method of applying this are given in Fig. 3.

The manner in which the sleeve of the plug is applied renders the leakage of this part impossible. The cap is also fitted with a metallic joint, which prohibits any leakage at this point. In addition, there are no threads to be marred by the insertion of the washout nozzle, the only threads cut on the sleeve being located on the outside. When a locomotive is shopped for repairs, the caps should remain attached to the sleeves to protect them from ill-usage while undergoing reconstruction.

When applied to large holes and wasted mudring corners in old equipment, the plate near the holes may be restored by autogenous welding at the same time that the sleeves are welded into the sheet. When manufacturing the plug, the sleeves as well as the caps may be drop-forged and the finished device thus be made standard. Such an operation is more economical and satisfactory than turning up brass plugs on the lathe and then tapping

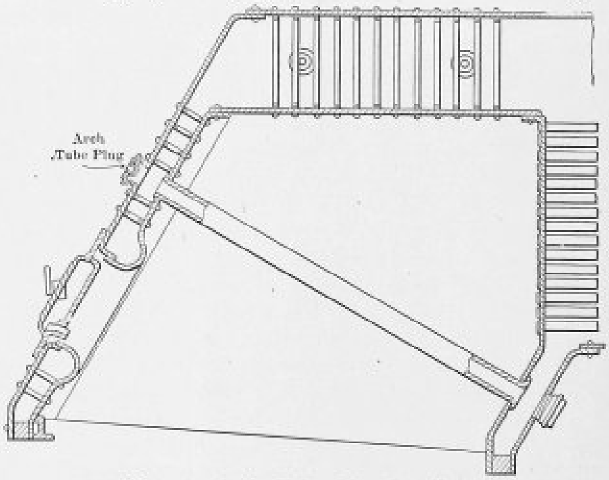



Fig. 4.—Arch Tube Plug Installation

the necessary holes, with the consequent maintenance of tap equipment at the various division points over an entire railroad system for repair work.

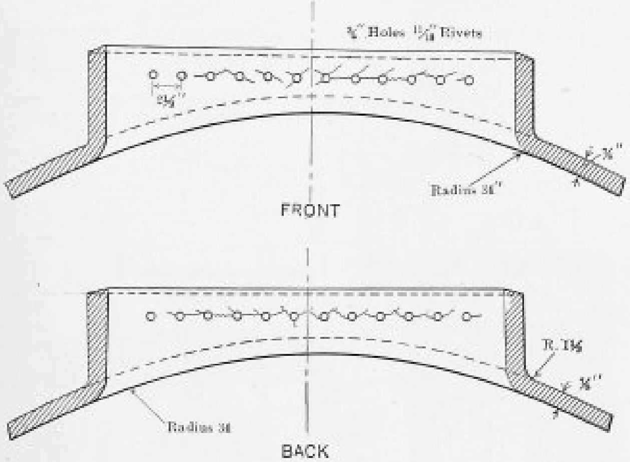
Yonkers, N. Y. A. R. Hodges.
Jersey City, N. J. H. A. Lacerda.

## What a Hydrostatic Boiler Test May Show

Recently while inspecting a locomotive boiler that was under a hydrostatic test pressure, several fine streams of water were discovered coming from cracks between the rivets on the front and back of the dome flange. These cracks were barely visible to the naked eye, and would probably have escaped discovery if the hydrostatic tests had not shown them up.

At some previous time the rivets near the cracks had been renewed by hand-driven rivets. As these cracks had developed the calking edge of the dome flange had sprung away from the dome and showed that extreme calking had been necessary to keep it tight. It was thought advisable to cut out the rivets in these two locations, so that a more minute examination would be possible.

After the rivets were removed the cracks were plainly visible in the rivet holes. The dome was then taken off and the cracks shown in Figs. 1 and 2 were found. Some




Figs. 1 and 2.—Cracks Which the Hydrostatic Test Showed Up

of these cracks were fully 1/16 inch in width, and even so were not discernible on the outside.

It is needless to say that the flange and dome were removed and later replaced by a one-piece flanged steel dome.

Olean, N.Y. F. R. BURLINGAME.

## Weaknesses of Welded Tanks

(*Continued from page 108*)

to the angles, fitting a stay at the intersection of each horizontal and vertical angle.

Calculation will show that these angle stiffeners and cross stays need not be very heavy to carry the load, the main point to watch being to see that they are tightly riveted.

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The oxy-acetylene welder works in the dark and considerable experience is required before he is able to determine when thorough fusion and penetration are secured. the necessity of wearing colored glasses to protect the eyes from the injurious heat and light rays is imperative. The beginner experiences difficulty in distinguishing the puddle and seeing the margins of the joint. Between watching the puddle, manipulating the torch, and feeding the welding rod he is pretty busy, and until a considerable degree of manipulative skill is acquired, some one of the operations is likely to suffer.

Choose colored glasses with care. Be sure that they protect your eyes without shutting out more daylight than is absolutely necessary.—*Autogenous Welding.*

## BOOK REVIEW

THE MODEL "T" FORD CAR. Victor W. Page, M. E. Size 5 inches by 7 inches. Pages 410. Illustrations 155. New York, 1920. Norman W. Henley Publishing Company. Price $1.50 net.

This book is a revised edition describing in detail the construction, operation and repair of Ford cars, the Fordson farm tractor, the F. A. starting and lighting system, and the worm-drive one-ton truck.

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An interesting little booklet on the use of graphite in cleaning boilers has been issued by the Joseph Dixon Crucible Company, Jersey City, N. J., and may be obtained on request from this company.

## PERSONAL

D. W. Phillips has recently become associated with the Heine Safety Boiler Company, St. Louis, Mo., at their office in that city.

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Major C. E. Lester, formerly general superintendent, 19th Grand Division, Transportation Corps, A. E. F., has returned to the boiler industry as supervisor of boilers of the Ohio and Chicago regions of the Erie Railroad.

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V. J. Hartley, formerly superintendent of the Badenhausen Marine Engine and Boiler Works, Philadelphia, Pa., and the Rummeli-Dawley Company, St. Louis, Mo., is now marine superintendent of the W. F. Spice Steamship Company, Baltimore, Md.

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C. B. Lindstrom, who for many years has conducted the Questions and Answers Department of THE BOILER MAKER, has recently severed his connections with the International Correspondence School, Scranton, Pa., to become superintendent of the General Boiler Company, Waukegan, Ill.

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In order to obtain closer co-operation between the factory and sales department, the Electrolabs Company announces the consolidation of all offices at 2635 Penn avenue, Pittsburgh, Pa. The request is issued by the company that all future correspondence be addressed to the Pittsburgh office. A branch office will be maintained at Room 313, 30 Church street, New York City.

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Charles C. Phelps recently became associated with the Uehling Instrument Company, 71 Broadway, New York, combustion engineers, as well as manufacturers of carbon dioxide recording equipment and other fuel economy apparatus. He is devoting most of his attention to research work in connection with the efficient combustion of fuel oil in boiler furnaces.

## OBITUARY

The Walsh & Widener Boiler Company, Chattanooga, Tenn., announces the death of their vice-president, Morgan Llewellyn, February 17, 1920.

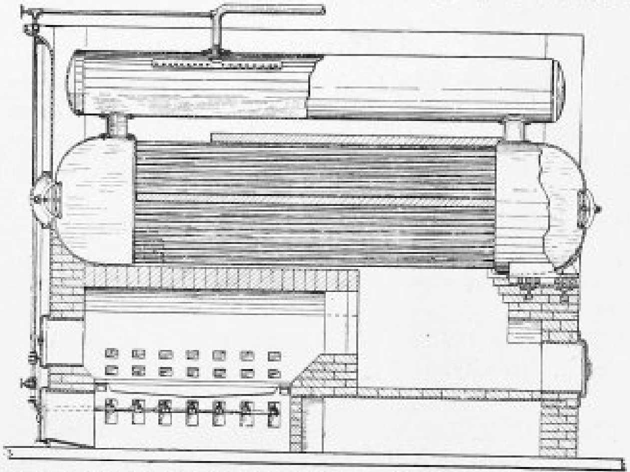
## Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,327,727. BOILER SETTING. LESTER NEVERS AND FRANK WHITBECK, OF GRAND RAPIDS, MICH.

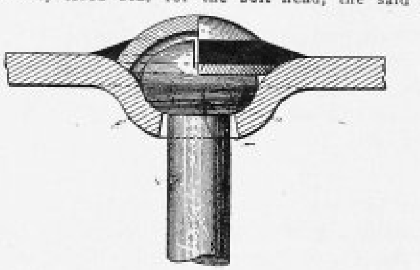
*Claim* 1.—In combination with a boiler, a setting therefor forming a fire place under the boiler and provided with an arch, said fire place being provided with an outlet, a grate in the fire place, a post located at



the back of the fire place and centrally of the same and dividing the outlet in the fire place into two passages, fire doors located on opposite sides of the middle of the front to enable the side portions of the fire place to be alternately supplied with fresh fuel, means for introducing heated air into the fire place at the sides thereof above the grate, and steam pipes located at the sides of the fire place and having outlets discharging into the fire place and arranged to draw heated air into the same, the steam outlets on each side of the fire place being adapted to force the smoke and gases from one side of the fire place to the opposite side thereof. Five claims.

1,319,772. FLEXIBLE STAYBOLT CONNECTION FOR BOILERS. CHARLES HYLAND, OF PITTSBURGH, PENNSLYVANIA, ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURGH, PENNSYLVANIA.

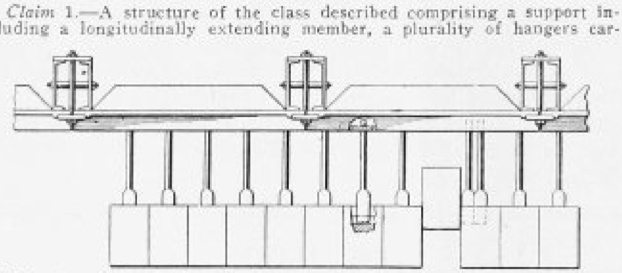
*Claim* 1.—In a staybolt construction, the combination of a boiler plate having a depressed seat for the bolt head, the said seat being



formed by pressing the plate inwardly, a bolt the shank of which passes through an opening formed at the bottom of said depressed seat, and an arched cap having a continuous edge abutting the plate within the depression and adjacent the outer edge of the latter and welded to the said plate.

1,328,511. SUSPENDED ARCH FOR BOILERS AND THE LIKE. WALTER E. GEHRING, OF MILWAUKEE, WIS.

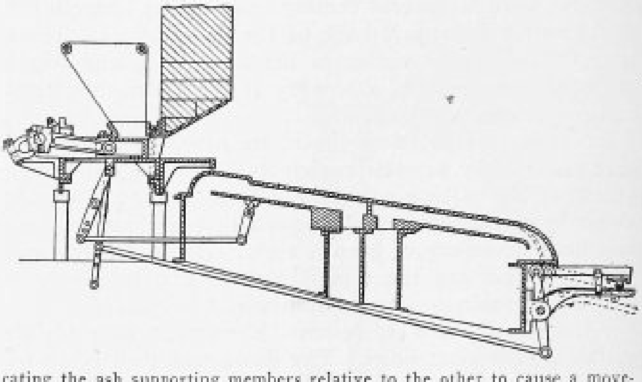
*Claim* 1.—A structure of the class described comprising a support including a longitudinally extending member, a plurality of hangers car-



ried by the member and slidable longitudinally thereof, each of said hangers having a block holder, and a like number of blocks, each having a holder receiving slot opening through opposite sides thereof, said slots being alined, each of said blocks being detached from its respective hanger by sliding the block holder of the latter out of the slot of the former beyond either end of the same until said hanger is out of the vertical planes of the sides of the block. Five claims.

1,326,197. BOILER FURNACE. JOHN M. HOPWOOD, OF DORMONT, PA., ASSIGNOR TO DARWIN S. WOLCOTT, TRUSTEE, OF SEWICKLEY, PA.

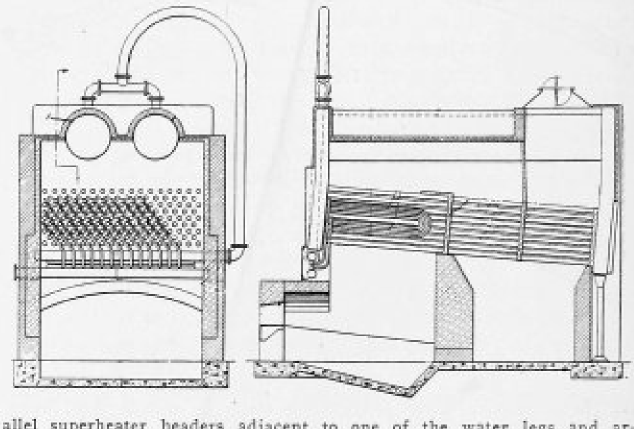
*Claim* 1.—In a furnace the combination of fuel supporting members and augularly adjustable ash supporting members, means for recipro-



cating the ash supporting members relative to the other to cause a movement of ashes across the ash supporting member without materially changing the angular position of one member relative to the other. Ten claims.

1,328,365. WATERTUBE BOILER SUPERHEATER. BENJAMIN BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

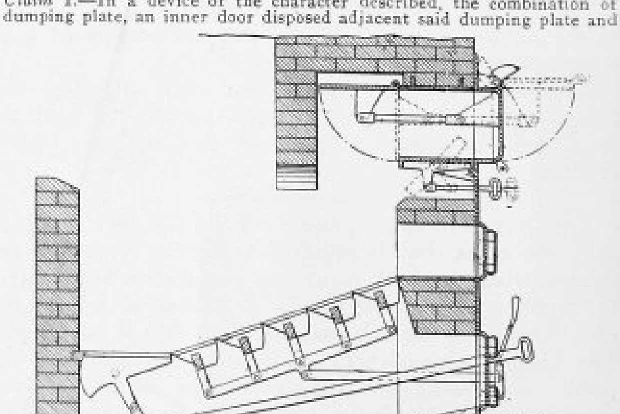
*Claim* 1.—In a boiler, the combination of two parallel water legs; water tubes connecting them and arranged in spaced rows; a pair of par-



allel superheater headers adjacent to one of the water legs and arranged transversely to the water tubes; a sub-header secured to one of the headers and extending into the space between two rows of water tubes and adjacent to the water leg; a second sub-header secured to the other header and extending into the space on the side of the first away from the water leg and not as far as the first; both sub-headers being of a diameter substantially equal to the space between the rows of tubes; and a plurality of tubular superheater elements attached to the pair of sub-headers and extending into the space between the water tubes, the elements being of materially smaller diameter than the space. Four claims.

1,328,116. FURNACE. HENRY BENTON, OF ELIZABETH, N. J.

*Claim* 1.—In a device of the character described, the combination of a dumping plate, an inner door disposed adjacent said dumping plate and



mounted to swing, an outer door disposed adjacent said dumping plate and likewise mounted to swing, connections from said inner door to said outer door for enabling said inner door to be actuated by movements of said outer door, and mechanism controllable at the will of the operator for actuating said dumping plate. 5 claims.

# THE BOILER MAKER

MAY, 1920

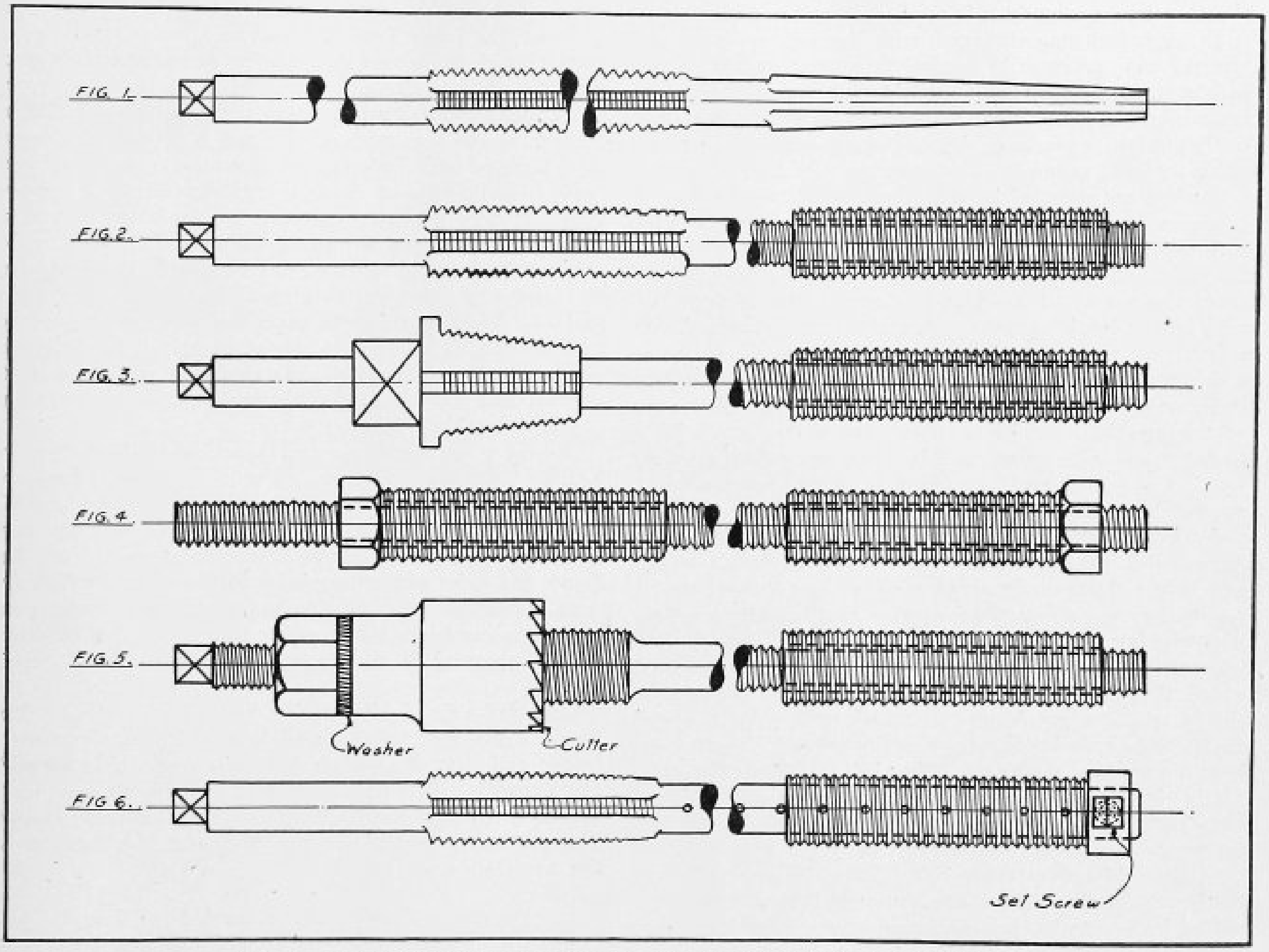




Plate 1.—Types of Radial Stays, Taps and Facing Tools Used in Boiler Construction

# Preparation and Installation of Radial Stays

*A practical discussion of such matter as that on radial stays given below is of very great benefit to the members of the boiler industry, and it is hoped that more readers of* THE BOILER MAKER *will give the trade the benefit of any special knowledge they may have in connection with boiler construction.*

Radial stays are the supporting stays which join the outside firebox of a boiler which has a semi-circular roof sheet to an inside firebox crown sheet of any desired shape transversely or of any slope longitudinally.

They are usually upset at both ends, and always at one end, thus avoiding the necessity for threading their entire length, and are intended to enter and follow the threaded holes which have been prepared for them without stripping the threads either on the bolts or in the holes.

The supporting bolts between a flat-topped roof and crown sheet which may have similarly sloped sheets are incorrectly named radial stays, although for the objects of this paper they are referred to as such, because their manufacture and objective are identical.

### DESCRIPTION OF RADIAL STAYS

Although it is not necessary to quote all the different designs of radial stays, a description of the following six styles in common use are those which are known to be closely related to the subject and are referred to in the order shown on Plate 2. Fig. 1 is a radial stay upset at both ends, consequently the body of the bolt is its weakest section. It can be applied from either the inside or the outside firebox end, although when the overhanging end is to be hammered over to form a head it is customary to apply the bolt from the outside, but when it is not hammered over at the crown sheet end and the sheet is faced to receive a faced nut without a copper gasket it is an advantage to apply the bolt from the crown sheet end.

Fig. 2 is a radial bolt which has its weakest section at the root of the thread at the small end of the bolt. It is seldom used except when repairing injured crown sheets, at which time it is manufactured for the purpose of preserving the original size of the hole in the outside firebox sheet, and consequently it is applied from the crown sheet end. A radial stay designed with the crown sheet end tapered and necessarily applied from that end is shown in Fig. 3. It is commonly used in oil-burning engines to replace button head bolts, because the latter become seriously affected by leakage due to their prominence and require frequent renewal. The taper on this style of radial bolt when not affected by the crown sheet tufting due to foreign matter or water shortage will resist a greater pressure per square inch than a parallel threaded bolt before the sheet will carry away from it. There are many, however, who are of the opinion that crown sheets supported with button head bolts through the top center, except for a few rows of ordinary bolts in a fusible zone at the front, will prevent boilers leaving the frames when working steam in the event of water shortage, whereas they suspect where the taper bolt has substituted the button head that the opposite result will be obtained. Any practice which will reduce the destruction at such times should be accompanied with immunity from maintenance leakage and the destroying effect to the threads on the bolts due to excessive material used in the button head design, which causes the flame to impinge with serious consequences, eventually destroying the integrity of the thread. Notwithstanding that a new button head radial stay stands up well under a cold test when new, there is abundant proof that there can be conditions of heating crown sheets when water is absent, which will permit sloped sheets to become hot for their entire length. There have been many cases where the boiler left the frames in spite of the fact that it was equipped with button head bolts. This indicates that they did not perform any better than ordinary plain hammered-down heads such as are in use with the oil-burning taper bolt. This bolt is weakest in the body and all of the aforementioned bolts are not permitted by law to have a maximum stress exceeding 7,500 pounds per square inch.

The question as to what stress should be permitted on bolts of the button head design, and whether or not they should be classed as forged bolts, because of the way they perform when heated, has been the subject of much thought and discussion without a decision.

Fig. 4 shows a button head radial stay designed for application from the firebox end, its weakest section being in the body of the bolt. This type was designed to reinforce a portion of the crown sheet through its top center, extending from the door sheet to within four or more rows from the tube sheet where the plain-headed bolts begin. These latter bolts are expected to allow the crown sheet to separate from them earlier when the engine is working steam during absence of water than is the case with the button head, and it is true they do under these conditions. Under a slow heat, however, and an absence of water, it is possible to defeat the good purpose of this design, and we frequently find that an entire sloped crown became hot for its entire length without fusing from the plain bolts at the front end. The boiler even left the frames, and the large button head bolts did not perform as was expected, their big heads being carried away from the bolts as the crown sheet tufted. For this reason it is questionable if they afford any more strength in supporting the sheet than the plain hammered-down heads.

The flexible radial stay of Fig. 5 is necessarily applied from the outside firebox with the usual sleeve and cap. It may either be hammered over at the crown sheet end to form a head or may have the threaded portion left long enough to use a nut at the crown sheet end. When the latter method is followed the best practice is to face the crown sheet to receive a faced nut, and then dispense with the copper gasket between the nut and the crown sheet, because the latter produces galvanic action and causes corrosion of the crown sheet in the immediate vicinity of the bolt, thus necessitating the frequent renewal of the nut and washer. Another style not shown has a button head next the crown sheet end and is held in the sleeve with a round nut. It is applied from the crown sheet end.

Flexible bolts have much to recommend them because they not only provide flexibility but have the virtue of having only one end to thread, thus removing the necessity for lead screw screwing machines, thereby removing the danger of stripping the threads due to non-conformity of lead. They may also be reclaimed for further service, as they can be used again where shorter bolts will suit. Thus when renewing fireboxes equipped with such bolts the material and labor cost is reduced compared with that obtained from rigid bolts.

On the other hand, the law specifies an inspection of flexible bolts every eighteen months with the removal of the caps, so that considerable expense is involved in their maintenance, and many who would otherwise favor them are prevented from adopting them for general use. The law is too strict concerning bolts of this design which are over ten inches long. An extension of time between the inspections is advisable, hammer testing and light inspection being used to govern bolts between general repair periods.

Ordinarily the flexible radial bolt of Fig. 6 is used to renew a plain or button head bolt which may require a larger end next the crown sheet than will pass through the sleeve. It is manufactured in two pieces and has a turnbuckle inside the boiler into which both are tapped. The parts are secured from getting out of alinement by the application of jam nuts.

### Practical Design for Radial Stay Holes

The art of good radial stay bolting largely depends on the design which is developed on prints and supplied to the boiler shop; therefore good results are expected from radial bolts when the inside firebox crown sheet holes are planned so that the bolts are at right angles to the inside sheet and in proper alinement with the holes of the outside box. Practical experience has demonstrated that to obtain immunity from leakage of radial stays at the crown sheet end the threads on the bolts should not run out, but it is impossible to design a semi-circular roof sheet and a different shaped crown without such results. It is absolutely necessary that the crown sheet holes be kept free from this objection, and that the running out of the threads should be confined to the roof sheet where the radial bolts are not subject to the action of the fire. This feature does not obtain with the Belpaire design of roof and crown sheets because they can be planned so that the bolts supporting them are at ninety-degree angles with both sheets.

### Allowance When Punching Holes

When new roof and crown sheets are being punched the radial bolt holes should be kept small enough so that the reamer on the tap will remove the incipient edge cracks surrounding the holes due to punching the crown sheet. This is also done to prepare the roof sheet holes so that they may have continuous threads through the thickness of the sheet due to the angularity of the bolts passing through it when arranged to accommodate radials at correct angles to the crown sheet.

### Threading Radial Stays

The proper method of threading radial stays is to have the thread corresponding to that of the tap, and this can be accomplished with the assistance of a lead screw screwing machine, except in the case of the button head (Fig. 4, Plate 2), which requires special arrangements. The threading of the button head radial bolt (or any other type) is well accomplished in a turret lathe by the following method:

The body of the bolt is first gripped with the assistance of sectional brass sleeves secured in the clutch of the machine. Then the two ends which require threading are turned to their proper dimensions, at which time the under side of the button head is faced and cut in to prevent overhanging threads from interfering with the heads, squeezing to a tight joint against the crown sheet. At the same time a short portion of the body of the bolt is trued to accommodate future gripping.

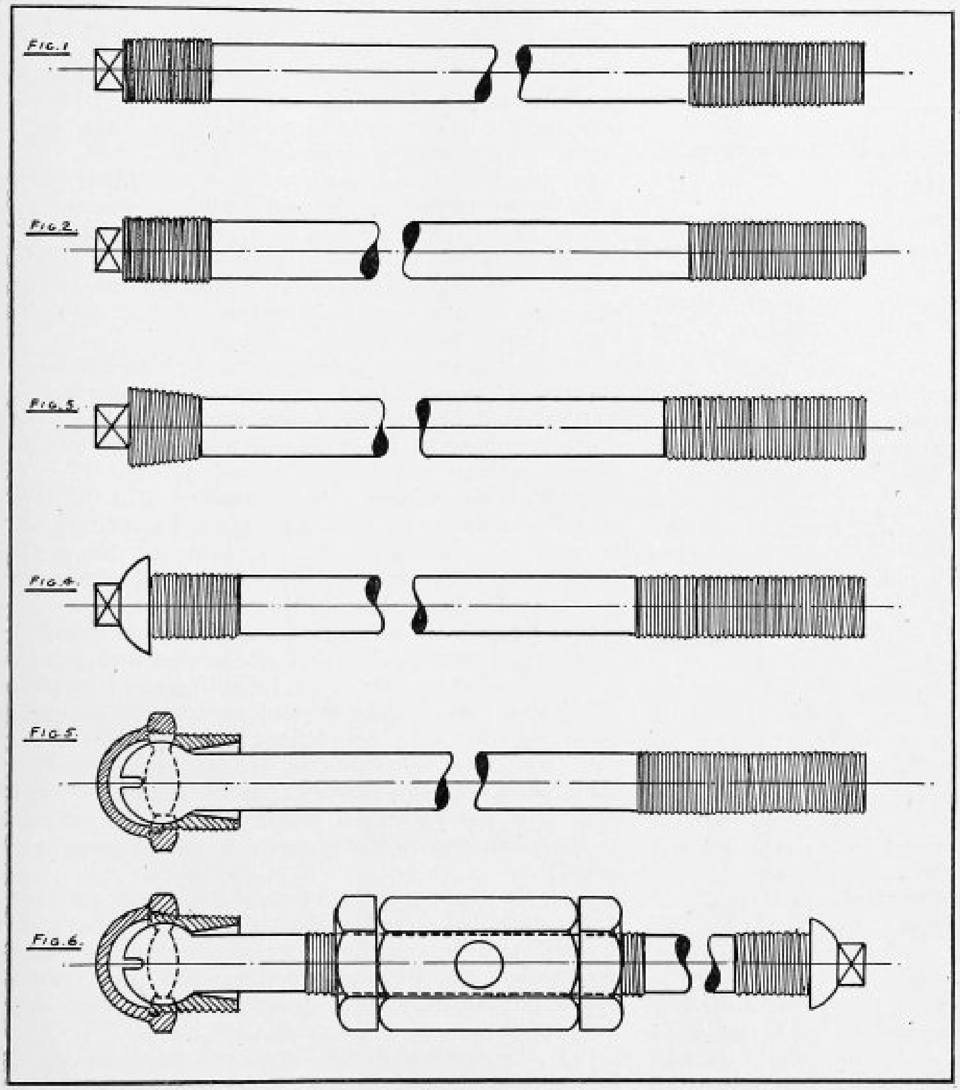


Plate 2.—Types of Radial Stays in Common Use

For the purpose of threading to lead, a specially arranged telescopic chuck with dies complete is fitted to the rear end of the turret, and another set of ordinary dies is secured in position in the front end of the turret. A master threaded bolt is then brought into use for the purpose of setting the telescopic dies to the lead and length to suit. The set screws on the telescopic arrangement are then secured against movement, after which the bolt is secured by the chuck gripping the squared end of the bolt, and according to the arrangement of dies the plain end of the bolt starts threading first in the telescopic die. Before that end is completely threaded the button head end has also started, thus allowing the threading at the plain end of the bolt to be completely screwed before the opposite die has run up to the button head, where it is prevented from injuring the facing on the under side of the head due to the use of a geometric self-opening die head.

### Tapping Holes for Radial Stays

When tapping holes in new roof and crown sheets, the long tap, Fig. 1, Plate 1, should be run through from the outside end with a motor, after which the crown sheet end of such holes as are intended to receive button head bolts have to be faced with a facing tool, Fig. 5, Plate 1. This tool is provided with a spindle introduced into the roof and crown sheet hole, which guides the facing tool to produce a true surface on the crown sheet to correspond with the head of the bolt. If oil-burning bolts are applied, the long tap, Fig. 1, Plate 1, should be run through in the same way and followed up with the use of a suitable tap, Fig. 3, Plate 1, at the crown sheet end provided with a telescopic sleeve, set to the proper length and lead to guide it with the roof sheet hole. So that all such holes may be tapped to the same size, it is essential that a controlling shoulder on the shank of the tap next the motor be used.

When tapping holes in new crown sheets when the old roof sheets are used, it is not necessary to run through the long tap which is used for new construction, because good substitutes are found in those with telescopic sleeves, Figs. 2, 4 and 6, Plate 1. These will tap the crown sheet holes true to lead if correctly made and judiciously used. Suitable taps shown as Figs. 2 and 4, Plate 1, have sleeves which are threaded internally as well as externally to the same lead as the tap. They therefore connect and thread to lead and are not dependent on small set screws and centers to keep them true to lead such as shown in Fig. 6,

Plate 1, and they are as adaptable to the work. There has been quite sufficient literature distributed showing how the flexible bolt Fig. 5, Plate 1, and the outside end of Fig. 6, Plate 1, have their holes threaded, and as no better method has been introduced, that practice is satisfactory. It is absolutely necessary to give radial stays the same lead as the tap with which the holes were tapped, in order to guard against the threads becoming stripped on the bolts or in the holes in the plate.

There is a satisfaction in knowing that any work is thoroughly and properly done, and this applies to the use of radial bolts threaded to lead. When they are installed they are absolutely bound to correspond with the threaded holes, and so the possibility of stripping is avoided.

"Maple Leaf."

## 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.*

Case No. 273.—Does paragraph 296 of the Boiler Code require that the tee or lever-handled cock be placed immediately under the steam gage where a long connecting pipe is used and the lock-open valve is permitted close to the boiler?

It is the intent of the requirement in paragraph 296 that the tee or lever-handled valve shall be located near to the steam gage, so that it will be readily evident to any one observing the gage, even though the locked-open valve is used at or near the boiler.

Case No. 274.—Is it permissible to use upon an horizontal return tubular boiler with the third return type of setting an extended nozzle formed of a short length of pipe screwed into flanged fittings at the boiler connection and the outer end, in order that it may reach well above the boiler brickwork?

The construction proposed will not meet the Code requirements where the pipe is over 3 inches pipe size and the working pressure exceeds 100 pounds per square inch. A double-flanged nozzle riveted to the boiler shell should be provided, or a standard pressed steel nozzle may be used in lieu of this. If such standard nozzle is used, it should be protected by insulation.

Case No. 276.—In the design of a cast-steel waterbox to be set in the side walls of furnaces and to be subjected to full boiler pressure, is it necessary to apply to the sections containing flat surfaces the formula in paragraph 199 of the Boiler Code, using $C = 120$, or is it necessary to use this formula with the value of $C = 156$?

It is the opinion of the Committee that the construction of pressure parts of the type referred to is provided for by paragraphs 9 and 247. If the Secretary of the Boiler Code Committee can be notified when the specimen is ready for test, steps will be taken to have a representative of the Committee present.

Case No. 277.—(*a*) An interpretation is requested of the application of paragraph *212a* of the Boiler Code with reference to any curved stayed surface subject to internal pressure. Does this refer to both the outer and furnace sheets of vertical tubular boilers?

(*b*) If under the requirements of paragraph 239 of the Boiler Code relative to furnaces under 36 inches in diameter the design of the furnace does not permit of operation without staying, is there any rule in the Code for the staying in this case, or must the furnace sheets be stayed as flat surfaces, using Table 4 for the pitch?

(*c*) Is it the intent of paragraph *212c* of the Boiler Code that the increased pitch allowed may be used for the same working pressure and thickness of plate as indicated in Table 4? It is the understanding that Table 4 is based on the formula given in paragraph 199.

(*a*) The term "curved stayed surface subjected to internal pressure" in paragraph *212a* of the Code is intended to refer to any surface in a boiler structure that is subjected to pressure on the concave side. It therefore refers only to that part of the outer shell of a vertical tubular boiler which is stayed.

(*b*) Where a furnace under 36 inches in diameter requires staying it should be stayed as a flat surface, as provided for in Table 4, except that the pitch may be increased as indicated in paragraph *212 c*.

(*c*) It is the intent of paragraph *212c* that the increased pitch there permitted may be used for the same steam pressure and thickness of plate as specified in Table 4.

Case No. 280.—(*a*) Is it permissible under the requirements of the Boiler Code to use a blow-off valve of the type used on locomotive boilers, operated by a lever lift, for stationary boilers?

(*b*) Is it considered safe to use superheated steam of 125 pounds pressure and 125 degrees of superheat, or total nominal temperature of 478 degrees, with a piping system having extra-heavy cast-iron fittings and medium-weight cast-iron valves?

(*a*) It is the opinion of the Committee that the blow-off valves required by paragraph 311 for stationary boilers may be of the lever-lift type, provided they are of extra-heavy construction, and so designed that they may be operated without shock to the boiler.

(*b*) Attention is called to paragraph 12 of the Code, which states that cast iron shall not be used for nozzles or flanges attached directly to the boiler for any pressure or temperature, nor for boiler and superheater mountings such as connecting pipes, fittings, valves and their bonnets, for steam temperatures of over 450 degrees F. While the Code only covers the parts therein specifically mentioned, this paragraph clearly indicates the judgment of the Committee as to the safety of the construction in question.

Case No. 281.—Is it the intent of paragraph 306 of the Boiler Code that every superheater shall be so fitted with a drain that it can actually be completely drained? Many superheaters are fitted with drains which are, however, unable on account of their positions to completely drain the apparatus.

It is the opinion of the Committee that every superheater should be so fitted with a drain as to substantially free the superheater from water when the drain is opened.

Case No. 282.—Is it the intent of the Boiler Code Committee that the diameter at the base of the threads on the threaded ends of through rods or braces for horizontal return tubular boilers shall be equal to or greater than the nominal diameter of the rod? Fig. 14 and paragraphs 208 and 211 would seem to infer that it should be at least equal, but isn't it preferable to make it greater, so that the point of greatest weakness in the rod may not be in the threaded portion where permanent set due to strain would tend toward fracture?

It is the opinion of the Committee that it will be desirable that the threaded ends of through rods or braces for horizontal return tubular boilers shall be sufficiently upset so that the minimum diameter at the base of the threads is in excess of the nominal diameter of the rod.

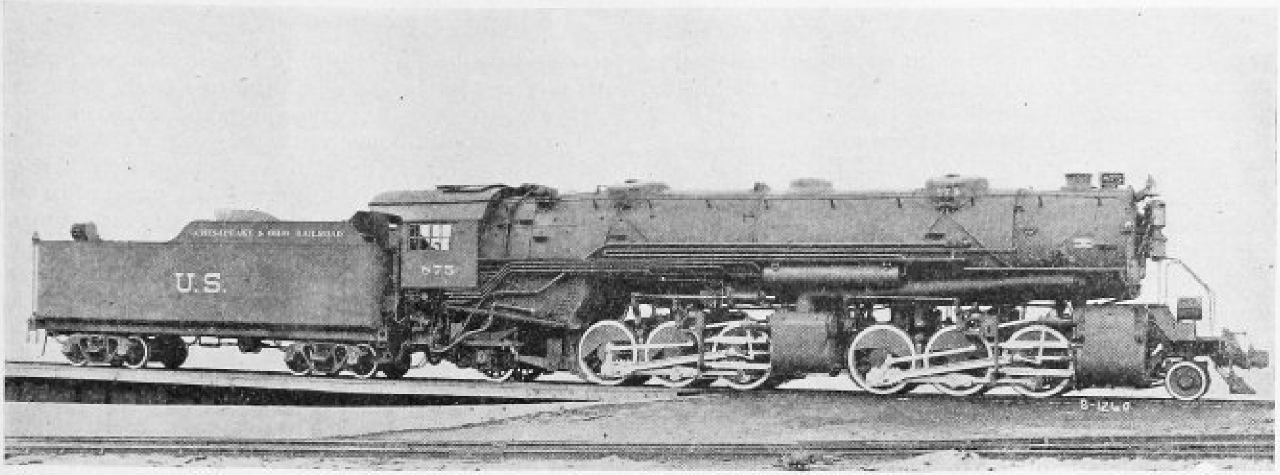


Fig. 1.—Class 2662 C S 448 Locomotive Built for the United States Railroad Administration by the American Locomotive Company

# Scientific Development of Locomotive Boilers

BY JOHN E. MUHLFELD

*In concluding the abstracts from the paper on locomotive design, read at the annual meeting of the American Society of Mechanical Engineers, which were commenced in the April issue of* The Boiler Maker, *the problems of heat insulation, the increase in boiler pressure and superheat, and the attendant increase in temperature of the steam are discussed. All of these factors must be considered in locomotive design of the future in order that the thermal efficiencies of engines may keep pace with mechanical developments.*

The transmission of the heat of combustion produced in a locomotive boiler is by means of radiation and convection to the firebox, flue, tube and superheater heating surfaces, by conduction to the water in the boiler and the steam in the superheater, and by convection through the boiler water and the superheater steam mass. In addition, there are the direct radiation losses, which in many instances are considerable.

The transformation of the molecular energy of a hot body into the wave motion of the surrounding ether and the propagation of these ether waves through space is termed heat radiation; and in a locomotive boiler the efficiency of combustion heat transfer through the firebox plates and boiler flues and tubes is from 20 to 25 percent greater as applying to those heating surfaces directly affected when subjected to the radiant effect of the incandescent combustible and non-combustible particles which have passed through the minimum distance, than the heat transfer efficiency when convection only is available. For example, when coal is hand- or stoker-fired and burned on grates or in retorts the radiant heat is at a minimum and applies only to the heat-absorbing surfaces adjacent to the fire bed while the heat of convection is at a maximum; whereas when the coal is burned in pulverized form in suspension this condition is reversed, as is evidenced by the intense incandescent flame which obtains not only in the furnace and combustion chambers of the firebox proper, but well into the boiler flues and tubes. The locomotive boiler of the future will undoubtedly depend more largely on radiant heat.

With respect to the loss of power through radiation to the atmosphere from all parts of locomotive boilers and machinery that are generators and containers of heat and pressure—to prevent which rather indifferent efforts have as yet been put forth, as the rate at which this loss of heat extends will depend upon the difference between the temperature of the body emitting the heat and the temperature and velocity of the surrounding atmosphere, there is sufficient justification for completely and properly lagging the boiler, firebox, cylinders and heads, steam chests and all other radiating surfaces, as well as for polishing certain machinery parts, in order to reduce the dissipation of heat that now takes place through these parts from the existing steam pressures and superheat.

### Heat Convection

The process whereby the diffusion of heat is rendered more rapid by the movement of the hot substance from one place to another is termed convection, and in the locomotive boiler applies particularly to the transfer and diffusion of the heat in the products of combustion throughout the firebox, flues, tubes and superheater by means of the smokebox draft and in the carrying of the heat through the boiler water mass by the currents produced by circulation. In the present locomotive boiler by far the greatest proportion of the heat is imparted to the evaporating and superheater surfaces by convection.

To secure the fullest benefit from heat convection the combustion volumes and gas areas must be so coordinated as to establish a "velocity pressure" or "frictional" action between the gases and the heat-absorbing plates and tubes in order to increase the rate of heat transmission. Likewise must the boiler circulation be expedited in order to quickly disengage and release the steam bubbles from the water side of the same plates and tubes in the final heat transfer.

The possibilities for improving heat transmission by convection in the locomotive boiler with its high water rate, i. e., a boiler horsepower for an average of less than two square feet of total evaporating surface, fully justifies additional study.

### Heat Conduction

The transmission of heat from one body of high temperature to another body of low temperature by contact, and from one part of a body to another part, is termed external and internal conduction, respectively, and in the locomotive boiler is principally associated with the thermal conductivity of the firebox, flue, tube and superheater materials and with the accumulation of soot and scale on the fire and water or steam sides, respectively.

Any increase in the rate of external conductivity, considering the present kinds and thicknesses of firebox, flue and tube materials as practically fixed, must be through an increase in the rate of flow of the heated gases, and this in turn means the expenditure of a greater amount of energy to pull these gases through the boiler.

However, questions as to the proper gas areas, rate of flow of gases, best sizes of flues and tubes for the maximum rate of heat transfer, and relating to like factors should be carefully analyzed in order that the highest absorptive efficiency may be obtained, not only with the high but also with the low gas temperatures. While there is no difficulty in now obtaining a boiler horsepower from each 1½ to 2 square feet of total evaporating surface, whatever further improvement can be made in this direction will provide just that much more margin of boiler over cylinder horsepower requirements and produce a corresponding gain in efficiency.

### Steam Generation

Efficient absorption of heat for the generation of steam in the modern locomotive boiler can be more readily provided for than can suitable feedwater, effective boiler water circulation, efficient combustion or the maximum pounds of dry saturated steam per hour, which latter is a fundamental requirement.

In present locomotive operation the quality of the steam, i. e., the percentage of vapor in a mixture of vapor and water, is one of the most important and least-referred-to factors in road and laboratory test reports, particularly as the average modern locomotive boiler is notorious for delivering saturated steam to the superheater or to the steam pipes with a high percentage of entrained moisture. This is due largely to the relatively small steam space in the boiler, the close proximity of the water level to the throttle valve and the backlash due to the firebox tube sheet, and also to the fact that the most rapid movement of the steam is next to the throttle valve, so that any water coming near it is immediately entrained, due to the high velocity.

Road tests recently conducted on modern Mikado types of locomotives showed an average quality of from 94.7 to 96.3 percent for the saturated steam as delivered to the superheater, indicating from 5.3 to 4.7 percent of moisture, which is valueless so far as its power for doing work is concerned, but which greatly increases the work to be performed by the superheater by throwing upon it work which should properly be done in the boiler.

The delivery of dry saturated steam from the boiler is an item that has been given but little consideration in steam locomotive practice, the principal idea having been to produce evaporating capacity and depend upon the superheater to perform auxiliary boiler functions. Many changes can and should be made to improve this condition.

### Steam Pressure Increase

One of the greatest and simplest improvements to be made in the steam locomotive can be effected by an increase in the boiler pressure in combination with greater quantity and better quality of saturated steam production, higher and more uniform superheat, and compounding.

The writer advocated a steam pressure of 250 pounds in 1902 when with the Canadian Government Railways, and inaugurated the use of 235 pounds boiler pressure in combination with 21-foot boiler tubes in 1903 in the Baltimore and Ohio Railroad Mallett articulated compound locomotive No. 2400, with excellent results from both an operating and maintenance standpoint. This at a time when the general tendency was to reduce rather than to increase locomotive steam pressures from an established practice of about 200 pounds.

While the loss in steam pressure between the boiler and the valve chests of saturated steam locomotives is considerable, this loss is substantially increased in a superheated steam locomotive, as will be noted from the approximate data in Table 4, taken from a laboratory test of a Pacific type locomotive operating at a uniform rate of speed.

Other tests have also indicated that the loss in boiler pressure at the valve chests when working at low rates of speed and cut-off will be about 5 percent, at medium rates about 10 percent, and at high rates about 15 percent.

During recent years stationary boiler engineers have not only determined upon their efficiency but have inaugurated the use of relatively high steam pressure, and with the urgent necessity for keeping the cylinders as small in diameter and the reciprocating and revolving parts as light as practicable, there would appear to be no good reason for not now utilizing saturated steam of 350 pounds pressure, which, in combination with 300 degrees F. of superheat, should provide, in addition to the many other advantages, a much greater opportunity for economy in power generation. In fact, many small single- and double-expansion compressed air locomotives now in use with from 40,000 to 50,000 pounds total weight on the driving wheels and 12-inch by 16-inch high-pressure cylinders carry from 800 to 1,000 pounds air pressure in their storage tanks, which in turn is reduced to 250 pounds pressure before entering the high-pressure cylinder and are operated without trouble and with considerable efficiency and economy.

TABLE 4.—LOSS IN STEAM PRESSURE BETWEEN BOILER AND VALVE CHESTS OF A SATURATED STEAM LOCOMOTIVE

| Test No. | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Speed, miles per hour | 56 | 56 | 56 | 56 |
| Boiler pressure, pounds | 206 | 206 | 206 | 206 |
| Superheat, degrees F. | 150 | 210 | 255 | 265 |
| Cylinder cut-off, percent of stroke | 20 | 30 | 40 | 50 |
| Loss in boiler pressure at valve chest, pounds | 6 | 12 | 19 | 31 |

### Steam Superheating

The use of superheated steam has done more to increase sustained hauling power, reduce fuel and water consumption and increase thermal efficiency than any of the other means and methods that have been generally adopted on the steam locomotive since its introduction, either singly or in combination. Sustained hauling capacity is increased due to the longer cut-off possible at comparative speeds and fuel and water economy result from the elimination of cylinder condensation, the increase in efficiency being progressive and in proportion to the amount of superheat up to the point at which the exhaust steam begins to show superheat.

With the average superheat now used, from 175 to 250 degrees F., the drawbar pull at a speed of 20 miles per hour is increased about 15 percent, and at 50 miles per hour about 40 percent; and, due to the combination of superheat, larger diameter of cylinders and reduced cylinder back pressure—resulting from the use of superheated steam—it is possible to increase train tonnage about 30 percent at speeds of about 30 miles per hour.

In the best existing steam locomotive practice the superheat generally increases with the cut-off up to 50 percent cut-off, beyond which there is usually a falling off in the superheat. Furthermore, with short cut-off a fair water rate, i. e., about 19 pounds per indicated horsepower, can be maintained; but if the cut-off at the same speed is increased to over 50 percent the superheat must be increased to about 300 degrees F. in order to maintain the same water rate, or otherwise, for example, at 67 percent cut-off the steam consumption will increase to 21 pounds or more per indicated horsepower. This for the reason that as the amount of superheat is increased the range of temperature in the cylinder during the stroke of the piston is decreased, until with sufficient superheat the changes in temperature cease entirely.

While the increased superheat results in a greater number of British thermal units being exhausted from the cylinder, any such loss of a marked degree is more than offset by the smaller amount of heat exhausted per stroke, due to the fewer British thermal units admitted to the cylinder per stroke at a given cut-off.

The use of highly superheated steam results in a saving of about 35 percent of the total water evaporation per unit of power and in from 10 to 45 percent saving in fuel when using steam, depending upon the power output.

Existing firetube superheaters produce the maximum superheat only when the locomotive is forced to its boiler capacity, whereas the maximum economy is more desirable when the locomotive is working under average conditions at economical cut-offs and when the superheater should give as nearly as possible a uniform degree of high superheat under all conditions of working, regardless of the boiler evaporation. For example, if the degree of superheat obtainable at speeds of 50 miles per hour with 50 percent cut-off could be obtained at 25 percent cut-off, a water rate of considerably less than 15 pounds could be obtained as compared with existing rates of about 19 pounds. Therefore, as the present limitation in the hauling power of the modern superheated steam locomotive is the capacity of the boiler to produce continuously sufficient dry saturated steam of high pressure and of the superheater to maintain a uniform high degree of superheat, the possibility of improving it by means of average higher boiler pressures and superheat temperatures and better utilization of fuel, steam and waste heat, in combination with radical changes in the design and arrangement of the boiler and superheater equipment and in the saturated and superheated steam connections, offers one of the greatest opportunities to increase efficiency and economy. This applies particularly to the larger locomotives, many of which consume more fuel and water and do less work than the smaller locomotives of the same general design and equipment.

The proposed changes, while applying especially to the production of greater efficiency at economical cut-offs for maximum power and speed, would also improve the maintenance and operation of superheaters, boilers, flues, front ends, valves, cylinders and exhaust nozzles and provide for the better equalization of a lower draft through the flues and tubes, lower front end temperatures, less throwing of smoke, sparks and cinders, and lower cylinder back pressure, all of which would reduce loss of power, fuel consumption and wear and tear on machinery.

Some of the particular troubles reflected in both maintenance and operation, due to the existing, generally used boiler and superheater equipment, may be stated as follows:

*a.* Air leaks around outside steam pipes where they pass through the front ends, resulting in steam failures, burning out of front ends, reduction in the size of exhaust nozzles for the purpose of making engines steam, and increased water and fuel consumption.

*b.* Joints between superheater units and the saturated and superheated chambers of the headers leaking, and the cutting out of the units at the neck, between the ball joint and the tube.

*c.* Too little water and steam space over top of firebox and combustion chamber sheets and flues, particularly on grades and curves, contributing to lower superheat temperature and cylinder efficiency, and to superheater unit tubes distorting due to entrained water being carried over with the saturated steam from the boiler to the superheater, causing obstructions in and damage to superheater tubes and obstructions at the header.

*d.* Extreme losses in steam pressure between boiler and steam chests.

*e.* Boiler flues clogging, due to ash and cinders packing in around return bends and centering clamps and tubes.

While the superheater has generally been considered as a part of the boiler, particularly as regards its evaporation of entrained moisture in the saturated steam, it has no relation whatsoever thereto in so far as its individual functioning is concerned, and the more that the saturated steam conducting and superheated steam delivering conduits, as well as the superheater equipment in itself, can be divorced from the boiler and front-end connections and their proper functions without introducing separately fired apparatus, the better will be the general results from the standpoint of efficiency, maintenance, operation and economy of the locomotive as a whole.

Some of the points to be considered in correcting existing deficiencies may be stated as follows:

### Steam Temperature

The steam temperature should be uniform for the variable speeds and capacities of operation. At the present time high temperatures obtain only at high speeds and capacities. A minimum temperature of 650 degrees F. quickly after starting, and of 700 degrees at maximum power and speed, would be much more effective and economical. For example, a locomotive equipped for generating 350 pounds steam pressure and 300 degrees superheat—representing a total temperature of about 736.4 degrees F.—will, as compared with one using 200 pounds steam pressure and 300 degrees superheat—representing a total temperature of about 687.9 degrees F.—require an increase of only 18 British thermal units, or 1.3 percent in total heat in the steam, and an increase of only 48.5 degrees, or 7.05 percent in the temperature of the steam, to produce an increase of 150 pounds, or 75 percent in the steam pressure.

The dome or steam outlet should be fitted with baffles for the purpose of reducing liability of priming and entrainment of water with saturated steam.

A saturated steam delivery pipe should be located outside of the boiler and be of adequate cross-sectional area to reduce steam pressure losses.

A steam trap or separator should be installed between the saturated steam delivery pipe and the superheater saturated steam chamber for the purpose of further eliminating moisture and condensation from the superheater units and also as a re-evaporation chamber.

The superheater header or saturated and superheated steam chambers should be removed from the interior of the front end.

Superheater units should consist of not more than two tubes per boiler flue and should be of such design and arrangement as will admit of location close to the top of the flue, in order to permit free passage for cinder and ash and cleaning of flues.

Unit joints should be removed from the direct path of gases and cinders so as to avoid cutting out, and should be supported in a positive, equalized and flexibly yielding manner to prevent leakage due to the loosening of one joint causing the loosening of another, and so that the joint bolts can be tightened at the top of the header castings.

Superheater dampers should be kept in good operating condition so that when the steam ceases to flow through the superheater units the products of combustion will stop flowing through the superheater flues, particularly when drifting at high speeds.

Steam delivery pipes from the superheated steam chamber should be made of adequate cross-sectional area to reduce steam pressure losses and removed from the interior of the front end so that no joint between these pipes and where they pass through the front end will be necessary.

An automatic saturated steam supply when drifting is essential to eliminate the human element and insure a proper supply of saturated steam with the superheated steam just before the throttle closes and continuously thereafter. A jet of saturated steam should also be supplied to the exhaust nozzle to neutralize the gases ordinarily drawn through the same into the valve chests and cylinders.

### Waste Heat Distribution and Utilization

As a reasonable estimate would show that 40 percent of the heat in the steam and in the products of combustion is exhausted from the stack, any considerable part of this heat that can be reclaimed for preheating boiler feedwater will add greatly to the overall efficiency of the locomotive and to the saving in fuel.

The principal means through which to accomplish this saving, in a practical way, are exhaust steam heaters and flue gas economizers, both of which can be readily adapted to a modern steam locomotive.

Exhaust steam heaters, together with the many steam-using auxiliaries such as those for air compressing, boiler feeding, valve gear operating and electric lighting, which operate when the locomotive is standing, drifting or working, a combination open and closed type of feedwater heater and purifier for the utilization of the exhaust steam from these auxiliaries, supplemented if necessary by steam from the main engine's exhaust, should receive prompt consideration.

From actual service tests of closed types of heaters made on modern superheated steam locomotives using a portion of the main engine exhaust steam only, it has been found that a feedwater temperature approximating 240 degrees F., or within 15 degrees of the exhaust steam temperature, can be obtained without interfering with the draft required for maximum steam and superheat generation.

High steam pressure and high superheat unquestionably save steam; and, while comparatively little heat is required merely to superheat them—probably not more than one-third as much as to preheat boiler feedwater—nevertheless, owing to the high rate of combustion and evaporation and in the process of superheating, much heat is usually wasted, as the gases from which the steam receives its heat must be hotter than the steam itself.

The higher the steam pressure the less is the average difference in temperature between the gases of combustion and the contents of the boiler; therefore, the slower the transmission of heat the greater the work of the economizer may be. Likewise, the lower the efficiency of the boiler will be if it is not supplemented by an economizer.

An economizer will heat the feedwater to a higher temperature than an exhaust steam heater and will recover most of the waste heat resulting from high steam pressure and high superheat, as it is able to recover low temperature heat that has escaped from the boiler evaporating or superheater surfaces because the average temperature of the feedwater within the economizer, which should, if practicable, be brought up to the boiler evaporating temperature, is much lower than the temperature of the water in the boiler.

As locomotive smokebox superheaters, now obsolete, have demonstrated that 50 degrees of superheat may be obtained from flue gases at 600 degrees F., there should be no difficulty in devising a locomotive economizer that will produce very effective results in combination with high boiler pressures, superheat and draft without baffling the boiler draft and evaporating capacity. In fact, with an average boiler efficiency of 60 percent and an economizer efficiency of 50 percent the possibility of recovering from 25 to 50 percent of the stack-gas losses and increasing the thermal efficiency of the entire unit is within the limits of possibility.

Another factor favoring the use of combination exhaust steam heaters and flue gas economizers is the opportunity to reduce the noise and nuisance now created by the steam exhausting from the main and auxiliary engines through the muffling of the exhausts.

### Insulation

The loss of heat through radiation justifies a considerable expenditure for its prevention, and the most practical method for reducing this waste is to first design and locate the heat-transmitting parts so that they will be he least exposed to the surrounding atmosphere and to then make use of a good non-conducting lagging, properly applied.

With the available non-corrosive heat-insulating materials that can now be readily molded into sectional blocks to any form and size desired for ready application and removal, and which will withstand the disintegrating effects of heat, vibrations and concussions incident to modern locomotive operation, there is no good reason why boilers, fireboxes, steam pipes, valve chests, cylinders and heads, air pumps, and other heat-radiating accessories or parts should be left exposed in the way they generally are, with the resultant steam and fuel losses.

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The British thermal unit is a measure of the energy of combustion of fuel. It is defined as the amount of heat required to raise 1 pound of pure water 1 degree F., and is equal in energy to 778 pounds raised one foot. Acetylene is rated at about 1,427 British thermal units per cubic foot at 62 degrees F. and 30 inches barometer. There are other gases that produce more British thermal units per cubic foot, but they all lack endothermic energy. This is the secret of the great power of the oxy-acetylene flame. When acetylene burns in an atmosphere of pure oxygen it first dissociates or breaks up, the carbon and hydrogen separating, and in the process 270 British thermal units are liberated. This produces intensely high temperature in the flame during the period of dissociation. No other gas flame known produces a temperature so high as that of the acetylene flame at the point of the white-hot cone.
—*Autogenous Welding.*

# How to Design and Lay Out a Boiler—XX

**Determining the Size of Safety Valves—Method of Mounting Valves—Calculating the Main Steam Outlet—Function of the Blow-Off Connection**

BY WILLIAM C. STROTT*

When it is recalled that according to the A. S. M. E. Code more than one safety valve will have to be applied to our boiler, because greater than 3 inches capacity is required, it behooves us to use two or more valves of such size that their combined capacity will at least equal that of a 4½-inch valve. Considering the fact that our boiler is of medium size, and that there is nothing to restrict the use of as few valves as possible, within the limits of the Code, we shall figure on two valves of equal size. The size of each is determined as follows:

From a table of dimensions of standard pipe we find that the internal area of a 4½-inch pipe is 15.95 square inches. Each valve will then correspond to a commercial pipe size having at least one-half this area, or 7.975 square inches. The nearest pipe size corresponding to this area is seen to be 3 inches. Hence we shall mount two 3-inch safety valves on our boiler. The pressure at which they are to be set the designer is in no position to determine, as this information must be given in the consulting engineer's or purchaser's specifications accompanying the order for the boiler. If the valves were specified to "pop"

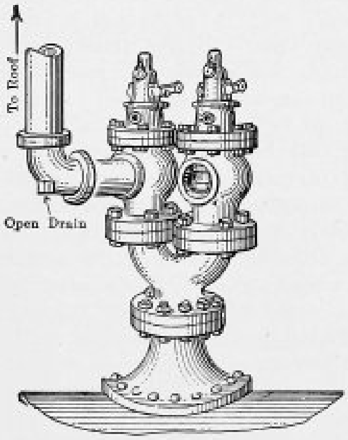



Fig. 72.—Twin Safety Valves Mounted On Common "Y" Base

at 135 pounds, could we order one to be set at 135 pounds and the other at 154.5 pounds (which is 3 percent above the maximum working pressure allowed on the boiler)? No, because the range of increase being then 154.5 — 135, or 19.5 pounds, is greater than 10 percent of the highest pressure to which any valve is set. When two or more safety valves are required on one boiler, they may be individual valves located at different points on the boiler, or they may be twin valves, made by mounting individual valves on Y bases, as illustrated in Fig. 72.

The size of the inlet on this fitting should, of course, be at least equal to the combined discharging capacity of both valves. For our case we would specify a 3-inch by 3-inch by 4½-inch Y base.

General dimensions of extra heavy Y bases are given in Fig. 73.

* Engineering Department of The Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

The dimensions and drilling of the flange must, of course, conform to either Table 8 or 9, depending on the working pressure. Notice the raised face on the flanges in Fig. 73. This was mentioned previously and refers only to the high-pressure standard.

CAST STEEL Y BASES FOR TWIN POP SAFETY VALVES.

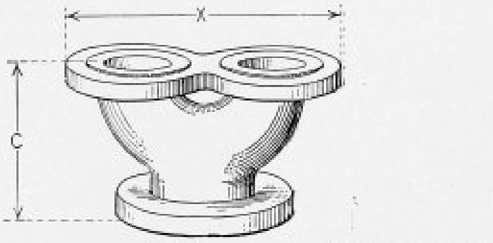



Fig. 73

DIMENSIONS

| | | | | | |
|---|---|---|---|---|---|
| Size outlets, inches | 2½ | 3 | 3½ | 4 | 4½ |
| Diameter top flanges, inches | 7½ | 8¼ | 9 | 10 | 10½ |
| Size inlet, inches | 3½ | 4½ | 5 | 6 | 7 |
| Diameter inlet flange, inches | 9 | 10½ | 11 | 12½ | 14 |
| Largest O. dimension—"X," inches | 15⅝ | 16⅝ | 18¼ | 20⅛ | 21⅜ |
| Face to face—"C," inches | 7¾ | 8½ | 9 | 9¾ | 10¼ |

In preference to the arrangement illustrated in Fig. 72, and especially when three or more safety valves are required on a single shell or drum, duplex, triplex or multiplex valves, having several valves in the same body-casing, may be employed. This type is illustrated in Fig. 74.

It should be remembered that in watertube boilers of the Babcock and Wilcox horizontal and the Sterling vertical types having two or more horizontal steam-drums, arangements similar to Fig. 72 need not even be resorted to. In such cases a single valve is mounted on each drum. However, if there are but two drums and four valves are required, then a twin-mounting is necessary on each drum.

## Valves with Flanged Inlet Connections

A safety valve over 3-inch size, used for pressures greater than 15 pounds per square inch, must have a flanged inlet connection. Valves 3 inches and under may be of the form previously illustrated in Fig. 70 and screwed

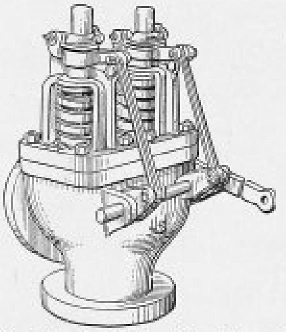


Fig. 74.—"Duplex" Safety Valve Consisting of Two Valves Mounted on the Same Body Casing

directly into forged or pressed steel pipe flanges or reinforcing pads riveted to the boiler shell.

There are other regulations concerning the mounting of safety valves, and although they do not come directly under the design of steam boilers, they are nevertheless very essential parts of a boiler designer's education. A few of the more important regulations follow.

### Rules Governing the Mounting of Safety Valves

A safety valve or valves should be connected to the boiler independent of any other steam connection and attached as closely as possible to the boiler without any unnecessary intervening pipe or fitting.

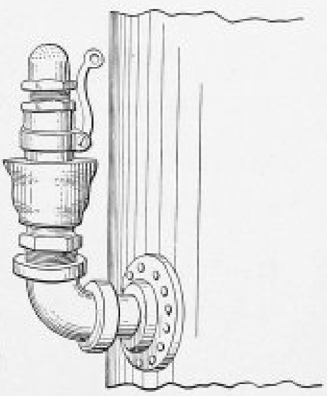


Fig. 75.—Illustrating Method of Mounting Safety Valve to a Side-Outlet Connection so that the Valve Remains in a Vertical Position

Every safety valve should be connected so that it will stand in an upright position, with the spindle vertical when possible. Although the Code states "when possible," there appears to be no reason why it cannot *always* be done. Fig. 75 illustrates the usual method of mounting a safety valve on the shell of a vertical boiler or dome. This arrangement is just as readily accomplished with flanged valves and fittings.

"Each safety valve shall have a full-sized direct connection to the boiler. No valve of any description shall be placed between the safety valve and the boiler, nor on the discharge pipe between the safety valve and the atmosphere. When a discharge pipe is used it shall be not less than the full size of the valve, and shall be fitted with an open drain to prevent water from lodging in the upper part of the safety valve or in the pipe."

Fig. 72 clearly shows how a discharge pipe is fitted to a safety valve. Although two valves appear in the illustration, one is not shown connected up, which was done so as not to obscure the valve on the far side. In practice, both valves would be connected to a common discharge pipe and the size of this pipe would be made equal to the large inlet at the bottom of the Y base—in other words, so that the discharge pipe would have a capacity equivalent to the combined area of both valves. Drain elbows as shown should be provided in order to comply with the Code, but nearly all safety valves are provided with a drain hole in the body of the valve for this purpose. The discharge pipe may run to the roof or other safe point of discharge, but no matter to where the outlet is carried, care should be taken to locate it clear of platforms, walks or other points where access must be had for operating valves, machinery, etc. The pipe should be well supported so as to relieve the safety valve of all strain.

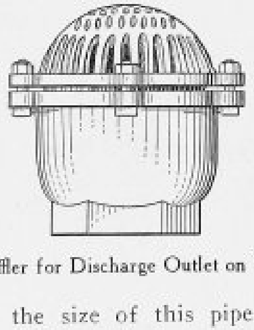


Fig. 76.—Muffler for Discharge Outlet on Safety Valves

### Muffler on Safety Valves

In some plants objection is made to the noise attendant to the escape of the steam when a safety valve is "blowing off." To alleviate this to a certain degree, mufflers are sometimes applied to the discharge pipe of a safety valve, or valves. Such a device is illustrated in Fig. 76.

If a muffler is used on a safety valve, it shall have sufficient outlet area to prevent any back-pressure from interfering with the proper operation and discharge capacity of the valve. The muffler plates or other devices shall be so constructed as to avoid any possibility of restricting the steam passages due to deposit. This matter is usually provided for by the manufacturers of the mufflers,* and if procured from reliable firms no undue concern need be placed on this point. Fig. 75 shows the muffler built integral with the main body of the valve.

### Main Steam Outlet Calculations

We shall now calculate the size of the main steam outlet required and then design the internal dry pipe mentioned in a previous chapter.

The main steam outlet evidently supplies steam to the plant and should be of sufficient size to discharge the steam as rapidly as it is generated by the boiler. The maximum evaporating capacity of our boiler was previously found to be 2.2 pounds per second, or 132 pounds per minute, and the latter value will be used in the calculations to follow.

The student may be under the impression that the same formula used in connection with the steam outflow for safety valves might also apply to the main steam nozzle. In the case of safety valves there exists an entirely different theory, in that instead of the steam flowing into closed pipes, where the pressure is nearly the same as in the boiler, the steam from a safety valve discharges into the atmosphere. Some time when the student undertakes the study of "Entropy and Steam" he will learn that when steam from one vessel flows into another at a considerably lower pressure, it does so at greatly increased velocity. This theory is applied to the design of steam turbines, when, as in the case of the purely reaction type (DeLaval), the steam, on expanding through specially designed nozzles, attains a final velocity of 4,000 feet per second. The velocity of steam in pipes is only 6,000 to 8,000 feet per minute. From this it should be very clear to the student that to discharge a given quantity of steam in a certain time the area of a safety valve orifice needs to be much smaller than a steam supply pipe.

A great many formulae have been presented bearing on the flow of steam in pipes. Of these, probably the most widely adopted is that devised by Babcock and first published in "Steam," issued by the Babcock and Wilcox Boiler Company. It is:

$$W = 87\sqrt{\left(\frac{pDd^5}{\left(1+\frac{3.6}{d}\right)L}\right)}, \qquad (25)$$

in which:

* See catalogue issued by the Crane Company, Chicago, Ill.

$W$ = weight of steam flowing in pounds per minute.
$p$ = difference in pressure between the two ends of the pipe in pounds per square inch.
$D$ = density of steam, or weight per cubic foot.
$d$ = internal diameter of pipe in inches.
$L$ = length of pipe in feet.

As the formula stands, one would have to assume a value for $d$ and solve for $W$, trying different diameters until the required result is obtained. In order to arrive at an approximate value for $d$, the author has devised the following formula:

$$d = \sqrt{\frac{W}{5}}, \qquad (26)$$

in which $W$ is the maximum weight of water in pounds evaporated by the boiler per minute.

Substituting, we get:

$$d = \sqrt{\frac{132}{5}} = 5.13,$$

which is very closely obtained in a 5-inch pipe.

We might now apply formula (25), but on examination it will be seen that the length of the pipe line and the pressure drop are other variables which should be known, and have considerable bearing on the final result. About 100 feet of pipe and 0.3 pound pressure drop are considered average values when figuring the size of ordinary steam pipe lines. However, in large power plants, or where the steam lines are carried several hundred feet or more, these values should be known exactly.

$$W = 87\sqrt{\frac{0.3 \times 0.363 \times 5^5}{\left((1 + \frac{3.6}{5})\right) 100}}, \text{ or 126 pounds, approximately.}$$

Although but 6 pounds less than the maximum per minute capacity of the boiler, a 5-inch steam nozzle may be considered satisfactory. The foregoing assumptions should serve merely as a guide, and each individual problem must be dealt with in the light of the actual conditions.

### Devices for Drying Steam

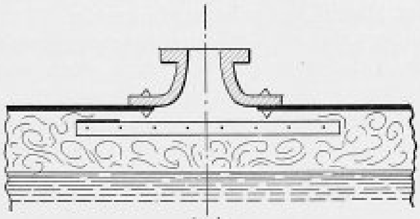
A steam-drying device is an essential part of every well-designed boiler. The steam as it disengages itself from the surface of the water carries with it considerable moisture, and it is very desirable to remove as much of this moisture as possible, for reasons previously cited.

There are two well-known methods in vogue for this purpose. One is the "dry-pan" and the other the "dry-pipe," illustrated in Fig. 77 (a) and (b) respectively.

In either case the fundamental principle is the same. The steam on leaving the water is deflected against the pan or pipe, and in doing so precipitates its entrained globules of moisture, which are drained back into the boiler.

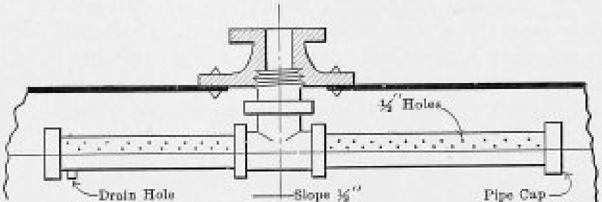
Of the two systems illustrated, the more effective is probably the dry pipe. A special nozzle must be riveted to the boiler, so designed that a thread may be cut on its interior for attaching the pipe. The internal pipe may be any length desired, but should not interfere with diagonal or through staying.

The combined cross-sectional area of the two pipes shall be not less than that of the main steam outlet. For our boiler we decided on a 5-inch steam outlet, the internal cross-sectional area of which is 20 square inches. The area of each branch pipe is therefore to be not less than 10 square inches. This area is very closely obtained in a 3½ by 3½ by 5-inch tee and should be a screwed fitting. Cast iron is satisfactory for this purpose, since the "tee" is under neutral pressure. The upper half only of each pipe is perforated with ½-inch diameter holes to admit steam into the pipe. The aggregate area of these holes shall be twice the area of the main steam outlet, to provide against the possibility of the holes becoming clogged up. The area of ½-inch diameter hole is 0.19635 square inch, and twice the area of a 5-inch pipe is 40 square inches. Hence the total number of holes required is $\frac{40}{0.19635}$, or approximately 200, 100 being drilled into each 3½-inch pipe.



(a)

Fig. 77.—(a) "Dry-Pan"




(b)

Fig. 77.—(b) "Dry Pipe"

### The Blow-Off Connection

Another important connection to a boiler is the "blow-off." It is attached to the lowest point of the boiler and its chief function is to periodically blow scale and sediment from the bottom of the shell, but it is also used as a means of emptying the boiler.

A bottom blow-off and its piping are illustrated in Fig. 78, and the A. S. M. E. requirements with explanations will follow.

The minimum size of pipe and fitting shall be 1 inch and the maximum size shall be 2½ inches. The size is restricted because in blowing off a boiler under high pressure the rapid discharge of water instantly reduces the pressure, and consequently a large volume of water within the boiler is expanded into steam. The pulsations arising from this cause serious vibrations in the boiler plates, and if carried to an extreme, rupture is liable to occur. The blow-off valves are to be opened slowly, until the pressure has been gradually reduced to a safe point. On the other hand, the Code has also fixed the minimum size due to the tendency of a small pipe to become clogged.

When the maximum allowable working pressure exceeds 125 pounds per square inch, the bottom blow-off pipe shall have two gate valves (not globe valves) or one gate valve and a cock. Of course, these valves must be flanged and of an extra heavy standard. Globe valves are not permitted on account of the fact that the seats of this type form pockets for the lodgment of dirt and scale, which prevents them from being closed absolutely tight. Furthermore, due to the design of a globe valve, the water is forced to change its direction at right angles to the line of flow. This, in addition to shocking the valve, also grinds away the bearing surface of the seat and disk, mak-

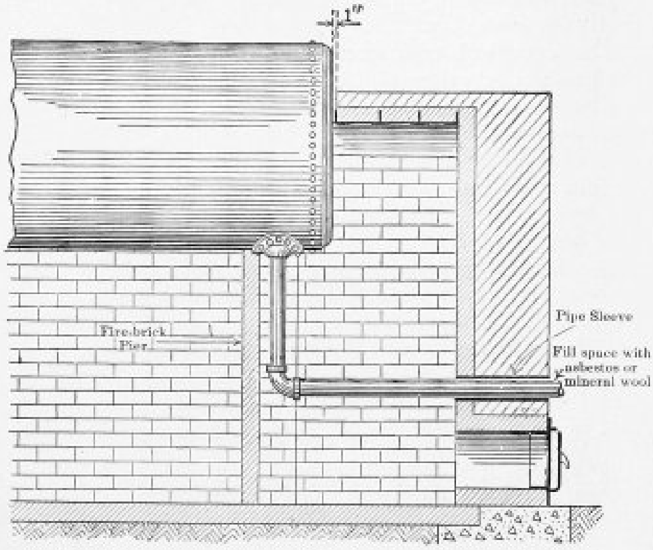


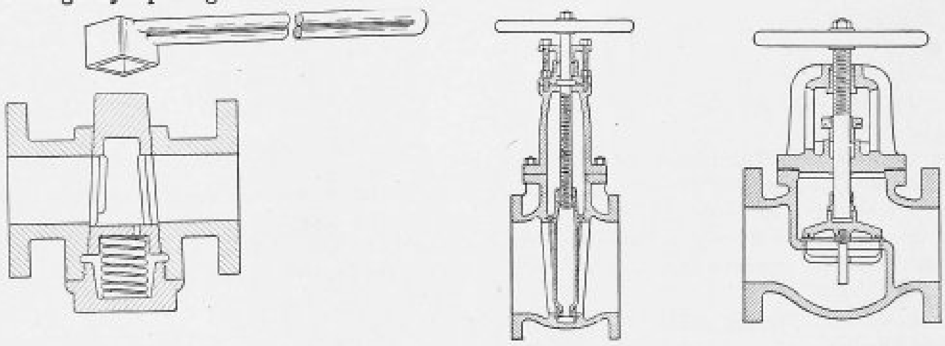

Fig. 78.—Bottom Blow-off Pipe Connection to Horizontal Return Tubular Boiler

ing necessary frequent repairs. The passage through gate valves, however, is direct. By the application of two valves as required by the Code, one will serve as an emergency in the event of failure of the valve nearest the boiler. The chief reason is that the operator may secure more gradual discharge by opening one valve at a time.

ature, with the result that, should the blow-off valves be opened too suddenly, the water rushing through the pipe is flashed into steam, causing "water-hammer." Water-hammer, to be explicit, is the pounding one hears in an ordinary steam heating radiator when the steam is turned on and the latter comes in contact with the cold water that was condensed since the radiator was shut off. These vibrations are minute "explosions" of the cold water in being suddenly evaporated on coming in contact with the high temperature of the incoming steam.

A bottom blow-off pipe when exposed to direct furnace heat, as in Fig. 78, shall be protected by firebrick, a substantial cast-iron removable sleeve or a covering of non-conducting material. Fig. 78 shows the more general method of protection given to these blow-off pipes. This consists of a triangular-shaped pier of firebrick built up in front of the pipe, as indicated in the sketch. All of this piping and fittings up to the valves must be of steel, and extra heavy, regardless of pressure. The elbow shown in the figure should be screwed, since if flanged the bolts will be seriously effected by the furnace gases. A much better method is to bend the pipe and eliminate the fittings entirely. A coupling must, however, be fitted to the pipe inside the combustion chamber to permit the head to be connected.

Reference should again be made to Fig. 78 concerning the point where the blow-off pipe passes through the rear wall of the boiler setting. The brick work must not be built up tightly around the pipe, but a sleeve either of cast iron or, for convenience, a plain piece of standard pipe a little larger than the blow-off pipe is bricked into



(a) Quarter Turn Steam Cock (b) Gate Valve (c) Globe Valve

Fig. 79

The cocks referred to are sometimes known as quarter-turn valves. Although much cheaper than gate valves of equal size, they are, however, inherently strong in construction. For convenience, cross-sectional cuts of steam cocks, gate and globe valves are illustrated in Fig. 79, (a), (b) and (c).

On a boiler having multiple blow-off pipes (as in the case of watertube boilers), only one gate valve or cock is required on each individual pipe, but a master gate valve must be placed on the common blow-off pipe from each boiler. This feature may also be applied to a horizontal return tubular boiler, such as ours, when it is equipped with a surface blow-off. In this case the bottom and surface blow-off pipes are each fitted with a single valve and another is placed in the common pipe into which both of these connect.

### Blow-Off Pipe on Horizontal Boilers

The blow-off pipe on a horizontal return tubular boiler is a dangerous connection. There is little, if any, water circulation possible within the pipe, and under high furnace temperature the pipe literally "boils dry." The steam becomes superheated and the pipe, if not effectively shielded from the flames, reaches a dangerous temper-

the rear wall, through which the blow-off pipe may freely move during expansion and contraction of the boiler and piping. Notice also the door in the bottom of this rear wall for the purpose of gaining access to the interior of the boiler setting. Although for clearness Fig. 78 shows this door directly under the blow-off pipe, it is not good practice. The door should be located to one side of the center of the boiler, so that entrance may be had through the opening without crawling under the blow-off lines. If possible, the access door may be located in the side walls. The size of access doors in brick work like manholes is also governed by the Code. They shall not be less than 12 inches by 16 inches, or equivalent area, but 11 inches is to be the least dimension in any case. This also applies to firing doors, which, of course, are also used for access from the front end of the boiler.

*(To be continued.)*

## Rules for the Use of Welding on Locomotive Boilers

The following rules adopted by the Committee on Standards for Locomotives and Cars of the United States Railway Administration have been sent to the regional directors by the assistant director of the Division of Operation, Frank McManamy. These instructions are intended to prevent the abuse of autogenous welding in places where it is not well adapted in the construction or repair of locomotive boilers. Failures which may have been caused or contributed to by the improper use of autogenous welding will be prevented in the future.

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.

Staybolt or crown stayheads must not be built up or welded to the sheet.

Holes larger than 1½ inches in diameter, when entirely closed by autogenous welding, must have the welding properly stayed.

In new construction welded seams in crown sheets will not be used where full-sized sheets are obtainable. This is not intended to prevent welding the crown sheet to other firebox sheets. Side sheet seams shall be not less than 12 inches below the highest point of the crown.

Only operators known to be competent will be assigned to firebox welding.

Where autogenous welding is done, the parts to be welded must be thoroughly cleaned and kept clean during the progress of the work.

When repairing fireboxes, a number of small adjacent patches will not be applied, but the defective part of the sheet will be cut out and repaired with one patch.

The autogenous welding of a defective main air reservoir is not permitted.

Welding rods must conform to the specifications issued by the Inspection and Test Section of the United States Railroad Administration for the various kinds of work for which they are prescribed.

## Dead Gas Pockets for Protecting Soot Cleaner Elements*

Inasmuch as the temperature of combustion in a boiler furnace frequently reaches 2,500 degrees F., it is evident that soot cleaner elements cannot be placed within the immediate zone of this high temperature. Protection of some kind against both convection and radiation is necessary, especially in steep tube boilers such as the Stirling, Erie City, Badenhausen, Connelly, Ladd, etc., which require cleaner elements at the bottom and top of the first pass. The temperature at the bottom and top of the first pass is usually high, whereas in the second and third pass it drops to a degree that does not influence the strength or properties of wrought iron or steel.

As applied to horizontal watertube boilers, the temperature problem is seldom a serious one, because it is the usual practice to place the soot cleaner elements at the top of the tube bank where the temperature seldom, if ever, reaches 1,000 degrees F., a temperature that does not affect cast iron sheaths.

To fully protect the soot cleaner elements in steep tube boilers a patented deflecting baffle tile, or row of firebrick forming a pocket in which the element is operated, is placed at the bottom of the first pass, as shown in Fig. 1. This pocket eliminates the direct scrubbing action of the hot gases. Space is allowed at the bottom of this baffle through which soot and ash will drop during the cleaning process. A cast iron sheathing is used for further covering and protecting this element.

At the top of the first pass is another patented dead gas pocket in which is located the second soot cleaner element. This element, also, is further protected by means of the special cast iron sheathing previously mentioned. This second element rests upon the circulating tubes close to the front drum. Contact with the comparatively cool tubes assists greatly in maintaining the element at a safe temperature.

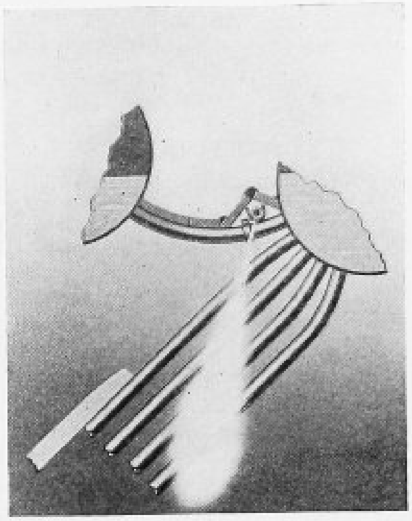


Fig. 1.—Deflecting Baffle of Tile or Firebrick Forming a Dead Gas Pocket Around Soot Cleaner Elements

By arching the baffle tile over the circulating tubes as shown, the hot gases, in their natural flow, do not come into direct contact with the element. The elements in both instances are placed in strategic and commanding positions, making it possible to clean easily what has heretofore been the most difficult and the most important portion of the boiler—the first pass. It is well known that in the steep tube type of boiler most of the steam is generated in this pass, hence the importance of keeping the first pass well cleaned.

In boilers of this type where the tubes are arranged in squares, perpendicular nozzles are used. That is, the nozzle makes a right angle with the axis of the element, hence the jet is directed between the tubes. With a nozzle blowing into every space, rotation of each element in Fig. 1 through approximately 90 degrees thoroughly cleans the entire bank of tubes.

In the Vogt boiler there is a departure from conventional horizontal watertube boiler design, making it necessary to place two of the elements closer to the high temperature zone. Hence the element number 1, which is closest to the hot burning gases and glowing fuel bed, is protected by a dead gas pocket as well as by cast iron sheaths. The next element reached by the hot gases is protected by a straight diagonal baffle forming a second dead gas pocket. The third element reached is protected by a dead gas pocket in a manner similar to element number 1. By the time the gases reach element number 4 the temperature of the gases has dropped sufficiently so that a dead gas pocket is not necessary, nor is it necessary to cover the element with cast iron sheaths.

Experience has proved that burned furnace gases are non-oxidizing, hence there is little, if any, hazard in exposing bare elements to the low temperature gases. The high temperature problem is, as a rule, of greater importance than the corrosion problem, but this has been effectively solved by means of combined dead gas pocket protection, cast iron sheaths, and contact with the comparatively cool boiler tubes.

* Compiled from data supplied by the research department of the Vulcan Soot Blower Company, Du Bois, Pa.

# Development of Oblique Pipe Intersections

### Methods Employed in Drawing the Layouts and Patterns of a Downcomer for a Blast Furnace

BY C. B. LINDSTROM

Oblique pipe connections usually prove perplexing, and they are not as easily handled as the ordinary run of sheet metal and boiler laying-out problems. The reason for this is due mainly to the fact that each pipe section is shown foreshortened in all of the principal views, and further that the angles between the adjoining sections in these views, namely, the plan, front, side or end elevations are also shown foreshortened, that is, not in their true size.

Fig. 1 illustrates how a series of tapering pipes may be connected about a vertical cylindrical furnace, and also to connect at the top and bottom with vertical pipes as shown. The pipe axes are of the same length as the path of the helix and have a uniform rise, thus giving a uniform rise or fall in the pipe sections.

#### Drawing the Construction Views

Describe a circle in the plan from point *O*, Fig. 1, with a radius equal to the outside diameter of the furnace. In the elevation lay off the vertical length between the extremities of the inlet and outlet pipes, as at *a* to *f*. Divide this length or distance into as many parts as there are sections in the downcomer. Locate the centers of the pipes *A* and *B* in the plan view as shown at $a''$ and $f''$.

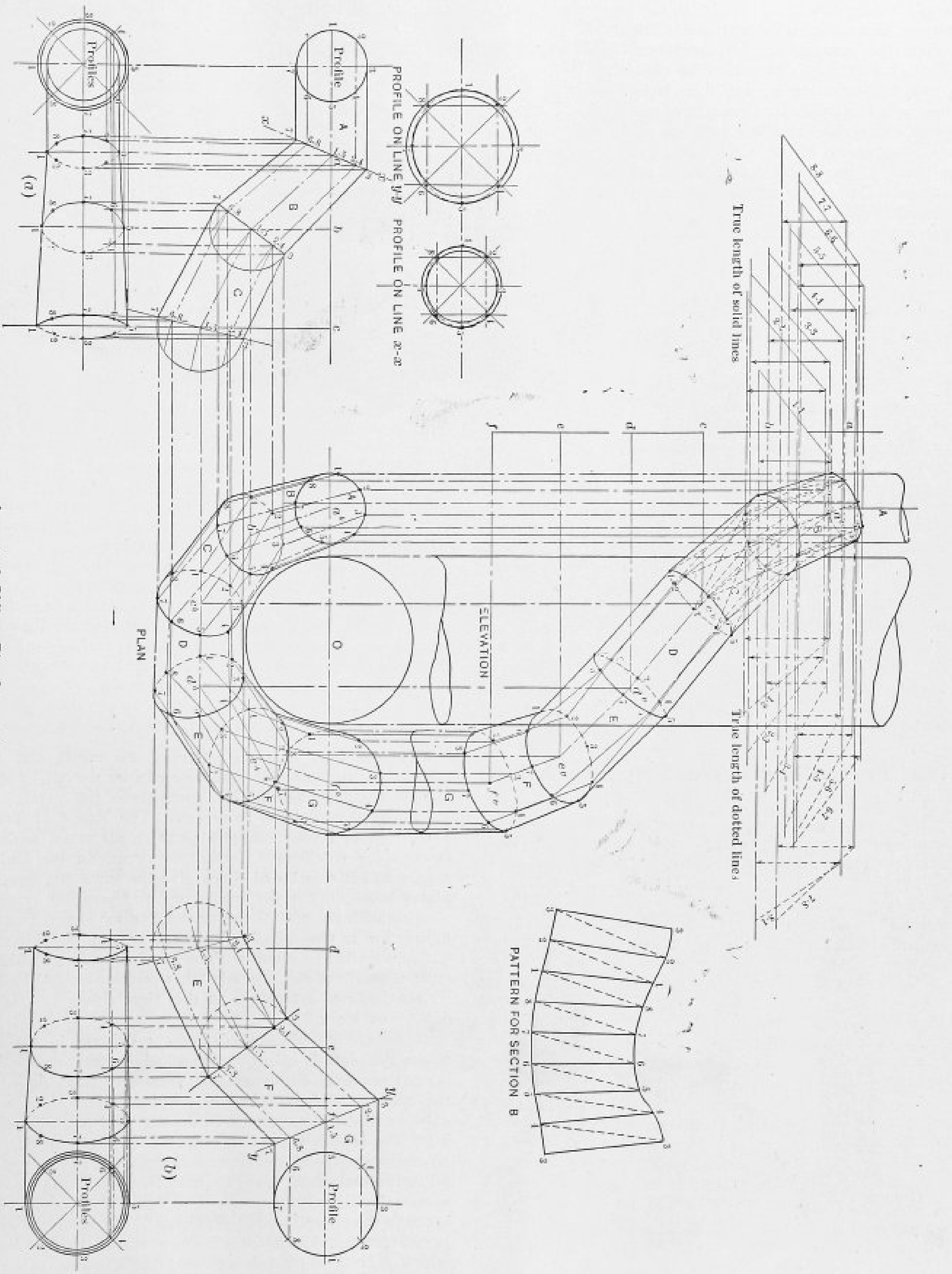
With *O* as a center, draw a semicircle with $O$-$a''$ as a radius. Divide the semicircle $a''$-$f''$ into the same number of divisions as in line *a-f* of the elevation, locating the points $b''$-$c''$-$d''$ and $e''$. Erect perpendiculars from these points to intersect the horizontal lines drawn from the points *a* to *f* inclusive, as at $a'$-$b'$-$c'$-$d'$-$e'$ and $f'$ in the elevation. Then join these points together with straight lines, which procedure locates the respective axes for the pipes *B*, *C*, *D* and *E*. The outline of the pipe sections can then be drawn in from the data given in Figs. 2 and 3.

In Fig. 2 is shown the second step of the construction, which gives the true length of the pipe sections *B* and *C*, but the angle between the pipes in this view is not the true angle. On the horizontal line *O-a* lay off the lengths $a'$-$b'$ and $b'$-$c'$, the axes of pipes *B* and *C* shown in the elevation. From *a*, *b* and *c*, Fig. 2, draw perpendiculars to line *O-a*, and parallel to *O-a* draw horizontal lines from the points $b''$ and $c''$ to intersect at 1-5, as shown. Connect the points 1-5 for *B* and *C*, which gives the true lengths of the axes for these pipe sections. Bisect the angle, and on this bisector is the miter line between the two pipes. Draw in the pipe's edge lines, completing a plan view.

The pipe sections are frustums of cones, and their respective profiles are circles, being equal in diameter to the ends of each pipe section. The profile shapes on the miter lines in this case are elliptical, as shown in the developed profile views taken on lines *x-x*, Fig. 2, and *y-y* of Fig. 3. The length 1-5 on the profile *x-x* equals the miter length 3-7 of the plan view, Fig. 2, and the minor axis of the ellipse, profile view, equals the diameter of the pipe *A*.

During the heavy snowfall early in March the rails of the Providence and Worcester Railroad at Northbridge, Mass., became ice-coated and caused a passenger train to be thrown from the tracks. The locomotive plunged over a four foot embankment and onto the thick ice which covered the Blackstone river at this point. Only the extreme thickness of this ice saved the engine from being entirely demolished. Fortunately, the passenger cars remained at the edge of the river and no one was badly hurt

If desired, the miter profiles might be made circular, which would cause the pipes *A*, *B* and *C*, etc., to be elliptical in form instead of conical. The two circles of the profile view are drawn and divided into equal parts and radial lines extended from these points passing through the center. From the points on the outer circle vertical projectors are drawn to intersect the horizontal ones, drawn from the points on the inner circle at 2-3-4-6-7-8 which lie on the ellipse.




Layout of Oblique Pipe Intersection

The elevation Fig. 2 (a) is next completed showing the shape of the pipe sections and miter line. The pipe sections of Fig. 2 (a) are now transferred to the positions shown at *A*, *B* and *C*, and those of Fig. 3 at *E*, *F* and *G*. The pipe *D* is parallel to the front plane and, as shown, therefore, in its true size. The other pipe sections are foreshortened. The plan of Fig. 1 may now be completed by projecting vertical lines from the points 1-2-3-4, etc., on the miters of the elevation, and from the corresponding points on the miters of Figs. 2 and 3 horizontal projectors are drawn. The points of intersection in the latter case locate the points on the miter plan view. Triangulation lines are now drawn in the sections of both the plan and elevation and their true lengths laid off as shown for *B*. The other sections are developed in a like manner.

PATTERN LAYOUTS

The layout of the patterns involves the assembling of the triangles, using the arc lengths of the profiles on the miter lines for the stretchout lengths. By this method of development, results will be obtained that meet all practical requirements. Another method that gives the same results involves, first, the finding of the true angle between the pipe sections and then the using of the bisector of the angle as the miter, which is the true miter in a layout of this kind.

The next step is to determine the arc length that one section must be turned on the other in order to obtain the necessary twist in the pipe connections, otherwise they would all lie in the same plane as in a regular pipe elbow. Where circular pipes are used in the spiral and the rise or fall of the connections is uniform, this twist is the same for all of the sections.

## Position Drilling Versus Separate Drilling

BY A. L. HAAS

The advocate of progress always finds opposition. Any improvement involving trouble and alteration in viewpoint produces a critic somewhere. Life, however, would be a dull business at best if there were no kick in it and everyone agreed.

Position drilling is one among many other factors which are essential to the production of first-class work in the boiler shop. From every point of view it is expedient to drill in place; it is certainly the cheapest, and up to the present it is far and away the best method.

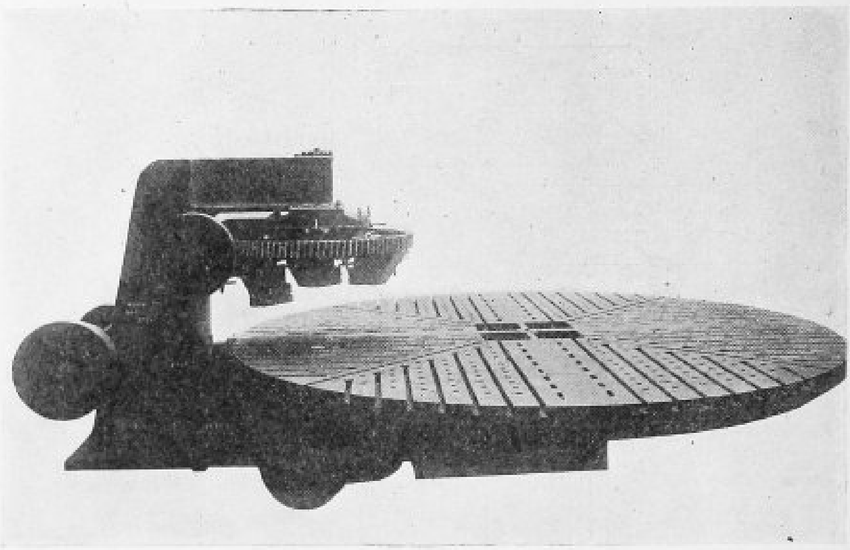


Fig. 2.—Double-Spindle Drill for Longitudinal Seams

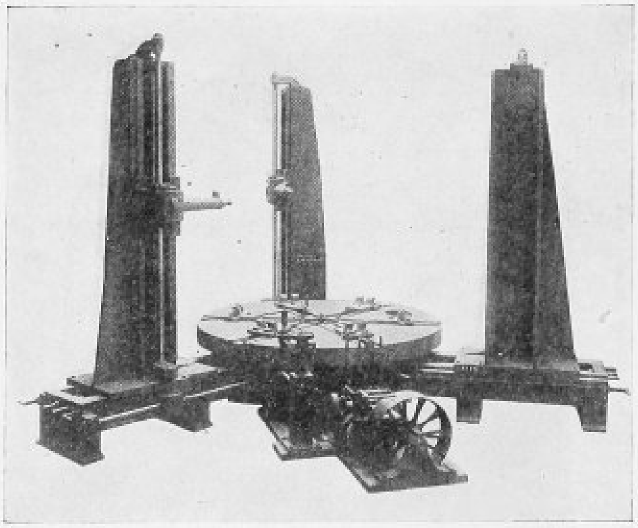


Fig. 1.—Radial Drill with Three Heads and Full Adjustment for Sheets Up to Ten Feet in Diameter

The arguments occur not on the merit of the process, which is unquestioned, but on its economic aspect. Critics admit that punched holes are inadmissible. I have been charged with one distorted belief, that my chief reason against any other cutting or machining method was that it altered the molecular structure of steel and would make it defective in subsequent manipulation.

EFFECT OF PUNCHING AND SHEARING

Punching and shearing distress the metal and the damage to its molecular structure can be proved by subsequent bending; cutting does not distress the metal.

Passing the criticism in review. The Board of Trade rules are cited which clearly penalize all other methods than position drilling. Certain surveyors in the United States Atlantic seaboard shops give the same efficiency to plates holed in the flat, rolled up and position reamed. Dealing with the cost of equipment, $50,000 is given as the figure for a two-spindle drill, but cannot be delivered within a period of months. The conclusion from which I must emphatically disagree is "that position-drilled boilers do not show to advantage at this time either in cost or quality of work."

There are no physical defects in drilling in the flat where the plate is subsequently rolled, but this course has several practical disadvantages. The hole so made in the flat cannot be round when in position. The process involves two distinct operations, drilling and position reaming. The layout in the flat, however, carefully made, will not serve to give close correspondence in position even on a longitudinal seam, while a circumferential seam becomes extremely difficult to compensate for difference in pitch between the two plates; if allowance is not made the error is cumulative. Again, there is the error of the drill itself, which defeats exact fabrication. The greatest objection is that each plate has to be separately handled and drilled, while with position drilling two and three plates are holed together, so that apart from all other considerations position drilling involves one single operation and gives positive results independent of any further treatment.

### Advantages of Position Drilling

This simple feature of holing all thicknesses at a single operation, leaving a finished job needing neither compensation nor adjustment, gives position drilling unique and peculiar advantages. It gives certainty. A seam consisting of two butt straps and plate, if done in the flat, needs three distinct drillings, while holing simultaneously in place can be done in less than half the time per completed hole if rightly handled.

Critics point out that the practice is to drill the holes one-eighth under size and ream them out full size after assembly in position, i. e., one-eighth of an inch in diameter to ream out of every hole. The tolerance is needed by the inexactitude of the method of drilling in the flat, consequently no two parts of any hole come fair. In actual fact, there is little doubt that even reaming cannot compensate the error of the method.

### Drawbacks of Reaming

In the matter of reaming it is well known and can be demonstrated that two portions of a hole out of line vitiates the finished result. Not so long since in quite another connection the writer prohibited the drilling of undersize holes in some spare gear, which had subsequently to take a fitting bolt, because from practical experience he is aware of the impossibility of reaming two out-of-line holes into exact correspondence.

Reaming in a machine shop means the finish by removal of the final thousandth to ensure exactitude. Removal of one-eighth in diameter is not reaming at all—it is hogging out stock—and, done by reaming methods, cannot give a satisfactory result. The upkeep cost of reamers must be excessive. This is in addition to upkeep cost of drills, and holes originally out of line cannot be brought fair and square to the plate surfaces. The type of burr formed by the removal of one-eighth inch of stock by a drill reamer is abnormal and requires dressing off—another additional expense. Therefore the workmanship with holes drilled in the flat and position reamed involves multiple processes and the result is bound to be inferior.

It has been said by some readers of The Boiler Maker that, of course, the finished product must be the same regarding the holes, which should be fair, good and cylindrical. "Fair" and "good" are relative terms. Position drilling is exact—cannot be otherwise; position-reamed work may be, and often is, anything but exact. From cumulative experience, work done by any other method than position drilling tends to be inferior. It is a doubtful practice at best and needs the closest supervision to ensure a decent job. When a better way exists, why, in the name of common horse-sense, do some boiler makers plead for the retention of a second best method?

### Equipment Cost

Coming now to the matter of equipment cost, these are days of more or less profiteering, but why pay $50,000 (£10,000) for a position-drilling machine occupying 40 feet square space and having only two spindles. Such an expense for such a result is hardly credible. Such a machine can only be needed for girth seams, since a battery of cheap wall radials will hole the longitudinal seams quite effectively. There is also the precedent of the Dallett rig, which is capable of extension. With some horse-sense and some structural steel it would be possible to do position drilling using simple type drill heads and avoid the capital cost quoted. There exist more elaborate means by special machine tools, but emergency needs and some gumption can position drill without being plundered.

### Typical Drilling Machines

The photographs herewith show, Fig. 1, a radial shell drill with three heads, dividing the table and full adjustment for shells up to 10 feet diameter. Fig. 2 pictures a

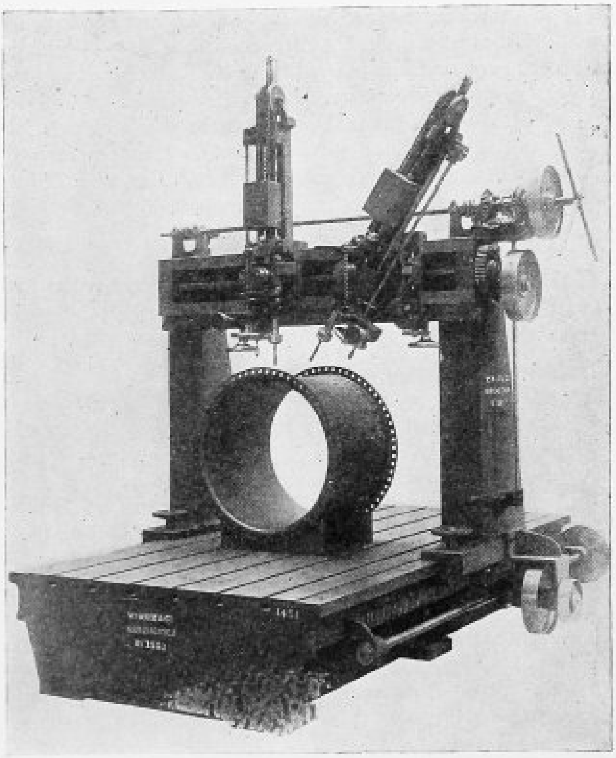


Fig. 3.—Trepanning Machine for Cutting Openings in End Plates

double-spindle seam drill for longitudinal seams, while Fig. 3 shows a manhole trepanning machine for cutting out openings in end plates. The cost of these machines is certainly not one-tenth of the figure quoted by my critic under normal circumstances. For the sum of $50,000 (£10,000) sunk in a single machine the customer ought to be able to hole at least 32 holes simultaneously, automatically divide for pitch, have every refinement and adjustment and single control. It should hole a large Scotch boiler at a single setting and do it in record time. The United States is the home of multiple drills in other connections, and a two-spindle drill at the price speaks badly for Yankee ingenuity, which has a warm admirer in the present writer.

### Board of Trade Rules

It is a very great pity that the extracts from the Board of Trade Rules given in the usual pocket-book are so condensed, for it costs little to have the actual publication and its use is considerable.

Like every other authority, the actual working pressure in boilers is fixed by the survey, and this is largely determined by the workmanship. It is very well put in the Rules:

"The Board of Trade consider that boilers well constructed, well designed and made of good material should be allowed an advantage in the matter of working pressure over boilers inferior in any of the above respects, as unless this is done the superior boiler is placed at a disadvantage and good workmanship and material will be

(*Continued on page* 149.)

## Programme of Master Boiler Makers' Convention to be Held in Minneapolis May 25-28

The twelfth annual convention of the Master Boiler Makers' Association will be held at the Curtiss Hotel, Minneapolis, Minn., on May 25, 26, 27 and 28. In the preliminary announcements for the convention it is suggested that each member report promptly after his arrival for himself, ladies and guests, and receive convention badges with such instructions as will be of value during the progress of the convention. Special emphasis is laid on the fact that no badges will be issued until after registration, at which time dues must be paid to the secretary or his representative. The official programme is as follows:

FIRST DAY

Tuesday, May 25

Registration of Members and Guests Continued at 8:00 A. M.

Business Session

Convention called to order, 10:00 A. M.
Invocation—
Rev. G. L. Morrill, Minneapolis, Minn.
Addresses—
Hon. J. E. Meyers, Mayor of Minneapolis.
Frank McManamy, Manager, Department of Equipment, United States Railroad Administration.
Annual Address—
Mr. John B. Tate, president of the association.
Routine Business—
Annual Report of the secretary, Harry D. Vought.
Annual Report of the treasurer, W. H. Laughridge.
Miscellaneous Business—
Unfinished Business.
New Business.
Appointment of special committees to serve during convention—
President's Address.
Resolutions.
Memorials.
Announcement.
Adjournment.

SECOND DAY

Wednesday, May 26

Convention called to order, 9:00 A. M.
Addresses—
A. G. Pack, Chief Inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission.
W. H. Bremner, President, Minneapolis & St. Louis Railroad Company.
H. H. Yorg, Superintendent, Motive Power, Great Northern Railroad.
Committee Reports—
"What is the Best Type of Washout Plug, Arch Tube or Hand-Hole Plate to Be Used in Order to Overcome Leaking When Boiler Is Under Pressure? Kind of Thread, Number of Threads per Inch and Taper per Foot?" 9:30 to 10:00 A M. C. P. Patrick, chairman; J. J. Orr, W. H. Laughridge.
"What Firebox Steel Gives the Best Results from Actual Service Test: Steel Having a Tensile Strength of from 48,000 to 58,000, or 55,000 to 65,000 Pounds per Square Inch?" 10:00 to 10:30 A. M. William J. Murphy, chairman; F. A. Mayer, Lewis Eberle.
"Is the Superheating and Reducing of Steam Pressure of Boilers Advantageous as to Stay Bolt Breakage Compared with Boilers of the Same Class Not Superheated?" 10:30 to 11:00 A. M. T. L. Mallam, chairman; E. J. Sweeney, F. A. Mayer.
"Is It Necessary to Maintain the Cinder Hopper on Bottom of Smoke Arch of All Locomotives? On What Size Locomotive Should It Be Maintained? What is the Better Design to Overcome Air Leaks?" 11:00 to 11:30 A. M. Frank Davison, chairman; T. J. Reddy, John L. Welk.
"Is the Flanging of Firebox Sheets on the Flange Press Detrimental to the Material? When Can Cold Flanging Be Employed to the Best Advantage?" 11:30 to 12 M. R. C. Gibson, chairman; John B. Smith, J. T. Wilson.
Announcements.
Adjournment.

THIRD DAY

Thursday, May 27

Convention called to order, 9:00 A. M.
Addresses—
William Schlafge, Mechanical Manager, Erie Railroad.
T. A. Foque, General Mechanical Superintendent, Sioux Line, Minneapolis, Minn.
E. Enockson, of St. Paul, Minn., Chicago, Milwaukee & St. Paul Railroad.
Committee Reports—
"To What Extent, If Any, Is the Boiler Plate or Firebox Plate Injured When Welded by the Electric or Acetylene Process? Describe Preparation, Placing in Position and Welding Cracks, Patches and Sheets; Also Electric Welding of Flues." 10:00 to 11:00 A. M. John Harthill, E. S. Fitzsimmons.
"Advantages and Disadvantages of the Madden Ash-Pan." 11:00 to 11:30 A. M. H. J. Wandberg, chairman; G. C. Duffy, James Walsh.
"Advantages and Disadvantages of the Prime Wash-Out Plug." 11:30 to 12 M. H. J. Wandberg, chairman; George Austin, T. P. Madden.
To report Topics for 1921 convention. 12 M. to 12:30 P. M. John F. Raps, chairman; D. G. Foley, George Austin.
Law. 12:30 P. M. to 1 P. M. A. R. Hodges, chairman; J. A. Doarnberger, George W. Bennett.
Announcements.
Adjournment.

FOURTH DAY

Friday, May 28

Convention called to Order, 9:00 A. M.
Addresses—
E. J. Brennan, Chicago, Milwaukee & St. Paul R. R.
H. M. Curry, Northern Pacific & St. Paul Railroad.
"What Is the Best Style of Grate for Bituminous Coal? Where Should the Dump Grate Be Located: (a) In Road Engines; (b) in Switch Engines? What Should Be the Percentage of Draft Opening in Ash Pans Compared with Area of Grates?" A. N. Lucas, William Strinsky.
Unfinished Business—
Report of Committee on President's Address.
Report of Committee on Resolutions.
Report of Committee on Memorials.
Election of Officers.
Good of the Association and General Discussion.
Announcements and Closing Exercises of the Convention.

# The Boiler Maker

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## CONTENTS



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All reports from headquarters of the Master Boiler Makers' Association committee in Minneapolis indicate that the twelfth annual convention to be held May 25-28, at the Curtiss Hotel, will be a great success. L. R. Porter, chairman of the committee of arrangements, states that nearly all available hotel accommodations have been taken, and that a record attendance is assured.

The discussions and addresses outlined in the programme of the convention printed on the opposite page are the best argument for the record attendance expected. It would be difficult to arrange for speakers at the various sessions of the convention who would be better able to present the various phases of boiler work. Papers to be presented this year are exceptionally interesting and should give a very good opportunity for some real discussions. The one suggestion that might be made at this time in order to be certain of having the most instructive convention in the annals of the association is for the members to commence planning for their discussions now.

Unfortunately it has not been possible for the Boiler Makers' Supply Men's Association to arrange exhibits on the floor of the convention as has been customary in the past, but many of the manufacturers have reserved space in the hotel to present their products for inspection. In connection with the annual meeting of this association, special entertainment will be provided and all members of the Master Boiler Makers' Association and the Women's Auxiliary have been invited.

It is certain that no master boiler maker can afford to miss any of the events of the convention, and if by chance there is a member of the association who has not already planned to be in Minneapolis for it, there is still time to make arrangements.

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This year's convention of the American Boiler Manufacturers' Association, to be held May 31, June 1 and 2 at French Lick Springs, Indiana, will be the first attempt by the association to combine business with recreation. In addition to the regular programme, golf tournaments, tennis tournaments and other sports will be arranged. On May 30 the executive committee of the association will meet at 10 A. M. to complete arrangements for the convention.

The opening reports on May 31 will be given by Mr. E. R. Fish and Mr. Charles E. Gorton, chairman of the Uniform Boiler Law Society, on the advances made during the past year in the adoption of the Uniform Boiler Code throughout the country. Following this, David Robert Myers will present a paper on "Fuel Conservation." The afternoon will be occupied by a golf tournament. In the evening the president's address and the report of the committee working with the Stoker Manufacturers' Association will be given. Papers will be presented by D. C. Alexander, Jr., on "Electric Welding," and by S. F. Jeter, of the Hartford Steam Boiler Inspection and Insurance Company, on the "Advantages of Cooperation Between Boiler Manufacturers and Boiler Insurance Companies."

The second day of the convention will be opened by an address on "Ethics" by George W. Bach, of the Union Iron Works, Erie, Pa. The other important features of this day include a discussion on the tabulation of wage rates, a golf tournament in the afternoon and the banquet in the evening.

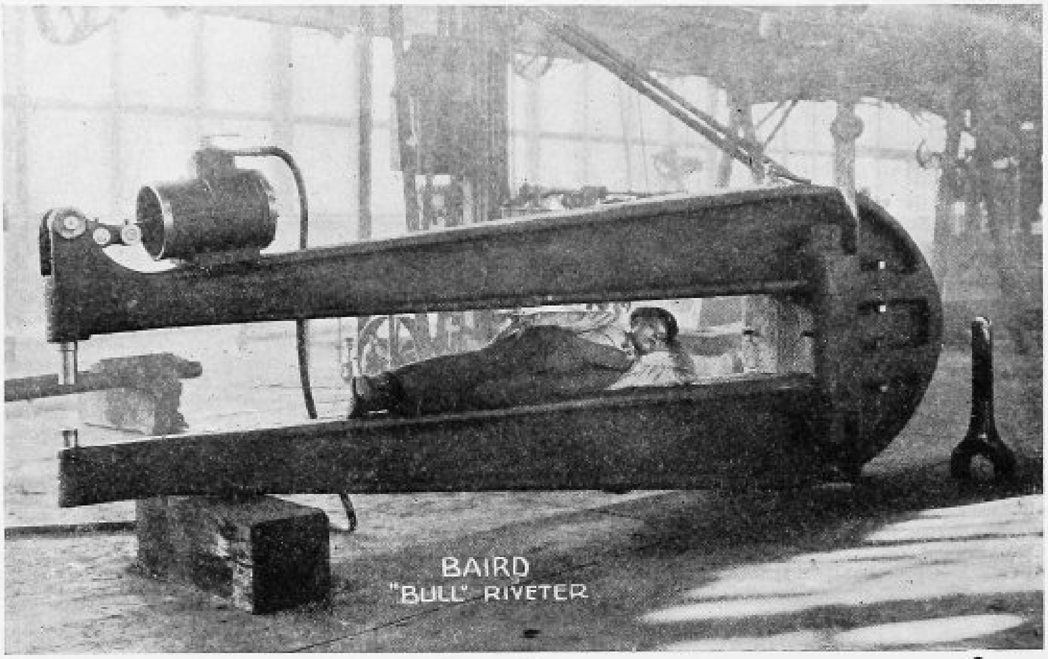
Wednesday, June 2, will be devoted to the report of the nominating committee, the election of officers and a topical discussion of subjects connected with the industry.

# Engineering Specialties for Boiler Making

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

### Riveter for Thresher Engine Boilers

The accompanying illustration shows a 140-inch reach Bull Riveter recently completed by the Baird Pneumatic Tool Company, Kansas City, Mo., for the Port Huron Engine and Thresher Company, of Port Huron, Mich. This picture was taken directly after this giant tool was put through a series of exhaustive tests at the Baird plant. When installed, it will stand upright and the boilers to be riveted will be slipped down over the lower stake. The double cylinder and pistons exert 140,000 pounds pressure on the rivet dies. The machine will drive ¾-inch steam-tight rivets with uniform heads. The total weight of the machine is 17,000 pounds.



Seventeen-Thousand Pound Bull Riveter Completed in Baird Plant

### Controlling Combustion in Boiler Plants

It is very necessary that the dampers in a power plant be regulated so that the proper relation between the draft and fuel for highest combustion efficiency is maintained at all times. The Carrick combustion control, produced by the Carrick Engineering Company, Chicago, Ill., accomplishes this condition by holding the dampers in a floating position at any point in the path of their travel, and also holds the stokers and forced draft blowers to speeds exactly corresponding with the changing load and varying damper positions. The control thus synchronizes the regulation of stokers, dampers, blowers and induced draft fans.

The basic principle of this combustion control is that of the barometer or "U" tube. In the same way that mercury in the barometer travels a known distance for a given change in atmospheric pressure, so the column of mercury in the Carrick control is actuated by such changes in combination with variations in the rate of steam flow. The apparatus consists of a mercury reservoir having a steam connection at the top; a vertical mercury cylinder and free-moving plunger with a pipe connection from the cylinder base to the bottom of the mercury reservoir; a floating valve gear with one side directly connected to the plunger, mounted as part of the hydraulic set; an hydraulic cylinder, the piston of which is directly connected to the other side of the floating valve gear, and a four-way hydraulic valve operated by the floating valve gear, which is connected with the water lines to the top and bottom of the hydraulic cylinder.

Each auxiliary control operating a damper, stoker or blower is a complete hydraulic set, consisting of a floating valve gear, a hydraulic cylinder and a four-way valve.

Pressure on the mercury reservoir forces mercury to the cylinder through the connecting pipe. Here the mercury stands at a known level for a given steam pressure. The plunger moves a distance of 1/32 inch for an increase of 1/64 pound in pressure. The mercury plunger in turn lifts one side of the floating valve gear operating the four-way hydraulic valve. This action admits water to the top of the hydraulic cylinder, forcing the piston down and lowering the opposite side of the floating valve gear with it. When the piston has traveled downward a distance equal to the upward travel of the mercury plunger, the lowering of the piston side of the floating valve gear automatically returns the four-way valve to a neutral position. A drop in the steam pressure lowers the level of the mercury in the cylinder and reverses the action of the floating valve gear. There is no further movement of the hydraulic cylinder until a change in the boiler or furnace condition causes a change in the level of the mercury.

The control is so designed that the regulating parts may stop at any point in their travel and move ahead or reverse the direction of travel instantly. This movement bears a definite relation to the load, for when the load is increased the control gradually speeds up the stoker engines and opens the dampers until they are in position to efficiently carry the changed load.

The general scheme for controlling oil and gas fuel is exactly the same as described for coal-burning plants. In these cases, specially designed connections automatically regulate the valves and dampers ordinarily operated by hand.

### A Small Electric Light Plant Equipment

An outgrowth of the small turbo-generator sets installed in locomotives for headlight service is embodied in the new Buda-Ross electric light plant equipment made by the Buda Company, Railway Exchange building, Chicago, Ill. The unit is intended for small industrial plants using boilers, for steamboats, dredges, steam shovels and for similar lighting purposes where the requirements do not exceed one kilowatt.

The outstanding feature of this type of lighting plant is the unusually small size for a steam turbo generator plant (the two sizes available are of ½-kilowatt and 1-kilowatt capacity).

Special automatic governors control the speed, while the fuel coils of the generator have compound winding, which keeps the voltage uniform over the lighting circuits. The operation is thus made entirely automatic and eliminates all other attention than the turning on of the steam when the lights are needed.

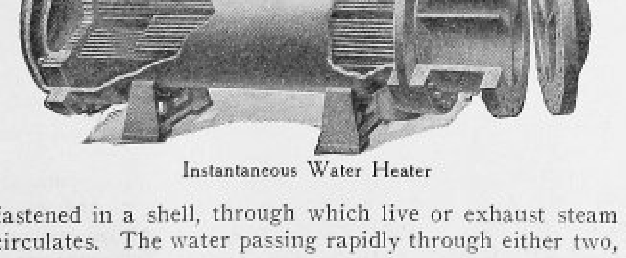
### New Combustion Recorder

The Mono Corporation of America, 48 Coal and Iron Exchange, Buffalo, N. Y., has produced a combustion recorder that enables the firemen to see that no carbon monoxide is present and that carbon dioxide is always maintained at a maximum. With the device the fuel must be so burned that the percentage of carbon-dioxide is always as high as possible and at the same time that the carbon monoxide must not show on the records. This is necessary for economical combustion. The company will be very interested in supplying complete information on the operation and construction of the device on request.

### Instantaneous Water Heater

A new heater has been designed by the Griscom-Russell Company, New York City, to be used as a boiler feedwater heater, or wherever quantities of water are to be heated by live steam.

The system provides for the water to pass through tubes



Instantaneous Water Heater

fastened in a shell, through which live or exhaust steam circulates. The water passing rapidly through either two, four, six or eight sections or tube bundles is rapidly raised to the desired temperature. It is claimed that the heater can be operated far in excess of its rated capacity with only a slight reduction in the final temperature of the water. The shell and head covers are of cast iron, while the tube plates are of rolled steel. The heating surface consists of ⅝-inch outside diameter seamless brass tubing. Tubes are expanded into the tube sheet; one tube plate is attached rigidly to the shell, while the other of the floating type permits the tubes to expand and contract without any strains on the joints.

The shell is designed for a steam working pressure of 50 pounds per square inch, and the tubes and water chambers for a pressure of 250 pounds per square inch. Saddles are supplied for supporting the heaters in horizontal or vertical positions, as desired.

## BUSINESS NOTES

The manufacturing sales department of the Wellman-Seaver-Morgan Company, which handles the company's sales of rubber equipment and machinery, and which is in charge of L. N. Ridenour, has been moved from the company's Akron office to its general offices at 7000 Central avenue, Cleveland.

The Foundation Company announces that Edwin J. Beugler, a member of the American Society of Civil Engineers and the Engineers Institute of Canada, has become associated with this company as vice-president in charge of engineering. Joseph H. O'Brien, member of the American Society of Civil Engineers has been appointed chief engineer.

A booklet containing notices of gas and oil engine accidents has recently been issued by the National Boiler & General Insurance Company, Ltd., Manchester, England. The book contains practical information for gas engine users, based on the experience of this company. Data includes the most frequently occurring failures and good hints for their prevention.

D. Gleisen, manager of the industrial bearings division of the Hyatt Roller Bearing Company, announces that their offices have been moved to 100 West 41st street, New York, where much larger quarters have been secured for the advertising, sales and engineering departments of the division. All the customers of the division are cordially invited to use these offices as their headquarters whenever they are in New York.

The Magnesia Association of America "Specification A.-A. for 85 Percent Magnesia," compiled and endorsed by the Mallon Institute of Industrial Research, University of Pittsburgh, has just been issued for the use of engineers, architects and others interested in non-heat conducting coverings for power and heating systems. Copies of the specification may be obtained from the headquarters of the association, Bulletin building, Philadelphia, Pa., on request.

W. H. Patterson, manager of the resale section, Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., has been appointed assistant to manager in the industrial department in charge of the metal and woodworking industries. Mr. Patterson has been identified for a number of years with the development of control apparatus for cranes, elevators, hoists and machine tools.

# 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.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Types of Staybolt Threads

Q.—The writer would be interested in having the various types of staybolts discussed, with particular reference to the three forms of threads used. F. B.

A.—The sharp V thread is used extensively in this country. The V thread is not standard and is not a good form for stay threads or screws. It is a weak form because it cuts a deeper groove in the stock of the bolt than the United States standard thread, and its sharp apex or point is easily broken.

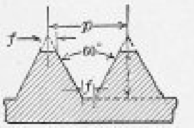


Fig. 1.—U. S. Standard Thread

$p = \text{pitch} = \dfrac{1}{\text{No. threads per inch.}}$

$t = \text{depth} = \text{pitch} \times .6495$

$f = \text{flat} = \dfrac{\text{pitch}}{8}$

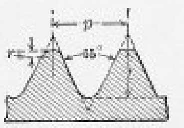


Fig. 2.—Whitworth Standard Thread

$p = \text{pitch} = \dfrac{1}{\text{No. threads per inch.}}$

$r = \text{radius} = \text{pitch} \times .1373$

$t = \text{depth} = \text{pitch} \times .64033$

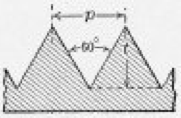


Fig. 3.—Sharp V Thread

$p = \text{pitch} = \dfrac{1}{\text{No. threads per inch.}}$

$t = \text{depth} = p \times .750$

The United States standard is recommended in place of the V thread. It is stronger, withstanding greater pulling and torsional stresses than the V thread. It is standard, having a uniform diameter, pitch, angle of thread and flat top and bottom.

The Whitworth standard with round tops and bottoms is also a good form and preferred to the V thread.

### Elbow Layout

Q.—Please show how to lay out an elbow square at one end and round at the other. K. S.

A.—This is an advanced problem and requires knowledge of many of the fundamentals in sheet-metal pattern work. The problem is one that would require an extended lecture to fully explain, but a brief outline of the method of making the patterns is given herewith, assuming that you understand the method of laying out the ordinary ellipse, and also how to develop surfaces by means of triangulation. Fig. 1 shows an elevation of the elbow. This one is made up of seven sections. The number of sections will depend upon the size and other conditions. It will be noted that there is a flat surface, *ABC*, of irregular outline on each side of the elbow, as well as a triangular flat section, *EFG*, on the outer circumference and one on the inner circumference as shown in Figs. 4 and 5 respectively.

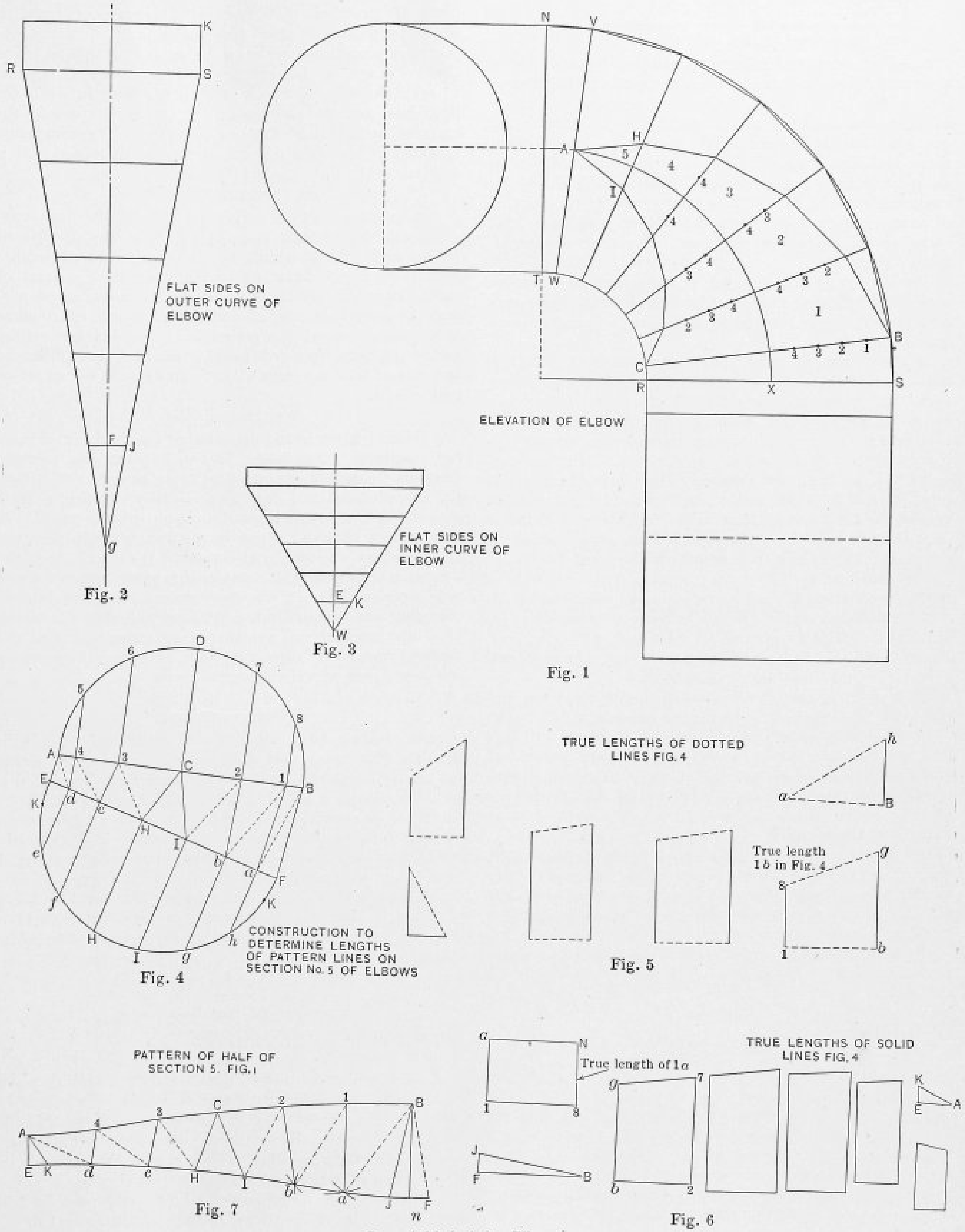
The first section, *CBRS*, at the square end is made up of flat surfaces and the first section, *TUVW* at the round end is made up of a circular section with one edge of the pattern a straight line and the other edge, *VW*, having the outline of an ellipse. The irregular flat area, *ABC*, on the side of the elbow is laid out by dividing half the base, *CB*, of section 1 into the same number of equal parts as there are sections having flat surfaces. In this case there are five divisions on each side of the centerline, and each succeeding joint has one less division until the sides come together at a point, *A*. The form of the flat area on the outer circumference, Fig. 2, begins with a rectangle having a length, *EF*, equal to the side of the square and a width, *FK*, equal to the width, *BS*, of the first square section. The succeeding areas form a triangle, *EFG*, with the sides coming to a point, *G*, on the joint at *A* of the circular section in Fig. 1. In like manner the flat surfaces, Fig. 5, on the inner circumference begin with a rectangle having a length equal to that of the square and a width equal to the width, *CR*, of the first square section, and the other areas diminish in size and form a triangle that has its apex, *W*, in the joint of the first circular section.

In this example the side of the square end is taken equal to the diameter of the circular end, so that the circle can be passed through the elbow. It should be noted that the circle will make contact along the centerline and be tangent to the flat surfaces, and that the joint lines, *WV*, etc., are longer than the diameter of the circle, and hence each section taken on a joint line will be an ellipse. Therefore, the curves of the patterns of the five sections outside of the flat surfaces will be ellipses.

In order to show how to lay out the pattern for one of the sections, the pattern for section 5 of Fig. 1 will be selected. The first thing to do is to lay out the cross sections of the elbow on the two joint lines that form section 5 and then from these sections get the true lengths of the construction lines so as to develop the pattern. In Fig. 4 is shown section 5 of the elbow. A half-section, *ADB* and *EKHIJF*, is laid off on each joint line. The joint line, *AB*, that connects with the first circular section, *TUVWG*, Fig. 1, is used as the long diameter of the ellipse, and the line *CD* is the radius of the circle, so that *ADB* will be an ellipse. The joint line *EF* that unites section 5 with section 4 of Fig. 1 is used as the base of the half-section. On the middle of *EF* lay off *HI* as the length of the flat area on this joint in Fig. 1. Also lay off from *E* and *F* the distances *FJ* and *EK* taken from Figs. 2 and 3 of the flat surfaces on the outer circumference and the inner circumference respectively. Divide the remaining portion of the arcs into equal spaces and draw the curves from *K* to *H* and from *I* to *J*, these being portions of ellipses. Then draw the series of solid and dotted lines on section 5 represented by *ABEF*.

The true lengths of these construction lines are given in Figs. 5 and 6. Thus the line *Ba* in Fig. 5 is taken from Fig. 4, and *Bh* is equal to *ah* in Fig. 4. Then *ah* of Fig. 5 is the true length of *AB* in Fig. 4, and this will be used as a radius in laying out the line *Ba* in the pattern shown in Fig. 7. In like manner all the other lines which are numbered the same in Figs. 5 and 6 as in Fig. 4 are laid out so as to get their true lengths.

The true lengths from 7 and 8 are used as radii, and the various arcs drawn in the half pattern are shown in Fig. 7, and then the curves are drawn through the points as located. In this half pattern it should be noted that the end lines, *mn* and *po*, are the centerlines along the outside curve and the inside curve respectively.



General Method for Elbow Layout

## Causes of Boiler Explosions

Q.—1.—What causes boiler explosions?
2.—What is meant by the elastic limit?
3.—What is meant by elongation?
4.—In autogenous welding, what is meant by neutral flame?
5.—What is meant by spot welding? R. H. L.

A.—The causes of boiler explosions are many, but as a general thing they are well understood. In some cases it has been next to impossible to determine the cause, owing to the nature of the wreck and the inability to find out what had been done by the operator. Then, again, there are cases where it is hard to inspect the boiler so as to learn its actual condition. The direct cause of the explosion may be one of a number, such as the sticking of safety valves, low water, the sudden feeding of cold water on the overheated surfaces, the sudden opening of large valves, etc.

The leading causes of boiler explosions may be grouped under the following headings: Defective design, poor construction, decay of the boiler, and mismanagement in the operation.

In many cases the shell, the flues or the bracing may be too light for the ordinary service required of the boiler; then, again, there may be defective circulation owing to a faulty arrangement of the parts, and the general design may be such as to cause overstraining due to unequal expansions that cannot adjust themselves. Defective material may be used, and even in cases where the material is good, faulty workmanship may produce a poor boiler. In case there is not efficient inspection, there is liable to be a failure to follow the instructions as given in the drawings, and to leave out necessary stays and braces.

The decay of the boiler may develop defects that have not been observed during operation and inspection. Boilers are liable to severe abuse and neglect through the ignorance and mismanagement of operators and the owners. It has been said that a boiler that is well designed and properly proportioned for its intended service, and which is built of good material and intelligently cared for and operated, has never been known to explode.

In connection with boiler explosions, it should be noted that the terrific destruction indicates a large amount of energy stored up in the volume of water that is heated to a high temperature. It requires a greater amount of heat to raise water to any given temperature than it does to raise the temperature of almost any other substance. When the boiler shell is split by an excess pressure, the opening permits the steam pressure to be relieved, which in turn allows the hot water to expand into steam and thus puts its stored energy into action. The case therefore is entirely different from that of air under pressure, for in the latter example there is no stored energy in the form of heat. It is very important that all boilers should be constructed under very close and intelligent inspection, and that they should be operated under very strict rules by competent men.

### Elastic Limit

By the elastic limit is meant the point at which the deformations in a material cease to be proportional to the stresses. This means that when a piece of the material is stretched with a load that is gradually increasing, there is a certain point in the test where the stretch becomes more rapid than at first. With most metals the elastic limit is at the point where the metal will not return to its original length when the load is removed. This is the important point to consider when using metal for any structure. While it may stand a greater load without breaking when it passes the elastic limit, yet the point of this limt is the one of maximum load that should be used for safety.

### Elongation

The elongation is the amount that a specimen of the material stretches. Thus when a sample of metal is tested by pulling it apart lengthwise, and when the two parts are placed together on a flat surface, it will be found that the length of the specimen has increased. It is usual to take a specimen which is 8 inches long between the shoulders, and the amount of elongation is given as the increase in length of the test specimen. The elongation is stated as a certain percent of the length to which it is applied.

### Autogenous Welding

Autogenous welding refers to a weld that is "self-produced." The term as used refers to the process of fusing and uniting metals by the application of intense heat from a gas flame without any physical process of compression or hammering. With the autogenous process the metals are melted and flowed together. In most cases the edges of the pieces being welded are melted and at the same time new metal is added from a filler rod and flowed into the joint so as to unite with the edges of both pieces.

### Neutral Flame

A neutral flame is one that neither oxidizes nor reduces the metals that are being heated. If the gas mixture contains too much oxygen, this extra oxygen will attack the heated metal and destroy it, usually forming a scale that flakes off and reduces the weight of the metal. If there is not enough oxygen in the gas mixture, then the acetylene has a tendency to carbonize the metal; or if the substance being heated contains oxygen, then the flame will remove this oxygen and reduce the metal, thus changing its composition. A neutral flame consists of a mixture that will not change the composition of the metals being heated, and a flame of this kind is necessary for most kinds of welding operations.

### Spot Welding

Spot welding is a process of electric welding which consists of forcing two sheet metals together by means of copper electrodes, and at the same time heating this spot that is under pressure hot enough to weld the sheets together. It requires pressure on a small spot and a heavy current for a very short time. The process is very widely used. It is very useful for attaching handles to sheet metal vessels and for putting together the metal frames of furniture and various light structures. Spot welding takes the place of riveting. It is much more rapid to make than riveting, and it has many points of advantage as regards strength and efficiency.

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## Camber of Beveled Cone

Q.—Will you please give me information on how to lay out the camber of a large high-beveled cone without scribing the radius line, shown in Fig. 1. J. S.

A.—According to this method, as shown in Fig. 2, an outline of the middle section of the cone is made as at *ABCD*. Draw the center line *ab* and lay off on this the height and the two diameters and complete the outline by drawing the tapering sides. Then lay off on each side of this outline an equal and similar one as shown.

The construction curves show how these may be laid out most easily. Draw the diagonals of the central figure and use these as radii, drawing the curves as shown. Then use the two diameters of the middle figure for radii, and with the corners of the figure as centers describe arcs intersecting the large arc. These intersection points will mark the outer corners of the areas. Complete the figures by drawing the diameters *AE*, *BF*, *CG* and *DH*. The pattern now consists of three areas constructed on the diameters of the cones. As the total circumference is equal to 3.1416 times the diameter, it follows that a slight addition should be made to each side in order to make a length equal to the diameter multiplied by 3.1416. After multiplying each diameter by this constant, divide the product

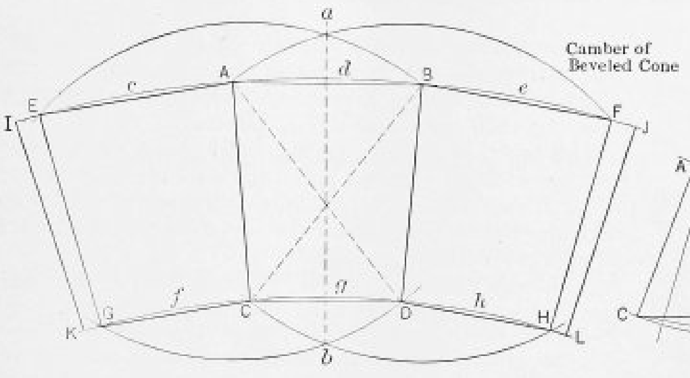

Fig. 2.—Camber of Bevel Cone

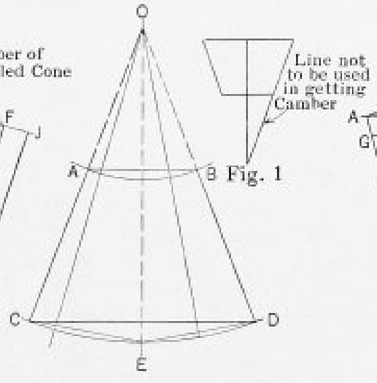

Fig. 3.—Curves Laid Out from Center

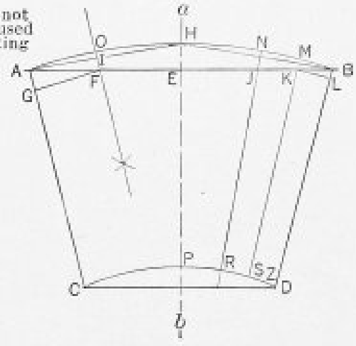
Fig. 4.—Chord and Radial Line Construction Without a Center

by 2 and lay off the quotient as the lengths *IE*, *FJ*, *KG* and *HL*. In addition to these lengths it will be necessary to lay off a width equal to the required lap, so as to form the joint. After getting the points, such as *E*, *A*, *B*, *F*, etc., draw through these a smooth curve such as *c*, *d*, *e*. These curves would be drawn by the use of a flexible template, or in any other way that is most convenient.

### Alternative Method

The second method consists of drawing radial lines by special construction so as to lay out points on the curve, this construction being formed by not getting the actual center of the curve. The method is the reverse of that shown in Fig. 3. In this case it will be noted that the center *O* is used to draw the curves *AB* and *CD* forming the ends of the pattern. The diameters are also drawn. Next the longest chords *CE* and *ED* are drawn. Then two or three intermediate radii are drawn and the chords are drawn to these. In all this construction the curve is used to locate the points to which the chords are drawn.

In Fig. 4 is shown the reverse of Fig. 3, in which the chords are drawn first so as to locate the points through which the curves can be drawn. In this case the diameters *AB* and *CD* are drawn on the centerline *ab*. Then some point *F* is located on the diameter *AB* so that the distance *FG*, perpendicular to *AC*, will equal *FE*. This is done by construction. Then through the point *F* draw a line bisecting the angle *GFE*. This is done by construction by using the points *E* and *G* for centers and drawing the arcs *x* so as to locate a point through which the radial line will pass. From the corner *A* draw the line *AH* perpendicular to the radial line, as at *I*. This line *AH* will be the chord of the curve and the point *H* will be the highest point on the centerline. Draw *HB* for the similar chord.

Next draw another radial line by locating the point *K* so that the distance *KL* perpendicular to *BD* is equal to *KJ* and bisect the angle *JKL*, giving the radial line *MS*. Then from the corner *B* draw the perpendicular *BM* to this radial line and extend it so as to locate the point *N*, which will be a point on the curve. Finally draw a smooth curve through these points in any way that is convenient and thus complete the end of the pattern.

In order to get the curve *CPD* at the bottom of the pattern, use the points at the top as centers, and with *BD* for the radius draw arcs locating the points *P*, *R* and *S*. A curve through these points will give the end of the pattern.

The pattern as laid out above represents that on the diameters of the cone, which is about one-third of the total pattern. Use this layout and place it on the sheet metal side by side so as to give an area of three times, and so that the curves at the top and the bottom will be continuous. Then on each end of the pattern lay off an additional distance equal to half the product of the diameters multiplied by 3.1416. In addition to this, lay off whatever may be required for the lap to form the joint.

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## High-Speed Tool Steel

Q.—What kind of steel is a high-speed drill made of, and how many degrees of heat does it take to temper a drill and why are they not used more extensively? J. F.

A.—High-speed drills are made from high-speed tool steels, which are alloys of iron, tungsten, manganese, chromium, titanium, etc. When steels of this kind are heated to a white heat and allowed to cool in the air they become very hard and are spoken of as self-hardening or air-hardening steels. The directions given by the makers should be followed in handling tools of this grade of steel.

To temper high-speed tool steel, heat the metal to a white heat slowly in a non-oxidizing fire. Cool it in oil or air. Compressed air is used by some tool makers in drawing the temper. Hot oil is recommended for reamers, drills, punches and dies.

Tools made of this steel are expensive, which may restrict their extensive use in boiler shop work. Only experienced and careful drill operators should be employed to use drills of this character.

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## Rules on Locomotive Boilers

Q.—Please inform me where I can get a book on the simplest authoritative methods of ascertaining specifications and measurements of locomotive boilers. R. W. J.

A.—Replying to your inquiry, will advise that the rules adopted by the Railway Master Mechanics' Association on design, construction and inspection of locomotive boilers are recommended. Write to the Railway and Locomotive Engineering Journal, 114 Liberty street, New York City, for a copy of the book containing these rules.

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At a recent meeting of the directors of the Davis-Bournonville Company, Jersey City, N. J., DeWitt V. D. Reiley, formerly vice-president, was elected president of the company to succeed Augustine Davis.

# Letters from Practical Boiler Makers

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

## Average Life of Punches and Dies

The chart, Fig. 1, shown herewith, was made up from records kept of the number of holes punched by each of several score of punches, together with the thickness of material punched.

Very few of the punches were repaired, as in nearly all cases when a punch broke the fracture was so close to the head that the punch was beyond repair.

In the few cases where a punch could be repaired it was retempered and put back into service. In the chart no account is taken of the repairing, the total number of holes punched up to the time the punch was totally destroyed being the number used in making up the record.

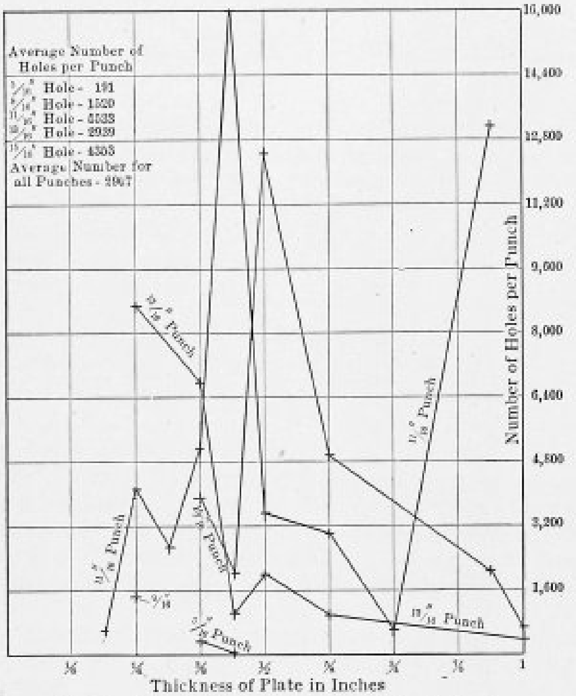



Fig. 1.—Chart Showing Average Life of Punches

The punches were not all of the same make, and no attempt was made to compare the production of the different manufactures, as it was felt that the conditions under which these tools work are too variable to afford any just criterion of the merits of any one punch.

The records were made from the output of about twenty punches of each size, working on stock material just as it happened to come through the shop. In nearly all cases each punch was used on one thickness of steel.

The quality of steel was in all cases the standard structural steel, and the dies were all 1/16 inch larger in the hole than the diameter of the punch.

The punching was done on a variety of machines, all in fair average working condition, no attempt being made to reach a record number of holes per punch, the idea of making the test being to get a line on what life might be expected from a punch under everyday conditions.

The points in the chart marked with a + represent the average number of holes punched by the punches of the size marked, in the thickness of material shown on the chart. These points are shown connected by straight lines for each individual size of punch.

The table accompanying the chart gives the average number of holes punched by all the punches of each size in all thicknesses of steel. These averages are totaled up and again averaged to show the mean output of all sizes of punches in all thicknesses.

As is well known, the life of punches, even of the same size and working on the same thickness of material, will vary from a few holes up to 20,000 or more. But when it is required to estimate the future needs, this chart will afford a fairly accurate idea as to the number of punches necessary to complete a certain piece of work.

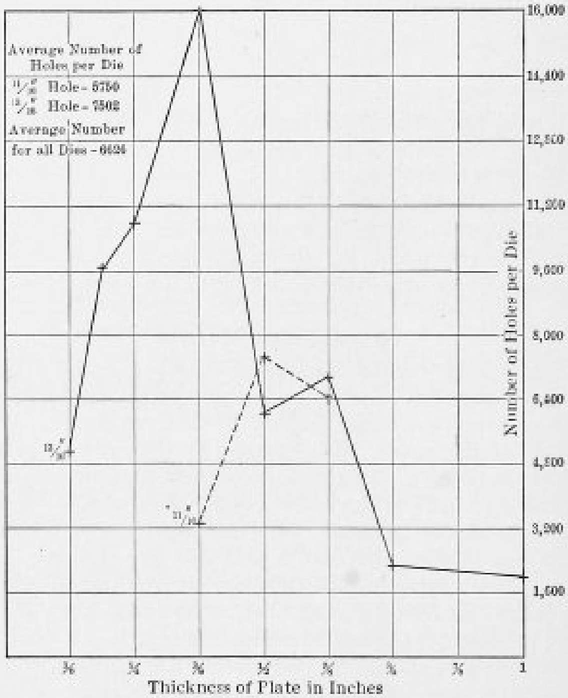



Fig. 2.—Chart Showing Average Life of Dies

It is interesting to note the marked similarity of the curves for the 11/16-inch and 15/16-inch diameter punches. These show that we can expect the longest life when working on 7/16-inch to ½-inch plate, and that on either thicker or thinner steel the production per punch falls off very rapidly.

The chart shows the life of an 11/16-inch punch in 15/16-inch steel to be 13,000 holes, but this particular number represents the record of only one punch, and is really a rather remarkable performance. If the average life of a number of this size of punch in 15/16-inch steel were available no doubt this quantity of holes per punch would be very considerably less.

The comparatively short life of the 11/16-inch and 15/16-inch punches in thin plates is probably due to the tendency of the plates to stretch under the punch and flow into the die thus jamming the punch.

It would probably be conducive to a longer life of the punch if the die were made only 1/32 inch larger than the punch when working on steel of a thickness of 3/8 inch or under.

Whether this saving in punches would pay for the extra cost involved in handling two sizes of dies for each size of punch will depend upon the kind of work being handled.

Fig. 2 is a similar chart for dies, and what has been written above in reference to the punches is equally applicable to the dies.

New Glasgow, N. S. John S. Watts.

## Oxy-Acetylene Welding and Cutting

There is no question but that welding in general and oxy-acetylene welding in particular is steadily gaining in favor in the boiler industry, as is evidenced by the number of shops in which its use is gradually being extended in regular production.

Although it has been condemned by some individuals, the causes of failures of oxy-acetylene welding are generally traceable to the inexperience or poor workmanship of the operator. To become a good welder or to be efficient in any line of work, it is necessary that a man must like that work and try his hardest at all times to produce the best results of which he is capable.

In the case of oxy-acetylene welding, the operator must study the action of the metal when subjected to the intense heat produced by the flame and understand why the welding progresses as it does. He must watch his flame and keep it neutral and be sure that he is actually welding and not simply sticking the metal from the filler rod onto the piece being welded. He must learn how to handle his torch and the filler to the best advantage. He must also be a cold-blooded sort of chap to be able to stand the intense heat in which he must sometimes work if he is welding a piece surrounded by a bed of red hot coals, as happens when preheating is necessary.

In the shops where the writer is located the torch is put to every possible use in the work. In its cutting capacity it is used to burn out all staybolts and old sheets and to cut all rivets. If the operator is careful, he can bevel the sheets to be welded with the cutting torch and save time and labor that would be required to do the same work with a chisel and air hammer.

Ash pans are in a great many cases welded now and seem to give as good service as pans with angle irons and

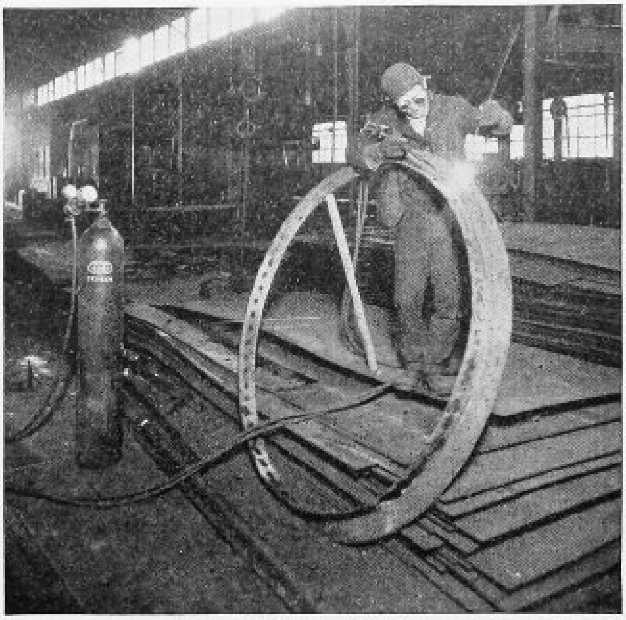


Fig. 4.—Top Section of 100-Foot Steel Stack Being Fabricated in Pennsylvania Shop for Erection in China

rivets. In building up ash pans the pieces of plate may be riveted to the casting before or after welding. The sides of the pan are held together at the top by a wire clamp. Before the welding is started, thin wedges are driven between the edges of the plates, forcing them apart about 1/4 inch.

All tool boxes used by the engine crews are welded. These boxes are built up of No. 12 gage sheet iron and are 18 inches long, 8 inches wide and 8 inches deep. Welding is done from the inside, the outside edges being smoothed after the operation is completed.

The great speed that can be accomplished in doing any of this shop work by means of welding is very much in favor of the process.

Recently it was necessary for the men in the shop to put a patch in the left back mudring corner of an engine. The patch was to cover an area which included two staybolts, eight mudring rivets on the door sheet, three mudring rivets where it lapped onto the side sheet, and three rivets in the running seam. It took just eight hours for a boiler maker, a helper and a welder to remove the old

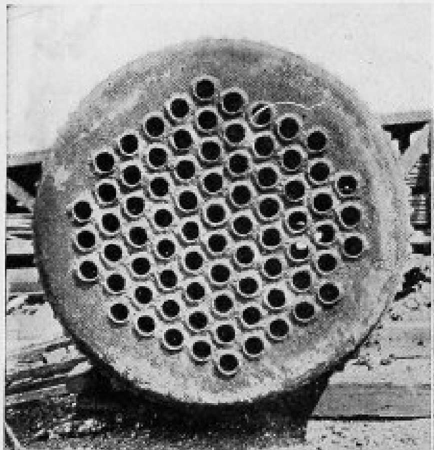


Fig. 1.—Set of Flues Welded to Top Flue Sheet of Pump Boiler

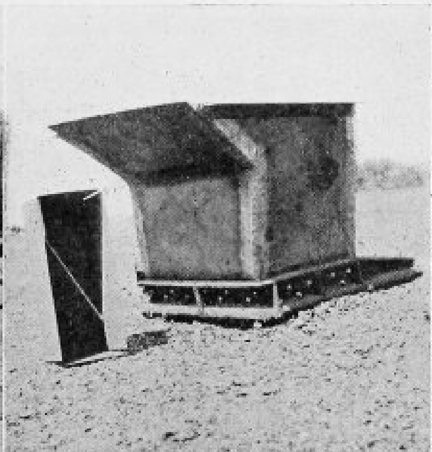


Fig. 2.—Locomotive Ash Pan and Tool Box Welded and Ready for Installation

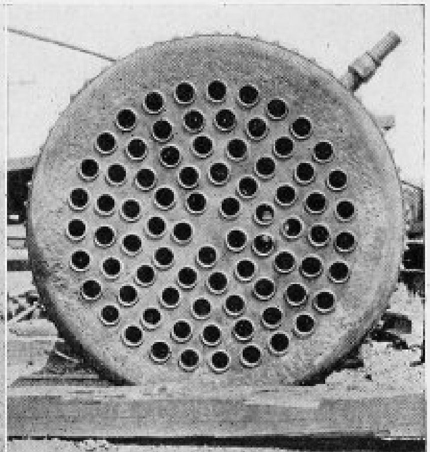


Fig. 3.—New Tube Area of Top Flue Sheet of Pump Boiler Welded in Place

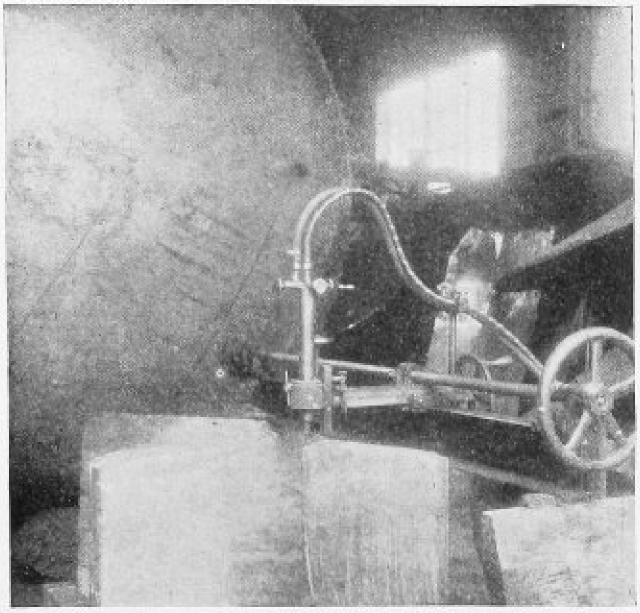


Fig. 5.—Oxy-Acetylene Cutting Device of Simple Construction, Which is Effective in Plate and Casting Work

piece and weld the patch into place. All that remained after this was to drill the holes for the mudring rivets, drive the rivets, apply the two staybolts, and chip and calk the patch.

Incidentally, the cutting torch was used to burn off the staybolts and the old sheet, as well as to preheat the patch when it was being laid up.

As yet we have not had to install any new side sheets or flue sheets, but probably will in the near future. When this becomes necessary, we intend to try cutting out the top of the back flue sheet just below the braces and weld in a new top piece, as several of the flue sheets are badly worn in the tube area, but perfectly sound below.

I should like to hear more from the readers of THE BOILER MAKER of their experiences with the oxy-acetylene torch and welding in general, for I believe the process to be one of the greatest helps in the work of the present-day boiler shop.

Denver, Colo. ARTHUR MALET.

## Tube Sheet Layout

The method of laying out tubes described in the June, 1919, installment of "How to Design and Lay Out a Boiler—VIII" omitted an explanation of the A. S. M. E. requirements in this connection. A study of the Boiler Code indicates that the rules governing tube spacing are not clear unless the student makes a thorough investigation of the subject. For the purpose of clearing up some of the difficulties, the following explanation is given:

### DETERMINING WIDTH OF BRIDGE

The tangential distance, or width of the "bridge" measured in any direction between adjacent tubes, shall not exceed that found by the following formula:

$$(x) \qquad P_2 = \sqrt{\frac{C \times T^2}{P}},$$

in which:

$P_2$ = tangential distance between edges of tube holes when measured in any direction.

$T$ = thickness of plate in *sixteenths* of an inch.

$P$ = maximum allowable working pressure, pounds per square inch.

$$C = \begin{cases} 112 \text{ for plates } not \text{ over } 7/16 \text{ inch thick} \\ 120 \text{ for plates over } 7/16 \text{ inch thick.} \end{cases}$$

For our case, formula ($x$) becomes:

$$P_2 = \sqrt{\frac{120 \times 9 \times 9}{150}} = 8.05 \text{ inches, say 8 inches.}$$

Concerning the tangential distance between the edges of tube holes and the outside face of the tube sheet flange, the Code has the following to say:

"That part of the tube sheet which comes between the tubes and the shell need not be stayed, if the distance to the nearest tangent common to two tube holes, when measured on any radius of the tube sheet that intersects the tangent between the holes, does not exceed that found by the following formula:

$$(y) \qquad p_3 = \sqrt{\frac{C \times T^2}{P}} + 3,$$

in which the notations are the same as for formula ($x$)."

The above rule, as given by the Code is almost incomprehensible to many persons, and for the purpose of clarifying the statement, Fig. 27(a) is appended, which is a diagrammatic illustration of what the above rule is meant to imply.

No further explanation should be necessary in connection with the above illustration, other than that the process is performed on each pair of adjacent tubes in the bounding rows, as shown, and none of the dimensions $p_3$ should exceed that found by formula ($y$).

For our case, formula ($y$) becomes:

$$p_3 = \sqrt{\frac{120 \times 9 \times 9}{150}} + 3 = 11 \text{ inches.}$$

Both formulae ($x$) and ($y$) appear to have given over-generous allowances, but this is only true in boilers having thick tube plates such as ours. It is not difficult, generally, to overcome this condition when there are plenty of tubes to be distributed over the sheet, but care must nevertheless be exercised so that these distances will not be

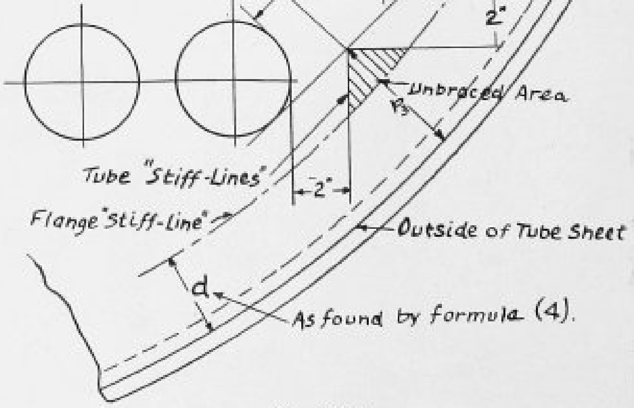



Fig. 27(a)

overreached. If the type of boiler and the conditions warrant it, the spaces may be increased beyond the above limits, providing the surface in question is substantially braced.

Reference must, however, be made to Fig. 27 (page 160,

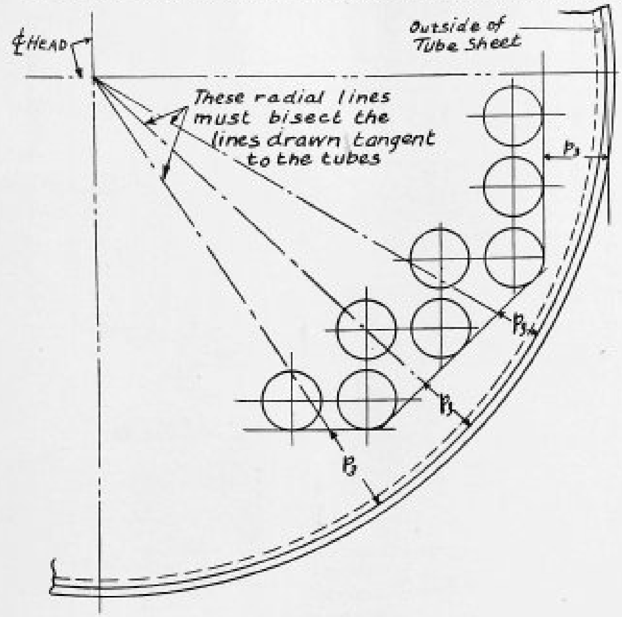



Fig. 27 (b)

June, 1919, Boiler Maker), in which attention is called to the small cross-hatched triangular segments at each side of the tube sheet, and lying between the two lower rows of tubes. Formula (y) particularly refers to such conditions, which, for convenience, are again illustrated, but to a larger scale, in Fig. 27(b).

The illustration is self-explanatory, except that it will be stated if dimension $p_2$ exceeds that found by formula ($x$), then dimension $p_3$ must be measured to the inside tube. If, in any case, $p_3$ exceeds that found by formula ($y$), then the segment must be braced.

## Position Drilling versus Separate Drilling

*(Continued from page 137.)*

discouraged. They have, therefore, caused the following rules to be prepared:

"When the cylindrical shells of boilers are made of material which has been duly tested and approved, *with all the rivet holes drilled in place* and all the seams fitted with double butt straps, each of at least five-eighths the thickness of the plates they cover and all the seams at least double riveted with rivets having an allowance of not more than 87.5 percent over the single shear, *provided that the boilers have been open to inspection during the whole period of construction,* then 4.5 may be used as the factor of safety, the minimum actual tensile strength of the plates being used in calculating the working pressure."

The intention of the Board of Trade is clearly indicated in the following extract:

In the case of the national emergency just passed, many things are expedient that are not justified in normal times. This may explain the less rigorous enforcement of rules designed for the more ordinary practice. The saving clause in the footnote to the rule penalties as to reaming or boring out in place is not in the discretion of the surveyor but a matter for original consideration by higher authority. It can safely be taken for granted that remission of sentence is not given lightly; no one need think that it is merely a matter of reference and casual consent. It is moreover certain that the job will have to be absolutely equal in every respect to position drilling, a condition very difficult to satisfy where extra careful scrutiny is given by a thoroughly competent expert who has to report on a special case, with a clearly expressed predilection for position drilling to guide him.

### Advantages of Position Drilling

My point was, and still is, that in all cases position drilling is superior. It is, all things considered, the cheapest and most expeditious method, is always granted the highest classification without question, and up to the present it is the best way to hole high-pressure boilers.

As stated by me long ago, punching has been abandoned by progressive structural yards, who drill all thickness simultaneously, and so position-drill for bridge members and roof trusses. They find it cheapest, reassembly presents no problem, the fabricated details assemble again like the proverbial clock. Reaming is a means of partially correcting an initially imperfect job, when it is more simple to have the job right to begin with.

That is my case. I maintain it is strong and overwhelmingly in favor of position drilling. Common horsesense approved it. All British shops doing decent work use no other method. The change-over has been within my own industrial experience and to a very large extent has been coincident with the introduction of mild steel plate in place of wrought iron, the general adoption of which has come within the last twenty years.

## PERSONAL

Frank Culver has resigned his position as superintendent of the Geneva Boiler Works, Geneva, N. Y.

V. J. Hartley, formerly superintendent of the Badenhausen Marine Engine & Boiler Works, Philadelphia, Pa., and the Rummeli-Dawley Company, St. Louis, Mo., is now marine superintendent of the W. F. Spice Steamship Company, Baltimore, Md.

James Crombie, formerly plant manager and general superintendent of the Badenhausen Company plants located at Bridgeport, Norristown and Cornwells, Pa., is now associated with the John O'Brien Boiler Works Company, St. Louis, Mo.

The annual stockholders' and directors' meeting of the Independent Pneumatic Tool Company was held in Chicago, Ill., Friday, April 23, and the following directors were elected to serve for the ensuing year: Boetius H. Sullivan, John D. Hurley, Leonard S. Florsheim, August Gatzert, James J. McCarty, William A. Libkeman, Ralph S. Cooper, Robert T. Scott, Edward G. Gustafson, Fletcher W. Buchanan. Officers were elected as follows: Boetius H. Sullivan, chairman of the board; John D. Hurley, president; Ralph S. Cooper, first vice-president; Robert T. Scott, second vice-president; Fletcher W. Buchanan, secretary; Edward G. Gustafson, treasurer. Boetius H. Sullivan is a son of the late Roger C. Sullivan, and was elected to fill the vacancy made by his father's death. Robert T. Scott, the newly elected second vice-president, who has been connected with the company for the past fifteen years and has been manager of the New York office, will continue his headquarters here. The report shows great progress in the company's business. There has been not only a steady increase in pneumatic tool sales, but the company is now strongly established in its electric drill department and has also commenced to manufacture a complete line of pneumatic motor hoists.

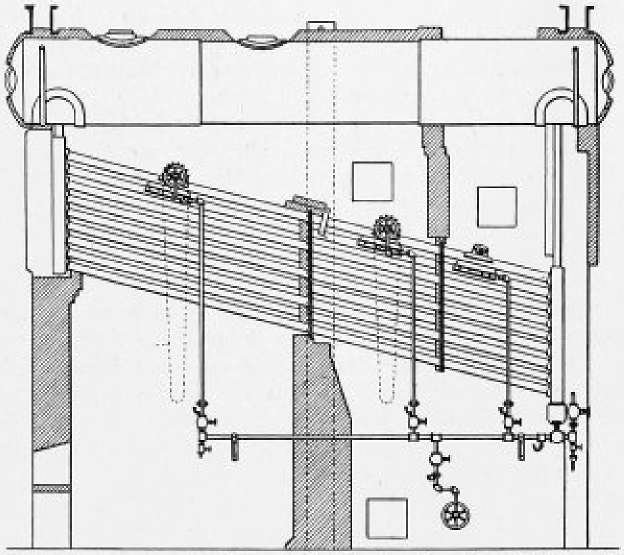
## Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,318,293. SOOT CLEANER. FREDERICK W. LINAKER, OF DUBOIS, PENNSYLVANIA.

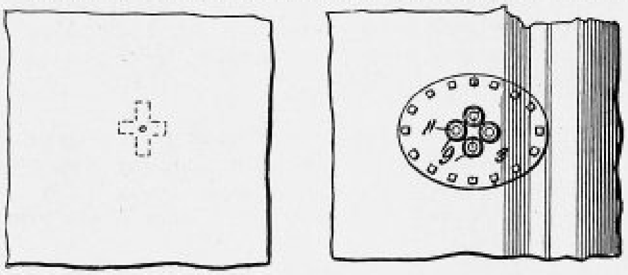
*Claim* 1.—In a soot cleaner for watertube boilers, the combination of a revolubly mounted cleaning fluid distributing pipe having radial



outlet openings, the jets from each opening adapted to discharge in planes at right angles to the longitudinal axis of the pipe, means for supporting the pipe above the tubes of the boiler, and means below and spaced from the pipe for protecting the tubes and deflecting the jets of cleaning fluid from the openings into the passages between the tubes. Ten claims.

1,327,846. BOILER PATCH. EVANDER TODD, OF WINN, ALA.

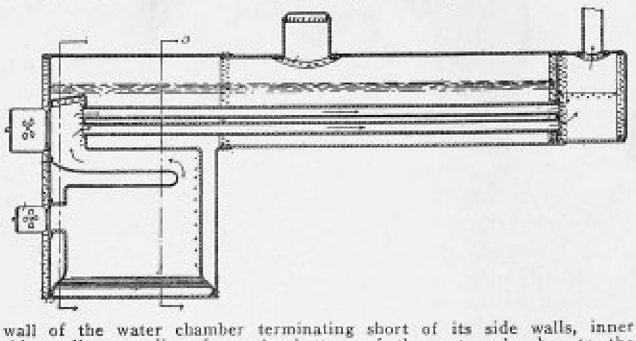
*Claim* 1.—A boiler patch comprising a plurality of bolts having angular



extension heads to fit the inner faces of the boiler to be patched, and a plug shaped to be inserted between and to close the space between the bolts. Six claims.

1,328,303. LOCOMOTIVE BOILER. WILLIAM SHINN, OF GRANDIN, MO., ASSIGNOR OF ONE-HALF TO CHARLES SHINN, OF GRANDIN, MO.

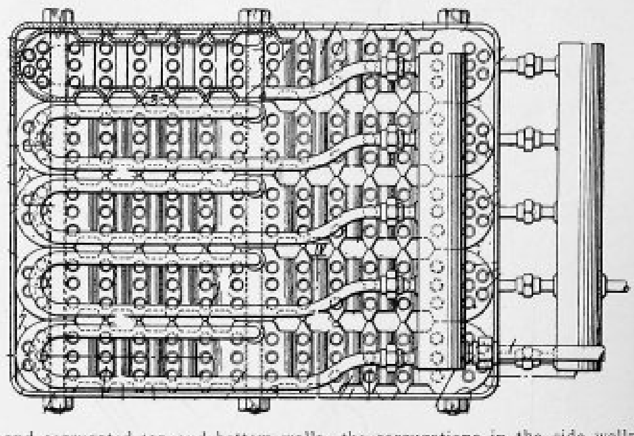
*Claim* 1.—In a steam boiler, a water chamber, a fire-box, disposed below the head end of the water chamber, the rear portion of the bottom



wall of the water chamber terminating short of its side walls, inner side walls extending from the bottom of the water chamber to the bottom of the fire-box and spaced from the side walls of the water chamber and secured to the same at the lower ends thereof, spaced inner and outer walls extending from the bottom of the water chamber and constituting the front wall of the fire-box and secured together at their lower ends, and spaced crown sheets extending across the fire-box below the water chamber and spaced from the inner front wall of the fire-box and forming a water compartment in communication with the spaces between the inner and outer side walls. Two claims.

1,327,188. STEAM BOILER. FREDERICK W. BALSTER, OF WILMINGTON, DEL.

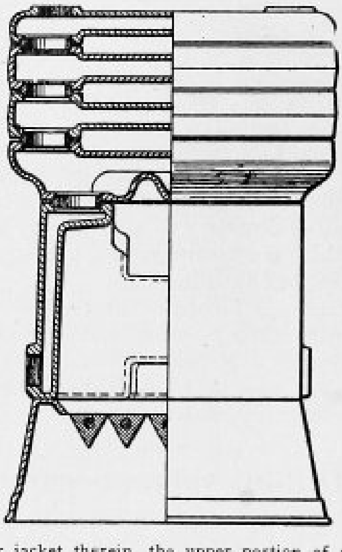
*Claim* 1.—In a steam boiler, sections made up of corrugated side walls



and corrugated top and bottom walls; the corrugations in the side walls being offset with respect to the corrugations in the top and bottom walls and disposed in planes parallel thereto. Twenty-one claims.

1,317,461. SECTIONAL BOILER. WILLIAM R. STOCKWELL, OF IRVINGTON, NEW YORK.

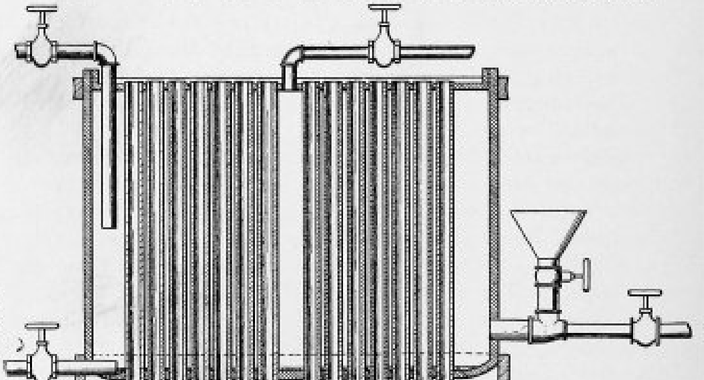
*Claim* 1.—In a sectional boiler, the combination with a combustion chamber section the upper portion of which has a straight vertical outer



wall and a water jacket therein, the upper portion of said water-jacket extending inwardly to provide a socket for a push-nipple, a removable combustion-chamber top having a push-nipple socket on its under side superposed and corresponding to the socket in the upper portion of the jacket of the combustion chamber, a nipple extending through both sockets, the combustion chamber top also having an outward extension in its upper portion and provided therein with a socket for a push nipple, and a push-nipple in said socket for establishing water connection with the upper sections. Two claims.

1,317,658. METHOD OF STOPPING LEAKS IN BOILERS AND THE LIKE. PHILIP D. JOHNSON, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-HALF TO CHARLES A. BROWN, OF HINSDALE, ILLINOIS.

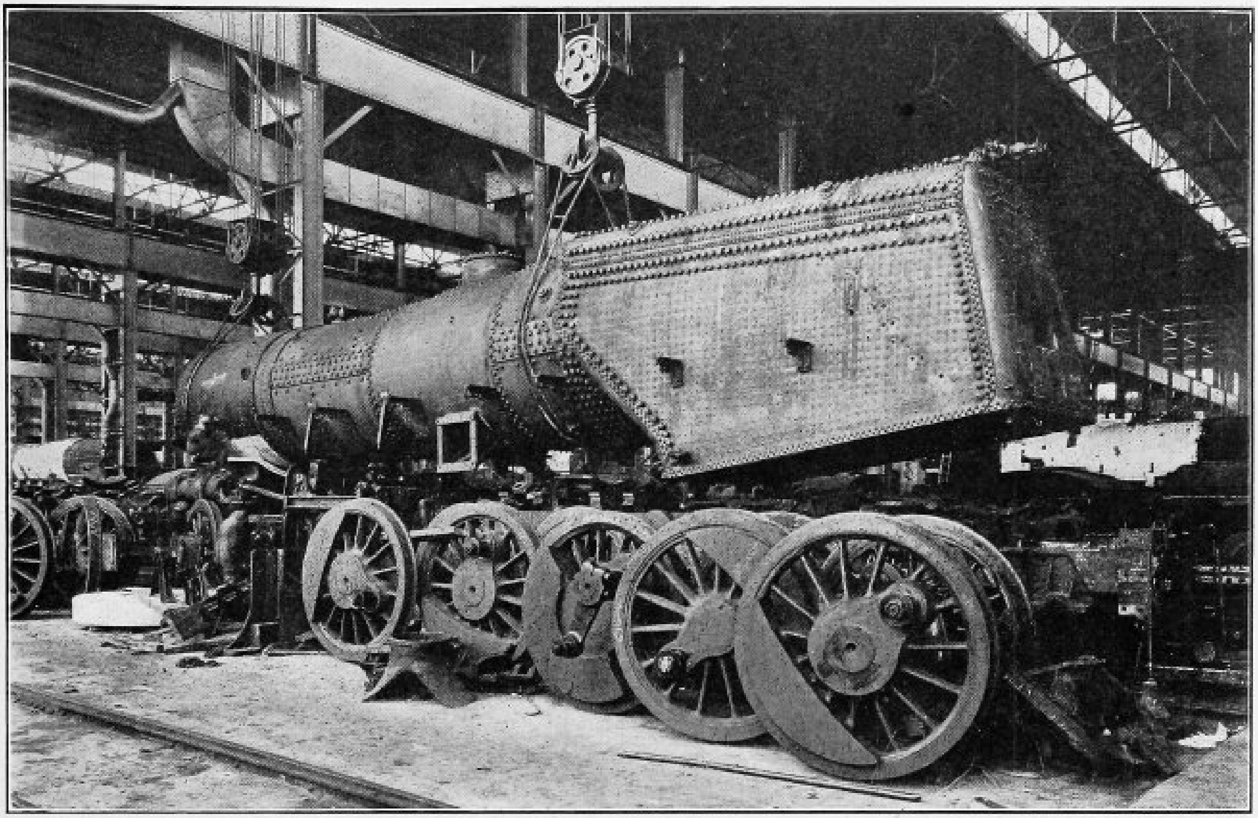
*Claim* 1.—The process of closing leaks in a boiler which consists



in partially filling the boiler with water, then adding lye to the water to form a strong caustic solution, then heating the solution in the boiler to the boiling point, and then blowing off contents. Three claims.

# THE BOILER MAKER

JUNE, 1920



View in Eddystone Erecting Shop

# Locomotive Construction in the Baldwin Works at Eddystone*

*The Baldwin Locomotive Works were founded in 1831 by Matthias W. Baldwin, and year by year the works and their activities were enlarged until the present capacity is three thousand five hundred locomotives per year. The fifty-thousandth locomotive was completed in September, 1918.*

The gigantic enterprise of the Baldwin Locomotive Works employs today 21,500 men, which is a greater number of persons than the population of many of our smaller cities. The Philadelphia plant covers 19.3 acres of ground and at that point are located the main offices, the drafting rooms and the principal machine shops.

The Eddystone plant is located on the shore of the Delaware River, and the panorama of this plant gives an idea of its extent. The buildings here include foundries, blacksmith shops, machine shops, two erecting shops and various other buildings. The tract covers nearly six hundred acres of ground and there is ample room for future extensions.

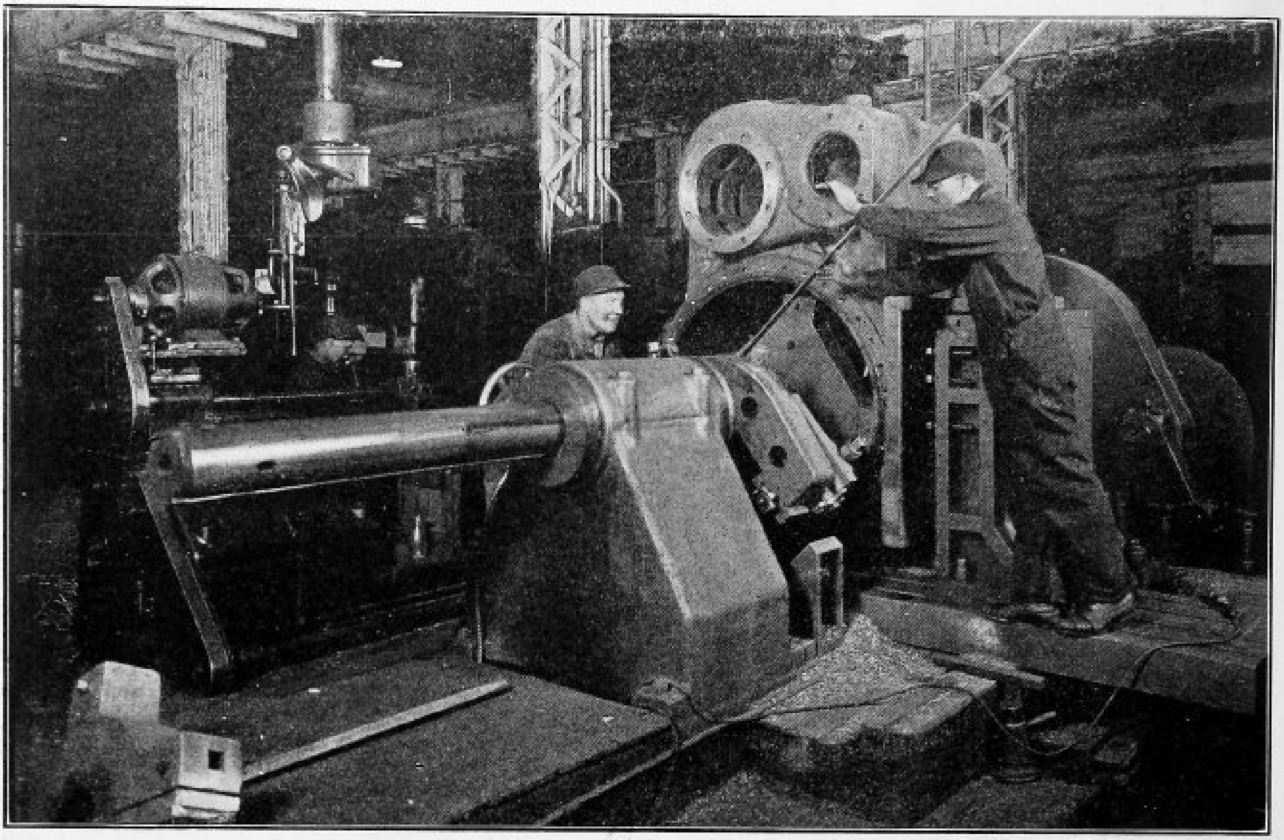
* From a lecture delivered at the March meeting of the St. Louis Railway Club by Arthur S. Goble, St. Louis representative of the Baldwin Locomotive Works.

The steel storage yards at Eddystone cover several acres and large quantities of raw material used in the construction of locomotives are stored there.

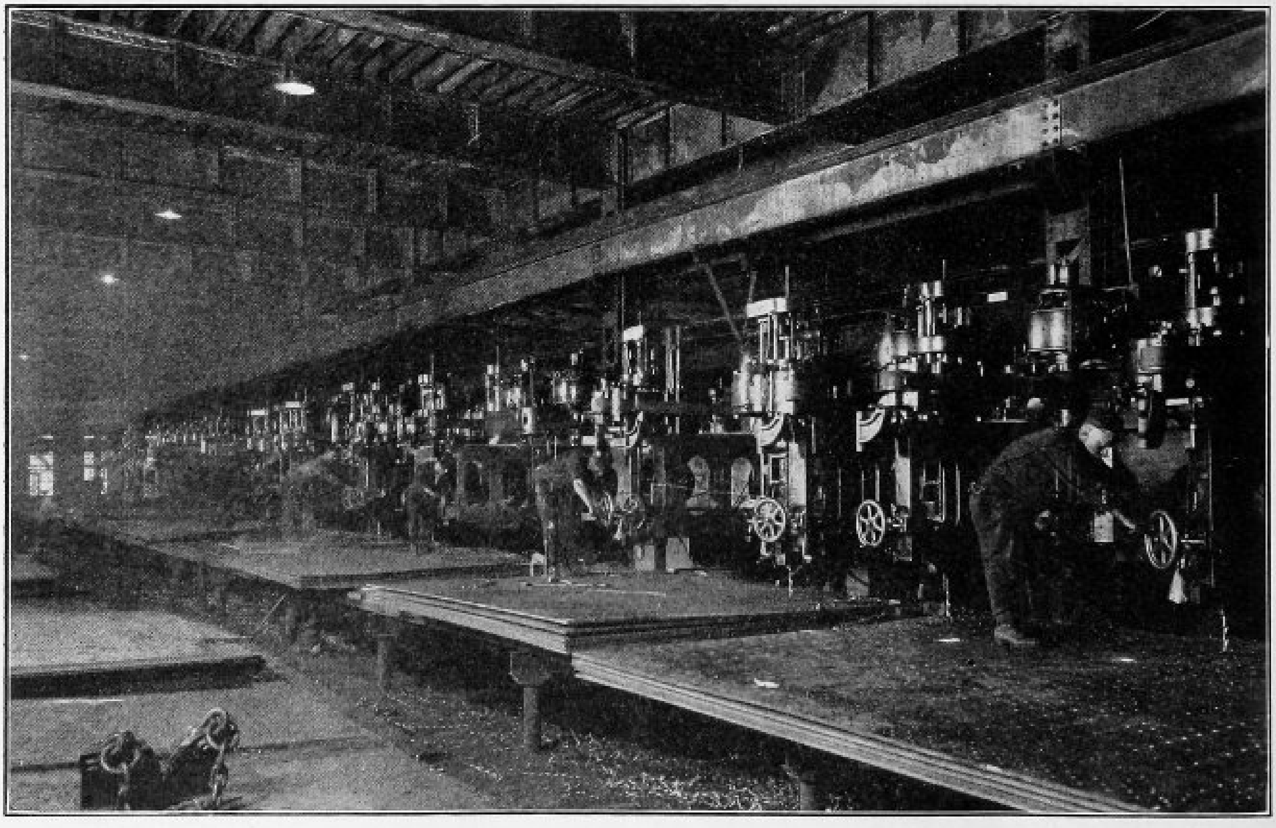
The building of "Iron Horses" is a real man's job, and each man brings to the work a regular appetite, and this is most efficiently looked after at the Eddystone cafeteria, where 900 hungry men can be accommodated at one sitting. Meals are served four times every twenty-four hours to both the day and night shifts.

### Foundry Work

The cylinder is one of the largest castings used in a locomotive. It is of hard iron and is cast in a sand mold. The mold is made in a large iron box or "flask," within which a wooden pattern of the cylinder is first placed.



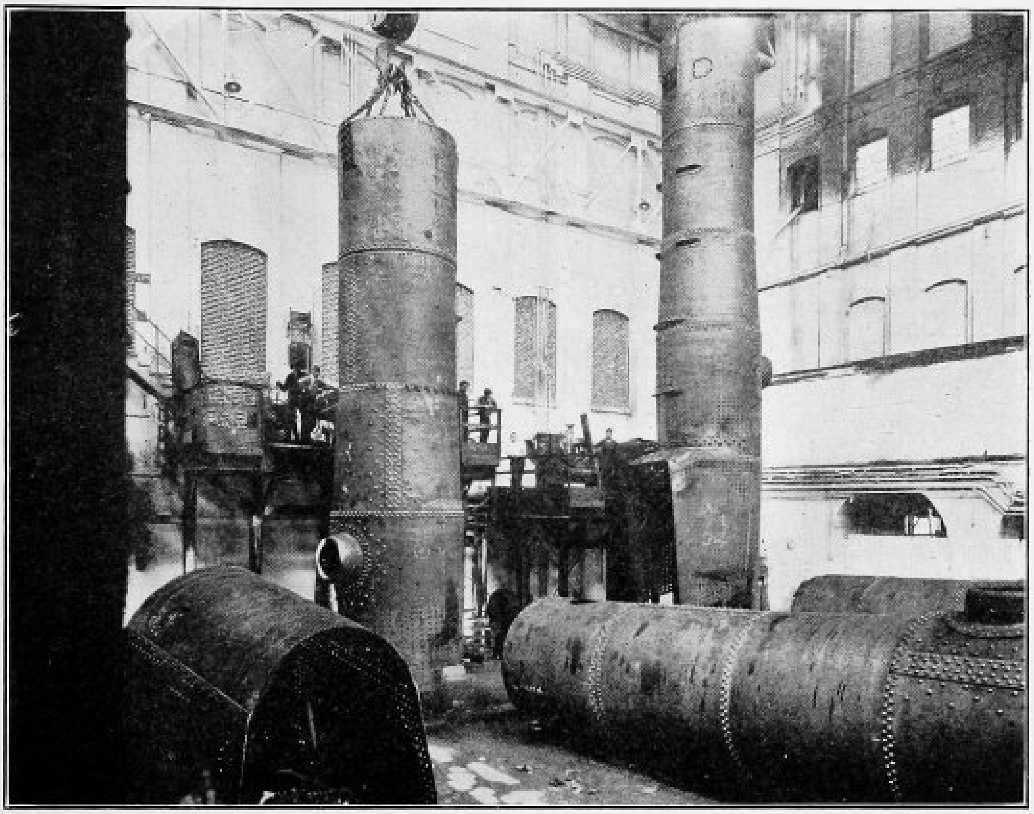
Cylinder Boring Mill in Operation



Multiple Boiler Plate Drills

The "flask" is filled with sand by means of a clam-shell bucket suspended from a traveling crane, and the sand is rammed tight by "jolting" the flask on a molding machine. The pattern is then carefully withdrawn, leaving its impression in the sand. The various passages and hollow spaces in the casting are formed by placing "cores" within the mold. The iron which is to form the casting is melted in a cupola, which is charged with iron, coke fuel and limestone. After the iron is melted it is drawn from the cupola and run into a large ladle. The iron is poured from the ladle into the mold, six tons being used in casting a large cylinder. After the casting has cooled and has been removed from the mold it is thoroughly cleaned. Compressed air is used to blow out the cores, and air chisels used to smooth off the rough edges of the castings.

The casting is next sent to the machine shop and "laid out" for machining. A specially designed machine bores the cylinder barrel and faces both ends simultaneously. The flat surfaces of the cylinder casting are then planed and the holes in the cylinder casting are drilled to gages and the cylinder is then carefully tested for defects under hydrostatic pressure. Next the cylinder bushing is applied and before the cylinder leaves the shop the machine work is carefully checked.



Philadelphia Plant Boiler Shop

### Fabricating a "Baldwin" Boiler

In the construction of boilers in "Baldwin" shops, standard practice is followed, with certain special variations developed for increasing production.

First, the rivet and staybolt holes on the boiler plates are located, preparatory to punching and drilling. Multiple-spindle drilling machines drill through five plates simultaneously. The flat plates are bent to a circular form in the bending rolls and such parts of the boiler as the tube sheets, throat sheets and steam domes are flanged into shape on hydraulic presses. Two additional operations on the press are required before the dome assumes its final shape.

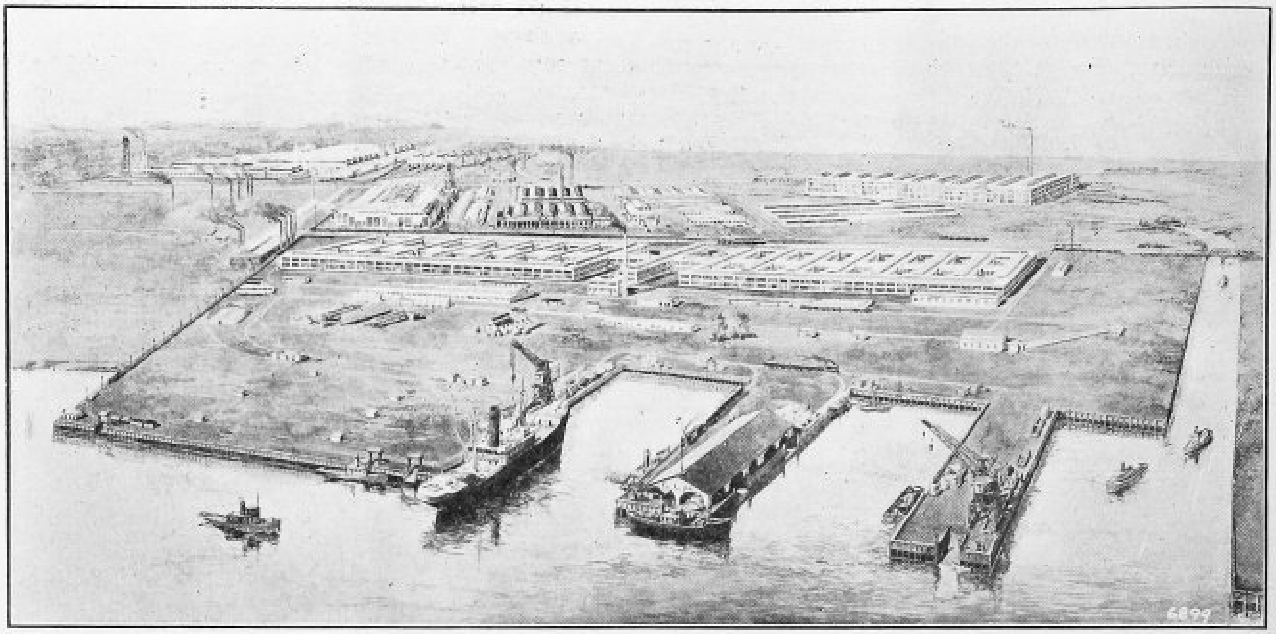
The boiler sections, after being temporarily bolted together, are placed in a vertical position and the permanently riveted on a large hydraulic machine. Holes for the firebox staybolts are tapped with portable pneumatic machines and the staybolts are then inserted and riveted over the heads.

The firebox seams are welded by means of an electric arc machine and the completed boiler is then tested.

### The Blacksmith Shop

Some of the most spectacular work is done in the blacksmith shop, where forgings, big and little, are turned out. Steel guide bars and the heavy equalizing beams are forged here under a steam hammer. Many of the lighter parts are forged in dies, the boiler brace jaws being so made. After the jaws have been forged they are trimmed to shape in a power-driven press. Bolt heads are die-forged on special machines and these forge heads on individual 1¼-inch bars. Still other machines cut the heated bars to the lengths desired and also forge the bolt heads.

The assembling of the driving wheels, axles and tires is an interesting process in the building of a locomotive. The key-way in the wheel hub is cut on a specially designed slotting machine. The finished axle is a trifle larger than the bore in the wheel hub and it is forced into the wheel on a hydraulic press. With a cast steel wheel and a large axle, the pressure gage shows a maximum thrust of 180 to 200 tons. The assembled wheels and axles are next put into a large lathe and the wheel rims are accurately machined. The tires are applied by shrinking them on the wheel centers, being first heated in a furnace to expand



Bird's-Eye View Eddystone Plant

them. The tires are then slipped over the centers, and as they cool they shrink and so bind themselves firmly in place.

The main frames are usually made of cast steel and are machined and finished. The cast steel frames are planed on large planing machines, while a slotting machine works on two sets of frames simultaneously. The frames are drilled to gages on multiple drilling machines and the finished frames are then assembled.

Next, the main and side rod forgings are ready for the milling machines. The side rods are bored for the crank pin brass and jaws are cut in the end of the side rod. The bolt holes are next drilled and tested with a stub gage, the connecting rods are polished and finished and made ready for the erecting shop.

The body of the crosshead is next planed and turned and laid out, preparatory to drilling. The crosshead keyway is drilled and the guides and crossheads fitted. The assembled guides and crossheads are now ready for the erecting shop.

The driving boxes are planed in groups on large planing machines and a specially designed slotting machine finishes the interior of the box.

The crown brass is accurately finished on a boring mill,

Main Office, Philadelphia

and the smoke box fronts are finished on another mill which takes two cuts simultaneously.

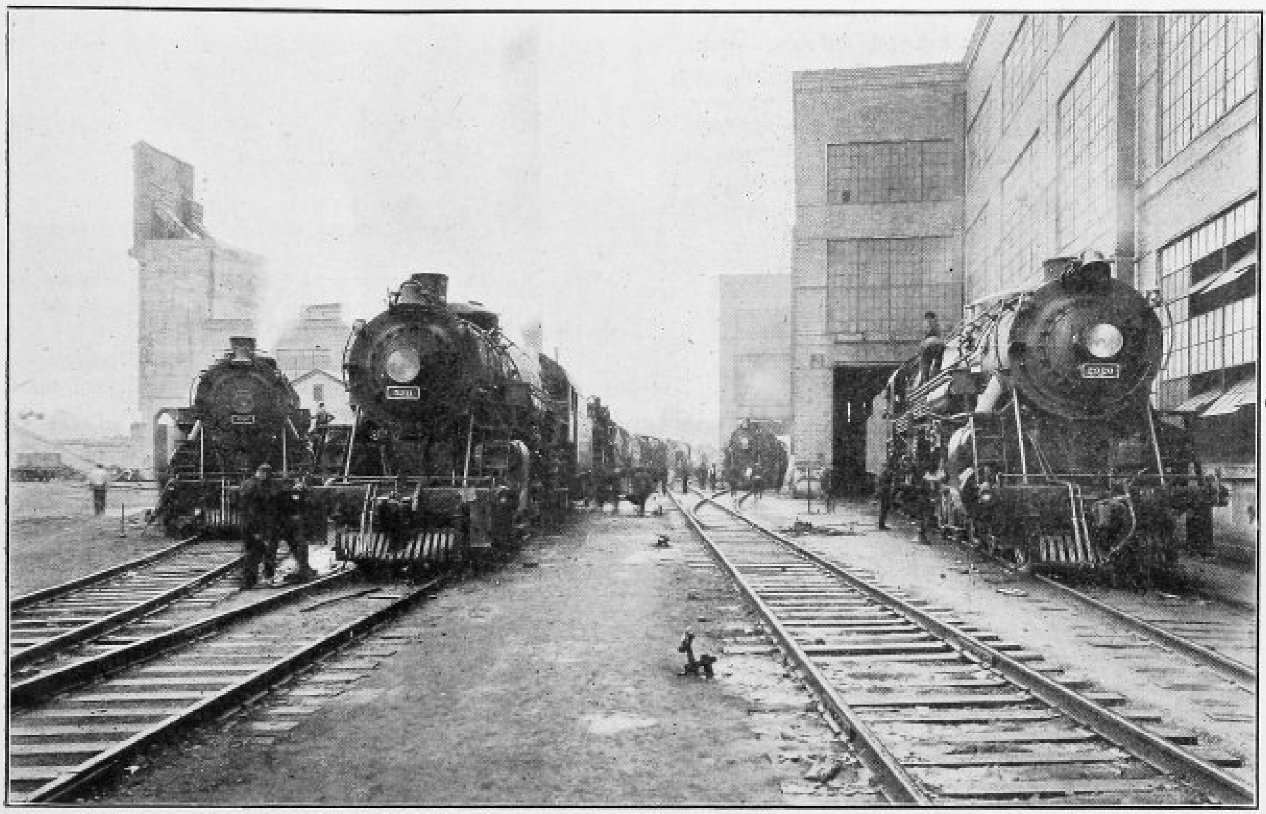
### Erecting Shops

The erecting shop in section E at Eddystone was built during the war period and represents the most approved type of shop construction. At this point the final assembling and erecting of the locomotives take place. Baldwin locomotives are built to gages and templates, so that the parts are received in the erecting shop ready to be put into place without further fitting or machining. Each erecting gang specializes in one operation, such as setting valves, putting up brass work, applying the boiler jacket, etc. A temporary wooden framework is placed over the boiler and is used for fitting the boiler jacket.

The locomotives are completed outside the erecting shop and a trial trip is then made on a testing track.

When looking over the completed "Baldwin" it does not require a vivid imagination to picture what would happen to anything that stopped to argue with it the right of way, and we are reminded of a story that is told about Robert Stephenson, the inventor of the first successful steam locomotive. Thinking to embarrass the inventor, one of a committee that had come to witness the demonstration said to him: "Suppose, Mr. Stephenson, that a cow were to get on the track, in front of your engine, what would happen?" Mr. Stephenson, who was a Northumberland man, replied: "It wad be verra bad for the coo."

For overseas shipments the plant includes a series of docks, served with 50-ton cranes. These cranes can pick up a locomotive intact and place it in the hold of a vessel.



Finishing Tracks at the Eddystone Plant of the Baldwin Locomotive Works

Before shipment the locomotives are carefully weighed, individual scales being placed under each wheel.

### Special War Work

It is interesting to note that during the war the Baldwin Works developed and built thirty-eight 7-inch guns on railway mounts for the United States Navy. In addition, several of the 14-inch naval rifles mounted on railway trucks, which were so successfully used in France, were built in these shops. Early types of this mount did not permit a higher angle of fire than 15 degrees, but the later equipment permitted fire at any angle.

## Testing Welds

In training welders to use either the oxy-acetylene torch or the electric arc apparatus, one of the first essentials is to instruct them in the necessity of not depending on the external appearance of the weld to determine the quality of the work. About the best way to show a welder what sort of work he is doing is to break some of his welds apart and continue to do this until he realizes that however smooth or sound the surface may appear, the interior of the weld may be very defective. The smooth surface may cover up blow holes, burned or oxidized metal and defective pieces of material.

By working under competent supervision the beginner very rapidly realizes what sort of work he is doing, and it is not long before he is able to produce nearly perfect joints.

The breaking of welds is about the most essential and helpful part of the education of a welder, for in this way he is able to learn by his own mistakes. For this reason it is good practice to commence work on small pieces of material that may be easily ruptured and examined.

## Work of the Boiler Code Committee

*The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone 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 following questions in connection with the design and construction of boilers have been submitted to the Boiler Code Committee of the American Society of Mechanical Engineers for decision during the past month.

Case No. 279.—Is it permissible under the requirements of the Boiler Code to construct steel heating boilers in diameters up to 72 and 78 inches with shell plates 1/4 inch in thickness? Is it the opinion of the Committee that boilers of the horizontal return tubular type so constructed have sufficient shell plate strength to permit of proper lug attachments for supporting the shell?

The section of the Code on heating boilers is incomplete in not specifying the minimum plate thickness to be used in the shells and tube sheets, and below which the thickness shall not be made in any case. The Boiler Code Committee recommends that until a revision be made to cover this class of boiler construction, the minimum thickness of shells and heads for various shell diameters of steel plate heating boilers shall be as follows:

| Diameter of Shell, Tube Sheet or Head | Minimum Thickness Allowable Under Rules | |
|---|---|---|
| | Shell, Inches | Tube Sheet or Head, Inches |
| 42 inches or under | 1/4 | 5/16 |
| Over 42 inches to 60 inches | 5/16 | 3/8 |
| Over 60 inches to 78 inches | 3/8 | 7/16 |
| Over 78 inches | 7/16 | 1/2 |

Case No. 284.—Is it the intent of paragraphs 269 and 270 of the Boiler Code that a boiler requiring safety valve relieving capacity greater than 2,000 pounds per hour shall have two safety valves, each one of which alone will properly discharge the steam, or does it require two safety valves, the combined capacity of which will probably discharge the steam?

For capacities greater than 2,000 pounds per hour, the Code requires two or more safety valves on each boiler, the combined capacity of which shall meet the requirements of paragraph 270.

Case No. 285.—Is it permissible under the rules of the Boiler Code to use standard, extra heavy, cast iron flanges and fittings on pipe connections between boilers and attached type superheaters, and on the ends of superheater inlet headers for pressures up to 250 pounds per square inch? It is pointed out that neither the inlet pipe connections nor the superheater inlet flanges would be subjected to other than saturated steam temperatures.

It is the opinion of the Committee that the flanges referred to may be made of cast iron, provided the temperature of the steam does not exceed 450 degrees F., as specified in paragraph 12.

Case No. 286.—Does paragraph 321 of the Boiler Code require that all water column connections to boilers must be fitted with crosses for clean-out purposes, or is it permissible in a connection of a water column to a steam drum as shown in Fig. 5 to omit the crosses, provided provision for clean-out is afforded by the gage glass connection on the opposite side of the water column?

It is the intent of paragraph 321 that a cross be applied at a right angle turn in the water connection to a column for purposes of cleaning. Where an easily accessible straight pipe connection is used without a turn, the cross is obviously not needed.

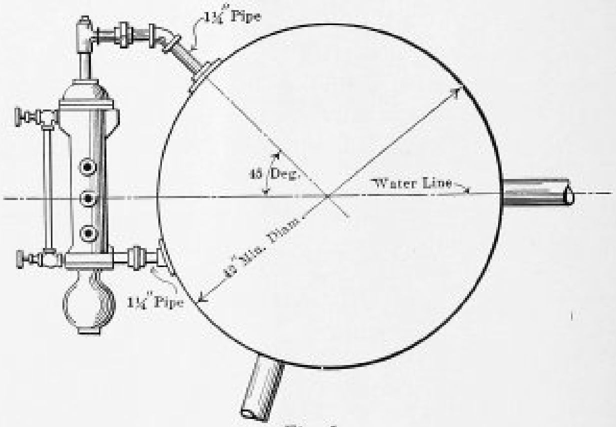



Fig. 5

Case No. 289 (Revision of Case No. 254).—Does the reply to Case No. 254 apply only to flat plates or also to the holes in the shells of drums?

This case applies to flat sheets. It is not permissible to burn tube or other holes into the shells of drums unless such holes are strengthened with flange or other reinforcements.

Case No. 290.—In determining the ratios of lengths between supports to diameter in Table 5, is the diameter at the root of the thread to be used, or the diameter of the body of the stay?

It is the opinion of the Committee that the diameter of the body of the stay is to be used in determining this ratio.

## Meeting of the American Welding Society

The annual meeting of the American Welding Society was held at the Engineering Societies building, 33 West 39th street, New York, Thursday, April 22. At the morning session, the business affairs of the society were considered, special attention being given to the proposal for establishing local sections at central points in districts where welding is of particular interest. The matter of "Welded Joints for Pressure Vessels" was also discussed at this session, with a view to determining an exact method for investigating the quality of an autogenous weld. Forge welding has a certain standing in court, and the autogenous process should be recognized on the same basis. In order to do this, it is necessary to devise means of making and inspecting welds which will be acceptable to the Boiler Code Committee of the American Society of Mechanical Engineers and to the insurance companies. To this end, it was voted by the research committee that the invitation of the A. S. M. E. Boiler Code Committee to co-operate with them on matters relating to welding be accepted. In addition, it was proposed that the society's research committee work with a similar committee from Lloyd's Register of Shipping on welding matters.

The following papers were presented and discussed in the course of the afternoon and evening sessions:

"Speed of Metal Arc Welding," by William Sparagen, of the department of electrical engineering, University of Washington; "Automatic Arc Welding Machines," by H. L. Unland, of the power and mining engineering department of the General Electric Company, Schenectady, N. Y.; "Recent Developments in Gas Cutting," by Stuart Plumley, of the Davis-Bournonville Company, Jersey City, N. J.

# How to Design and Lay Out a Boiler—XXI

**Types of Pressure Gages Used—Designing the Setting—Determining the Allowable Stresses in the Bracket Rivets**

BY WILLIAM C. STROTT*

A reference was previously made to surface blow-offs. These are funnel-shaped devices located in the steam space of a boiler for the purpose of drawing off "scum" from the surface of the water. Fig. 80 shows how a surface blow-off is usually attached to a shell or drum.

The size of a surface blow-off pipe shall not exceed 1½ inches and shall be carried through the head or shell with a brass or steel boiler bushing similar to that for a feed pipe connection. Surface blow-offs are rarely specified, as their absolute worth has as yet to be proved. They are evidently steam-wasters at best.

### Other Openings in Boiler Shell

The only other openings provided in a boiler are two ¼-inch pipes in the top of the shell. One of these is for the permanent steam pressure gage, while in the other is screwed a short pipe nipple with a valve on its end. This is for the inspector's test gage. Both these taps are located as close to the front ring seam as possible.

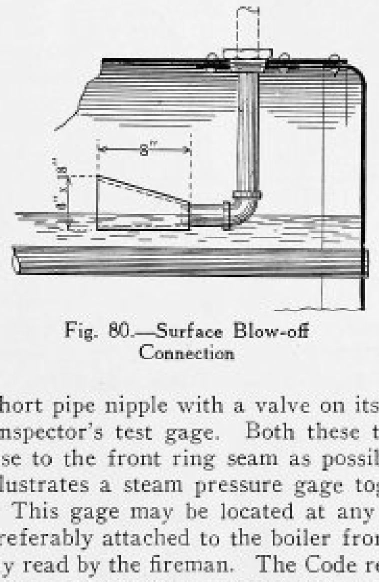


Fig. 80.—Surface Blow-off Connection

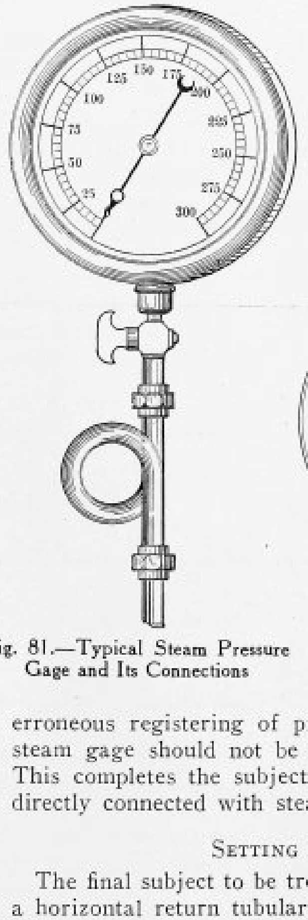



Fig. 81.—Typical Steam Pressure Gage and Its Connections

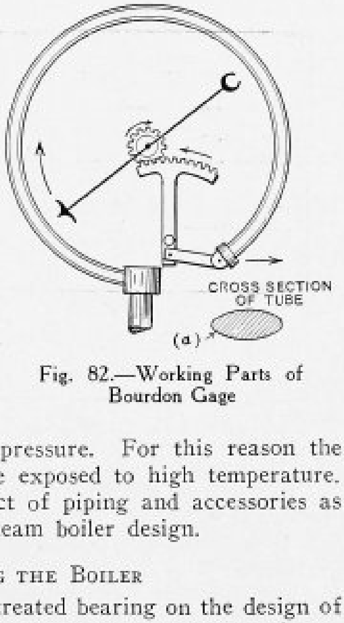



Fig. 82.—Working Parts of Bourdon Gage

Fig. 81 illustrates a steam pressure gage together with its fittings. This gage may be located at any convenient point, but preferably attached to the boiler front, where it may be easily read by the fireman. The Code requires that the dial of the gage shall be graduated to not less than 1½ times the allowable working pressure. For our boiler this would mean a dial graduated from 0 to 225 pounds at least. The only valve allowed on a steam gage connection is the cock shown in the illustration. It is to be placed directly under the gage and shall have its lever or "tee" handle arranged so that it will set parallel to the pipe when open. According to this, the valve in Fig. 81 is shown in the open position. The bent pipe below the valve is called the syphon. This forms a trap which is filled with water before the gage is attached. Many persons working in connection with steam boilers are not even aware that it is the pressure of the steam within the boiler against this entrained water that actuates the gage.

Fig. 82 illustrates the main working parts of a dial pressure gage. This gage was invented by M. Bourdon. It is designed in accordance with the principle that a flattened, curved tube closed at one end tends to become straight when subjected to internal pressure. The tube which is usually oval in section, as at (a), is bent into the arc of a circle. One end is fixed and is in communication with the boiler; the other end is *closed* and free to move. The syphon previously mentioned is filled with water, which transmits the pressure and keeps the spring at a nearly constant low temperature, although live steam, if permitted to enter the gage, would actuate the spring coil, causing the latter to expand further, due to the high temperature, thus resulting in erroneous registering of pressure. For this reason the steam gage should not be exposed to high temperature. This completes the subject of piping and accessories as directly connected with steam boiler design.

### Setting the Boiler

The final subject to be treated bearing on the design of a horizontal return tubular boiler is the manner of supporting it in its brick setting. There are two distinct methods employed for supporting boilers, viz., by means of lugs or brackets riveted to the side of the boiler shell and bearing directly on the side walls of the setting. The other method is by the outside suspension method when the boiler is "slung" independently of the brick work from structural beams and columns commonly known as a "gallows frame." The suspension is here accomplished through the medium of "U" or hook bolts attached to steel loops or hangers riveted to the side of the boiler shell. Both these methods of support will be designed for application to our boiler, and because of its great simplicity of calculation the system of brackets will be handled first. There are two kinds of these—pressed steel and cast.

### Types of Brackets

The forms of pressed steel brackets are many and varied, nearly every well-known boiler manufacturer having his own patented design. The patents, of course, cannot cover the principle, but merely the forms and the method of manufacturing the brackets. Fig. 83 illus-

* Engineering Department of The Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

trates the "Union" pressed steel side lug, manufactured by the Union Iron Works, Erie, Pa. It was designed and

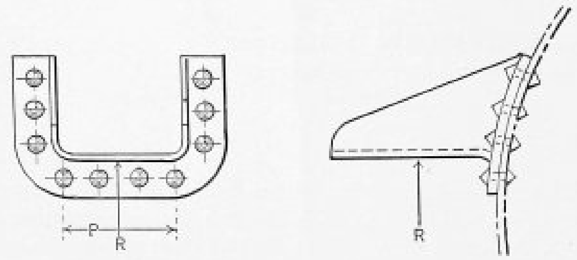



Fig. 83.—Union Pressed Steel Side Lug for Supporting Boilers

patented by Charles S. Hooper, of that company.

A form of side bracket which anyone can copy, however, is cast from patterns, as illustrated in Fig. 84.

When a horizontal return tubular boiler is supported by side brackets the Code states that for all shell diameters over 54 inches and up to and including 78 inches, eight such brackets must be employed and set in pairs at four points on the boiler. This feature is illustrated in Fig. 85.

bearing load for brick is taken at 100 pounds per square inch, which means that our brackets shall have a bearing surface on the walls of not less than $\frac{5,000}{100}$, or 50 square inches. Having already assumed a dimension 10 inches, of which not more than 8 inches can be considered as effective, on account of coming somewhat back of the inside edge of the wall, we find the minimum width of the bracket to be $\frac{50}{8}$, or 6.25 inches, say 7 inches.

Although these figures are based on a certain size boiler, it would be poor policy to carry on hand different sizes for different boilers. The most economical practice would be to design one or two patterns for use on even the heaviest boilers. Brackets about 8 inches by 11 inches are the usual proportions which seem to give an approximate square bearing surface 8 inches by 8 inches on the brick work and good for a load not exceeding 7,000 pounds.

There is generally no difficulty encountered in designing the body of the bracket. The usual method of procedure

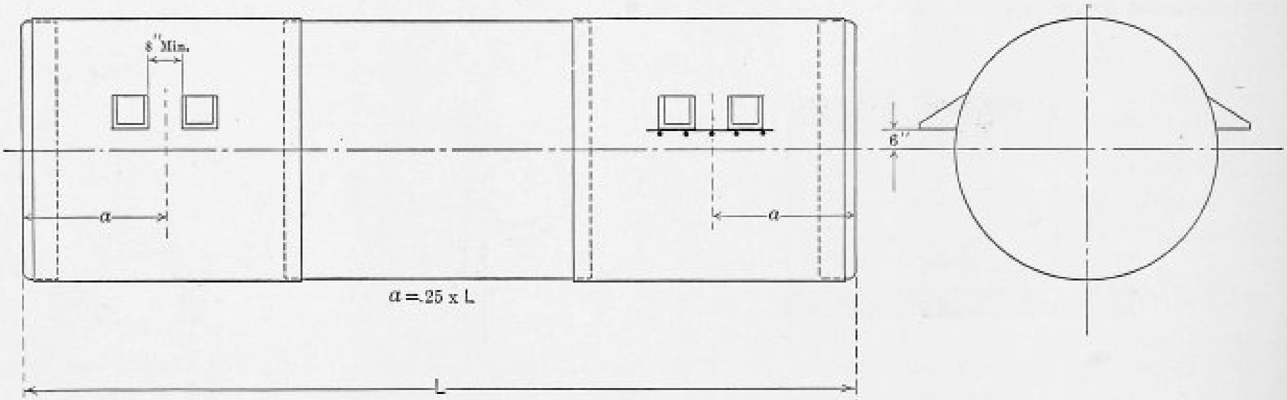



Fig. 85.—Diagram Illustrating Method of Supporting Boilers by Means of Side Lugs

Although the Code makes no provision for the exact location or spacing of these lugs, they should be placed as far down towards the centerline of the shell as practicable. With regard to the location of the bracket, the boiler may be considered as a beam supported near its ends and uniformly loaded. The proportions given in the figure are practical and have been derived from this assumption. If the brackets are placed too near the heads, particularly in very long shells, the latter will tend to sag, thereby straining the seams and causing leakage.

### DESIGN OF BRACKETS

The actual design of the brackets themselves is based on accurate engineering principles as follows: The brackets are theoretically short cantilever beams with the load considered as concentrated at the center of pressure on the bracket. This center of pressure is indicated by the arrows on Figs. 83 and 84. It will be found that these brackets should be about 10 inches long in order to get good bearing on the brick walls, and the width is determined by calculation. We should at this stage figure the weight of the boiler under operating conditions, which means filled with water. It will be found that our boiler then weighs approximately 40,000 pounds. The reaction "R" on each lug is $\frac{40,000}{8}$, or 5,000 pounds. The safe unit

after the main dimensions have been fixed is to proportion the various parts by the eye and then test for strength. There should be sufficient metal through section "A-A," Fig. 84, to resist shear; crushing may be likely to occur through section "B-B" and should also be investigated. This work constitutes the application of beam formulae, and for convenience and reference the maximum bending moments of simple beams are given in the accompanying diagram, Fig. 86.

The first three beams are for uniform loads, and the remaining four are for concentrated loads. The imaginary beams are shown bent to demonstrate where the maxi-

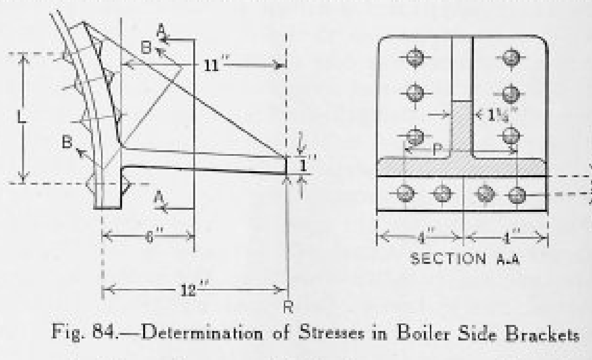



Fig. 84.—Determination of Stresses in Boiler Side Brackets

mum bending stress and deflection occur. After having calculated the maximum bending moment, the following formula for the stress in the section at the point of maximum moment is then applied:

$$S = \frac{M}{Q}, \qquad (27)$$

in which the notations are those given in Fig. 86. The

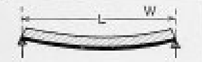
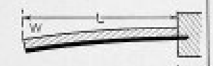
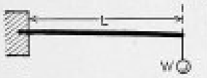
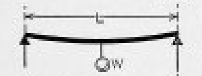
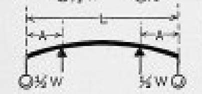
| Method of Loading | | Maximum Bending Moment M | | Maximum Load W | Deflection D |
|---|---|---|---|---|---|
| Length Feet | Load Pounds | Foot-Pound | Inch-Pound | Pound | Inch |
|  | | $\frac{WL}{8}$ | $\frac{3WL}{2}$ | $\frac{2QS}{3L}$ | $\frac{5Wl^3}{384EI}$ |
|  | | $\frac{WL}{6}$ | 2WL | $\frac{QS}{2L}$ | $\frac{Wl^3}{60EI}$ |
|  | | $\frac{WL}{2}$ | 6WL | $\frac{QS}{6L}$ | $\frac{Wl^3}{8EI}$ |
|  | | WL | 12WL | $\frac{QS}{12L}$ | $\frac{Wl^3}{3EI}$ |
|  | | $\frac{WL}{4}$ | 3WL | $\frac{QS}{3L}$ | $\frac{Wl^3}{48EI}$ |
|  | | $\frac{WA}{2}$ | 6WA | $\frac{QS}{6A}$ | $\frac{Wa}{48EI} \times (3l^2-4a^2)$ |
|  | | $\frac{WA}{2}$ | 6WA | $\frac{QS}{6A}$ | Between Supports $\frac{Wa}{16EI} \times (l-2a)^2$ |

Fig. 86.—Simple Beam Formulas

S = Stress in Extreme Fiber
Q = Section Modulus

section modulae for various sections are listed in Fig. 87.

In using the above table the designer should bear in mind that the sectional modulus employed is the one taken at right angles to the line of application of the load. Fig. 87 is based on this axis, and attention is merely called to it because some handbooks give the moments of inertia and section modulae through two or more axes and the designer is often at a loss to know which is the one to use.

To assist the student in arriving at reasonable values for $S$ when applying formula (27), Table 17 is applied:

TABLE 17.—STRENGTH OF METALS, IN POUNDS PER SQUARE INCH

| Material | Ultimate Tensile | Ultimate Compression | Ultimate Shearing | Modulus of Rupture | Modulus of Elasticity Millions |
|---|---|---|---|---|---|
| Wrought iron | 48,000 | 46,000 | 40,000 | 44,000 | 27 |
| Structural steel (soft) | 56,000 | 56,000 | 48,000 | 54,000 | 29 |
| Structural steel (medium) | 64,000 | 64,000 | 50,000 | 60,000 | 29 |
| Steel, castings | 70,000 | 70,000 | 60,000 | 70,000 | 30 |
| Cast iron | 15,000 | 80,000 | 18,000 | 30,000 | 12 |
| Brass, cast | 24,000 | 30,000 | 36,000 | 20,000 | 9 |
| Bronze, phosphor | 50,000 | ...... | ...... | ...... | 14 |
| Bronze, aluminum | 75,000 | 120,000 | ...... | ...... | .. |
| Aluminum, commercial | 15,000 | 12,000 | 12,000 | ...... | 11 |

A safe value for $S$ is the modulus of rupture divided by the factor of safety. This modulus is the pounds pull registered by the testing machine at which the test specimen just begins to separate, and evidently lies just beyond the elastic limit of the material. The factor of safety for steel may be taken at 5 or 6, but cast iron, owing to its brittleness and uncertain strength, should be figured very low, a safe factor of safety being not less than 10 or 12. However, when materials are used in compression, we base our calculations on their crushing strengths. Notice the very high resistance to crushing afforded by cast iron being higher than any other metal except bronze.

### Stresses in Rivets

Practically the greatest uncertainty existing in boiler brackets or lugs lies in the rivet stress. Referring again to Figs. 83 and 84, it will be seen that the rivets in the bottom flanges are mainly in tension, and in addition to this they carry their proportionate part of the shearing load also. In fact, if enough rivets could be placed at this point to resist the total shear, none would be necessary above the leg of the brackets, since the only duty of these rivets is to prevent the bracket from sliding up.

Assuming dimension $L$, Fig. 84, as 12 inches, the total stress in the four rivets in the bottom flange is found by equating the maximum bending moment at the rivets with the resisting moment offered by these rivets. Substituting the values assumed as an example, we write: $6 \times 5{,}000 = 10\ X$, in which $X$ is the resistance of the rivets and is found to be 3,000 pounds. Now, in addition, each of these four rivets carries one-tenth of the total upward force on the lug, or 500 pounds. It stands to reason that the combined stress as bending and shearing, or bending and tension, etc., has a greater destructive effect than a single applied stress. It is greater even than the actual sum of the two distinct stresses. How much greater this is cannot be accurately determined, and it is here that a wide divergence of opinion has occurred. As a result the

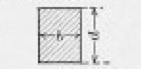
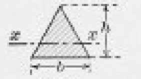
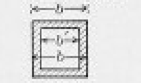
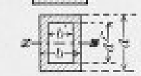
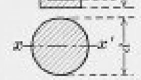
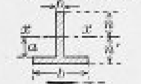
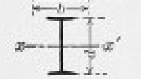
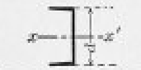
| Shape of Section | Moment of Inertia I | Section Modulus Q | Sq. Least Radius of Gyration $R^2$ |
|---|---|---|---|
|  | $\frac{d^4}{12}$ | $\frac{d^3}{6}$ | $\frac{d^2}{12}$ |
|  | $\frac{b\,d^3}{12}$ | $\frac{b\,d^2}{6}$ | $\frac{b^2}{12}$ |
|  | $\frac{b\,h^3}{36}$ | $\frac{b\,h^2}{24}$ | $\frac{I}{A}$ |
|  | $n \times Q$ | $\frac{d^2(a^2+4ab+b^2)}{12(a+2b)}$ | $\frac{I}{Q}$ |
|  | $\frac{b^4-b'^4}{12}$ | $\frac{I}{.5\,d}$ | $\frac{b^2+b'^2}{12}$ |
|  | $\frac{b\,d^3-b'd'^3}{12}$ | $\frac{I}{.5\,d}$ | $\frac{I}{A}$ |
|  | $\frac{\pi d^4}{64}$, or $.0491d^4$ | $\frac{\pi d^3}{32}$, or $.0982d^3$ | $\frac{d^2}{16}$ |
|  | $.0491\,(d^4-d'^4)$ | $.0982\,(d^3-\frac{d'^4}{d})$ | $\frac{d^2+d'^2}{16}$ |
|  | $\frac{b\,d^3-2\,b'd'^3}{12}$ | $\frac{I}{0.5\,d}$ | $\frac{I}{A}$ |
|  | $\frac{b'n^3+bn'^3-(b-b')a^3}{3}$ | $\frac{I}{n}$ | $\frac{I}{A}$ |
|  | $\frac{A\,d^2}{6.66}$(Approx.) | $\frac{A\,d}{3.2}$(Approx.) | $\frac{I}{A}$ |
|  | $\frac{A\,d^2}{7.34}$(Approx.) | $\frac{A\,d}{3.67}$(Approx.) | $\frac{I}{A}$ |

Fig. 87.—Properties of Various Sections ($x$ — $x$ is Neutral Axis)

A. S. M. E. Code has established a minimum value for the shearing stress in these rivets, which is 8 percent of the

(Continued on page 186)

# Annual Convention of Boiler Manufacturers

**Progress in Adoption of Uniform Boiler Code—Cost Methods Discussed—Review of Economic Conditions—Standard Contract Forms**

The thirty-second annual convention of the American Boiler Manufacturers' Association opened at 10 A. M., May 31, in the French Lick Springs Hotel, French Lick, Ind. This convention was the first attempt ever made by the association to combine recreation with the business sessions, and for this purpose French Lick proved to be an excellent place. The order of business was so arranged that members and their guests were able to take part in golf tournaments between meetings. A great deal of valuable work was accomplished in the three days of the convention.

### Fuel Conservation

Because of the prime importance of conserving fuel in the operation of boiler plants, a paper on this subject was read before the association by David M. Meyers, consulting engineer, of New York City. In this paper the existing fuel conditions were well brought out and emphasis was given to the fact that boilers must be so designed in the future as to conserve every particle of fuel possible. The complete paper will be published in a later issue of The Boiler Maker.

### Uniform Boiler Laws

Charles E. Gorton, chairman of the American Uniform Boiler Law Society, reported on the work accomplished by this organization since the last annual convention. At present, the boiler code is being used as a text-book in the leading technical schools and universities of the country. The office of the boiler code committee of the American Society of Mechanical Engineers is being used as a clearing house for all problems pertaining to boilers that come under the code.

At the Buffalo convention a year ago it was proposed to put into effect uniform stamping requirements that would be used on boilers wherever the code was enforced. At the same time the matter of examination standards for inspectors in all states governed by the code were discussed, as well as the general requirements in training and experience for these men. At the last annual meeting of the American Society of Mechanical Engineers in December a National Board of Boiler and Pressure Vessel Inspectors was formed for the purpose of promoting uniformity of requirements in inspection throughout the states so that a boiler acceptable in one state would be equally acceptable in another without further inspection. The duty of the boiler code committee is to pass judgment only on such general questions of boiler design in which the rulings of the code are not clear, while the new organization of inspectors will pass judgment on the specific design of individual boilers. This work the boiler code committee is not permitted to do.

The past year was not a favorable one in so far as the adoption of the code by state legislatures was concerned, because of the fact that only five new legislatures have convened since the last session of the association. A code bill was introduced in Indiana in November at a meeting of the Industrial Commission of that state. Up to that time the rules governing boiler inspection partly filled the code requirements, but certain reservations had been enforced since 1915. The provisions of the 1915 bill were so altered that the A. S. M. E. code is to be absolutely enforced in the future.

At a special session of the Oregon legislature a bill was introduced which practically included the provisions of the code without the exact wording. This was thought advisable because of peculiar conditions existing at this time. If this bill is passed the Industrial Accident Commission of the state is to be instructed to enforce only national safety codes of various kinds, such as the A. S. M. E. Boiler Code.

The state of Arkansas adopted the code and it is being enforced at present.

Five or six boiler bills were introduced in the Virginia legislature so that it was thought better not to introduce a strict code measure at this time. The legislature instructed the chairman of the Industrial Commission of the state to study the code and the other bills introduced to make recommendations on them at the next meeting of the legislature.

In Maryland the Boiler Inspection Bill was passed by the House and Senate, the provisions to go into effect June 1. The A. S. M. E. code is to be made standard in Maryland June 1, 1921.

Utah has adopted the code.

The state of Washington is to take the matter up within two or three months.

A hearing was given to the code bill in the Louisiana legislature June 3, but as yet the decision reached has not been reported.

At the Buffalo convention a commitee was appointed to investigate the Masachusetts Board of Boiler Rules and to petition for certain changes in them so that the code might be used in the state. The petition as finally presented to the Massachusetts Board was that the code rules of construction and inspection of boilers and pressure vessels be accepted in Massachusetts where their provisions did not conflict with the statutes of that state. The petition was made in this way because of the fact that only one paragraph which conflicts with the code is statutory, and this states that "all boilers must have fusible plugs," which provision may be easily taken care of.

The finances of the society are on a sounder basis than ever before, as all the organizations supporting the movement of uniformity in boiler requirements throughout the states have realized the importance of the work and have promptly contributed the funds for carrying it on.

### National Board of Boiler and Pressure Vessel Inspectors

C. O. Meyers, treasurer and secretary of the National Board of Boiler and Pressure Vessel Inspectors, presented a paper which dealt mainly with the work of this organization and the necessity of uniformity of inspection and examination for inspectors in the various states using the code.

#### Object of the Organization

It has been realized for a great many years that some means must be devised whereby we may secure interchangeability of steam boilers between states. With this object in view the American Uniform Boiler Law Society and the American Society of Mechanical Engineers' Boiler Code Committee have devoted their untiring efforts and have succeeded in getting thirteen states, eleven cities and one county, a total of twenty-five boiler inspection departments, to adopt the American Society of Mechanical Engineers' boiler code.

These societies should be given credit for their excellent work, as it can be seen that many obstacles had to be overcome in order to secure the adoption of this code by so many different states and municipalities, as each of them had its own ideas of boiler construction and inspection.

It was thought that the adoption of this code would solve the question of interchangeability between states, but we find this is not the case, as each state and municipality, after adopting the code, is compelled to make rulings on specific designs of boilers and appurtenances, not covered by the code, and the more states that adopt the code, the greater will be the number of problems to be solved. It can be seen that these rulings will vary according to the ideas of each separate state, thereby destroying all the benefits to be derived from uniformity and interchangeability.

In order to clarify these conditions by uniformly acting upon such specific designs of boilers and their appurtenances, and to uniformly enforce the interpretations of the American Society of Mechanical Engineers' Boiler Code Committee, and to promote a plan whereby we may hold a uniform examination for boiler inspectors, and to adopt a uniform method of stamping standard boilers, it was necessary to organize all the states, counties and municipalities now operating under the American Society of Mechanical Engineers' boiler code.

This organization is known as the National Board of Boiler and Pressure Vessel Inspectors and was organized December 2, 1919, in New York City. The membership consists of a representative in charge of the boiler inspection department of the states, counties and municipalities operating their laws under the A. S. M. E. boiler code. The following officers were elected: Joseph F. Scott, New Jersey, chairman; James Neil, Pennsylvania, vice-chairman; C. O. Myers, Ohio, secretary-treasurer. By-laws were drafted and we have succeeded in getting twenty-two members to accept them. All of the work is now being handled through correspondence by the secretary.

This board at the present time has under consideration seven specific cases of the designs of boilers and appurtenances, not covered by the code, and upon which the A. S. M. E. code committee has no authority to act. One of these cases has been disposed of, with the result that the members disapproved of a device which, as it now stands, cannot be used in any of the code states.

Our experience has been that boiler manufacturers have been greatly inconvenienced by the multiplicity of stamps required upon boilers in order to make them interchangeable, and it is the purpose of this national board to eliminate those conditions, and steps have been taken along these lines. This may appear to be an easy problem, but you must not lose sight of what these stamps mean to those in charge of the enforcement of boiler inspection laws, as each separate state department has inspectors who are registered in such departments as qualified inspectors. These inspectors are given the authority to place a certain stamp upon boilers which is easily identified, so that the department may know that such boilers have been inspected through construction and conform in every detail with their rules.

The most difficult part of solving this question is that some states and municipalities now operating under the A. S. M. E. boiler code have no provisions or requirements for a person to comply with before acting as a boiler inspector, as they hold no examination or other test of ability, thereby permitting the appointment of persons who are not familiar with boiler construction. Inspectors are thus placed in the same category with those who have passed no examination, and states having rigid boiler requirements are expected to accept boilers inspected by such incompetent inspectors.

In one case to which our attention has been called, a blacksmith had the authority to inspect A. S. M. E. boilers and witness the stamping of them. This is no violation of the A. S. M. E. code as it is now written, as paragraph 332, page 86, 1918 edition, states that an A. S. M. E. boiler may be inspected by either a state inspector, municipal inspector, or an inspector employed regularly by an insurance company, but does not require certain necessary qualifications for such inspector, leaving this matter entirely up to the states in which boiler is to be used.

We have found that it is possible for a person to take an oral examination in one state, and upon the result of this examination he may be issued a certificate of competency by a number of other states without re-examination, and it can be seen that in such cases where no record is kept of the examination that there is a possibility of an incompetent person becoming a duly qualified boiler inspector for a number of states.

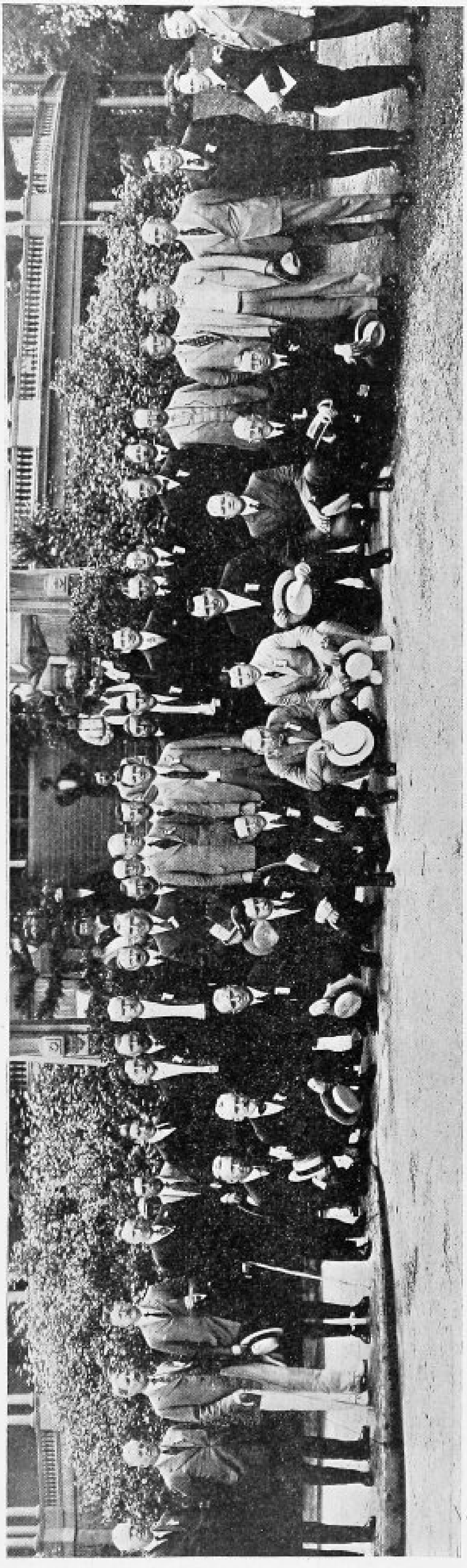
With a system of inspection as outlined above, I think you will agree with me when I state that it would be unreasonable for us to ask a state department to accept a code boiler carrying only the A. S. M. E. symbol, and no other identification marks to indicate where this boiler was built or by whom inspected.

Before a uniform stamp can be adopted it will be necessary to eliminate the above-mentioned conditions, and the national board is undertaking to do this at this time by promoting a system of uniform written examinations to be held in each code state for boiler inspectors, and then an inspector who has passed this examination, or one equivalent to it, in one of the code states may be registered in each of the other code state departments without re-examination. This will then permit an inspector who has qualified by taking such an examination to inspect a boiler in any of the code states and stamp it with a uniform stamp, which will be accepted by all of the departments where such inspector is registered. As above stated, we have some code states who have not the required provisions in their laws to provide for inspectors of this kind. For this reason I would suggest that all of the states, counties or municipalities who have not the proper provisions in their laws to require competent inspectors be not permitted the use of the A. S. M. E. code of boiler rules. If this were done it would eliminate a great many of our difficulties, as we can never get the consent of the states with the proper inspectional requirements to accept a code boiler with only the A. S. M. E. symbol.

Inasmuch as it can be seen from the above-mentioned conditions that there is a considerable amount of work to be done in the states now operating under the A. S. M. E. code, and that the more states that are added to this list the more confusing these problems will be, I would suggest that instead of working toward getting additional states that more energy be put forth to strengthen uniformity and interchangeability between states now operating under the code.

This work cannot be carried to a successful termination without financial assistance to make it possible for the national board to do these things and secure the help necessary to bring about the desired results.

It has been suggested, in order to defray the expenses of the national board, that the states pay a membership fee, but this is impractical for the reason that this is a



Members of the American Boiler Manufacturers' Association Attending the Thirty-second Annual Convention at French Lick Springs

national movement, and the individual states, cities and counties are not directly benefited by it, as they create laws and appropriate funds for the enforcement within their respective jurisdictions, and while some of them may have funds available for such purposes, a great many of them have not, thereby preventing them from taking part in this movement.

Inasmuch as there are funds now being raised from those who are most benefited by uniformity to support the American Uniform Boiler Law Society, which has been expending such funds for the extension of the A. S. M. E. boiler code into new states, and if this method of attempting to secure uniformity and interchangeability is continued it can be seen from the facts herein stated, the more states that adopt the code and are added to the existing lists without proper inspection requirements, the greater will be the tangle which will have to be corrected at some future date. Therefore, some arrangement should be made immediately to divert a sufficient portion of such funds to the treasury of the National Board of Boiler and Pressure Vessel Inspectors that will make it possible to carry on this work with the greatest possible speed and to get the states, counties and municipalities who now have adopted the code to uniformly act upon its provisions. This can only be done by having uniform qualifications for the inspectors who are responsible for the enforcement of the rules as provided in the code. And it can also be seen that it makes no difference what precautions are taken in drafting the code of boiler rules; if the proper inspectional requirements are not made, then the work of the American Uniform Boiler Law Society in attempting to secure uniformity is a waste of time, energy and money.

The Ohio Board of Boiler Rules is in a position to see the absolute necessity for concerted action by all the states having boiler inspection laws, and, believing that it is to the best interests of all concerned, has suggested the organization of the National Board of Boiler and Pressure Vessel Inspectors, as above outlined, and stands ready and willing at all times to cooperate in solving the question of uniformity and interchangeability of boilers between states.

E. R. Fish, who represents the American Boiler Manufacturers' Association in the Uniform Boiler Law Society, outlined the need for every member of the association to support the movement. Another feature is entering into the matter of uniformity throughout the states, and one in which the boiler manufacturers are vitally interested. This is the A. S. M. E. code for unfired pressure vessels and tanks which is now being discussed by the American Society of Mechanical Engineers and which will no doubt be adopted at the next meeting of the society. When this is put into effect, all the states using the boiler code will probably adopt the new code as well, and other states in which the code bill is introduced in the future will include provisions for this pressure vessel code.

At the hearing on this matter, held at the St. Louis convention of the American Society of Mechanical Engineers, various suggestions and criticisms were made of the provisions, particularly in regard to the welding of tanks. All members interested in this matter are particularly requested to study this code and make any suggestions that seem advisable.

The Uniform Boiler Law Society and the National Board of Boiler and Pressure Vessel Inspectors have the same object of furthering uniformity of requirements through the states, and in order that the new organization may be able to render its best service, some means of financing the movement must be found. It may be possible that the Uniform Boiler Law Society will divert certain funds for this purpose, but the members of the Boiler Manufacturers' Association should keep in mind the need of supporting the movement.

### Report of Secretary and Treasurer

Following this paper the annual report of H. N. Covell, secretary and treasurer of the association, was read. Four members of the association have resigned since the last convention and six new members have been added to the roll. During the year, three of the older members of the association have died: Pierre Bigelow, The Bigelow Company, New Haven, Conn.; Bartholemew Scannell, Scannell Boiler Works, Lowell, Mass., and M. W. Llewellyn, of the Walsh & Widener Boiler Company, Chattanooga, Tenn. The total membership of the association at present is 78.

The finances of the association during the past year have been in excellent condition, the total receipts being $4,715.98, the disbursements for all purposes $3,547.43, leaving a balance in the treasury of $1,168.55. An auditing committee was appointed to check the report.

The remainder of the first session was spent in appointing various committees.

## MONDAY EVENING SESSION

President W. C. Connelly, of the D. Connelly Boiler Company, Cleveland, Ohio, delivered his annual address at the opening of the evening session.

*To the members of the American Boiler Manufacturers' Association, in convention at French Lick Springs:*

This convention offers me the opportunity to address the members of this association for the fourth time as your president, and I assure you that I am not unmindful of this unusual privilege. There are many things to be offered for your earnest consideration during this meeting, and as the executive committee have given their time to preparing a report containing recommendations as to the future activities of the association, I will not dwell on any of the subjects contained in it.

There are, however, some other general topics that I desire to bring to your notice, as they will need the full support of each of you if they are to be brought to a successful conclusion.

#### Taxation

In my address of a year ago I made mention of the urgent necessity of a reduction in the rates for war taxes. Since that time there has been some reduction, but the present rate of tax and the manner of assessing it are far from satisfactory, as is also the expensive manner of collecting this revenue.

We must, of course, offer a better method if we desire to criticise the present one, and as a basis for such a system there has been proposed "a straight tax of 1 percent upon all sales whether wholesale or retail." With certain other additions which have also been carefully worked out, a new and simpler tax law can be had that will be more equitable in its provisions. This matter deserves your earnest support and should also be recommended by you to your representatives at Washington.

#### Future of the Boiler Making Industry

In my address of a year ago I ventured the opinion that new business was at that time on the upward turn (following the cessation caused by the closing of the war), and that if it was allowed to be guided by business men of experience we had nothing to fear as to its volume.

My anticipations in that respect have been more than realized. However, due to the labor and economic conditions of the past twelve months, I predict that the peak has been reached and that new business is not to be expected in nearly so great a volume in the future.

In my opinion, this slowing up of business is one of the best signs of "returning sanity" that we have had, and it will eventually prove to be the only "stabilizer" that can steady the "ship of commerce."

#### Reasons for Present High Prices

Prices of practically everything, including the everyday necessities of life, have reached a point beyond all reasonable proportions, due mainly to the increased wage rate, the decrease in production and the shortened weekly hours of production.

As an illustration of this statement, the president of a building and loan association in Cleveland informed me within the past two weeks that upon investigation regarding present abnormal costs in building he found, as one instance, that where before the war a bricklayer set up an average of 1,800 bricks in eight hours he is now setting up only about 500 bricks in the same period.

Wages of bricklayers have increased about 100 percent, while output has been reduced 66 percent.

This condition is neither local nor unusual, but prevails throughout the United States and in all trades.

#### National Strikes

Since our meeting of a year ago industry has gone through perhaps the greatest period of unrest we have ever had in the United States—at least I am quite certain that it has been the most unsatisfactory period during the business career of any man in this association.

We first had the steel strike, which was, of course, the opening gun for a closed shop in the steel industry. This attempt was defeated, and the sound American policy of the "open shop" still prevails in the leading industry of America.

Next we had the coal strike brought about at the beginning of the winter (November, 1919), although the miners were then under a contract to work under agreed conditions until April 1, 1920. The result in this strike was far from satisfactory to the public, for although the president put the matter in the hands of Dr. Harry Garfield, who had been fuel commissioner during the war and who worked out what was considered even more than an equitable scale of wages, his basis of settlement was not accepted for the reason that certain politicians at Washington took the matter out of his hands and reversed him.

We are now, and have been for about eight weeks, in the throes of a strike of railroad switchmen. Not all the men in that line, I am glad to be able to say, violated their agreement, but enough did as to greatly interfere with business.

#### Open Shop Principles

The answer to each and all of these unwarranted strikes must be the retention, as well as the extension, of the "open shop principles." When we have again firmly established the open shop throughout industry, then we will have increased production, which will in turn procure a downward revision in the cost of everyday needs of our citizens.

The man with energy and ability will then readily obtain recompense in proportion to his just deserts, while the slacker will not be able to continue in permanent employment through his labor union affiliations.

The employers of today were in a large measure the employees of yesterday, and America must preserve at all hazards the opportunity to rise in the field of commerce for those who will give their energy, time and brain to the general advancement of industry, science and invention.

### Other Associations

The time has arrived when manufacturers must be ready to work together for the preservation of the standards established by our forefathers and to be able to offer advice on *national* problems.

The National Association of Manufacturers are endeavoring to do this, and their measure of success will be in direct proportion to the assistance they get from the manufacturers. I therefore suggest that any of us who are not members of and supporting this organization should at once become members.

### Chamber of Commerce of United States

This organization is also doing excellent work in lines somewhat different than the Manufacturers' Association, but is contributing in a large measure to the solution of *your* problems and *mine*, and is therefore worthy of your moral and financial support.

You will remember that it was this body that organized every industry in America (after we entered the war) and through the war service committee of each industry assisted the War Industrial Board in obtaining war needs from American factories in an efficient manner.

### Extension of Plant

I offer you the suggestion that this is not the time to make any improvements or extensions to existing plant facilities, as costs must of necessity be revised downward; thus present prices are sure to be deflated.

Purchasing only of necessities by everyone will within a period of several months result in adjustment of prices to more nearly normal.

### Inventories

In view of my last statement I believe that *now* is the time for all of us to reduce our inventories to as low a point as is practicable. Furthermore, I do not consider it a good time to make contracts for our materials, and if necessary to do so, then only for short periods—say 30 days' requirements.

A slowing up of business cannot but result in a reduction in prices by the independent producers of steel to those prices established and maintained by the United States Steel Corporation.

### Collections

Statistics have proven that in the past, during periods of reductions in prices, there has been a considerable increase in business failures, and I therefore recommend that we give this end of our business its proper consideration, as well as to carefully investigate into the finances of new companies seeking credit.

### Standardization

In the matter of standardization, we have done some things of great benefit to our industry, the first of which has been standardized boiler construction as brought about by the boiler code of the American Society of Mechanical Engineers. We have made considerable progress, and will continue to do so, in the way of "proper cost finding." We will also, I hope, during this convention arrive at certain standards regarding guarantees, terms of payment, etc. In addition to those things, I wish to offer a recommendation for standardizing sizes of all documents going out of our offices, such as specifications, order forms, invoices, etc. The reason for this suggestion is that the proper filing of documents is a serious one with all of us, and as the size of the concern grows, so in proportion do their filing troubles increase.

### Co-operation

In each of my previous addresses I have urged as necessary to the advancement of our industry co-operation of all of us with others engaged in this line of trade, and once again I desire to impress upon you that our future progress depends greatly on how closely we desire to work together.

This association, in my opinion, is stronger today than it has ever been, and the credit for this belongs entirely to those who have been faithful in attendance at our meetings and lent their advice on the various work we have undertaken and to the work and study of the men serving as your executive committee.

## Cost Finding Methods

A report was next made by G. S. Barnum, The Bigelow Company, New Haven, Conn., giving a synopsis of cost finding methods that might be used to advantage by the association.

Following this, the report of the committee appointed to confer with the Stoker Manufacturers' Association on the definition of boiler terms in which both the boiler manufacturers and stoker manufacturers are interested, was given by E. C. Fisher, of the Wickes Boiler Company, Saginaw, Mich. This report will be published in a later issue of THE BOILER MAKER.

The terms of the report were discussed and accepted by the association.

A paper on "Electric Welding" was presented by D. C. Alexander, Jr., president of the Quasi-Arc Weldtrode Company, Inc., Brooklyn, N. Y., and another on the "Advantages of Co-operation Between Boiler Manufacturers and Boiler Insurance Companies," by S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn.

## TUESDAY MORNING SESSION

The session opened with the reading of a paper on the "Necessity of Establishing a Code of Ethics in the Boiler Manufacturing Industry," by George W. Bach, Union Iron Works, Erie, Pa.

A. G. Pratt, vice-president, Babcock & Wilcox Company, New York City, reported the recommendations of the executive committee on the future activities of the association. Report will be published later.

C. V. Kellogg, Kewanee Boiler Company, Chicago, Ill., introduced the question of including the interest on investments in any boiler manufacturing plant in the overhead charges of that plant. This is a question that has been discussed at length at various other meetings of the association, and no agreement has been reached to include this item in overhead. The discussion in the matter was concluded by J. N. Barnes, treasurer of the J. S. Schofield's Sons Company, Macon, Ga., who read a paper covering the possibilities in this connection.

## WEDNESDAY MORNING SESSION

Discussion on the tabulation of wage rates, based on replies to the questionnaire submitted to members of the association was introduced by F. G. Cox, of the Edgemoor Iron Company, Edgemoor, Del. The report was distributed to the members. As the value of the report lies simply in comparing wage rates in different sections of the country, very little discussion was given to the matter

Under this head, however, matters of insurance and bonus payments in the various shops were introduced and a general survey made of labor conditions throughout the country.

### Topical Questions

E. G. Pratt reviewed the general economic conditions existing in the country and spoke of the necessity for all the members of the association to work out their problems together. From time to time it is advantageous to compare conditions in the various plants, the matter of cancellations, the holding up of shipments, the labor situation, the raw material market and other matters pertaining to the boiler industry. All members of the association in a certain district should meet frequently for this purpose. The mutual aid obtained from these meetings will prove helpful in carrying the industry successfully through the present critical period.

G. W. Bach took up the question of co-operation between manufacturers in keeping the proper distribution of labor for their respective needs in order that no attempt might be made by one plant to hire labor away from another, in which case the work of the latter would be more or less curtailed.

### Election of Officers

The nominating committee reported the officers for the following term, and these were elected by the unanimous vote of the association.

President, A. D. Schofield, of the J. S. Schofield's Sons Company, Macon, Ga.

Vice-president, G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and treasurer, H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee:

W. C. Connelly, of the D. Connelly Boiler Company, Cleveland, Ohio.

C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.

F. C. Burton, The Erie City Iron Works, Erie, Pa.

F. G. Cox, Edgemoor Iron Company, Edgemoor, Del.

W. A. Drake, The Brownell Company, Dayton, Ohio.

W. H. Mohr, John Mohr & Sons Company, Chicago, Ill.

E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.

W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.

E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo., representing the A. B. M. A. on the A. S. M. E. Code Committee and also representing the A. B. M. A. in the American Uniform Boiler Law Society.

A. D. Schofield, the new president of the association, gave a short talk on his plans for the association during the next year.

### Autogenous Welding

E. R. Fish thought it advisable to bring the matter of autogenous welding to the attention of the association in order to make clear the position this process holds at present in the industry. The boiler code up to the present has forbidden the use of welding in boilers. In the case of riveted joints it is possible to tell what sort of work has been done, but in a weld it is impossible to determine what the interior structure is like. Because of the fact that the welders at present are in most cases not sufficiently trained for the work, too much reliance cannot be placed on them. The time is coming, however, when autogenous welding will have reached the point of development where it may be safely utilized in boiler construction. Terms under which autogenous welding may be used will undoubtedly be included in the provisions of the code for unfired pressure vessels to be passed on at the next meeting of the American Society of Mechanical Engineers.

As representative of the association in the Uniform Boiler Law Society, Mr. Fish again emphasized the necessity of financing the National Board of Boiler and Pressure Vessel Inspectors. With the proper support the members of this organization from the various states will be able to meet frequently to discuss ways and means of increasing the uniformity of requirements in the states. The final object of the organization is to make it possible for a boiler after passing inspection in one state under the code requirements to be acceptable wherever the code is enforced.

### Report on Resolutions

Various resolutions were presented to the association for adoption by C. V. Kellogg.

It was resolved that the American Boiler Manufacturers' Association is opposed to any change in the present system of measurements except where such changes are for the purpose of simplifying the English system. The association is absolutely against any attempt to introduce the metric system in this country because of the hardships that would be imposed on the industries.

It was resolved that every means be taken to support co-operation between capital and labor and to recognize the principle of collective bargaining on the part of capital and labor. It was further resolved that the American Boiler Manufacturers' Association endorse the principle of the open shop and oppose collective bargaining when the control is from outside the shop. This resolution is intended to prevent outside influences from disrupting the satisfactory relations existing between members of the association and the workers in the industry.

An industrial committee is to be appointed to investigate the working conditions in the shops.

The American Boiler Manufacturers' Association placed itself on record as disapproving the bonus bill introduced in Congress and feel that money should be spent for the wounded and others incapacitated for work.

### Standard Contracts

The programme for this session included a discussion on the standard form of contract covering the brick work in connections with boiler settings.

J. S. Hammerslough, of the Springfield Boiler Company, Springfield, Ill., wished the members of the association to state how the estimates on brick work were included in their contract, and whether or not the manufacturer who was responsible for the work was obliged to guarantee it for any length of time.

A. G. Pratt, Babcock & Wilcox Company, stated that his company did not include brick work unless it was absolutely necessary to do so. In such cases, however, a special contract form is used which gives the standard of work to be maintained and also calls for a one-year guarantee by the mason who performs the work. Certain repair costs are included in the original estimate and as the cost of firebrick and other materials, as well as labor, are changing constantly, a clause is inserted to provide for such changes as may occur in the prices of the work. An additional 10 percent of the actual cost in such cases is added to the base rate of this contract.

It is absolutely necessary that brick work in the setting be of the highest standard because the efficiency of the

(*Continued on page 176.*)


Twelfth Annual Convention of Master Boiler Mak

# The Master Boiler Makers' Convention

**Lecture Delivered on Locomotive Failures—Tensile Strength of Steel Discussed—Use of Autogenous Welding in Locomotive Boilers to Be Investigated**

The twelfth annual convention of the Master Boiler Makers' Association opened at the Curtis Hotel, Minneapolis, Minn., at 10 A. M. Tuesday, May 25. About 250 members were present at the opening session. The opening address was given by Hon. J. E. Meyers, mayor of Minneapolis, who welcomed the association to the city.

Following this William Schlafge, mechanical manager of the Erie Railroad, spoke of the necessity of organization in the industries, in order that productive efficiency might be increased. The duty of all boiler makers and particularly the foremen, is to hasten the replacement of power equipment in the country by carrying on the good work which has in the past marked their efforts. During the war the principles of conservation of labor and of materials were applied with remarkable results. Machine equipment was adopted wherever possible to aid production, in other words, every effort was made to obtain a maximum result with a minimum expenditure of time and labor. The same principles must be applied to a higher degree now to carry the nation through the present economic crisis without undue hardships. Turning from their constructive duties, Mr. Schlafge spoke of the responsibilties that superintendents and all others in positions of authority have toward the men under them, in instructing them in their work and understanding their requirements. All radical tendencies must be stamped out and the sad experiences of labor in European countries prevented.

### President's Address

The president of the association, John B. Tate, delivered his address on power units of the future. The engineering departments of all roads must provide for more powerful locomotives—engines capable of hauling 150 cars of 150 tons each. In the present freight congestion this need for greater power has been well demonstrated. Stationary boiler design must also be improved so that the operating efficiency may be increased and the cost of upkeep diminished. Because of the increasing tendency toward the electrification of roads, the size and efficiency of power plant units must be increased. During this reconstruction period, the men who hold the responsibilities of supervision in the shops must act at all times in such a manner that decisions are entirely fair and impartial. A complete understanding is necessary at all times between superintendents and the men under them.

### Secretary and Treasurer's Report

A summary of the secretary and treasurer's report was given by Harry D. Vought, who stated that the total receipts for the year were $2,675.60.

The total number of members in good standing March 31, 1919, was 337; associate members, 20; honorary members, 6 making a total of 363. At the Chicago convention in 1919, 183 members were enrolled. Three applications have been received since that time and five of the former members reinstated. The total number of members in good standing on March 31, 1920, was 529. The secretary's report was accepted and placed on the records The treasurer's report, which had been certified by a public accountant, was accepted and also recorded.

Following the reports, the secretary introduced the question of the invitation for the association to become a member of the American Railroad Association, section III-Mechanical. This matter has been in the hands of the executive board for consideration and a report was given by John F. Raps, chairman of the committee. The consensus of opinion of the committee seemed to be that the matter should be dropped without further action in accepting or rejecting the invitation. This suggestion was made because of the fear that an amalgamation with the American Railroad Association would cause the Master Boiler Makers' Association to lose its individuality. The matter, however, was not settled definitely at this time for many of the members were of the opinion that the strength of the association rather than being diminished by union with the Railroad Association would be greatly benefited and the added prestige of the larger organization strengthen the standing of the Master Boiler Makers' Association. It was finally decided to lay the matter on the table until further investigations of the executive committee might be made.

Association at Curtis Hotel, Minneapolis, May 25-28

## WEDNESDAY SESSION

The opening address at the Wednesday session was made by J. M. Hall, assistant chief inspector, Bureau of Locomotive Inspection, Interstate Commerce Commission on the "Causes of Boiler Failures." Lantern slides of disastrous locomotive explosions were exhibited. The accidents illustrated the more usual contributory causes and in each case these were quite apparent. Low water, corrosion of plates, bad welding of seams, formation of scale in the water glass and in the gage cock plugs have all increased the total number of locomotive disasters. When patches are put on boilers they must be properly designed and have as nearly the strength of the original plate as possible. The rivets must be spaced so that this result is obtained. In fact, complete computations for any patch should be made before it is inserted in a locomotive boiler. (Many of the instances cited were given in the annual report of the chief inspector, Bureau of Locomotive Inspection, which appeared in the February issue of The Boiler Maker.)

Mention was made of experiments conducted by the chief inspector's office on the relative accuracies of the gage cock and the water glass in indicating the true height of water in the boiler. The conclusion reached after testing various locomotives in different sections of the country under all sorts of water and service conditions is that a roll of water is raised at the back flue sheet. The highest level of this water is indicated by the gage cock while the water glass shows the true level to be 4 inches to 8 inches lower, depending on the size and type of the boiler.

Within a short time the Bureau of Locomotive Inspection will issue instructions on the proper installation of gage cocks and water glasses in relation to each other and to the boiler in order to overcome the danger from former inaccuracies. No doubt many of the low water failures that have occurred during the past few years have been due to no other cause than the assumption by an engineer that he was carrying sufficient water in his boiler as indicated by the gage cocks, while actually he may have been down to the danger level.

As this was the first convention of the association held since the return of the railroads to private ownership, W. H. Bremner, president of the Minneapolis & St. Louis Railroad, impressed on the members of the association the necessity of giving the private companies the same loyal service that was rendered to the government while the railroads were under Federal control. The same necessity for the best workmanship in construction and inspection exists now as it did during the war in order that the present equipment of the railroads may be maintained at 100 percent efficiency. Although replacements have been commenced on practically all roads, it may be many months before any of the old locomotives are eliminated. The nation's welfare is absolutely dependent on the service of the railroads which fact is being well demonstrated at the present time and the work of keeping the rolling stock in condition for the heavy service demanded of it is practically in the charge of the members of the Master Boiler Makers' Association.

A communication from the Boiler Makers' Supply Men's Association, stating the reasons for failure of the members to exhibit their products was then read by the Secretary. The lack of space in the hotel, combined with the conflict of convention dates made it impossible for all but a very few of the supply companies to make any attempt at exhibits.

The discussion of papers submitted by members of the association was commenced and continued for the remainder of the Wednesday session.

### Relative Advantages of Handhole Plate and Washout Plug

No formal report on this subject was submitted by the committee which was appointed to prepare the paper. This committee consisted of Charles P. Patrick, chairman; John J. Orr and W. H. Laughridge.

Charles P. Patrick presented the following report in connection with this subject:

"The question understood means 'What is the best washout opening device to tighten under pressure?' This question involves other considerations which must be met. Accidents, expense and terminal delays to locomotives are to be considered with the subject.

"The best device to overcome leakage when the boiler is under pressure is a good order brass plug having twelve threads per inch and tapered ¾-inch per foot.

"These plugs must be full in size, made of good material and have four continuous threads at least in the sheet. If these conditions are maintained there will be but little chance of material leakage and if leakage does occur there is little or no trouble or danger in tightening a good order plug properly applied which has from some cause or other not been made tight when the boiler was empty.

"We cannot provide against neglect of sheets or plugs which cause failures and accidents. These conditions are controlled by the boiler inspectors and men in charge of the work.

"If the threads in a plug are bad or the plug allowed to be used after it gets a shoulder by which it is temporarily frozen tight or the sheet allowed to grow thin to the extent it does not contain sufficient threads to hold the plug or the threads bruised and battered so that a plug will not tighten, accidents or engine failures may occur.

Charles P. Patrick, President-elect

Also the brass screwed washout plug is the most economical washout opening device in use to-day and there are no other removable attachments in the boiler that give less trouble or cause less accidents."

DISCUSSION

The President: The report on various designs of the opening for washing boilers is quite complete and contains what we would term good common sensible advice and counsel. With the plug properly applied there is nothing better, but when it is not properly applied what will happen? Various designs have been developed to overcome conditions that have caused trouble. I would like to hear an expression of opinion on this matter.

T. P. Madden, of the Missouri Pacific: It is my belief that very few of the locomotive boiler makers of today have had much experience with hand hole plates. I have worked in marine shops and contract shops a number of years ago, and we have had a great deal of trouble keeping hand hole plates tight.

H. J. Wandberg, of the C. M. & St. P. R. R.: My experience goes back a few years in railroading. All our old locomotives are equipped with hand hole plates at the bottom. We patched them all up something like 20 years ago, and have ever since used the brass plug, which we found was a great deal easier to maintain, and has given us good results. There is absolutely no danger with a brass plug, providing it is properly applied. I can mention at least one serious accident with a hand hole plate in my experience. Through some cause or other a bolt broke and the hand plate came out and scalded a brakeman.

I would like to hear from as many here as possible as to the exact taper a plug should have. Our present standard is ¾-inch to the foot. I understand there are a greater number using a 1-inch or 1¼-inch taper. I believe that with a little larger taper the plugs would last longer due to the fact that they would be more easily removed. Take a brass plug 1½ to 2 inches long with a 1¼-inch taper and that plug is practically straight. We oftentimes screw them in too tight, and the brass being softer than the steel forms a shoulder.

A great deal is said about the graphite forming on the plug, which it does, but I have found a number of plugs that have been applied to light sheets, say 5/16 inch or ⅜ inch, where the plug has been put in so tight it has been reduced. Naturally it is hard to remove and probably has to be replaced when taken out.

C. E. Elkins, of the Little Rock: On our road we use a plug with a taper of 1¼ inches per foot, and I believe that is a better taper than 1 inch or ¾ inch to the foot, for the reason that a ¾-inch taper will shoulder quicker than a 1¼ inch.

We have been using this design for a number of years, and have never experienced any difficulty. I believe that it is far superior to the hand hole plate.

B. C. King, of the Northern Pac.: I recall the time when we used the hand hole plate in this country. Two years ago, gentlemen, over in Siberia they used a 1⅝-inch brass bushing, and a copper gasket when they could be obtained. Leather was often substituted. Many engine failures occurred, and as a matter of fact locomotives were held up 50 percent of the time by leakage from the hand hole plates. It was necessary to remove the brass bushing, the opening not being large enough for a cleaner.

On our railroad we use a brass plug with a taper of 1 inch in twelve, which is very satisfactory, and we have very little trouble with it.

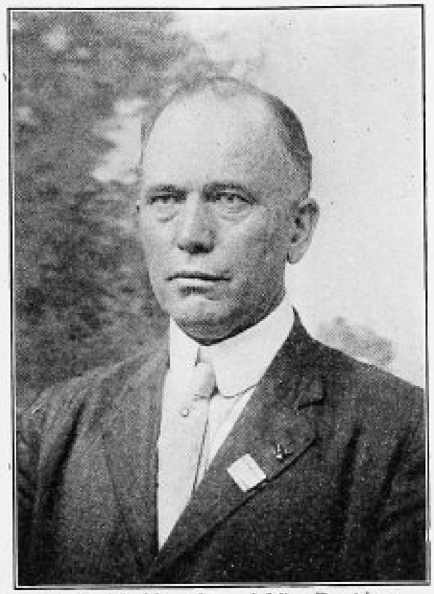
George Austin, of Topeka, Santa Fe R. R.: On our road we have about 2,200 locomotives, with an average number of screw plugs of 40 on each, making a total of 88,000 plugs.

These locomotives are washed out about 10 times a month. That is 880,000 plugs a month to go over. If it takes a minute and a half to remove a washout plug, I do not believe a hand hole plate could be removed and replaced in 5 minutes, even when things are working well.

Thomas Lewis, First Vice-President

If a railroad is so unfortunate as to be afflicted with very heavily charged and incrustated water, and a large number of openings is necessary to remove scale, a hand hole plate might be best; but that is not our condition, and I personally am not in favor of changing to hand hole plates of any kind.

Charles E. Hagan, Western Indiana R. R.: For a number of years I have been associated with several roads, and am thoroughly familiar with all of their standards. In the last few years we have tried out, on some of these



T. P. Madden, Second Vice-President

various roads, the Griffith plug. We have had a good deal of trouble with it, and we have tried the old hand hole plate and have had a good deal of trouble with it also. The latter has been most unsatisfactory.

In my opinion with the number of years' service I have seen with the various plugs, I think the brass plug, properly tapped into the sheet, with 12 threads, ¾ inch to the foot taper, has given us better service than any other plug I have ever handled.

STATISTICS OF WASHOUT PLUG ACCIDENTS

Charles P. Patrick amplified his previous report on the subject by citing statistics on arch tube and washout plugs.

"There is no general data concerning the locomotive, in a more complete or reliable form than the records in the annual reports of the chief inspector, Bureau of Locomotive Inspection of the Interstate Commerce Commission.

"In the records the following accidents may be charged to the failure of these plugs.

"We have 69,000 locomotives coming under this department (Bureau of Locomotive Inspection). During the past eight years accidents from arch tubes and washout plugs were:

13 in 1912; 20 in 1913; 21 in 1914; 16 in 1915; 17 in 1916; 8 in 1917; 14 in 1918; 30 in 1919; making a total of 139 accidents from all causes or an average of 17.3 per year. Assume the number to be 18 accidents per year.

"Of the total number of locomotives, 40 percent, or 27,600 are equipped with arch tubes and the average number of plugs is 25, making a total of 690,000 plugs.

"The remaining 41,400 locomotives are without arch tubes and therefore have 8 plugs less or 17 per boiler. The total in this case is 703,800 plugs and the grand total for all locomotives is 1,393,800 plugs.

"Under certain water conditions it is only necessary to remove plugs once a month, but in bad water districts or where the water has been heavily treated with soda ash, ten washouts a month are made. To be on the safe side, however, we will assume an average of two washouts per month, which means 33,451,200 plugs removed each year. As before stated, we have an average of 18 accidents a year or one accident for every 1,858,177 plugs removed.

"There is really no reason whatever to be alarmed about accidents from washout plugs. They are the safest devices of which I know on a locomotive boiler considering how often they are handled.

"The device is also the cheapest in my opinion. It can be used for stopping up a hole in a boiler which has to be unstopped and restopped from one to ten times a month."

Frank Yochem, Ft. Scott, Kan., M. P. R. R.: There are a great many places where we can apply a plug where a hand hole plate would not be practicable. For instance, a plug can be more easily applied close to a knuckle or between staybolts than a hand hole plate. Where you have to apply a hand hole plate to an irregular shape (not a flat surface), there is not a design that will pull up tightly to the sheet. After the engine is fired the gasket will blow out. You will experience more trouble with leaky hand hole plates than you will with leaky plugs.

I am in a bad water district. Every other day a locomotive has to be washed out, and I am satisfied that you will experience a great deal more trouble with hand hole plates than with plugs.

B. F. Whalen, Indianapolis, of the C. & I. W. R. R.: When I first started railroading there were quite a number of engines with hand hole plates. A great deal of trouble was experienced with them in hard water districts. I have seen hand hole plates pulled up tight, cold, and after the pressure on the boiler was raised up the clamping nut, could be turned with the fingers.

The universal brass plug eliminated most of the leakage troubles. We use a 12 thread B. plug with ¾-inch taper per foot. A year ago last January we installed what is called the Housley Safety Washout Plug on our ten-wheel passenger engines: and I am telling each one of you frankly that we don't know that the washout plugs are in the boiler as far as trouble is concerned not one of them has been removed, nor have any of them leaked. They cannot be cross threaded because of the guide slots.

E. W. Young, Third Vice-President

In addition there are no threads to be damaged by the cleaning rod.

I believe this is the best plug that is on the market. While it is not universally used now, I understand there are 35 different railroads in the country using this plug, and trying it. I saw a telegram last Saturday ordering 600 of them at once for the Baldwin locomotive shops.

John O. Crites, Williamsport, Pa., Penn. R. R.: I just want to give you the case of a passenger engine that came under my notice last week, on the Schuylkill division. The boiler was washed and made ready for the pressure. Before we had 150 pounds pressure, the plate on the right hand side gave out. Well it got leaking so badly that the water had to be let out and another gasket inserted. We tried the pressure a second time, but before we had gone very far it gave out on the left side, and we had to do the same thing over again. We didn't get that engine out till the next morning.

I am certain that if a plug has the same taper as the sheet, and a good thread on the sheet it will be absolutely tight.

F. J. Jenkins, Dallas, Tex., Texas & Pac. R. R.: We have down on our railroads the McCulloch United States standard switching engine. Several months ago we had leaky arch tube plugs, and I went over there and worked at the trouble myself. I had the plugs taken out and new plugs made and the holes re-tapped. And then I didn't stop. These plugs were made with a short square; a little taper on the square. Well, they couldn't be pulled in tight enough to keep them from leaking. If you did do that you were likely to be severely handicapped to get them out. So I went down to the main shop and had these plugs made with a square 1½ inches and 2 inches long. I had those put into the engines, and I have had no trouble since.

Plugs often leak because they are not made so they can be put into the boiler tight enough to keep them from leaking, and nearly every accident that has happened on our railroad from washout plugs has resulted from some roundhouse foreman too hurried to try out the engine. If properly cared for I believe the plug is better than the handhole plate.

### Tensile Strength of Firebox Steel

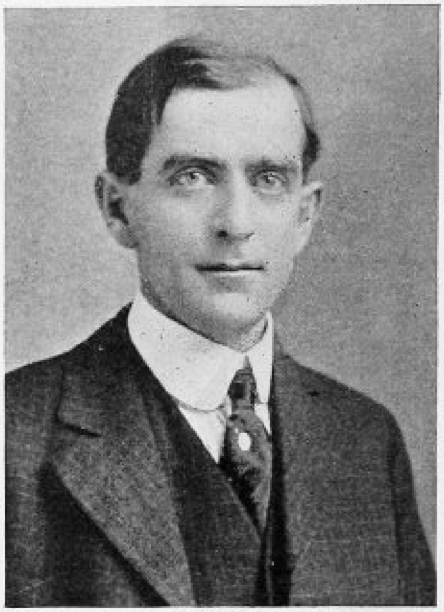
On the question of whether the best results may be obtained from firebox steel having a tensile strength from 48,000 to 58,000 pounds per square inch or from 55,000 to 65,000 pounds per square inch, the

Frank Gray, Fourth Vice-President

committee has endeavored to make the report on the subject as brief as possible. In gathering this information we find there is a very slight difference of opinion, or rather a slight difference in the specifications of the various railroads, for firebox steel.

The members of the committee have given considerable attention to the care of locomotive boilers, including the study of failures of firebox sheets.

In general, firebox sheets fail in one of two ways:



Thomas F. Powers, Fifth Vice-President

(1) Gradual Failures: The sheet may have a good many small cracks which are mostly in a vertical direction. These cracks are thickest, radiating out from the staybolts as centers and frequently running from one staybolt to another in the same vertical row, but never between staybolts horizontally. These cracks are almost always on the fire side and at times extend through the thickness of the sheet, first going through next to the staybolts. Such sheets are almost always accompanied with more or less corrugation and the cracked and corrugated condition is almost always confined to the lower half of the sheet.

Sudden Failure or Rupture: The sheets may fail by a single crack or rupture from a foot to several feet long. In bad cases the crack may extend from the mud ring to the crown sheets, but ordinarily the cracks are confined to the lower half of the sheet, extending upward from the mud ring or from a few inches above it, and it is always near the middle of the side sheet longitudinally. Such sheets may show no corrugation and may show very little if any other defects.

The failures of the first kind are of gradual formation, but those of the second class occur suddenly.

The records on file of one of the largest railroads in the United States show that between the years 1886 and 1913, 115,000 tons of boiler and firebox steel were used on locomotive boilers and they do not have any record of any failure that resulted in injury to persons or loss of life due to the character of the material.

This same railroad in 1892, specified and adopted firebox steel with a tensile strength of 55,000 to 65,000 pounds per square inch, and they are using the same grade today.

It is the opinion of the committee that the life of the firebox sheets does not entirely depend on the specifications or tensile strength of the material, but rather on the care and treatment to which the plates are subject; for instance, the washing of boilers with cold water before the boiler is properly cooled down; second, using the injectors when active steam production is not going on.

In conclusion from the best information this committee was able to obtain, firebox steel with a tensile strength of 55,000 to 65,000 pounds per square inch gives the best results.

W. H. Laughridge, Treasurer

However, we would also add that it is our experience that by suitable treatment of water supplies, a proper arrangement for delivering feedwater into the boilers and proper methods of caring for boilers in the enginehouses and elsewhere, long life can be expected with most any grade of firebox steel.

The report is signed by W. J. Murphy, chairman, F. H. Mayer and Lewis Eberle.

Discussion

T. P. Madden, M. P. R. R.: This is a very serious question. Many of the railroads have a different specification on the tensile strength of steel. On the road I represent we use 55,000 and 60,000 pounds per square inch.

R. C. Gibson, Pittsburgh, Kan., K. C. S. R. R.: My experience is that firebox steel with a tensile strength ranging from 50,000 to 56,000 pounds has always been the most serviceable.

The President: The experience of our lines has been with steel ranging from 55,000 to 65,000, and we get very good results. But that is brought about by complying with the various state laws for stationary boilers, as required by the American Society of Mechanical Engineers. For our own locomotive type boilers the tensile strength is not so high.

W. J. Murphy, Alleghany, Pa., Penn. R. R.: In the specifications from which this report is made up they specify 12 to 30 percent for firebox carbon steel, and for other parts of the boiler a harder steel. If you read through this report you will find that my experience is that a whole lot of firebox failures are not only due to the tensile strength of the steel, but also to the care of the boiler.

Frank Yochem, Fort Scott, Kan., M. P. R. R.: We use firebox steel 50,000 to 55,000 pounds per square inch tensile strength. My opinion is that the tensile strength of the steel doesn't cut much figure, providing your staybolts are applied properly in the fire line. I think most of our cracks are due to loose staybolts. The constant driving of staybolts opens the holes. This causes the cracks to develop around the sides of the staybolts. Eventually they get longer and result in the rupture of the sheet.

John F. Raps, Chicago, Ill. Central R. R.: On the Illinois Central we use firebox steel having a tensile strength of 55,000 to 65,000 pounds per square inch. We thought we would be able to increase the life of our firebox sheets, and increased it from 48,000 to 55,000 pounds per square inch about 1916 when the steel companies refused to furnish steel according to our specification.

## Effect of Steam Pressures on Staybolt Breakage

On the subject of superheating and reducing steam pressures in locomotive boilers and their effect on staybolt breakage, the committee submitted the following report:

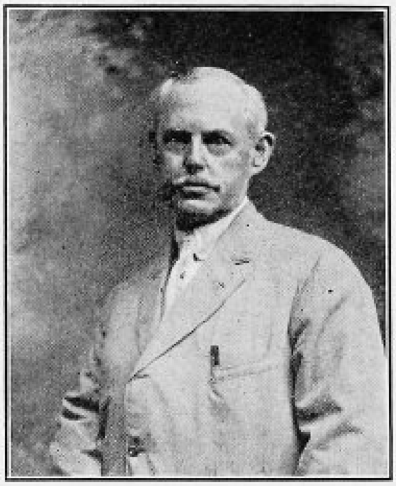
The compiled data taken from six different territories or districts where the service, water condition, etc., differ largely and steam pressure is about the same, are given below:

DATA ON STAYBOLT BREAKAGE COVERING PERIOD OF FIVE YEARS

| District Number | Number of Locos. | Steam Pressure | Total Broken | Bolts Broken Per Yr. | Bolts Broken per Engine Per Yr. |
|---|---|---|---|---|---|
| Superheater ..... | 5 | 185 to 200 | 127 | 25.4 | 5.08 |
| Saturated ........ | 5 | 220 | 514 | 102.8 | 20.56 |
| Superheater ..... | 5 | 185 to 195 | 216 | 43.2 | 8.64 |
| Saturated ........ | 5 | 220 | 710 | 142 | 28.4 |
| Superheater ...... | 5 | 185 to 200 | 1,193 | 238.6 | 47.72 |
| Saturated ........ | 5 | 220 | 1,848 | 269.6 | 73.9 |
| Superheater ..... | 5 | 185 to 200 | 196 | 39.2 | 7.84 |
| Saturated ........ | 5 | 220 | 1,610 | 322 | 64.4 |
| Superheater ..... | 5 | 185 | 432 | 86.4 | 17.28 |
| Saturated ........ | 5 | 220 | 470 | 94 | 18.8 |
| Superheater ..... | 1 | 185 to 200 | 71 | | |
| Saturated ........ | 5 | 220 | 358 | 71.6 | 14.32 |

All engines involved are Pacific type.

The chart shows there is no doubt that the superheater and reduction of steam pressure of boilers from 220 to 195



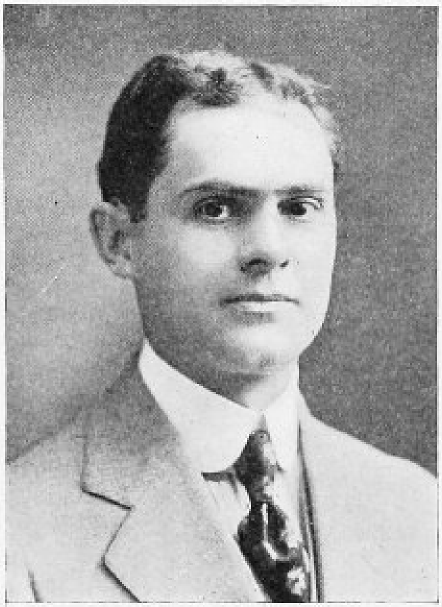
Harry D. Vought, Secretary

pounds pressure will decrease the staybolt breakage.

We have also compared 10 locomotives previously operated as saturated without brick arches. These locomotives were later equipped with superheaters and brick arches, and the pressure remained the same—205 pounds.

The comparison shows considerably less staybolt breakage. (While this paper is not on the brick arch, we consider they are co-related and have some bearing on the subject.) The reduced breakage of staybolts is accounted for along these lines: The brick arch acts as an indicator making the proper handling of the boiler compulsory. If the boiler is blown down too soon arch tubes will be distorted. Saving the arch tubes also saves the staybolts.

Our records show that superheating and reducing of



J. F. Raps, Chairman Executive Committee

steam pressure of boilers result in a reduction of staybolt breakage.

The report is signed by T. L. Mallam, chairman, F. A. Mayer and E. J. Sweeney.

### Discussion

An individual report on this subject was submitted by E. J. Sweeney of the report committee.

"The New York Central Railroad in connection with the Pennsylvania, during 1910 made two elaborate series of tests, and the results obtained showed that superheater locomotives decreased the demand on the boiler from 25 to 35 percent; that is to say, the boilers of the superheater locomotives have to make considerably less steam than the boilers of the other type. This is, of course, due to the fact that less superheated steam, with its greater heat content, is needed for a given power.

"In line with the results of these tests and my own experience, I contend that superheated boilers do not break as many bolts as boilers not superheated. We have in service on our road four O. G. style fireboxes that are not superheated. These four engines carry 200-pounds per square inch pressure, whereas all the others carry 180-pound pressure. We find that more staybolts are broken in these four engines than in any eight superheaters.

"There is a question in my mind whether the lesser staybolt breakage on our superheaters is the result of the lower boiler pressure or whether it is the result of other conditons caused by superheat, design and service. As just mentioned, I think the superheater boilers do not have to make as much steam as the saturated steam boilers and therefore do not have to be worked as hard as the latter, with the result that firebox sheets are not punished as badly. The lower boiler pressures of a superheater may help, but I am of the opinion that the greater advantage to staybolts and boiler maintenance conditions from superheat is that with it an engine can be more easily fired and the steam maintained more uniformly.

"I believe everyone appreciates the fact that staybolts are caused to break by expansion and contraction, which again causes the inside and outside sheets to move with relation to each other. The harder and more irregularly the boiler is forced, the greater will be such movement and the greater the staybolt strain. The lower the factor of safety in the design, the greater becomes the chance for staybolt breakage with this strain."

R. C. Gibson, Pittsurgh, Kan., K. C. So. R. R.: It is not a question of superheated steam, it is not a question of saturated steam, it is just a question of being able to reduce the pressure by not superheating.

C. E. Elkins, Little Rock, Ark., of the M. P. R. R.: I cannot see any connection between the superheated and the saturated problem as far as the breakage of the staybolts is concerned, except that the steam pressure is reduced. We have engines on our line in which we have reduced the steam pressure and the steam cuts out the staybolts. On other locomotives of the same type there is apparently no effect on the staybolts.

W. H. Lucas, of the M. C. R. R.: Isn't it a fact that where the engines have been superheated and changed over, that they reduce the pressure? On the Milwaukee all our superheated engines are reduced in pressure. We had 180 pounds per square inch, but they were put back to 200 pounds per square inch. I also figure where an engine is superheated that the tonnage is increased as well.

John F. Raps, Chicago, of the Illinois Central: I happened to be chairman of the committee, and am partly responsible for this topic coming up. Our superintendent asked me one time whether there was any difference in the breakage of staybolts on the superheated engines, and I didn't have any engine that I could make a comparison on.

Now members have been getting up here and telling about cutting steam pressures. That does not mean very much, because on the Illinois Central we have cut our steam pressure. We superheat an engine and we increase our tonnage; and the tonnage is the answer to it. The more tonnage you pull the more staybolts you are bound to break. A reduction of 15 pounds in the pressure is not going to have very much effect on the breakage of staybolts.

W. H. Evans, Augusta, Georgia, of the Georgia R. R.: We have 8 engines that are of exactly the same type. Four of them have been superheated for about three years. The other 4 are still saturated. And I have noticed the breakage of staybolts in them very carefully; and I do not think there is a particle of difference. I believe that the superheated breaks just as many. In fact I know they do, because I keep a record of every broken staybolt, and the superheated break just as many staybolts as the saturated do.

Possibly some of those who have spoken do not take into consideration the fact that when you superheat an engine you give it a general overhauling, and they therefore appear to have an advantage over the saturated.

Another thing, I can't see why superheating should stop staybolts from breaking because I believe it is a matter of expansion and contraction, and even though you do reduce the steam you still have enough steam to break staybolts.

H. J. Wandberg, Milwaukee, Wis., of the C. M. & St. P. R. R.: As far as the two types of engines are concerned, I don't see a particle of difference We have got several classes of engines that have been superheated. I have cared for them since, and as far as the breakage of have cared for them since, and as far as the breakage of bolts is concerned I can't see a bit of difference.

Now our superheated engines, on which the pressure was cut to 180 or 185 pounds, have been again increased to 200, and it means that instead of being easier, they are no doubt harder worked on the boiler, but for all that I have seen no difference in the breakage of bolts.

Another thing, most of our superheated engines are of a later type. A great many of them come to us new—right from the factory. Others have received heavy repairs in the shop, and received new fireboxes; consequently our staybolts are all new; and I would not consider it any comparison unless I took a boiler of the same age, type, and length of service, and in the same service. Now we have divisions on the Milwaukee that will break a great many more bolts than others do, due to water conditions.

T. F. Powers, Oak Park, Ill., C. & N. W. R. R.: There are several elements that enter into the breaking of staybolts besides either superheating or reduction of steam. One I believe is the geographical condition of the country the locomotives run in. Vibrations will break bolts. We break more bolts on our lines west of the Mississippi, than we do on all the rest of our engines put together; for two reasons: one, water conditions; the other, the geographical conditions of the country, and being subject to frequent expansion and contraction.

Another thing, in that country the type of locomotive, the type of boiler, makes a good deal of difference; and the steam pressure makes some difference. Eight years ago we put out 2 engines carrying 160 pounds of steam, in a district where it is nothing to have 40 to 400 staybolts taken out at one roundhouse in a month. On these two engines we didn't break any staybolts for the last 4 or 5 years, and very few up to within eight years.

W. J. Murphy, Allegheny, Pa., of the Penn. R. R.: Isn't it true that we have a lot less broken staybolts in wide fire boxes than we do in narrower fire boxes? My experience in wide fire boxes is that we do not have many broken staybolts in them. And it is also true that more wide fire boxes are superheated, therefore the great majority of broken bolts will be found in boilers which are not superheated.

D. A. Lucas, Milwaukee Prime Mfg. Co.: My experience has been that there is little difference in the breakage of staybolts on superheated and saturated steam locomotives. What breaks the staybolts is the uneven contraction and expansion in the boilers, and one boiler will break more bolts than another with the same pressure, because of a difference in design. If this theory of reducing the pressure from 200 pounds to 180 will eliminate the breakage of staybolts, we should not have any breakage in 140 pound boilers. However, the same difficulty exists in our 140 pound boilers.

Thomas Lewis, Sayre, Pa., of the Lehigh Valley R. R.: There seems to be a general opinion in regard to the breakage of staybolts, that the design of the boiler has a whole lot to do with it. Now we have nearly all kinds of designs on our road. We have boilers that will run for 6 years without applying a new firebox—on a certain class of engines, the wide Hubbard. We have another boiler we call our semi wide firebox. They will only run 4 years before we have to apply a new firebox. And the same principle will apply in the breakage of staybolts. On the wide Hubbard fireboxes we do not have nearly the number of broken staybolts that we do in the semi type.

Jas. T. Johnston, Los Angeles, Calif., of the Santa Fe R. R.: I believe that expansion and contraction of the metal in the sheets as well as the vibration is responsible for the greater number of staybolt breakages. Temperature and pressure have little or nothing to do with the matter.

### Cinder Hopper on Bottom of Smoke Arch

From inquiries and observations made, the committee finds that the use of a cinder hopper on the bottom of the smoke arch is quite varied. There are roads that have some of their engines equipped with a hopper, and others not so equipped, and their performance is also varied; some engines with the hopper as well as those without it clean themselves satisfactorily and steam well, while other engines of the same class and type, having the same design and adjustment of front-end appliance set alike, do not

(*Continued on page* 185.)

## Registration at Master Boiler Makers' Convention

C. H. Aiken, 740 E. 120th St., Cleveland, O.
A. A. Akins, F. B. M., C. G. & W. R. R., St. Paul, Minn. (115 E. Isabelle St.)
Jacob Albert, asst. boiler foreman, C. & W. I. R. R., 51st St. shops, Chicago, Ill.
J. A. Albrecht, F. B. M., N. Y. C. R. R., 40 Hubbell Ave., Buffalo, N. Y.
Andrew Anderson, general boiler insp., D. & R. G. R. R., 970 S. High St., Denver, Colo.
Joseph O. Ashback, Box 224, Deer Lodge, Mont.
George Austin, G. B. I., A., T. & S. F. R. R., 6 Devon Flats, Topeka, Kan.
A. M. Baird, V. P., Baird Pneumatic Tool Co., 718 Monroe St., Kansas City, Mo.
W. R. Barnes, chief B. I., C. of G. R. R., 563 Oak St., Macon, Ga.
F. A. Batchman, F. B. M., N. Y. C. R. R., 1421 Krau St., Elkhart, Ind.
C. J. Bauman, F. B. M., N. Y., N. H. & H. R. R., 305 Howard Ave., New Haven, Conn.
Fred Bayer, F. B. M., P., C., C. & St. L. Ry., 410 St. Clair Ave., Columbus, O.
Arthur J. Beland, general F. B. M., Chicago Jct. R. R., 7346 Kenwood Ave., Chicago, Ill.
G. W. Bennett, dist. insp., I. C. C., 15 Kent St., Albany, N. Y.
C. J. Bieser, boiler foreman, St. Louis & South Western R. R, 216 Gold St., Tyler, Tex.
Matthew Billington, F. B. M., B. R. & P. R. R., 72 Central Ave., E. Salamanca, N. Y.
R. J. Blaney, boiler maker foreman, C. & N. W. R. R., 364 Frank St., Huron, S. D.
Calvin M. Bono, boiler foreman, C. M. & St. P. R. R., Box 721, Mobridge, S. D.
L. Borneman, general F. B. M., C., St. P., M. & O. R. R., 1121 Sleby Ave., St. Paul, Minn.
James Bove, F. B. M., N. Y. C. R. R., Brewster, N. Y.
John A. Brandt, general boiler insp., N. Y., O. & W. R. R., 343 North St., Middletown, N. Y.
John Brennan, F. B. M., Grt. N. R. R., 1315 E. Grand Ave., Everett, Wash.
C. H. Browning, F. B. M., G. T. Ry., 53 Cherry St., Battle Creek, Mich.
Percy Browning, boiler maker foreman, Penn. R. R. shops, Canton, O.
Thomas E. Burdett, B. M. F., C. & N. W. R. R., 509 Elmore St., Green Bay, Wis.
E. R. Burgan, boiler maker foreman, Northern Pacific Ry., 1521 Lyndale Ave., Helena, Mont.
L. J. Burno, F. B. M., N. P. R. R., 1067 Como Pl., St. Paul, Minn.
R. Burnside, dist. B. I., N. Y. C. R. R., 105 E. Third St., Oswego, N.Y.
Jeremiah Cahill, dist. B. I., G. N. R. R., 907 2d Ave. So., Glasgow, Mont.
John C. Campbell, Keller Pneu. Tool Co., 40 E. Jackson Blvd., Chicago, Ill.
J. H. Chastain, B. M. F., N. C. & St. L. R. R., 299 S. Boulevard, Atlanta, Ga.
J. Christianson, boiler shop foreman, C., M. & St. P. R. R., 832 Maple Ave., Green Bay, Wis.
R. W. Clark, G. F. B., N. C. & St. L. R. R., 720 17th Ave. So., Nashville, Tenn.
John A. Clas, general foreman, boiler dept., N. Y. C. R. R., 20 Stephen St., Albany, N. Y.
John C. Codden, boiler inspector, Grt. N. R. R., Superior, Wis.
P. J. Conrath, boiler tube expert, National Tube Co., 4414 Michigan Ave., Chicago, Ill.
Robert L. Conroy, asst. B. F., Indiana Harbor Belt, Gibson, Ind.
E. C. Cook, mgr. editor *Railway Journal*, 637 Webster Bldg., Chicago, Ill.
Walter Cook, F. B. M., G. T. P. R. R., 11757 122d St., Edmonton, Alberta.
J. E. Cooke, M. B. M., Bessemer & Lake Erie R. R., 360 S. Main St., Greenville, Pa.
Charles C. Corns, B. F., C. & N. W. Ry., Belle Plaine, Ia.
P. E. Cosgrove, G. F. B. M., Elgin, Joliet & Eastern R. R., 103 Glenwood Ave., Joliet, Ill.
M. S. Courtney, boiler F., Grt. N. R. R., 1107 Harmond Pl., Minneapolis, Minn.
R. A. Creger, general foreman boiler maker, N. P. R. R., 415 9th St., S. Brainerd, Minn.
R. P. Crimmins, F. B. M., Big Four R. R., 812 Charleston St., Mattoon, Ill.
John O. Crites, G. B. I., G. Cent. Div., P. R. R., 928 High St., Williamsport, Pa.
Jas. Crombie, general supt., J. O'Brien Boiler Wks. Co., St. Louis, Mo.
James Daly, boiler insp., I. H. B. R. R., 479 E. State St., Hammond, Ind.
J. J. Davey, G. B. I., N. P. Ry., N. P. Cen. Office Bldg., St. Paul, Minn.
Frank Davison, F. B. M., C. P. & St. L. R. R., 271 Hardin Ave., Jacksonville, Ill.
H. Denzler, F. B. M., Penn. R. R. shops, Indianapolis, Ind.
Peter Derrig, boiler foreman, G. N. R. R., 116 Dayton Pl., St. Paul, Minn.
A. C. Dittrich, general boiler ins., Soo Line, 1409 N. 5th St., Minneapolis, Minn.
Thomas P. Donahue, asst. F. B. M., N. Y., N. H. & H. R. R., 4 Day St., Norwood, Mass.

Richard Doolin, night B. M. F., engine house, N. Y. C. R. R., 721 Sohl St., Hammond, Ind.
Charles H. Douglass, F. B. M., Central Vermont R. R., 36 Main St., St. Albans, Vt.
James L. Downs, F. B. M., N. Y. C. R. R., 1005 Summit Ave., New York City.
Lewis Eberle, B. M. F., B. & O. R. R., 111 Peters St., Garrett, Ind.
Jeremiah Eder, F. B. M., C. & N. W. R. R., 1351 N. Avers Ave., Chicago, Ill.
P. J. Egan, F. B. M., B. & O. R. R., Brunswick, Md.
C. E. Elkins, general F. B. M., M. P. R. R., 1212 W. 11th St., Little Rock, Ark.
M. B. Erickson, boiler foreman, C., M. & St. P. R. R., Austin, Minn.
W. H. Evans, F. B. M., Georgia R. R., 1034 Broad St., Augusta, Ga.
William F. Fantom, F. B. M., I. C. R. R., 7721 Eggleston Ave., Chicago, Ill.
John B. Feld, F. B. M., M. & St. L. R. R., Marshalltown, Ia.
M. J. Fennelly, dist. boiler insp., N. Y. C. R. R., 30 Magnolia Ave., Jersey City, N. J.
George G. Fisher, F. B. M., Belt R. R. of Chicago, 8711 Peoria St., Chicago, Ill.
E. S. Fitzsimmons, Flannery Bolt Co., P. O. Box 25, Oakland Station, Pittsburgh, Pa.
Kearn E. Fogerty, general B. F., C., B. & Q. R. R., 309 S. 12th St., Havelock, Neb.
E. F. Follin, G. B. F., G. N. R. R., Glendale Apt. 26, Great Falls, Mont.
Myron C. France, boiler insp., C., St. P., M. & O. Ry., 57 B. Piedmont Apt., St. Paul, Minn.
W. F. George, general boiler insp., Mobile & Ohio R. R., 2638 A St., Meridian, Miss.
Peter J. Gibler, general B. F., G. C. & S. F. Ry., 720 N. Angline St., Cleburne, Tex.
Archibald Giddings, F. B. M., D. & I. R. R., Two Harbors, Minn.
K. K. Gill, F. B. M., A. & W. P. R. R., 424 N. McDonough St., Montgomery, Ala.
James T. Goodwin, boiler tube expert, National Tube Co., 740 Carlton Ave., Plainfield, N. J.
John T. Gorman, dist. G. B. I., C., M. & St. P. Ry., 8500 Ind. Road, Kansas City, Mo.
Charles W. Grant, B. M. F., U. & D. R. R., 96 E. Chester St., Kingston, N. Y.
T. P. Green, gen. B. F., C. T. H. S. E. R. R., 1315 11th St., Bedford, Ind.
Andrew S. Greene, G. F. B. M., Big Four System, 3209 E. 16th St., Indianapolis, Ind.
M. J. Guiry, F. B. M., Grt. N. R. R., 684 Grand Ave., St. Paul, Minn.
James G. Gunn, F. B. M., I. C. R. R., 115 E. Elm St., Cherokee, Ia.
Chas. E. Hagan, M. D. M., C. & W. I. Ry., 5553 S. Green St., Chicago, Ill.
George N. Hagan, F. B. M., Erie R. R., 235 Blaine Ave., Marion, O.
Robert J. Hanna, F. B. M., Erie R. R., 192 Pacific St., Paterson, N. J.
Carl A. Harper, F. B. M., C. N. R. R., 674 N. Washington St., Van Wert, O.
F. C. Hasse, F. C., general supv., Service & Eqpt., Oxweld R. R. Service Co., 339 Ry. Exchange, Chicago, Ill.
M. E. Healy, F. B. M., B. & O. R. R., 855 Hamilton Terrace, Baltimore, Md.
Andrew Hedberg, Div. F. B. M., C. & N. W. R. R., 1203 William St., Winona, Minn.
Edward H. Heidel, welding supv., C., M. & St. P. Ry., 503 30th Ave., Milwaukee, Wis.
C. W. Heiner, foreman, I. C. R. R., 212 S. 15th St., Mattoon, Ill.
C. L. Hempel, G. B. I., U. P. R. R., 2545 Davenport St., Omaha, Neb.
John E. Hidde, general loco. insp., M. & St. L. R. R., 1519 James Ave. No., Minneapolis, Minn.
P. J. Hiett, F. B. M., J. C. So. Ry., 1801 N. Grand Ave., Pittsburg, Kan.
Ernest E. Hilliger, F. B. M., N. Y. C. Lines, 250 Wagner Ave., Sloan, N. Y.
William A. Hogan, supv. welding, Oxweld R. R. Service Co., 3640 Jasper Pl., Chicago, Ill.
J. A. Holder, G. M. B. N., Seaboard Air Line, 931 Ann St., Portsmouth, Va.
J. P. Housley, rep., Housley Flue Con. Corp., 2760 Roosevelt Ave., Indianoplis, Ind.
Frederick J. Howe, general boiler F., C., B. & Q. R. R., 234 N. Root St., Aurora, Ill.
William Hucabee, F. B. M., K. C. So. Ry., 1543 Laurel St., Shreveport, La.
Edward Hunt, asst. G. B. I., I. C. R. R., 908 Central Station, Chicago, Ill.
P. S. Hursh, general boiler insp., B. R. & P. R. R., 17 Linden Ave., Du Bois, Pa.
George B. Hutchinson, boiler foreman, C., M. & St. P. R. R., P. O. Box 94, Spirit Lake, Idaho.
R. W. Janes, B. I., C. M. & St. P. Ry. shops, Miles City, Mont.
F. J. Jenkins, general loco. insp., T. & P. R. R., Dallas, Tex.
Gilmore Jennings, general boiler foreman, B. & O. R. R., 513 Sycamore St., Washington, Ind.
Jas. T. Johnston, asst. G. B. I., A., T. & S. F. R. R., 1315 W. 41st St., Los Angeles, Cal.
G. J. Jones, general boiler foreman, B. & O. R. R., New Castle, Pa.
J. C. Keefe, F. B. M., T. & O. C. Ry., 114 Liberty St., Bucyrus, O.
William F. Keidel, F. B. M., D. & H. R. R., 95 Chestnut St., Oneonta, N. Y.
J. W. Kelly, boiler tube exp., National Tube Co., 515 N. Grove Ave., Oak Park, Ill.
Thomas F. Kilcoyne, trav. eng., Am. Arch Co., 4344 Floral Ave., Norwood, Cincinnati, O.
B. C. King, asst. G. B. I., N. P. Ry., 790 Grand Ave., c/o H. Barnacle, St. Paul, Minn.
J. C. Kingsley, F. B. M., N. Y., N. H. & H. R. R., 313 Howard Ave., New Haven, Conn.
William Kinninger, G. F. B. M., A., T. & S. F. R. R., 319 Quinton Blvd., Topeka, Kan.
Frank H. Kissinger, asst. G. B. I., P. & R. Ry., 104 Douglass St., Reading, Pa.
Charles M. Klink, F. B. M., C., M. & St. P. R. R., 3309 19th Ave., Minneapolis, Minn.
F. W. Knauer, B. F., D., T. & I. R. R., 82 Chestnut St., Jackson, O.
O. H. Koebernik, G. B. I., N. Y. C. & St. L. R. R., 498 State St., Conneaut, O.
Charles Kraus, F. B. M., Big Four System, 22 W. 19th St., Indianapolis, Ind.
Charles N. Kreider, C. B. I., P. & R. Ry., 127 S. 11th St., Reading, Pa.
John Kremer, F. B. M., C., M. & St. P. R. R., 4014 Washington Blvd., Chicago, Ill.
Harry A. Lacerda, inspector of boilers, U. S. Shipping Board, 3258 Hudson Blvd., Jersey City, N. J.
O. F. Ladtkow, instr., Oxweld R. R. Serv. Co., 1311 Fredericka Pl., Milwaukee, Wis.
W. S. Larason, F., Hocking Valley R. R., 1070 Lexington Ave., Columbus, O.
William H. Laughridge, G. F. B. M., Hocking Valley R. R., 537 Linwood Ave., Columbus, O.
James Laysck, F. B. M., G. N. R. R., 2601 Banks Ave., Superior, Wis.
Theo. Laysek, boiler foreman, G. N. R. R., Havre, Mont.
A. C. Lenz, F. B. M., Ann Arbor R. R., 508 E. Williams St., Owosso, Mich.
Thomas Lewis, general B. I., L. V. System, Sayre, Pa.
Jos. R. Libera, B. M. F., 448 Marshall St., Milwaukee, Wis.
Franklin T. Litz., general B. F., C., M. & St. P. R. R., 3601 Parkhill Ave., Milwaukee, Wis.
Charles J. Longacre, F. B. M., Penn. R. R., 664 Monroe Ave., Elizabeth, N. J.
A. N. Lucas, dist. mgr., Oxweld R. R. Service Co., Railway Exchange, Chicago, Ill.
D. A. Lucas, The Prime Mfg. Co., 1218 Ry. Exchange Bldg., Milwaukee, Wis.
W. H. Lucas, trav. B. I., M. C. R. R., 67 Rosebury Pl., St. Thomas, Ont.
Peter Lux, F. B. M., C. & N. W. R. R., 1101 N. Keeler Ave., Chicago, Ill.
M. M. McCallister, boiler expert, Am. Flexible Bolt Co., 230 E. 26th St., Erie, Pa.
McCloskey, Joseph, boiler foreman, Erie R. R., Box 1095, Galion, O.
John McDermott, F. B. M., I. C. R. R., 104 S. Court St., Water Valley, Miss.
John McGarrigal, B. F., I. C. R. R., 1024 Broadway, Paducah, Ky.
L. P. McHugh, general boiler insp., Mobile & Ohio R. R., 215 N. 18th St., Murphysboro, Ill.
John F. McKenna, F. B. M., N. Y., N. H. & H. R. R., 95 Orms St., Providence, R. I.
John McKeon, F. B. I., Erie R. R., 350 Payne Ave., Galion, O.
S. A. McMonagle, F. B. M., M. P. R. R., 316 N. Lawn Ave., Kansas City, Mo.
J. W. McNamara, G. F. B. M., L. E. & W. R. R., 815 N. Medcalf St., Lima, O.
W. Mackeroth, boiler insp., G. N. R. R., 408 Walder St., Minot, N. D.
J. J. Madden, boiler foreman, C., R. I. & P. R. R., 1108 7th St., Fairbury, Neb.
T. P. Madden, general boiler insp., M. P. R. R., 6947 Clayton Ave., St. Louis, Mo.
E. J. Maher, B. M. F., N. P. Ry., 2026 W. 2d St., Duluth, Minn.
John J. Mahoney, G. F. B. M., U. P. R. R., 123 W. 27th St., Cheyenne, Wyo.
John J. Mansfield, chief boiler insp., C. R. R. of N. J., 74 Pearsall Ave., Jersey City, N. J.
R. L. Marshall, F. B. M., B. R. & P. R. R., 407 S. State St., Du Bois, Pa.
Nicholas W. Martin, F. B. M., M. & St. L. R. R., 52 Ash St., Minneapolis, Minn.
S. C. May, general boiler insp., G. T. P. Ry., Transcona, Man., Canada.
M. L. Medinger, F. B. M., C. M. & St. P. R. R., Sioux City, Ia.
James H. Minehan, engine house F., D. L. & W. R. R., 132 Mifflin Ave., Scranton, Pa.
Lee A. Mitchell, boiler foreman, I. C. R. R., 209A N. 6th St., E. St. Louis, Ill.
L. O. Moses, F. B. M., K. & M. R. R., Box 632, Middleport, O.
Martin Murphy, general B. I., B. O. S. W. R. R., 1005 Regina Ave., Price Hill, Cincinnati, O.
W. J. Murphy, G. F. B. M., Penn. R. R. Lines W., Fort Wayne shops, Allegheny, Pa.
John T. Neary, boiler F., C. & N. W. R. R., 1014 4th Ave., Antigo, Wis.
H. B. Nelson, B. M. F., M. P. R. R., 312 E. 7th St., Sedalia, Mo.
Lewis Nicholas, Jr., G. B. I., C., I. & L. Ry., La Fayette, Ind.
E. J. Nicholson, F. B. M., C. & N. W. R. R., 1372 Island Ave., Milwaukee, Wis.
William Norton, boiler F., I. W. R. R., 415 N. State St., Indianapolis, Ind.
Thomas J. O'Loughlin, G. F. B. M., G. N. Ry., 626 Aurora Ave., St. Paul, Minn.
John J. Orr, general F. B. M., D., L. & W. R. R., 322 Taylor Ave., Scranton, Pa.
J. D. Osborn, F. B. M., A., T. & S. F. R. R., 427 9th St., Richmond, Cal.
Charles Pable, boiler foreman, C. & N. W. Ry., 327 Bartlett Ave., Milwaukee, Wis.
Charles P. Patrick, mgr., Chicago Wilson Welding Repair Co., 1442 McCormick Bldg., Chicago, Ill.
R. T. Peabody, sales asst., R. R. Dept., Air Reduction Sales Co., 120 Broadway, New York City.
C. F. Petzinger, M. B. M., Cen. of G. R. R., 742 Courtland Ave., Macon, Ga.
William Pollock, G. F. B. M., B. & O. R. R., 310 Renova St., Pittsburgh, Pa.
I. J. Pool, gen. B. I., B. & O. R. R., 1430 Harlem Ave., Baltimore, Md.
L. J. Pool, asst. F. B. M., Erie R. R., 1042 Grove St., Meadville, Pa.
R. Porter Louis, F. B. M., Soo Line, 804 20th Ave. N. E., Minneapolis, Minn.
David W. Potts, F. B. M., I. C. R. R., Centralia, Ill.
John P. Powers, F. B. M., C. & N. W. R. R., 905 First St., Escanaba, Mich.
Thos. F. Powers, system G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence Ave., Oak Park, Ill.
Frank J. Rahrle, F. B. M., B. & O. S. R. R., 499 Church St., Chillicothe, O.
J. N. Ralston, F. B. M., A. B. & A. Ry., Fitzgerald, Ga.
John F. Raps, G. B. Insp., I. C. R. R., 4041 Ellis Ave., Chicago, Ill.
Edward J. Reardon, dist. insp., loco boilers, I. C. C., 7112 Euclid Ave., Chicago, Ill.
G. M. Rearick, general boiler insp., B. & S. R. R., 85 Germania St., Galeton, Pa.
T. J. Reddy, general boiler F., C. & E. I. R. R., 908 E. Main St., Danville, Ill.
A. J. Redmond, B. F., L. I. R. R., 85 Forest Ave., Rockville Center, L. I.
Paul C. Renno, Rep., Niles-Bement-Pond Co., 111 B'way, N. Y. City.
George N. Riley, National Tube Co., 7225 Mead St., Pittsburgh, Pa.
G. S. Robertson, G. F. B. M., Ft. W. & D. C. R. R., P. O. Box 192, Childress, Tex.
G. P. Robinson, Am. Loco. Co., 30 Church St., New York City.
Louis Roehrig, B. M. F., S. P. R. R., 548 Pershing St., Portland, Ore.

E. W. Rogers, G. F. B. M., Am. Loco. Co., Schenectady, N. Y.
Horace Rushton, asst. F. B. M., P. M. R. R., 10 Wilson Ave., St. Thomas, Ont.
Robt. Russell, boiler insp., G. T. R. R., 9 Irving St., Battle Creek, Mich.
Clement Ryan, F. B. M., U. P. R. R., 4228 Mason St., Omaha, Neb.
Corbet A. Ryder, F. B. M., L. & N. R. R., 461 S. Lawrence St., Mobile, Ala.
T. N. Sadler, F. B. M., C. & N. R. R., So. Kaukauna, Wis.
F. C. Sampson, G. B. M. F., B. & O. R. R., Cumberland, Md.
B. F. Sarver, F. B. M., Penn. Lines W., 234 E. Woodlawn Ave., Ft. Wayne, Ind.
H. J. Scholl, B. M. F., N. P. R. R., 2207 6th St. N., Minneapolis, Minn.
A. Seaburg, B. M. F., N. P. R. R., 303 S. H St., Livingston, Mont.
Nels Seaburg, B. M. F., N. P. R. R., 106 16th St. N., Fargo, Minn.
John Service, F. B. M., C. & N. W. R. R., 1625 Ainslee St., Chicago, Ill.
H. H. Service, supv. welding, A., T. & S. F. R. R., 308 Jefferson St., Topeka, Kan.
C. W. Shafer, I. C. R. R., 4041 Ellis Ave., Chicago, Ill.
A. E. Shaule, B. M. F., D., M. & N. R. R., Proctor, Minn.
Geo. M. Sherbert, F. B. M., Rutland R. R., 93 Plain St., Rutland, Vt.
Edw. G. Simms, insp. loco. boilers, I. C. C., 707 Grt. Northern Bldg., Chicago, Ill.
W. J. Simons, boiler F., C. G. W. R. R., 128½ E. Winifred St.
F. Smith, boiler shop F., Kansas City So. Ry., 1809 N. Locust St., Pittsburg, Kan.
James P. Smith, B. M. F., C., M. & St. P. R. R., 809 Third Ave. S. W., Aberdeen, S. D.
Daniel A. Stark, G. B. F., L. V. R. R., 611 S. Elmer Ave., Sayre, Pa.
L. W. Steeves, F. B. M., M. C. R. R., 76 Moore St., St. Thomas, Ont.
M. L. Steinbuck, B. M. F., C. & N. W. R. R., 318 Shelton St., Chadron, Neb.
Albert F. Stigmeier, general boiler F., B. & O. R. R., Mount Clare shops, Baltimore, Md.
E. E. Stillwell, asst. supt., Huastica Oil Co., Apartado 216, Tampico, Mexico.
William Strinsky, B. M. F., C. M. & St. P. Lines, Tacoma, Wash.
F. J. Sullivan, B. M. F., I. C. R. R., 197 Empire St., Freeport, Ill.
Joseph Sullivan, F. B. M., N. Y. C. R. R., 275 Hoyt St., Buffalo, N. Y.
C. C. Swarmer, B. M. F., C. & N. W. R. R., 543 W. Midwest Ave., Casper, Wyoming.
E. J. Sweeney, general F. B. M., N. Y. C. R. R., 421 Bauer St., Hammond, Ind.
T. J. Talbott, F. B. M., R. F. & P. R. R., 409 Marx St., So. Richmond, Va.
John B. Tate, F. B. M., P. R. R., 200 Logan Ave., Altoona, Pa.
M. K. Tate, mgr. Service, Lima Loco. Wks., Lima, O.
Peter Thompson, F. B. M., C., R. I. & P. R. R., 1315 Center St., Goodland, Kan.
Frederick Todtz, F. B. M., N. W. Ry., 310 Omaha Ave., Norfolk, Neb.
U. R. Tracy, F. B. M., C., R. I. & P. Ry., 1508 Wells St., Little Rock, Ark.
G. A. Troutman, F. B. M., H. & B. T. R. R., Saxton, Pa.
Tad P. Tulin, asst. F. B. M., Erie R. R., North Side shops, Jersey City, N. J.
E. C. Umlauf, G. F. B. M., Erie R. R., 50 Church St., N. Y. City.
George B. Usherwood, supv. boilers, N. Y. C. R. R., 119 Wood Ave., Syracuse, N. Y.
Otto C. Voss, supt. boiler shop, Allis-Chalmers Mfg. Co., 218 24th St., Milwaukee, Wis.
George Wagstaff, Am. Arch Co., Room 2034A, 30 Church St., N. Y. C.
Frank Walla, F. B. M., C., St. P. & O. Ry., 1405 Prairie St., Sioux City, Ia.
H. J. Wandberg, trav. B. I., C., M. & St. P. R. R., 3221 Sycamore St., Milwaukee, Wis.
Chas. Ward, boiler foreman, N. Y. C. & St. L. R. R., Conneaut, O.
Victor Warner, F. B. M., N. Y. C. & St. L. R. R., 9226 Clyde Ave., Chicago, Ill.
Leon E. Washburn, F. B. M., Erie R. R., 215 Willow Ave., Susquehanna, Pa.
John L. Welk, Gen. B. Insp., Wabash R. R., 944 E. Eldorado St., Decatur, Ill.
Benj. F. Whalen, F. B. M., C. & I. W. R. R., 346 N. Holmes Ave., Indianapolis, Ind.
Chas. P. Whalen, F. B. M., N. Y. C. R. R., 535 Seymour St., Syracuse, N. Y.
C. L. Whitman, F. B. M., C. & N. W. R. R., 1065½ 36th St., Milwaukee, Wis.
John Wick, B. M. I., N. P. R. R., 6003 P. S. Ave., So. Tacoma, Wash.
Frank E. Wilson, F. B. M., F. E. C. Ry., St. Augustine, Fla.
J. T. Wilson, B. I., C., M. & St. P. R. R., 607½ Main St., Miles City, Mont.
F. N. Witting, F. B. M., D., S., S. & A., 1123 N. Third St., Marquette, Mich.
Frank Yochem, B. M. F., M. P. R. R., 15 N. Holbrook St., Fort Scott, Kan.
C. F. Young, B. I., L. S. & M. S. R. R., 920 Willard St., Elkhart, Ind.
E. W. Young, Gen. Boiler Insp., C., M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Ia.
George L. Young, F. B. M., P. & R. Ry., 422 Robeson St., Reading, Pa.
Reynold C. Young, F. B. M., C. & N. W. R. R., 323 3d St., Baraboo, Wis.
Emil Zeigenbein, G. F. B. M., M. C. R. R., 119 Gilbert St., Jackson, Mich.
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## Convention of Boiler Manufacturers

*(Continued from page 165)*

boiler depends on it to a certain extent. It is essential that a boiler to operate satisfactorily must have a proper setting, and to this end various companies furnish the plans and specifications to the customer, and even if not included in the contract they make sure that the brick work in the setting is properly made according to the correct design.

It was decided that the various companies having standard contract forms should submit them to the secretary of the association. The features of the various contracts were to be included in a master form and sent to the members of the association for study.

Questions on the use of steam outlet nozzles on firetube and watertube boilers and of studded pads to be used in place of such nozzles were brought up, and it was decided that these and all other matters pertaining to design be submitted to the committee, which was to work in conjunction with the A. S. M. E. Boiler Code Committee.

Another matter brought to the attention of the meeting was the standard guarantee clause pertaining to material and workmanship, which was to be referred to the commercial committee. Heating and ventilating problems in boiler shops were discussed, and it was decided that a committee be appointed to investigate and report on the matter.

REGISTRATION

The following members of the American Boiler Manufacturer's Association were in attendance at the convention held at French Lick Springs, May 31, June 1 and 2:

C. B. Acheson, Erie City Iron Works, Chicago, Ill.
E. J. Anderson, Duluth Boiler Works, Duluth, Minn.
R. E. Ashley, Muskegon Boiler Works, Muskegon, Mich.
George W. Bach, Union Iron Works, Erie, Pa.
E. E. Baker, Kewanee Boiler Co., Kewanee, Ill.
J. N. Barnes, J. S. Schofield's Sons Co., Macon, Ga.
G. S. Barnum, The Bigelow Co., New Haven, Conn.
B. F. Bart, Standard Seamless Tube Co., New York.
W. H. S. Bateman, Parkersburg Iron Co., Champion Rivet Co., Phila.
C. P. Berry, Oil City Boiler Works, Oil City, Pa.
L. S. Blodgett, Simmons-Boardman Publishing Co., New York.
C. A. Brendt, Locomotive Superheater Co., New York.
H. L. Brink, American Hoist & Derrick Co., St. Paul, Minn.
J. H. Broderick, Broderick Co., Muncie, Ind.
M. H. Broderick, Broderick Co., Muncie, Ind.
F. C. Burton, Erie City Iron Works, Erie, Pa.
W. S. Cameron, The Frost Mfg. Co., Galesburg, Ill.
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H. N. Covell, Lidgerwood Mfg. Co., Brooklyn, N. Y.
F. G. Cox, Edge Moor Iron Works, Edge Moor, Del.
J. T. Cullen, The Cullen Co., Clinton, Ia.
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E. R. Fish, Heine Safety Boiler Co., St. Louis, Mo.
E. C. Fisher, The Wickes Boiler Co., Saginaw, Mich.
Michael Fogarty, Michael Fogarty, Inc., New York.
D. W. Glanzer, Otis Steel Co., Cleveland, O.
Anna Glaska, 1304 Bellefontaine St., Indianapolis, Ind.
Chas. E. Gorton, Uniform Boiler Law Society, New York.
J. S. Hammerslough, Springfield Boiler Co., Springfield, Ill.
S. M. Harrington, Frost Mfg. Co., Galesburg, Ill.
Isaac Harter, Babcock & Wilcox Co., New York.
Houston, Houston, Stanwood Gamble Co., Cincinnati, O.
S. F. Jeter, Hartford Steam Boiler Insp. and Ins. Co., Hartford, Conn.
W. D. Johnson, Milwaukee Boiler Co., Milwaukee, Wis.
Robert June, Diamond Power Specialty Co., Detroit, Mich.
C. V. Kellogg, Kewanee Boiler Co., Chicago, Ill.
T. L. Kirk, Standard Seamless Tube Co., Pittsburgh, Pa.
L. W. Llewellyn, Walsh & Weidner Co., Chattanooga, Tenn.
F. R. Low, "Power," New York.
C. R. D. Meier, Heine Safety Boiler Co., St. Louis, Mo.
W. J. Mohr, John Mohr & Sons Co., Chicago, Ill.
M. F. Moore, Kewanee Boiler Co., Kewanee, Ill.
W. P. Moore, Moore, Central Iron & Steel Co., Harrisburg, Pa.
D. M. Myers, Griggs & Myers, New York.
L. H. McGowan, Casey-Hedges Co., Chattanooga, Tenn.
J. A. McKeown, John O'Brien Boiler Works, St. Louis, Mo.
H. R. Nelson, Duluth Boiler Works, Duluth, Minn.
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H. J. Williams, Duluth Boiler Works, Duluth, Minn.
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# The Boiler Maker

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EDWARD A. SIMMONS, *President* SAMUEL O. DUNN, *Vice-President*
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HENRY LEE, *Vice-Pres. and Treas.* ROY V. WRIGHT, *Secretary*
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H. H. BROWN, Editor
L. S. BLODGETT, Associate Editor

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## CONTENTS



Due to the delay in obtaining the entire report of the proceedings at the Master Boiler Makers' convention for this issue, the complete discussions of the papers on "Autogenous Welding" and the "Best Style Grate for Bituminous Coal" will appear in the July number, as well as abstracts from the lecture on "Locomotive Accidents" given by John M. Hall, assistant chief inspector of the Bureau of Locomotive Inspection.

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The 32d annual convention of the American Boiler Manufacturers' Association proved to be one of the most profitable from many standpoints of any meeting the association has ever held. The general report of the proceedings in this issue of THE BOILER MAKER indicates the scope of the questions discussed, and the action taken on current problems and future activities of the association.

Little progress in the adoption of a uniform boiler code by the various states has been made during the past year because of the fact that few new legislatures were in session. The Uniform Boiler Law Society has been active, however, in preparing the way for the extension of the code throughout the country.

The Uniform Boiler Law Society and the American Boiler Manufacturers' Association together with other associations interested in the uniformity of boiler requirements have expressed their intention of supporting the National Board of Boiler and Pressure Vessel Inspectors, and the work of this organization as a result will be greatly facilitated. It is hoped that one result of the meetings of the chief inspectors of the various state boards, will be the acceptance of boilers in all states governed by the provisions of the boiler code once they have been passed according to code requirements.

Practically every phase of standardization in construction, inspection and in the operation of boiler manufacturing plants has been discussed for some time past at the meetings of the association, and the progress made in these matters as reported at the convention indicates the practical nature of the co-operation existing between the members of the organization.

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Although the twelfth annual convention of the Master Boiler Makers' Association was not the record breaking one of last year, it was very satisfactory in many respects. Financially and in the new membership reported, it was probably the most successful year of the association's history.

Unfortunately, because of lack of space at the hotel, and the fact that it was almost impossible to send express shipments from one convention to another in time, the Boiler Makers' Supply Men's Association was unable to exhibit the products of the member companies, as has been customary in past years.

Many valuable points were brought out in the discussion of the various papers, especially on the subject of autogenous welding. Ever since welding has been used in locomotive work the subject has come to the attention of the association periodically for discussion, but the only results from the arguments on the floor of the convention have been to gain an idea of the general causes bringing about the failure of welds.

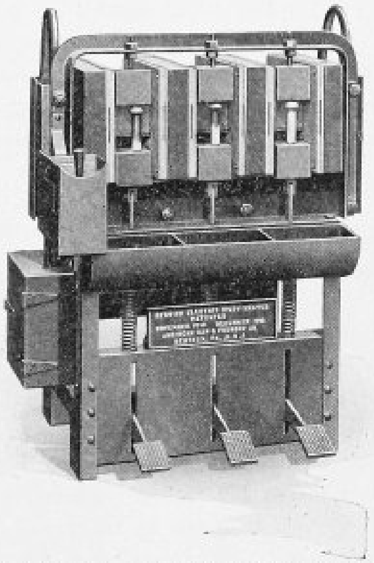
In order that a complete and authoritative report on the application of fusion welding to locomotive construction and repair may be given at the 1920 convention, a committee has been appointed to visit the principal railroad shops in the country and make a thorough investigation of the process. Such a report will indicate without question the measure of success with which autogenous welding is meeting in railroad work. If welding is ever to be recognized and accepted by the inspection departments of the government and insurance companies, and if provisions for its use are ever to be incorporated in the American Society of Mechanical Engineers' boiler code, all of which objects are the hope of those interested in advancing the process, some such organized investigation as this of the Master Boiler Makers' Association is one of the best means that could be taken to bring about these results.

# Engineering Specialties for Boiler Making

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

### Electric Rivet Heater Developed

For the past six years the American Car & Foundry Company, New York, have been developing and improving an electric rivet heater for use in its shops. In 1919 this heater was made available to the general market, under the name of the Berwick Electric Rivet Heater.



Three Electrode Berwick Electric Rivet Heater

Electrically the Berwick heater consists of a specially designed transformer with a single primary winding and secondary windings consisting of heavy copper blocks between which the rivets to be heated are placed. A suitable control in the primary makes possible the adjustment of the current and heat to any desired value within the limits of the machine.

In heating the rivets on this machine the copper blocks which form the secondary terminals are forced apart by a foot treadle, the rivet is placed endwise between the blocks, and the treadle released. When the pressure is removed the blocks are forced together by springs, thus gripping the rivet firmly between them. A slight twist of the rivet in the block insures contact and the rivet starts heating instantly. Owing to its smaller cross-section, the end of the rivet to be upset becomes hotter than the head of the rivet, which is, of course, a desirable feature. As the rivet is not heated in a blast of air, it may be cooled and reheated without injurious oxidation.

From 20 to 30 seconds is required to heat the ordinary size rivet sufficiently for use, depending on the type of machine used and the number of rivets heated at once.

Berwick Electric Rivet Heaters are furnished with from two to five electrodes or more, according to the capacity required, and for various sizes of rivets up to 1½ inches by 10 inches or larger. It is claimed that from 75 to 600 hot rivets can be supplied per hour, and when operated at less than the maximum capacity the cost of heating is not increased. In other words, single rivets can be heated on a 5-electrode heater with the same current consumption per rivet as though the heater were running at full capacity. The power consumption is approximately 1 kilowatt hour for heating from 5 to 7 pounds of rivets.

### Condenser Steam Tables

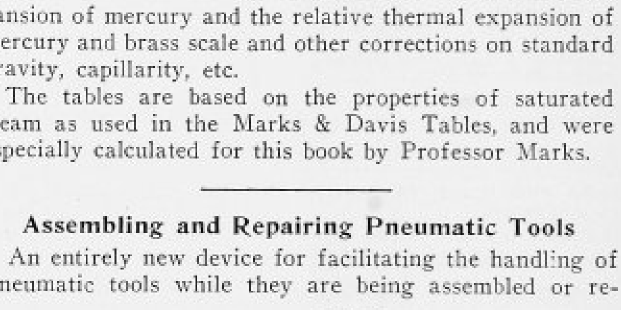
The fifth edition of "Steam Tables for Condenser Work" has recently been issued by the Wheeler Condenser & Engineering Company, Carteret, N. J. This handy book contains steam tables with pressures below atmosphere, expressed in inches of mercury, referred to a 30-inch barometer, and also includes a discussion of the use of the mercury column, the errors in such measurements and constants for their corrections.

The first table gives the properties of saturated steam from 27.8 inches vacuum to atmospheric pressure, the independent variable being *Vacuum* in this case. In Table 2 the properties of saturated steam are given from 32 degrees F. to 212 degrees F., *Temperature* being the independent variable. The third table gives the properties of saturated steam from 0 pounds gage pressure to 100 pounds gage pressure with the independent variables *Gage Pressure* and *Absolute Pressure*. In addition to the tables the corrections include those for the thermal expansion of mercury and the relative thermal expansion of mercury and brass scale and other corrections on standard gravity, capillarity, etc.

The tables are based on the properties of saturated steam as used in the Marks & Davis Tables, and were especially calculated for this book by Professor Marks.

### Assembling and Repairing Pneumatic Tools

An entirely new device for facilitating the handling of pneumatic tools while they are being assembled or re-




1101
Vise Ready to Attach Drill

paired has been produced by the Independent Pneumatic Tool Company, Chicago, Ill.

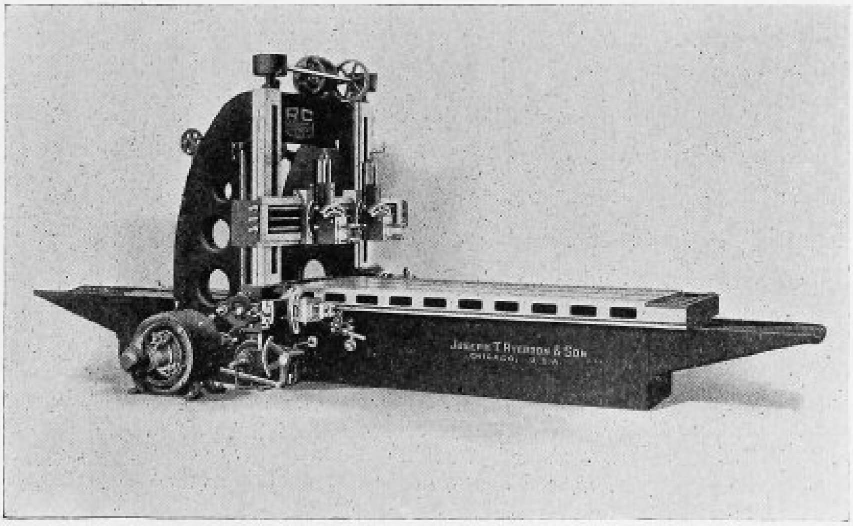
The device is called the "Universal Assembling and Repair Vise," and consists of a flanged upright machine post or stand, having a sliding stop collar which will quickly adjust the device to the proper height. For convenient working, this collar is held by a set screw. Directly over the collar is a clamp swiveling on it. The collar may be held in any position by tightening a quick-action clamp screw. At the other end of the clamp is a hole in which stems having ½-inch and ¾-inch pipe threads are engaged. For small size drills ⅛-inch pipe threads are used in connection with the stem support.

In operating the device, the sliding collar is first adjusted to the desired height and the proper size stem support required for the drill to be repaired is inserted. If a large drill is to be repaired it is screwed in place at the dead-hand hole, but if work is being done on drills of small size the top clamp screw must first be tightened, then the stem inserted in the support and a nut screwed on the short threaded end of the stem. This allows the long end of the stem to project through the support. The small drill may then be screwed on the stem at the dead hand hole until it is tight against the formed square head of the stem support. The drill is then ready for repair.

When the top clamp screw is released it is possible to turn the drill in any desired position for inspection, reaming, lapping piston holes, removing the gear case, spindle, valve gear, connecting-up rods or adjusting, by a simple pull of the side clamp screw lever.

## Multi-Speed Planing Machine of High Power

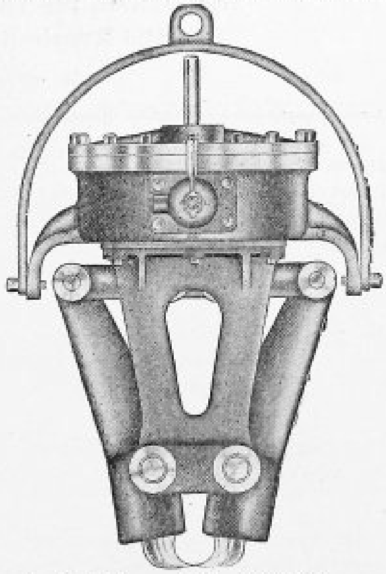
Production of the Ryerson-Conradson multi-speed planing machine has just been announced by Joseph T. Ryerson & Son, Chicago, Ill. The outstanding feature of the machine is the fact that the serious disadvantage of a reversing motor or shifting belts has been eliminated. The planer is primarily designed to be motor-driven, but it is equally efficient when arranged for a constant speed single pulley drive. High-speed reversing parts have been omitted from the design, and four cutting speeds and a constant quick return motion for the table have been provided. The reverse is obtained by means of self-compensating pneumatic clutches. Feeding is by means of pneumatic attachments. The ways are 15 degrees from horizontal and 15 degrees from vertical. A separate motor is used to elevate the cross rail. Parts are lubricated throughout by a splash system of oiling. It is possible for the side heads to feed at any angle. The aprons are extended beyond the maximum travel of the table and are used to catch all surplus oil.




High Power Multi-Speed Planing Machine

## Cutter for Staybolts

Among other products of the Baird Pneumatic Tool Company, Kansas City, Mo., which are of interest to the boiler making industry is a staybolt cutter intended to replace the methods of clipping bolts usually practised in the shop.



Staybolt Cutter of the Baird Type

The staybolt cutter is composed of a 15-inch diameter air cylinder, the piston head of which connects directly through a toggle movement with a pair of lever arms, into which are securely fastened cutter knives of sufficient strength to stand up under the service required of them. A pressure of 100 pounds per square inch is delivered at the piston. On transmission through the toggle movement, a pressure of 88 tons is obtained at the knives. This pressure gives the machine a cutting capacity for staybolts up to 1⅛ inches in diameter.

The cutter blades are so designed that when placed against the crown sheet, the staybolt is cut off the proper distance from the sheet to allow for heading. The machine is arranged so that it can be operated on modern radial stay boilers or marine boilers by one man. Full details of the machine may be obtained from the company on request.

# 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.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

## Development of Slope Sheet

Q.—I would like to see in your next issue the plain method of developing a gusset sheet or slope sheet of the barrel of a boiler.

R. C. D.

A.—There are several forms of slope sheet. In Fig. 1 is shown a general form in which the slope is not uniform, but which has some slope both at the top and at the bottom.

In order to make a pattern for this sheet it is necessary to make a drawing showing two views of the sheet, as in Fig. 2. Divide the end view into two parts by a vertical line through the center and divide each of the arcs into equal spaces. In this case eight spaces have been used. Join the corresponding points of the two arcs as shown and project the points onto the side elevation and letter the points the same in both views.

The next thing to do is to find the true lengths of these construction lines. Another feature with boiler work in connection with the true lengths of the lines is to allow for the thickness of the metal. One method of allowing for the thickness of the metal by means of a diagram is shown in Fig. 3. A straight line *iT* is drawn equal in length to the circumference at the large end of the sheet, and a line *jU* equal to that at the small end of the sheet. These circumferences are found by multiplying the respective diameters by 3.1416. In addition to this circumference, a length is laid off to allow for the thickness of the metal. This length is usually 7 times the thickness. Thus, if the sheet is ½ inch thick, the lengths *TW* and *UV* added will be ½ × 7 = 3½ inches on the circumference. Use the entire length as a radius and describe an arc *WX*. From *X* where this arc cuts the perpendicular from the theoretical circumference, draw a sloping line to the center. Then erect perpendiculars *hH*, *gG*, etc., from the base line, and the corresponding lengths on the sloping line will be the true distances on the long curve of the pattern. The lengths forming the shorter side of the pattern are taken from the smaller diagram.

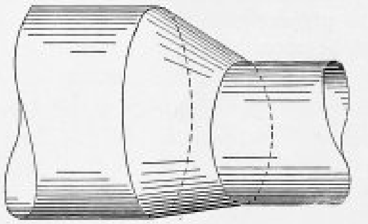


Fig. 1.—Slope Sheet With Varying Slopes

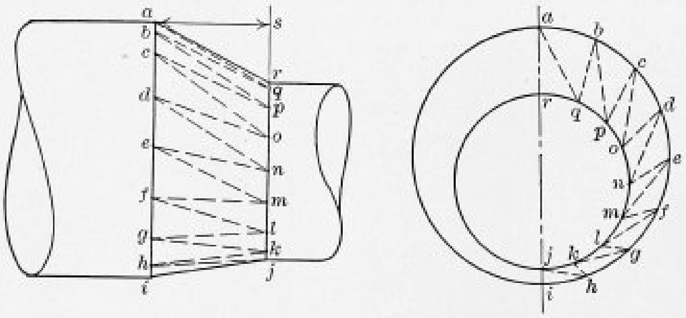


FIG. 2.- PATTERN LAYOUT FOR SLOPE SHEET

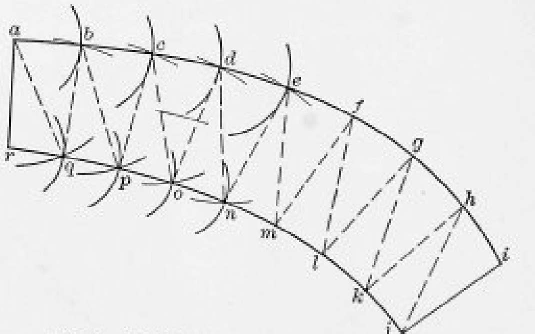


FIG. 4.- PATTERN FOR ONE-HALF THE SHEET

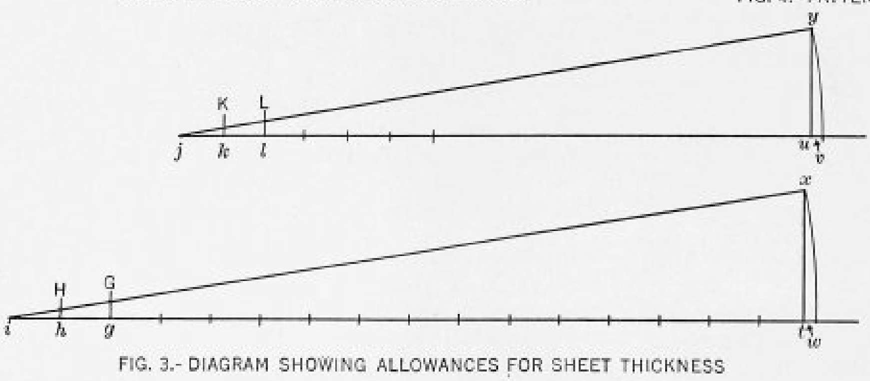



FIG. 3.- DIAGRAM SHOWING ALLOWANCES FOR SHEET THICKNESS

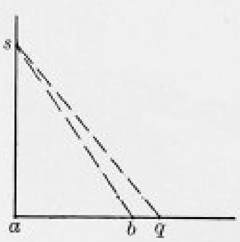



FIG. 5.-TRUE LENGTHS OF CONNECTIONS

Development of Slope Sheet

The pattern for half the sheet is shown in Fig. 4. The line *ar* is laid off equal to the longest slope length *ar* from

Fig. 2. Then from *a* and *r* as centers, arcs are struck, using radii equal to the lengths *iH* and *jK* taken from the sloping lines in Fig. 3. Next Fig. 5 is used to get the true lengths of the connecting lines in Fig. 2 so as to use these as radii to draw arcs that will intersect the first arcs drawn on the pattern. In Fig. 5 lay off *as* equal in length to *as* taken from Fig. 2. Then on the base lay off the distance *aq* equal to the distance *aq* taken from the end view of Fig. 2. Finally the sloping line *sq* in Fig. 5 will be the true length of the line *aq* in Fig. 2.

With *a* as a center in Fig. 4 and *aq* as a radius, draw an arc intersecting the arc struck from *r* as a center. This intersection locates the point *q* on the pattern. In like manner get the line *bs* in Fig. 5 equal to the true length of *bq* in the end view of Fig. 2. Using *q* as a center in Fig. 4 and *bq* as a radius, describe an arc cutting the one described from *a* as a center, and thus locate the point *b* on the outer edge of the pattern.

In like manner proceed with all the other construction lines until the line *ij* is drawn on the pattern equal in length to *ij* taken from the side view of Fig. 2. In making a pattern of this kind the draftsman will use many short cuts, but the principles involved are the same as those explained above.

## Locating Stays in Circular Head

Q.—How should the layout for twelve stays be made in a 60-inch air reservoir head? B.

A.—One method of locating twelve stays in a 60-inch head is shown in Fig. 1. Lay off a central circle having an area of 191 square inches. Divide the outer circle into eleven arcs and draw radial lines so as to lay off eleven trapezoids of equal area between the central circle and the outer circle. Find the center of gravity of one of these trapezoids and describe a circle through it and locate the stays on this circle as shown. The center of gravity of a trapezoid can be found graphically as follows:

Draw a diagonal dividing the trapezoid in two triangles. Locate the center of gravity on each triangle, which is at one-third the distance from the base measured on the line from the vertex perpendicular to the base.

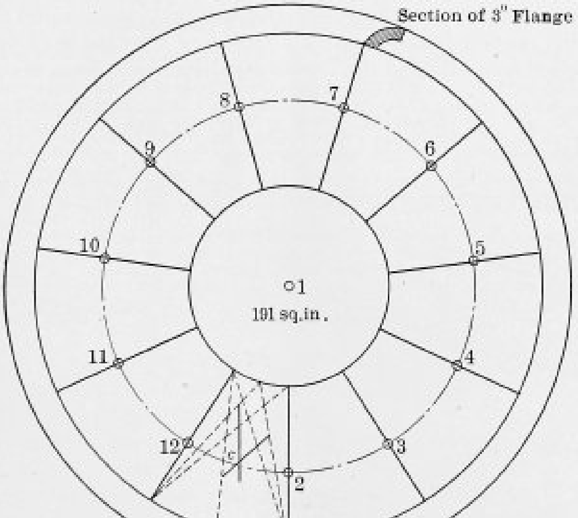



Fig. 1.—Laying Out a Circular Head for 12 Stays

Join these centers by a line. Then draw the second diagonal of the trapezoid and locate the center of gravity on each of these two triangles as above, and where the two connecting lines intersect, as at *C*, is the center of gravity of the trapezoid.

A method of locating thirty-four stays in a 60-inch head is shown in Fig. 2, which is laid off on top of the work shown in Fig. 1. Draw a central circle *A* having an area of 67.5 square inches. Put eleven stays in a circle *B* outside the circle *O*, which has the original eleven stays. Locate the center of gravity of the trapezoids lying between the 54-inch circle and the circle *O*. Then draw the third circle *D* through the center of gravity of the trapezoids lying between the inner circle *A* and the circle *O*. The figures show the location of the eleven stays in each circle. It is advisable to locate the stays in circles.

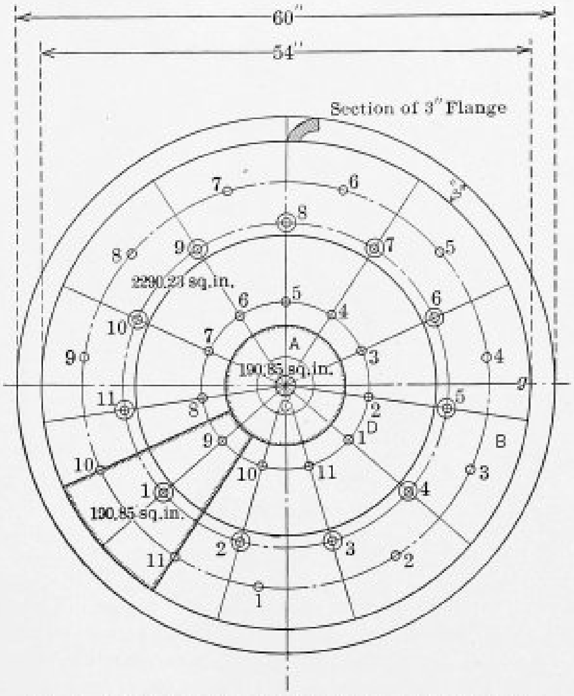



Fig. 2.—Method of Locating 34 Stays in 60-Inch Head

## Layout of Spiral Conveyor

Q.—(1) Please lay out a spiral conveyor such as is used for loading from one floor to another.
(2) How is the length and diameter of a smokestack and petticoat pipe found to suit a locomotive boiler? J. F. D.

### Spiral Conveyor

A.—To lay out the pattern for a spiral conveyor, proceed as follows: Make a diagram like that shown in Fig. 1 where the base *AB* is equal to the outside circumference of the spiral, and the height *AC* is equal to the distance advanced in one turn. Also lay out a similar diagram, using the base *AD* equal to the circumference of the shaft and the height *AC* equal to the distance advanced in one turn. Complete the diagrams by drawing the hypotenuse or third side of each. Measure the length of this line carefully and divide the length by 3.1416. The quotient will be the diameter of a circle having this length for its circumference. Use one-half of this diameter as the radius for describing a circle on the sheet metal stock. Likewise describe a central circle equal in length to the shorter hypotenuse. The pattern for a single turn of the spiral will appear like Fig. 2. Cut through the pattern with a radial line *A*. Place the pattern around the shaft and separate the two ends lengthwise of the shaft a distance equal to the required advance in one turn.

If heavy metal is used the blades should be made of short pieces riveted together. Where many spiral conveyors are built of heavy stock, a cast iron die is used to shape the sections after they have been cut from the sheet.

The sections are heated and then placed between the spiral dies and pressed into the finished shape. It should be noted that the blade of a spiral conveyor is a warped surface, and a surface of this kind cannot be formed from

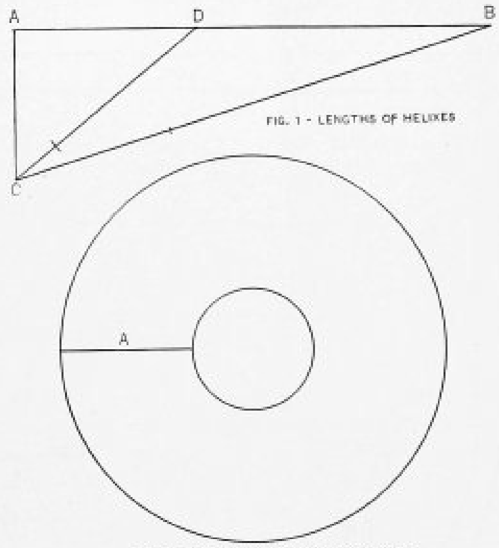



FIG. 1 - LENGTHS OF HELIXES

FIG. 2 - PATTERN FOR CONVEYOR SECTIONS

Patterns for Spiral Conveyor

a flat surface without distorting the metal. Therefore, the pattern laid out on a flat surface is not strictly accurate, but the method given above is generally used and the metal can be forged into shape so as to be accurate enough for practice.

### The Petticoat Pipe

The length of a petticoat pipe is found by trial. The length is made adjustable so as to give the best results. The length may not be the same for any two engines of the same size. If the fire burns quickest and brightest in the front end of the firebox, it indicates that the lower tubes have the greater draft, and hence the petticoat pipe should be shortened. On the other hand, if the fire burns brightest at the back end of the firebox, it indicates that the draft is greater through the upper tubes, and hence the petticoat pipe should be lengthened. The plan should be to adjust the length of this pipe so that the fire will burn evenly all over the grate.

The petticoat pipe is made smaller in diameter than the stack. The diameter of the stack is proportioned by the designer of the boiler so that it will carry the volume of gases produced in the firebox. The stack also serves to carry off the exhaust steam and to produce a draft by the use of the exhaust. The smaller the stack the stronger will be the draft produced by the exhaust steam. The diameter of the diamond stack at one time was made equal to the diameter of the cylinders. The practice today in straight stack construction is to make the diameter near the bottom from 1 to 3 inches smaller than the diameter of the cylinders. If the stack increases in diameter toward the top, the smaller end is known as the *choke*.

## Corrugated Furnace Repairs

Q.—Being a subscriber to THE BOILER MAKER, I have noted in your Questions and Answers column many interesting subjects relating to repairs on boilers. I would be very grateful if you could enlighten me as to the most practical method in forcing back collapsed corrugated furnaces of a Scotch marine type boiler. Do you think forcing back these collapsed parts, cold, would be more detrimental to the furnace than if local heating was given to the furnaces? J. B. R.

A.—The collapsed parts should be heated and forced back by applying a former corresponding to the circumference and shape of the furnace. Possibly screw or hydraulic jacks could be used to apply the pressure against the former while the local heating is being done. If the repair is located so that the heating can be done on the outside while the apparatus for applying the pressure, etc., is being operated on the inside, a very satisfactory repair could be made.

## Layout of a Locomotive Ashpan

Q.—Kindly show me how to lay out the patterns for a locomotive ashpan. J. F. D.

A.—The first thing to do is to make an accurate drawing of the ashpan, which will include a side view and two end views. Note carefully the form of the different surfaces so that the pattern may consist of flat sheets and curved sheets. Fig. 1 shows the three views that are required, together with the various construction lines necessary to produce the patterns.

The curves on the end views are laid off in equal arcs, and these division points are projected onto the ends of the side view. By the use of these construction lines the true lengths of the lines are found by the method shown below the side view.

The only line that is given in its true length on the side

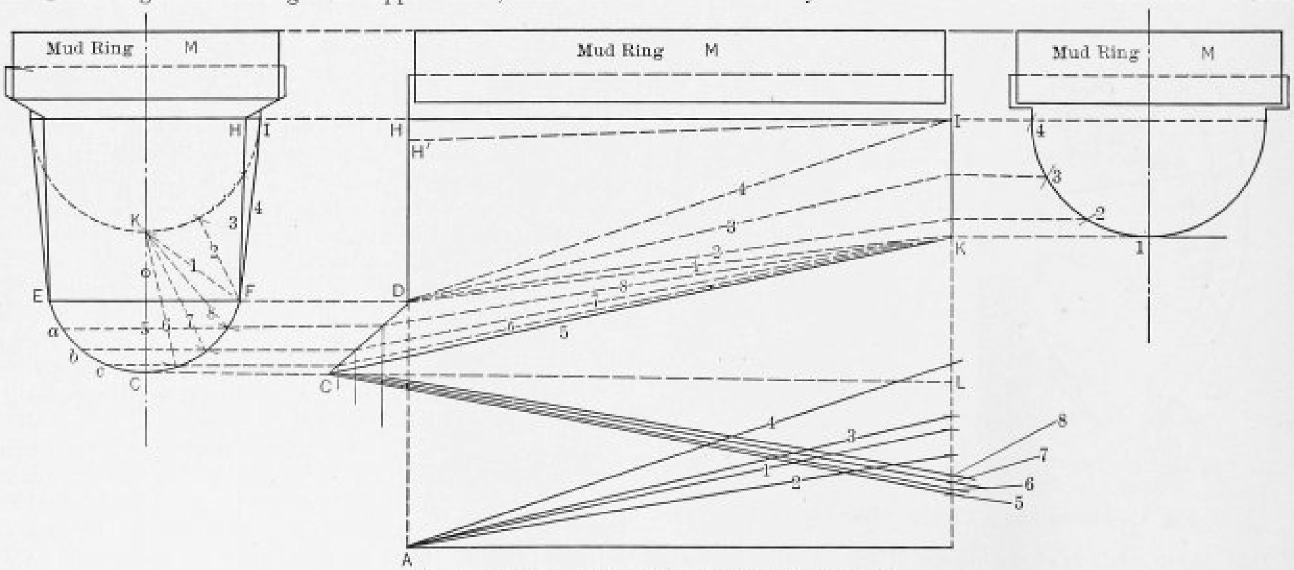



Fig. 1.—Construction Layout for Locomotive Ashpan

view is *CK*. In order to get the true lengths of the construction lines on the curved surface forming the right-hand end view, proceed as follows:

Draw the line *AB* equal to the horizontal projection or length of the ashpan. At the end *B* erect a perpendicular and lay off distances from *B* equal to the lengths 1, 2, 3 and 4 taken from the left-hand view. Then draw the diagonal lines 1, 2, 3 and 4 from the point *A*, and these lines will be the true lengths of the construction lines on the side view, and they will be used to lay out the pattern.

Next find the true lengths of the construction lines drawn from the point *K* to the line *CD*. The horizontal projection of this line is on the line *CL*, and from *L* there is laid off downwards the lengths 5, 6, 7 and 8 taken from the left-hand view. The diagonal lines drawn from the point *C* and the other projected points on *CL* give the true lengths of the construction lines.

The patterns are shown in Fig. 2. First draw the line *CK* equal to that taken from the side view of the drawing. Then from the point *K*, using radii equal in length to 6, 7 and 8, describe arcs, and from *C* lay off distances by describing arcs equal to those taken from the curve at the bottom of the left-hand view. Through these intersecting points draw the curve *CD*. Also from *K* as a center describe an arc equal to the length of the arcs from the right-hand view of the ashpan, and from the point *D* use the true lengths of the construction lines to strike arcs that will intersect the one drawn from *K* and the other points above *K*. Through these intersecting points draw the curve *IK* forming the edge of the pattern.

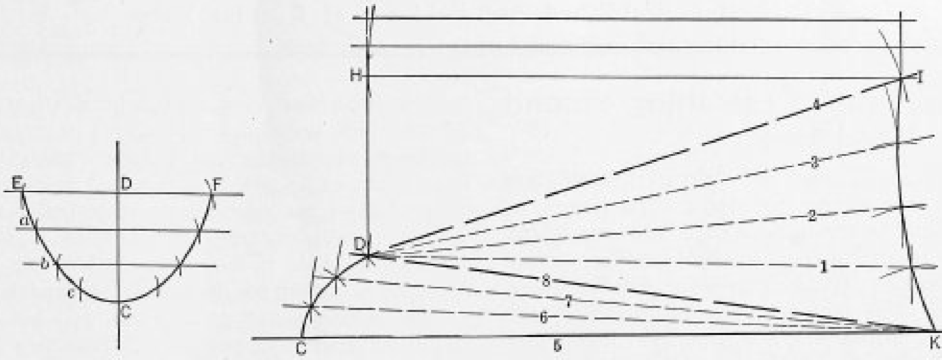



Fig. 2.—Patterns for Half of Ashpan Body

Lay off the triangle *HID*, using lines taken from the left-hand view and the side view of the drawing. Note that *HF* is the true length of *HD* and that *H'I* is the true length of *HI*. Finally lay out the rectangular areas above *HI* to form the required flanges on the upper edge of the sheet. The pattern as now laid out is that for half the ashpan.

The end views show the correct forms of the patterns for the two ends of the ashpan exclusive of the door *CD*. This door must be laid out as shown. First draw the vertical line *CD* equal in length to *CD* on the side view of the drawing. On this line lay off the distances taken on *CD* of the drawing and through these points draw horizontal lines and make them equal in length to the lengths *a*, *b* and *c* of the left-hand view. The curve drawn through these points will give the correct form of the door. The method outlined may be slightly varied in detail to suit special designs.

## Sagged Boiler Tubes

Q.—We have a 150-horsepower Hawkes combination boiler, carrying 100 pounds pressure, installed eight years ago. At the end of five years the watertubes, 4 inches in diameter and 19 feet long, heavily baffled, sagged so badly that they had to be removed. The new tubes were not so heavily baffled in order to lessen the weight; yet after a little over three years they again are so badly sagged that looking in at one end daylight can hardly be seen at the other. The tubes are nearly horizontal and clean.

I am advocating the building of an arch over the bridge wall as a support for the tubes, care being taken not to reduce the area any more than absolutely necessary.

I also want to mention that these tubes over the fire have a number of small blisters from two to three inches in diameter. The blisters can be driven back by heating and covering them with a form corresponding to the circumference of the tube. Is it possible that these blisters are caused by steam pockets in the tubes, or are they an indication of an overworked boiler and excessive firing or poor material? C. J. V.

A.—It is quite likely that the long tubes could be supported by an arch at the bridge wall. It is common to support tubes in this way.

The blisters on the tubes are caused by overheating, which results from poor circulation when the boiler is being forced. The metal becomes overheated when there is scale or oil on the surface or when the circulation is poor. The overheating is most prominent when there is excessive firing, but even under normal firing the boiler will not do good work when the circulation is poor. Possibly there is some remedy for the circulation trouble. The fact that the tubes sag badly and become blistered indicates that there is something wrong with the design of the boiler or of the furnace, or that the operation is faulty.

## BUSINESS NOTES

F. W. Sinram, president of the Van Dorn & Dutton Company, Cleveland, O., was unanimously elected president of the American Gear Manufacturers' Association at its fourth annual convention recently held in Detroit.

The Page Steel & Wire Company announces the change of their central district sales office from 29 South LaSalle Street to 208 South LaSalle Street, Chicago, Ill. The request is made by this office that all future communications be sent to the new address.

The Rome Iron Mills, Inc., Rome, N. Y., manufacturers of solid and hollow locomotive staybolt and engine bolt iron, announce the appointment of A. M. Castle & Company as their western representatives. The offices of this company are located in all the principal cities of the West and warehouses are maintained in Chicago and Seattle.

The K-G Welding & Cutting Company, 556 West 34th Street, New York city, manufacturers of welding and cutting apparatus, have opened a sales office at 12 and 14 East Harrison street, Chicago, Ill. William McCarthy, who has been in charge of the railroad service department, has been appointed western sales manager.

# Letters from Practical Boiler Makers

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

## The False Economy of Installing Second Hand Boilers

Not long ago I was told about an owner of a small plant who thought he saw a chance to save a little money by buying a second-hand boiler instead of a new one. Iron looks like iron to most folks, especially in boilers—from the outside—and in this particular case the outside looked like most outsides. In fact, after being installed, the boiler went so far as to act like a real boiler. The owner patted himself on the back out of respect for his business acumen. After two months, however, the boiler began to leak. It didn't leak in one place only, but in a number of places. The tubes proved to be mighty weak, and the owner had to have his "good buy" partially re-tubed. He spent $150 to stop the leaks, but, nevertheless, they still persisted.

One month later the owner acknowledged that he had erred and had the boiler thrown out. He didn't get three months' use out of the old boiler. Did he put in another second-hand boiler? Did he? What do you think? And after the new boiler was installed the owner did some quiet figuring. He didn't tell about it from a public soap box, but on the quiet he learned that the cost of the old boiler, plus the cost of reduced output, plus the cost of repairs, was equivalent to more than the cost of the new boiler. Instead of getting a bargain, therefore, he paid for two new boilers and only got one.

True, a second-hand boiler is worth something as junk. I don't know the exact figure, but let us place it at 98 cents and 9 mills.

Brooklyn, N. Y. W. F. SCHAPHORST.

## Detail and Trouble

If news which reaches me is correct, and there is little room to doubt either its authentic nature or my informant's reliability, some of the new standard ships have proved troublesome due to boiler defects and after the first voyage across the Atlantic have been laid aside for serious repairs.

Little of the boiler trouble on these ships is ascribed to simple riveted circumferential seams, but nevertheless a certain amount is due to this practice long since abandoned over here. My informant who has had an extended boiler experience refers to such design as "book built boilers."

Obviously, a circumferential seam of equal dimensions in all parts as a longitudinal seam is exactly twice as strong, but the advantage of a double staggered row of rivets lies in its greater resistance to fullering the seam. Smaller rivets and lessened spacing result in greater stiffness. Assuming that my informant is correct as to the trouble and incorrect as to cause, there remains the explanation that owing to emergency conditions the workmanship is of an inferior quality, due to the fact that marine boiler making has been in inexperienced hands. There is a vast difference between the methods needed with the much greater thickness of plates involved in high pressure Scotch boilers and those of smaller diameter, whether of locomotive or other land design.

I hope that "the report is greatly exaggerated," using the words of Mark Twain when his death was prematurely reported; but the evidence produced in these pages relative to the standard practice of American boiler shops may have much to do with the reported troubles.

Speaking from experience, while boiler trouble due to defective work on inferior materials is always lamentable, nowhere is it more regrettable nor does it cause greater trials than on shipboard. A land breakdown may involve stoppage and consequent loss, but a ship has to make her voyage in any case irrespective of the infinite labor and restricted facilities of repairs while afloat.

There are several experiences within my knowledge where a want of conscience on the part of some unknown boiler maker has led to many hours of the most appalling work in the bowels of marine boilers in times of bad weather and in dangerous proximity to shore. Where there are only two boilers in a freighter and one gives out, disaster may result, especially when the total engine power is just sufficient to give the ship steerage way.

Imperfectly expanded tubes and oblique and badly closed rivets always choose inconvenient and awkward moments to fail. There is in short a special and peculiar responsibility on the boiler maker, whose initial default, however small, can cause so large a future trouble.

The engineer in charge of a plant takes over a vast mass of other men's work; he assumes they have at least been honest, and by due skill and thought left him a dependable legacy to administer and control. Sometimes his confidence is sorely misplaced and the resulting correction is always more difficult than an original adjustment. There is not a single fault covered over but that ultimately comes to light as someone's misfortune.

It is little things, small details, which show the thoughtful man, and small refinements which go to make approximate perfection. The man whose mind is always fixed upon the big things is apt to disregard as contemptible the smaller details which, taken together, build up the bigger structure. Houses are made of simple bricks, each of which has to be placed; boilers are built by single rivets, each of which has to be closed. So much detail work like drilling holes, screwing home stays, working up single plates, represents the routine by which boilers are materialized. It is never safe to despise the trivial detail or the daily round and common task; that way lies poor work, inferior production, unreliable goods and undependable men. The mechanical business in all its phases consists more in detail, origination and improvement, in intensive culture of the little things, than in the conception of big schemes. The opportunity to do something big, whether in design or manufacture—building a railway or a thousand-foot span bridge or utilizing the power of Niagara Falls—comes only to a very few. The responsibilities of the average man are confined mainly to smaller-scale jobs—similar in kind, though differing in degree. Default in the detail and the big scheme comes to naught; casualty and contingent failure rest more often upon the detail than the design.

Detail is 99 percent of life and is the chance afforded every single individual; workmanship is detail, attention to small things in a spirit of honesty.

London, England. A. L. HAAS.

## The Master Boiler Makers' Convention

(*Continued from page 173.*)

perform as well with the same equipment installed.

The committee is aware of the fact that with some grades of coal the front end fills up to a greater extent than with other kinds, and to facilitate the removal of cinders the hopper is a convenience, if not a necessity. However, its use or non-use depends largely on local conditions, kind of fuel and grade of coal used. We incline to the opinion that it is not necessary to maintain the hopper on oil burning nor on coal-burning engines that have front-end draft appliances so designed, fitted and adjusted that they will clean themselves without danger of throwing sparks of such size and glow that they cause fires on the road.

Our inquiries further indicate that the foregoing also applies equally as well to the second part of the subject, "On what size locomotives should it be maintained?" and that the use of the cinder hopper is about evenly divided between the larger and smaller classes of engines on the various railroads.

In regard to the third question of the subject, viz., "Which is the better design to overcome air leaks?" we find that there are a number of different designs used by the various roads. Some have hoppers with a double nozzle lengthwise of the smoke arch, others a double nozzle transverse with the arch, the cover held in place by a bolt and spring between the nozzle, while on others a single nozzle with the cover hinged so it will drop down, or one that opens to one side is used. Again, others have the single nozzle hopper, the cover being of wedge shape. As it is of great importance to keep the front end as free as possible from air leaks, it is our opinion that the single nozzle hopper with the cover plate fastened on each side is a better design.

The report is signed by Frank H. Davison, chairman, Thomas J. Reddy and John L. Welk.

DISCUSSION

The need of the cinder hopper on the bottom of the smoke arch has long since been eliminated by most roads. In its place a standard form of non-adjustable, self-cleaning front end has been applied. In some instances a patch is riveted under the smoke arch and a two-inch washout plug arranged to take care of leakage from the pipes or superheater tubes.

### THURSDAY SESSION

A short talk was given by A. H. Kipp, mechanical superintendent of the Soo Line, on the duties of the members of the association to the country. Following this the discussion of papers was resumed.

### Electric and Oxy-Acetylene Welding of Firebox Sheets

In the absence of a report, Prof. A. S. Kinsey, in charge of welding and shop practice at Stevens Institute of Technology, gave a general survey of the present standing of autogenous welding and the future prospects of its recognition as a permissible process of boiler construction.

Professor Kinsey had just been present at the St. Louis meeting of the American Society of Mechanical Engineers, at which a prominent insurance company requested that the Boiler Code Committee, of which Professor Kinsey is a member, allow the use of autogenous welding in stationary heating boilers generating steam up to 15-pounds pressure. The Boiler Code Committee is considering this petition seriously and will probably report favorably on it. In connection with this subject the A. S. M. E. Boiler Code Committee has appointed a sub-committee to investigate the matter of welding seams in boilers and pressure vessels with a similar committee from the American Welding Society.

Forge welding has been allowed a rating of 52 percent, or a permissible load of 52 percent of the strength of the metal, by insurance companies. Although autogenous welding is not recognized as yet, there is no reason why fusion welding cannot be made very nearly as strong as forge welding. As a matter of fact, an increase in the rating of forge welding from 52 to 75 percent is now being considered by the A. S. M. E. If every one interested in advancing the process is united, first of all, in demanding the best welds possible in the shops where the process is used and then in advocating its adoption and recognition by the insurance companies and the A. S. M. E., there can be little doubt of the outcome.

From consultations with A. G. Pack, chief inspector of the Bureau of Locomotive Inspection, and from extensive examinations of defective welds taken from exploded boilers, Professor Kinsey stated that they were some of the worst welds he had ever examined and that they had done a great deal to retard the advance of the process.

The development of autogenous or better, fusion welding, has nearly reached the point where it is possible to weld manganese steel frogs on rails. Firebox plates can be welded as safely as they can be riveted by either the electric arc or acetylene torch. Any weld may be easily made to lose its strength by burning or oxidizing the metal, and this is the greatest defect to be combated in the operation of welding.

Two rules should be followed in welding. The grain of the metal should be so refined as to come back to its original size and, in the case of steel, the weld should be annealed. When recognized by the A. S. M. E., this requirement for annealing will probably be inserted in the rules for permissible welding procedure.

At the St. Louis meeting of the A. S. M. E. the safe-ending of boiler tubes was discussed at one of the Boiler Code Committee sessions, and the records were consulted to determine if welding were allowable in this case. It was found that it is permissible to weld the safe ends of tubes in firetube boilers but not in water tubes, which means that locomotives may use it in this connection.

DISCUSSION

The criticisms brought out at the last convention have served their purpose in arousing the interest of all members of the association, and no doubt the fewer accidents from the letting go of welded seams may be due to the closer supervision of all welding in railroad shops. However, if the reports of the Bureau of Locomotive Inspection continue to show any disastrous explosions from the failure of welded seams, it will be a difficult matter to obtain an early official recognition of the process.

A short paper on the procedure used in electric arc welding was given by one of the members.

On the Santa Fe the welding departments of all shops are required to send test specimens of their work to the laboratories to be tested to destruction. The seams are reinforced about 20 percent and when pulled average about 83 percent, which is about what is obtained with riveted joints. One instance was cited of 29 specimens taken out of plates after being in service 4½ years, which tested 71 percent.

As on all other questions, opinion was divided. Certain members advocated great caution in adopting the process, particularly where human life depends on the quality of the work. So long as there is a doubt as to the safety of a seam, and certainly until disasters from weak seams have stopped, it is well to avoid the extensive application of autogenous welding.

The discussion turned from welded seams to the welding of flues. In certain sections of the country it was found electrically welded superheater flues cracked, while smaller tubes were not found to do this. In still other districts leaks are found in both superheater and smaller flues. In bad water districts, scale forms in pockets around the flue end, and by preventing the cooling effect of the water, permits the heat to crack the tube. This applies to the side sheet under the arch as well as where the heat is intense. When staybolts are calked where they enter the side sheets, pin cracks are started if the water does not circulate properly. Flues should be prossered in bad water districts.

Where welds have been found sound in good water districts, a few months with hard water have only been necessary to allow the formation of cracks. The conclusion seemed to be that in good water districts welded flues remained tight, while bad water tended to hasten the formation of cracks in safe ends.

WELDING INVESTIGATION COMMITTEE

It was decided that the matter of welding had never been thoroughly investigated by the association and, in order to determine the success or failure of the autogenous processes of welding in the railroad shops throughout the country, a committee is to be appointed to visit the various sections and submit a complete report of conditions at the next annual convention.

The report on topics for the coming year was read by J. F. Raps, chairman of the committee and accepted by the meeting with one or two changes in the wording of the report:

TOPIC 1. Describe the present and best method of welding safe ends on locomotives tubes:

Iron end to iron body.
Steel end to iron body.
Steel end to steel body.
Shape and length of scarf, and flux, if used.
Results obtained by applying safe ends without scarfing.
Degree of heat necessary to obtain best results in welding and advisability of having a pyrometer on welding furnace.

TOPIC 2. Are the advantages and merits of the hot water boiler washing system of greater benefit than the disadvantages? Describe system used and what benefit is derived therefrom.

TOPIC 3. Which is the better crown stay for the different classes of locomotives; the stay screwed into the crown sheet with the taper and riveted over, or the button head crown stay?

TOPIC 4. How can the deterioration of firebox sheets behind grate bars and supports be eliminated?

TOPIC 5. What is the cause of the boiler shell cracking through girth seam rivet holes? Is there any way in which this can be overcome or the time of rupture be prolonged?

TOPIC 6. What is the best type of side sheets to be applied to narrow and wide firebox locomotives? Depressed, corrugated, vertical or longitudinal, or straight?

TOPIC 7. What is the most economical method of repairing cracked mud rings or corners without removing the mud rings?

rings?

TOPIC 8. Oxy-acetylene welding.
TOPIC 9. Electric Welding.
TOPIC 10. Law.

## FRIDAY SESSION

### Best Style Grate for Bituminous Coal

No report was submitted by the committee, but a brief outline of the use of the box grate was presented by William Strinsky. In the course of the discussion it was stated that the time is rapidly approaching when the dump grate will be eliminated from both ends of the firebox. The best results have been obtained with box grates having a width of nine inches. If a dump grate is used it must be kept from under the flues, for if used in this position all sorts of leakage and trouble result.

The draft opening in the ashpan was brought up for discussion, and the opinion seemed to be general that at least 15 percent of the grate area should be opened in the pan to obtain complete combustion of fuel. Even with the opening in the pan, sufficient flues must be installed to carry off the gases. Side openings and center openings have been tried, and netting has been used in the pan, all bringing about good results where used to fill certain operating requirements.

Box grates up to 11 inches wide have been tried and minimum openings of 18 percent with varying degrees of success. The standard, however, seems to be a 9-inch grate and a 15-percent ashpan opening.

Following this the annual election of officers was held.

OFFICERS FOR 1920-1921

President, Charles P. Patrick, Wilson Welding Repair Company; first vice-president, Thomas Lewis, Lehigh Valley; second vice-president, T. P. Madden, Missouri Pacific; third vice-president, E. W. Young, Chicago, Milwaukee & St. Paul; fourth vice-president, Frank Gray, Chicago & Alton; fifth vice-president, Thomas F. Powers, Chicago & North Western; secretary, Harry D. Vought; treasurer, W. H. Laughridge, Hocking Valley.

Executive board for one year: L. M. Stewart, Atlantic Coast Line; John F. Raps, Illinois Central; John Harthill, New York Central. For two years: W. J. Murphy, Pennsylvania Railroad; Harry F. Weldin, Pennsylvania Railroad; E. J. Reardon, Interstate Commerce Commission. Three years: B. F. Sarver, Pennsylvania Lines; George Austin, Santa Fe; H. J. Wandberg, Chicago, Milwaukee & St. Paul.

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## How To Design and Lay Out Boiler XXI

(*Continued from page 159*)

8 percent of the ultimate single shearing stress of rivet steel, or $0.08 \times 44{,}000 = 3{,}520$ pounds per square inch. In other words, this represents a factor of safety of 12.5 and is so high that the tensile stress in the rivets may be disregarded. Usually 8 or 9 ⅞-inch diameter rivets are sufficient in the largest bracket, but if more strength is required the size or number of rivets may be increased.

Another exceedingly important point to provide for is the spacing of the rivets in the lower flange. The net section of plate between the center lines of the two outer rivets must be strong enough to resist tension. This applies to both the boiler shell plate and the bracket, for either may break between the rivet holes. Suppose that the distance *P*, Fig. 83, were 6 inches and 15/16-inch holes were punched out. The thickness of this bracket being 5/16-inch, or 0.3125 inch, the net sectional area through *P* is $(6 - 3 \times 0.9375) \times 0.3125$, or 0.9961 square inch. At a factor of safety of 5, the working strength of this plate is $\frac{55{,}000}{5}$, or 11,000 pounds.

The load on this plate section is but 5,000 pounds, being, of course, the uplift on the bracket. In this particular case we happen to be safe because eight lugs are employed.

(*To be continued*)

## TRADE PUBLICATION

ELECTROLABS—is the name given to the oxygen and hydrogen cells manufactured by the Electrolabs Company, Pittsburgh, Pa., for use in supplying gas.

WHITING CRANES—The Whiting Foundry & Equipment Company, Harvey, Ill., in their 1920 bulletin No. 151, extensively describe and illustrate cranes, and various other foundry and railway equipment manufactured by them.

STEAM-REDUCING VALVE—The Chaplin-Fulton Manufacturing Company, 28-34 Penn Avenue, Pittsburgh, Pa., in a four-page pamphlet recently issued, describes and illustrates the Fulton steam-reducing valve as well as price lists of the various types.

THE AERIAL RAILWAY OF INDUSTRY—is the title of an interesting catalogue recently published by the Shepard Electric Crane & Hoist Company, Montour Falls, N. Y. It describes in detail the Shepard Electric cage operated monorail hoist which not only loads and unloads, but also conveys the material to any part of the plant or yard.

GAGES—Catalogue No. 43, issued by the Greenfield Tap & Die Corporation, Greenfield, Mass., describes and illustrates in great detail the various types and sizes of gages and their appurtenances, manufactured by this company. This booklet contains many useful tables and is fully indexed.

THOR PNEUMATIC MOTOR HOISTS—The Independent Pneumatic Tool Company, 600 West Jackson Blvd., Chicago, Ill., have issued a bulletin No. 95 which describes in detail the operation and care of Thor pneumatic motor hoists .

PACIFIC STEEL HEATING BOILERS—Catalogue No. 5, published by the General Boilers Company, Waukegan, Ill., contains complete descriptions and illustrations of Pacific Steel Boilers which have been designed in many types and sizes for heating purposes exclusively.

THE HUMP METHOD OF HEAT TREATMENT OF STEEL—is the title of a catalogue issued by the Leeds & Northrup Company, 4901 Stention Avenue, Philadelphia, Pa. This booklet gives a detailed description of the Hump method and its application to the treatment of various steels.

CENTRIFUGAL PUMPS—The DeLaval Steam Turbine Company, Trenton, N. J., has recently prepared a catalogue "B" describing and extensively illustrating various single-stage and multi-stage general service centrifugal pumps both for stationary and marine installations.

RIVET SETS—The Pneumatic Universal Tool Company, Inc., 57 North 6th Street, Brooklyn, N. Y. has issued a catalogue illustrating the various types of rivet sets manufactured by them. This pamphlet includes tables of dimensions for sets to be used with pneumatic tools.

STORAGE BATTERY-DRIVEN LOCOMOTIVES, Cranes and Cars —In this bulletin, the Atlas Car & Manufacturing Company, Cleveland, Ohio, describes the standard line of storage battery equipment manufactured by the company, calling special attention to the storage battery locomotives and cars adapted to the use of coal mining companies.

AMERICAN INGOT IRON WIRE—The Page Steel & Wire Company, 30 Church Street, New York has recently issued a pamphlet which presents in convenient form, data and tables pertaining to the properties of American Ingot Iron Wire. This information is of interest to engineers, superintendents, purchasing agents and to the wire industry in general.

## ASSOCIATIONS

### Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Co., Milwaukee, Wis.

Vice-President—William B. Wilson, Flannery Bolt Co., Pittsburgh, Pa.

Secretary—George Slate, THE BOILER MAKER, 6 East 39th Street, N. Y.

Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

### International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte Building, Kansas City, Kans.

Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte Building, Kansas City, Kans.

James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte Building, Kansas City, Kans.

William Atkinson, Acting Assistant President, suite 315 Wyandotte Building, Kansas City, Kans.

International Vice-Presidents—Joe Reed, 1123 East Madison Street, Portland, Oregon; Thomas Nolan, 700 Court Street, Portsmouth, Va.; Joseph Flynn, 111 South Park Avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth Street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth Street, Columbus, Ohio.

### American Boiler Manufacturers' Association

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.

Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

### Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.

First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.

Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton Avenue, St. Louis, Mo.

Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.

Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry Street, Bloomington, Ill.

Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence Avenue, Oak Park, Ill.

Secretary—Harry D. Vought, 95 Liberty Street, New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood Avenue, Columbus, Ohio.

Executive Board—John F. Raps, gen. B. I., C. R. R., 4041 Ellis Avenue, Chicago, Ill., chairman.

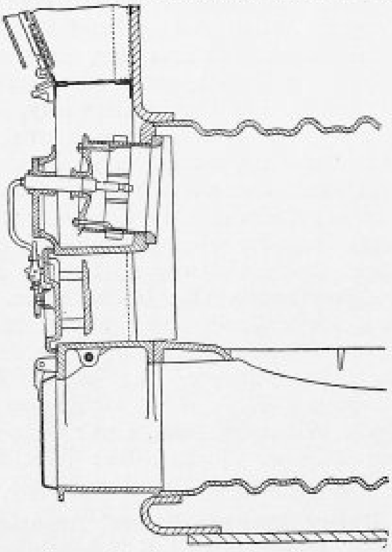
## Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,338,136. FURNACE. JAMES HOWDEN HUME, OF GLASGOW, SCOTLAND, ASSIGNOR TO JAMES HOWDEN & COMPANY, LIMITED, OF GLASGOW, SCOTLAND, A COMPANY INCORPORATED AND REGISTERED UNDER LAWS OF GREAT BRITAIN AND IRELAND.

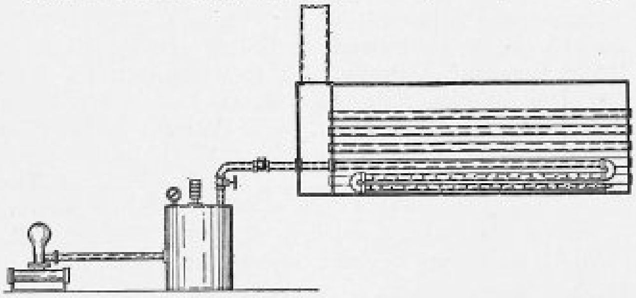
*Claim* 1.—In a furnace, in combination with the furnace door, a



pivoted latch member on the door, a catch to be engaged by said latch member, a fuel oil supply pipe for the furnace, a turning oil cock fitted to said pipe, a handle for turning said cock, and a depending extension connected to and movable with said cock and arranged to lock said latch member in its catch when said cock is turned to open position.

1,327,159. STEAM BOILER. LOUIS F. HOFFMAN AND WINNIE J. UNKEL, OF KINDER, LA.

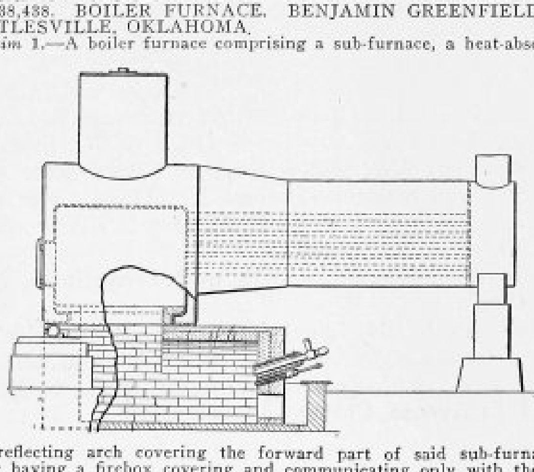
*Claim.*—The combination, with a steam boiler, of a perforated pipe



arranged in the water space of the boiler, said pipe being provided with a series of folds or convolutions arranged in a vertical plane, a reservoir for compressed air, an outlet pipe provided with a regulating valve and a check valve and connecting the air reservoir with the top convolution of the said perforated pipe, and a pump for forcing compressed air into the reservoir. One claim.

1,338,438. BOILER FURNACE. BENJAMIN GREENFIELD, OF BARTLESVILLE, OKLAHOMA.

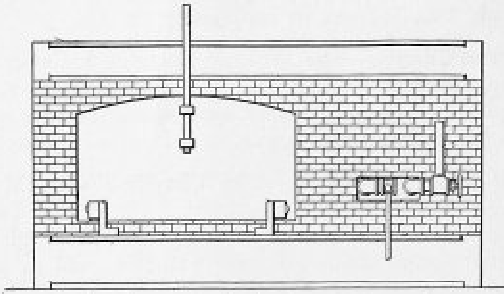
*Claim* 1.—A boiler furnace comprising a sub-furnace, a heat-absorbing



and reflecting arch covering the forward part of said sub-furnace, a boiler having a firebox covering and communicating only with the part of said sub-furnace not covered by said arch, and means for introducing fuel and air beneath said arch. Eleven claims.

1,336,980. FURNACE. ALBERT C. RHODES, OF HOPEDALE, MASS., ASSIGNOR TO DRAPER CORPORATION, OF HOPEDALE, MASS., A CORPORATION OF MAINE.

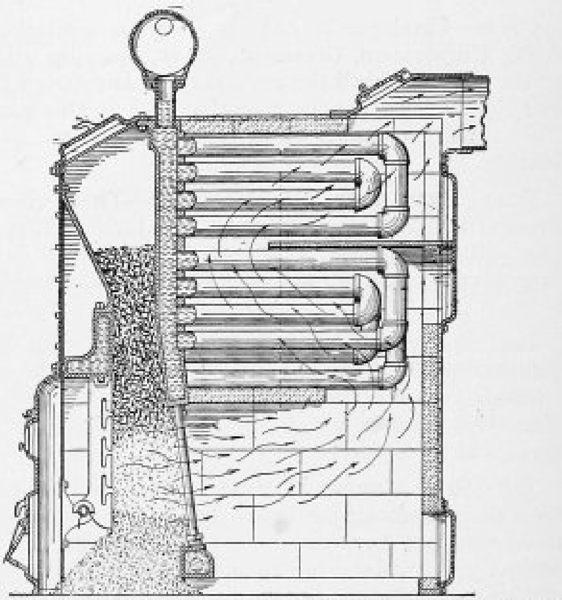
*Claim* 1.—A self-contained removable baffle block for a furnace having



a baffle projecting from the body thereof presenting a convex exterior deflecting surface, an interior chamber extending into said projecting baffle, and air admission and exit openings into and from said chamber, whereby air in its passage through the chamber abstracts heat from the baffle, thus cooling the baffle and heating the air. Seven claims.

1,337,632. COMBINATION BOILER AND FURNACE. JOHN W. ALLAN, OF MINNEAPOLIS, MINN.

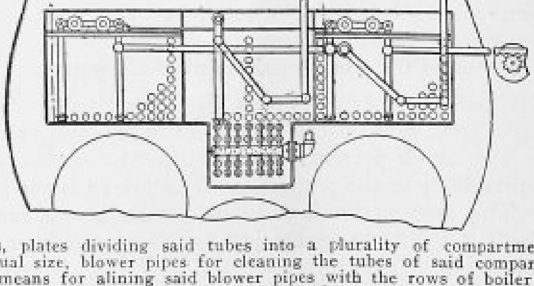
*Claim* 1.—In a heating apparatus, a fuel magazine and a firebox beneath the same, the magazine converging downwardly and the fire-



box diverging downwardly, the communicating contiguous portions of the magazine and firebox constituting a coking zone, a water chamber extending along the rear wall of the magazine and coking zone, water chambers extending along opposite sides of the magazine, coking-zone and firebox, a water chamber extending across the front of the coking-zone and communicating with the side water chambers, an upright open grate arranged to constitute the front of the firebox, and spaced-apart tubes in communication with the rear water chamber at the lower portion of the coking-zone and with a header at the lower part of the firebox whereby fuel in the magazine and coking-zone is protected by the water chambers against excessive heat and gases are drawn from the coking-zone and they together with products of combustion of the firebox are passed between the tubes at the rear of the firebox below the coking-zone. Five claims.

1,337,557. BOILER-TUBE CLEANER. SAMUEL J. HERMAN AND CHESTER M. MacKENZIE, OF DETROIT, MICH., ASSIGNORS TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

*Claim* 1.—The combination with vertically arranged rows of boiler



tubes, plates dividing said tubes into a plurality of compartments of unequal size, blower pipes for cleaning the tubes of said compartments and means for alining said blower pipes with the rows of boiler tubes, said means comprising mechanism adapted to move the blower pipes in one of the compartments a predetermined amount before causing any movement of the blower pipes in one of the other compartments to thus compensate for the difference in the size of the compartments. Two claims.

THE BOILER MAKER

JULY, 1920

# The Construction and Inspection of Boilers in Locomotive Shops

BY C. E. LESTER

*The building of locomotive boilers in quantities, from innumerable different drawings, presents many vexatious problems, and in order to obtain good work many hard and fast rules must be laid down for the guidance of the men engaged in the work. The following suggestions should serve to eliminate a great deal of the trouble of locomotive boiler inspection as well as construction.*

Having been both a railroad and a building inspector, the writer wishes to state most emphatically that in the majority of cases the complaints heard in boiler shops are mostly unfounded, or, rather, not altogether justified. Carelessness and inefficiency are usually traceable to the workmen or possibly to a sub-foreman who can be quickly brought to time by complaint to the proper officials.

In a number of years' experience on both sides of the fence, the writer has generally found that any reasonable request or demand for alterations or corrections would be promptly if not cheerfully complied with and usually without going further than the head of the general department. It is nearly always the young inspector who has the most trouble; knowledge comes by experience, and the inexperienced inspector does not know what he wants or should have half as well as those who are doing the building. From many months on the floor of a locomotive manufacturing concern as a builder's inspector and as a railroad inspector, I have seen many, many men sent by railroads who could have helped their company more by staying at home.

Of the larger boiler builders, each employs boiler inspectors whose sole duties are to assist in getting good work. These duties are so regulated that there is sufficient time to ably inspect the various parts and operations by systematizing the inspections in different departments, so that it is unnecessary to go over the work a second time in order to make sure that the defects reported have been corrected or the changes inaugurated.

### Checking Rejected Boiler Plates

An elaborate system of checking against rejected boiler plate is in vogue at some plants and it is practically impossible for a rejected plate to get into a boiler. Immediately on the rejection of a plate at the mill, the company's mill inspector prepares a rejection notice for his firm in duplicate, keeping one on file for his own information and forwarding the other to the locomotive works. On receipt of the notice at the plant, one copy is sent to the engineer of tests, two copies to the material supervisor, and three copies to the boiler shop foreman. The material supervisor sends one to his yard checker, instructing him if the plate comes into the yard to have it laid aside for return to the plate mill.

The boiler shop foreman gives one copy to the shop material checker and one copy to the head layer-out. Whenever a rejected plate is found by any of these men it is at once laid aside and marked *Rejected* in large letters of red paint. In addition to this precaution, the layer-out and the material checker are required to check twice daily all plates laid out for mill and heat numbers to insure that none of the rejected plates are used.

### Standardization of Parts

There is considerable demand for interchangeability in boiler work, as well as in other mechanical branches, and rightly so. In these days of efficiency it is essential that work move rapidly.

In a locomotive repair shop, where the foreman knows that in a certain number of engines the boiler or firebox sheets are exact duplicates, he is prepared to give good figures on heavy repairs because he knows that the sheets can be completely fabricated from the prints in quantities and carried in stock ready for immediate use.

Three days for laying out, punching, shearing, flanging, annealing, drilling and milling a back flue sheet is pretty good time, but would be amply sufficient for a locomotive repair of this nature if completed sheets were carried in stock. In the cases of boilers built several years ago this plan is not feasible, as perhaps many of you know who have tried it.

The general cry for standardization reached the boiler shops some time ago, and the use of the following rules will insure good work as well as interchangeability. These methods are not submitted as the only successful way to obtain the desired results, but are methods and practices of some year's standing—tried and found reliable. So reliable in fact as to have been adopted by a well-known concern and issued in the form of instructions to the foremen and inspectors.

### Laying Out the Boiler

Center lines on all sheets. Flanges must be scribed and center punched in a manner to be plainly noted by the operators in the process of flanging, fitting and lining up.

All flanges must be correct and must not exceed ¼-inch variation from the correct travel. This travel must at all times be taken each way from the centerline at the top of the flanges, in order to make sure that both sides are equal and that the sheet is square.

In laying out holes in a flange, whether this is done before or by marking off from the sides, work from the centerline of the crown and sides, and top and sides, corresponding with the center of the door sheet, tube and back sheet. Center the lines of all sheets to correspond with the center of the firebox ring.

The firebox tube sheet in every case must be square with the centerline of the boiler and the door sheet at the proper angle, according to the drawings.

The lead holes for tubes in the front and back tube sheets must not be laid out until after the tube sheets have been flanged. The laying out must be done from the concave side of the sheet by means of a wooden or sheet metal template. The template must be made so as to drop easily into place inside the flanges.

This practice secures great uniformity, inasmuch as the template is required to be very accurately made. The outer tube holes are kept the proper distance from the flanges and the marking of the sheets through the template with a marking peg instead of a center punch insures uniform ligaments between the tube holes and lessens the liability later on of distorted holes and broken bridges.

Shells and back ends of boilers at the throat made from the same card must be interchangeable. This is an exceptionally important feature, as on the interchangeability of these parts depends entirely the possibility of locomotive owners or operators carrying finished back ends in stock with which to make a rapid application and lessen the time required for shop repairs. For this reason, as well as for economical building, all sheets should be marked off from the corrected templates of the first boiler.

### Flanging the Sheets

Throat sheets must be flanged square and to the proper shape so as to make it possible to lay out all the rivet holes in accordance with the card, if necessary before fitting and applying to the boiler. They must be correct before leaving the flange fire.

The ends of the gusset or taper course plates must be flanged to the proper angle when hot, and in no case must they be flanged cold in the hydraulic riveter or otherwise.

### Drilling, Punching and Reaming

All holes in the firebox and casing are to be drilled as nearly full size as possible to permit full threads when tapped. All punched rivet holes (except those in smoke boxes) are to be made 3/16 inch smaller than the rivets and reamed to 1/16 inch larger than the rivets after the plates are rolled and assembled.

All reamings should be thoroughly blown out or removed from the sheets and from the rivet holes, paying special attention to the firebox rings.

The finished drilling of longitudinal holes after the sheets are formed insures absolutely fair holes, so that there is but little excuse for not having a riveting job perfectly done. With the application of the big double side plate drills with eight or ten heads, the punching of plates is rapidly falling into disuse. The several plates may be bolted under the template and drilled more quickly and accurately than they could be punched, and without damage to the plates caused by the minute fractures following punching.

### Fitting Up the Boiler

All boiler shells must be as nearly round as it is possible to get them. A variation exceeding ½ inch will not be permitted.

In fitting up the back head and throat to the top and sides, work from the centerline.

Roofs and sides, as well as the boiler shell, must be rolled to a true circle (when not otherwise shown on the drawings).

Before the dome course is finally fitted up in connection with the other courses, the dome may be put in position, reamed and riveted, being straight on the centerline of the shell (longitudinally).

Before fitting up the shell complete, the horizontal seam in the first course should be riveted, also the front tube sheet. The junction ring is then applied and the smoke box bolted on. All courses should then be bolted together, lined up and plumbed, after which holes should be reamed at the four quarters of the circumferential seam and turned bolts of a driving fit applied. All holes may then be reamed and slightly countersunk inside and out to remove sharp edges. A tram mark on each circumferential seam should be made after the boiler is lined up, and again checked before going to the bull riveter.

In connecting the top and sides to the shell, the back head and firebox ring must be firmly bolted in position and the firebox ring made level and of the required slope if any (horizontally).

The boiler shell should be perfectly plumb and of the correct length as trammed at the connection point.

All holes in the throat sheet flange should be marked off when in place, the throat sheet taken down and punched as required, and when bolted in position the boiler should again be lined up. Several holes should then be reamed at different points and thoroughly bolted.

On the first boiler of each order, while the throat sheet is bolted to the mudring and casing with the firebox tube sheet in position, the staybolt holes should be marked off from the tube sheet in accurate alinement. From this a template should be made from one-half of the sheet, which may be used for the remaining number of throat sheets required.

All holes for the firebox ring must be laid out square with the center of the firebox sheets, this centerline being scribed in the first operation of layout.

The inside top portion of the firebox rings at the corners must be rounded off to ⅛-inch radius to avoid injury to the sheets while fitting up.

All seams must be closely fitted and bolts applied every sixth hole or less so that a 1/64-inch feeler cannot be inserted between the sheets at any point.

All plates must be closely laid up at every point and bolted together before any riveting is done. Special care must be used to see that all laps are properly heated and so closely laid up that a feeler cannot be inserted between the plates.

Care must be taken to insure proper laps from the centers of rivets to the edges of the plates and to see that the calking edges of all plates are beveled to an angle of about 75 degrees.

### Riveting and Driving Staybolts

The cups in the riveting dies must be of the proper depth and shape. The rivets also must be of the proper length and sufficiently upset to thoroughly fill the holes. In no case should the rivets be short enough or the dies deep enough to allow them to touch the plate. A rivet will be assumed loose if the plate shows any impression of the die around the rivet. If an instance of this kind occurs, the rivet must be replaced.

Care must be taken to see that the staybolts and radial bolts are of a proper fit in their holes and that they project through the plates in accordance with standard practices (3/16 inch for iron and ⅜ inch for copper bolts).

Drive bronze and copper bolts inside and out with a hand hammer and cup the bolts on the outside with a small air hammer.

Indentations around staybolts must be avoided.

The tube holes must be accurately spaced and of the exact size shown on the drawings or specifications. They must have a smooth bore on the inner and the outer edges of the firebox tube sheet and the outside only of the front tube sheet must be chamfered with a suitable tool.

### Laying Out and Fitting Tubes

Tubes should be reduced at the firebox end to such a size as will only require a light driving fit to position.

Tubes should be reasonably free from scale where connected to the tube sheet. Tubes should project sufficiently to insure a full head. Sheets must not be marked or cut by the beading tool.

Prossering should be a thorough job. Great care should be exercised in selecting the tool to see that it is of the proper dimension to conform to the thickness of the sheet.

Tubes should project through the front end tube sheet not less than 3/16 inch or more than ½ inch. Where tube holes are 1/16 inch larger than the diameter of the tube, the tube should be opened up by heating before entering the boiler. This is not necessary where the difference in size is not more than 1/32 inch. Tubes will not be beaded on the front tube sheet unless specified.

Tube sheets must be perfectly straight and must not be drawn in to suit the length of the tubes.

Tubes will be placed under water pressure, tapped around the weld and inspected for leaks while the pressure is on, after being safe ended.

### Testing the Boiler

Before the hydrostatic test and the steam test of the boiler, all studs, plugs, checks and valves (engine safety valves excepted), the throttle, drypipe and tee head should be in position.

After the boilers have been entirely tested in accordance with standard practice, they must be blown down *and the water changed,* after which they must be fired up the third time and tested again under their own steam to 20 percent above the working pressure.

For the purpose of cleansing the boilers of oil and grease, thereby protecting the firebox sheets from possible injury, a solution of soda ash and hot water must be put into every boiler after the water test has been made and before the firing or steam test is begun.

For the different sizes of boilers, the following quantities of soda ash should be used:

- 20 pounds of soda ash for boilers of 48 inches to 60 inches diameter.
- 30 pounds of soda ash for boilers of 60 inches to 70 inches diameter.
- 40 pounds of soda ash for boilers of 70 inches to 80 inches diameter.
- 60 pounds of soda ash for boilers of 80 inches and over.

The Interstate Commerce Commission requires that the dome cap and throttle standpipe be removed after the hydrostatic test of the boiler has been applied. This should be done at this point and a careful internal inspection made. This provision does not apply to boilers having an auxiliary dome.

Trial firing of boilers without safety valves is a dangerous practice and will not be permitted under any circumstance. Safety valves as they come from the manufacturers must not be used for testing purposes. One or more safety valves should be maintained for testing purposes and adjusted to suit the pressure as required in the specifications. One safety valve is to be used on each boiler while under test. Other openings should be plugged. Safety valves may be set, if necessary, according to the specifications and any question of their accuracy eliminated before leaving the shop.

### Steam Gages

New gages belonging to locomotives must not be used for shop tests. All steam gages must be tested before being applied to the locomotives. A permanent record of each steam gage applied should be kept in the following form:

*Date Make Number Condition If corrected, how? Tested by*

After gages have been tested and the necessary corrections made, a small slip as follows:

Tested "G"
Date
C. P. K.

the symbol of the plant, date and test and initials of the person testing must be inserted between the glass and the dial.

To insure tight rivets, all holes in a boiler must be inspected to see that they are fair and in proper shape to receive the rivet. All rivets must be tested for tightness before the fireboxes have been applied and before the boilers are otherwise assembled fully. The inspector assigned to this work will prepare the proper form indicating that all holes are fair and all rivets tight or otherwise, as discovered by his inspection.

Inspectors and foremen should always make sure that the system of instructions, as practised in the shop, are carried out to the fullest possible extent, and that all defects which develop on the preliminary test are corrected before the final test is run.

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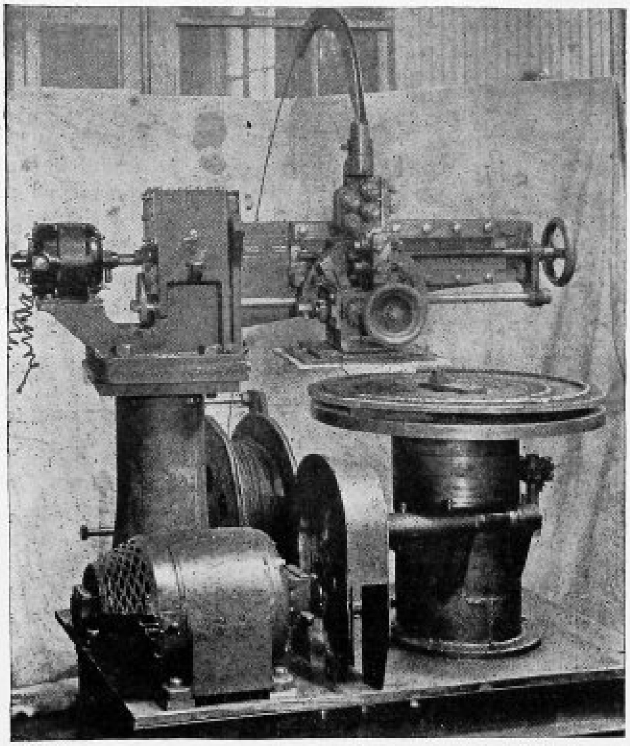
## Welding With the Automatic Arc Welder*

BY H. L. UNLAND†

The automatic arc welder is a device for feeding the metallic electrode wire into the welding arc at the rate required to hold a constant arc length. Under these conditions the electrical conditions are kept constant and the resulting weld is uniform and its quality is thereby improved. It is possible with this device to weld at a speed of from two to six times the rate possible by skilled hand operators. This is partly due to the stability of the welding conditions and partly due to the fact that the electrode is fed from a continuous reel, thus eliminating the changing of electrodes. The automatic welder is adaptable to practically any form of weld from butt welding of plates to the depositing of metal on worn surfaces such as shafts, wheels, locomotive fireboxes and the like.

Everyone who has made any investigation of electric arc welding has noted the wide variation in results obtained by different welders operating, as nearly as can be determined, under identical conditions. This also applies to the operations of a single welder at different times under identical conditions. These variations affect practically all factors of welding such as the speed of welding, the amount of electrode consumed, etc. When indicating instruments are connected to an electric welding circuit, continual variations of considerable magnitude in the current and voltage of the arc are at once noticed. This same condition was found some years ago in the cutting of steel plates by the gas process, and when an equipment was devised to mechanically travel the cutting torch over the plate, a series of tests to determine the maximum economical speed, gas pressure, etc., for the various thicknesses of plate were made. The result was that the speed of cutting was increased to as much as four or five times

* From a paper read before the American Welding Society.
† Power and Mining Department, General Electric Company.



Typical Automatic Arc Welding Installation

the rate possible when operating under the unsteady conditions incident to hand manipulation of the torch. Further, the gas consumption for a given cut was found to be decreased very greatly.

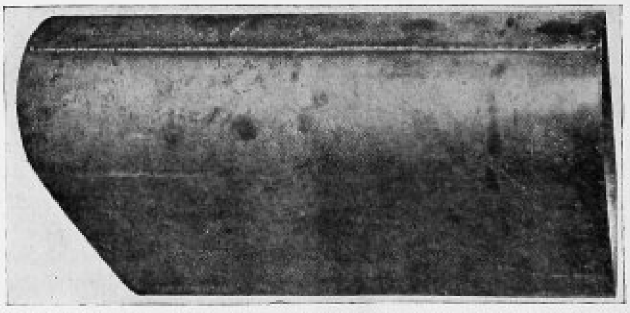
As a result of these experiences an investigation was started to determine what could be done in controlling the feed of the metallic electrode in the arc welding circuit. An electric arc is inherently unstable, the fluctuations taking place with extreme rapidity. In any regulating devices the sensitiveness depends on the percentage of variation from normal, rather than on the actual magnitude of the values, since these are always reduced to approximately a common factor by the use of shunts, current transformers or series resistances. The characteristics of practically all electric welding circuits are such that the current and voltage are inter-related. An increase in one causes a corresponding decrease in the other. Where this is the case it will generally be found that the percentage variation of the voltage from normal when taken at the customary arc voltage of 20 will be approximately twice the percentage variation in current. Further, an increase in arc voltage, other conditions remaining the same, indicates that the arc has been lengthened, thus giving the metal a greater opportunity to oxidize in the arc, with a probable reduction in the quality of the weld.

The automatic welder utilizes the arc voltage as the basis for regulating the equipment. The rate of feeding the wire varies over a wide range due to the use of electrodes of different diameters, the use of different current values, etc., caused by details of the particular weld to be made. The simplest and most reliable method of electrically obtaining variations in speed is by means of a separately excited direct current motor. Thus the operation of this equipment is limited to direct current arc welding circuits, but these may be of any established type, the variations in characteristics of the welding circuits being taken care of by the proper selection of resistors, coils, etc., in the control.

The welding head consists essentially of a set of rollers for gripping the wire and feeding it to the arc. These rollers are suitably connected through gearing to a small direct current motor, the armature of which is connected across the terminals to the welding arc. This connection causes the motor to increase in speed as the voltage across the arc increases, due to an increase in the length of the arc and to decrease in speed as the voltage decreases due to a shortened arc. A small relay operating on the principle of a generator voltage regulator is connected in the field circuit of the motor which assists in the speed control of the motor as the arc voltage varies. Rheostats for regulating and adjusting the arc voltage are provided by means of which the equipment can be made to maintain an arc of the desired length, and this value may be varied from over twenty to as low as nine volts. No provision is made for the adjustment of the welding current, since the operation of the automatic machine is in no way dependent on it. This adjustment is taken care of by the control panel of the welding set. This may be either of the variable voltage or constant potential type, but it is necessary to have a source of constant potential to excite the fields of the feed motor. It may be possible to obtain this excitation from the welding circuit, but this is not essential. The voltage of both the welding and constant potential circuits is immaterial provided it is not too high. These voltages must be known before the proper rheostats can be supplied.

Observation of indicating meters on the control panel show that the current and voltage are practically constant, but it should be remembered that all indicating meters have a certain amount of damping which prevents the observation of variations which are extremely rapid or of small magnitude. The resultant value as read on the instrument is the average value. Oscillographs taken with short arcs show that notwithstanding the fact that the indicating meters show a constant value, a succession of rapid short circuits is continually taking place, apparently due to particles of the molten wire practically short-circuiting the arc in passing from the electrode to the work. This is indicated by the fact that the voltage curve falls to zero each time accompanying a fluctuation, while there is also an increase in the current. It was found that with the shorter arc the frequency of occurrence of these short-circuits was considerably higher than was the case when the arc was increased in length. To all appearances the arc was absolutely steady and continuous and there was no indication either by observation of the arc itself or of the instruments that these phenomena were occurring.

The following tables give an idea of the speed of welding which may be expected, but it should be borne in mind that these figures are actual welding speeds. It is necessary to have the material properly clamped and supported and to have it travel past the arc at a uniform speed. In some cases the figures given have been exceeded and



Oil Switch Tank With Seams Welded on Automatic Arc Machine under certain special conditions it may be desirable to use lower values than those given.

SEAM WELDING

| Thickness in Inches | Amperes | Speed, Inches, per Minute |
|---|---|---|
| .040 | 45 to 50 | 20 to 30 |
| 1/16 | 50 to 80 | 15 to 25 |
| 1/8 | 80 to 120 | 6 to 12 |
| 3/16 | 100 to 150 | 4 to 6 |

BUILDING UP WORN OR UNDERSIZED METAL

| Diameter or Thickness, Inches | Electrodes, Diameter, Inches | Amperes | Speed, Inches per Minute | Pounds Deposited per Hour |
|---|---|---|---|---|
| Up to 1 | 1/16 | 60 to 90 | 11 to 13 | 1.04-1.56 |
| Up to 3 | 3/32 | 90 to 120 | 6 to 8 | 1.59-2.1 |
| Over 3 | 1/8 | 120 to 200 | 4 to 6 | 2.5 -4.5 |

On account of the great variation in conditions under which this equipment may be used, it is provided with a base which may be bolted to any form of support. It may be held stationary and the work traveled past the arc or the welding head may be movable and the work held stationary. These points will be dictated by the relative size of the work and the head and the equipment which may be available. Provision must be made for traveling one or the other at a uniform speed in order to carry the arc along the weld. In the case of straight seams a lathe or planer bed may be utilized for this purpose, and for circular seams a lathe or boring mill may be used. In many cases it will be found desirable to use clamping jigs for securely holding the work in shape and also to facilitate placing it in position and removing it from the feeding mechanism.

The principal field for this device is where a considerable amount of welding is required, the operations being a continuous repetition of duplicate welds. Under these conditions one can economically provide jigs and fixtures for facilitating the handling of the work and the clamping. Thus can be reaped the benefit of the increased speed in the actual welding which would be lost if each individual piece had to be clamped and handled separately.

# Diagonal and Horseshoe Boiler Patches

## Diagonal Boiler Patches Show Greater Efficiency Than the Longitudinal Type—Relative Advantages of Horseshoe Patches

BY R. J. FURR

The writer, a boiler inspector, has been asked by owners and engineers in states not governed by inspection laws to state some of the best methods of patching horizontal tubular boilers, so that they may be permitted to carry the same working pressure as before a rupture. It is to be understood that the following method is not advocated as a permanent repair, but only as temporary, for the reason that it is not in accordance with good engineering practice. Then, too, there is a loss in value due to resultant complications, which usually take the form of fire cracks, leakage, poor workmanship, etc. Some data on the subject may be of general interest to boiler owners, engineers and inspectors. While the following method of computation does not cover all the refinements, it forms a good basis and gives a close approximation to working conditions.

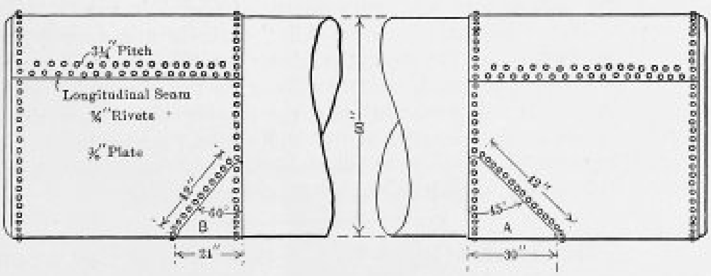



Fig. 1 (a).—Types of Triangular Service Patches

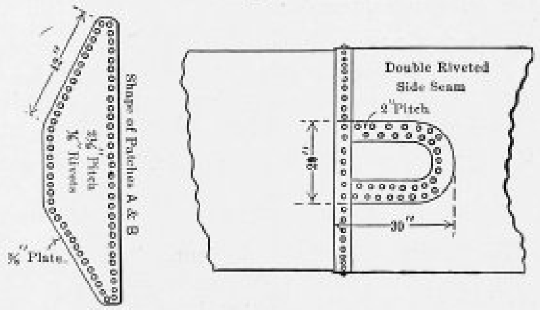



Fig. 1 (b).—Horseshoe Boiler Patch

### Triangular Patches

The patch recommended is single riveted and is triangular or trapezoidal in shape. When riveted to the boiler, the seam may have a 45-degree (A) to 60-degree (B) angle, Fig. 1 (a). When a boiler has fire cracks of such nature in the girth seam that continuous leaking and deterioration are going on, or when the cracks extend into the body of the sheet and there are blisters, bulges or other defects that call for patches, the method illustrated may be used. It may be suggested that a whole or three-quarter sheet be put on; but, as it is sometimes difficult to obtain the required amount of steel in the territory where the boiler is located, a piece of steel suitable for making a patch can be obtained. If a whole or three-quarter sheet were required, it would have to be ordered from some distant boiler or steel works, thus delaying the repair of the boiler.

### Computing the Patch

To illustrate the strength of the patch, it will be assumed that it is to go into a boiler the dimensions of which are as follows:

| | |
|---|---|
| Diameter | 60 inches |
| Length | 16 feet |
| Built in three courses; double-riveted lap joints | |
| Pitch of rivets | 3¼ inches |
| Size of rivets | ⅞ inch |
| Shearing strength of rivets | 43,000 pounds |
| Thickness of sheet | ⅜ inch |
| Tensile strength | 55,000 pounds |
| Efficiency of joint | 73 percent |
| Working pressure (using factor of safety of 5) | 100 pounds |

We will suppose that a longitudinal patch 30 inches long will be required. Therefore, for a 45-degree angle the diagonal line would be 42 inches, making allowance for rolling the patch to the desired shape.

The patch material should have a tensile strength of 55,000 pounds; thickness of plate, 3/8 inch; pitch of rivets, 2 1/8 inches; size of rivets, 7/8 inch, and shearing strength, 42,000 pounds. Assuming that the efficiency of this single riveted seam is 57 percent, the efficiency of the seam of the patch, or its power to resist the major or circumferential stress by reason of its diagonal position, is found by the formula:

$$E = \frac{d \times P}{h} = \frac{42 \times 57}{30} = 79 \text{ percent},$$

where:

$E$ = Efficiency of patch.
$d$ = Diagonal length of seam.
$P$ = Percent efficiency of the given seam (computed as for longitudinal joints).
$h$ = Horizontal (longitudinal) length of patch.

Using this efficiency in the usual manner in calculating the pressure, with a factor of safety of 5, we would have a working pressure of 108 pounds, or 8 pounds more than the original longitudinal seam. If the patch were 24 inches its efficiency would be 99 percent and the working pressure would be 136 pounds with a factor of safety of 5, or 36 pounds more than the original longitudinal seam. It is also of interest to note that the efficiency of this patch can be made greater than a butt and double-strap joint, quadruple-riveted.

### Weakness of Longitudinal Seams

As a further illustration that an inclined or diagonal seam is stronger than a straight or longitudinal seam, the ratio of strength $R$ of an inclined or diagonal seam to that of a straight or longitudinal seam may be found by the following formula:

$$R = 2 \div \sqrt{3 \text{ (cos of the angle of inclination of seam)}^2 + 1}$$

Example: How much stronger is a riveted seam when inclined at an angle of 45 degrees than a similar longitudinal seam of a cylindrical boiler shell?

$$R = 2 \div \sqrt{3 \text{ (cos of the angle of inclination of seam)}^2 + 1}$$
$$= 2 \div \sqrt{3 \ (0.707)^2 + 1}$$
$$= 2 \div 1.58 = 1.265,$$

which, reduced, is 126.5 percent. This indicates that a diagonal seam at the 45-degree angle will resist bursting strains 26.5 percent greater than a similar seam in a longitudinal position.

Various writers have given different formulae for the computation of the diagonal seam, some claiming that the different angles for patches of this type should be computed separately, others than the average angularity of the curve of the patch should be considered. In every case only those who have a knowledge of higher mathematics are able to compute the efficiency of the patch from these formulae. For this reason the simplified formula is given in order that those having a limited knowledge of mathematics can derive the relative strength of the patch to the solid plate.

### Efficiency of Patch

The high percentage of efficiency of the diagonal patch will allow the same working pressure on the boiler. There are no two rivets in line parallel to the longitudinal seam. The patch will give little or no trouble under operating conditions if carefully laid out and riveted to the boiler and a large percentage of the shear on the rivets is eliminated, so that some, if not all, boiler insurance companies will pass the patch. The disadvantages are: The waste of metal when cutting out the patch, unless from scrap sheets; the large number of tubes which have to be removed to put on the patch (however, the writer has seen this patch put on without the removal of any tubes); the difficulty in riveting the patch and obtaining a good joint, and the extra seam placed in the fire.

### Horseshoe Patches

Suppose a patch of the commonly called horseshoe type be used instead: size, 20 inches by 30 inches; single-riveted; pitch, 2 inches; rivets, 7/8 inch; shearing strength, 42,000 pounds; sheet, 3/8-inch thickness; tensile strength, 55,000 pounds; efficiency, 56 percent. The working pressure, using the same factor of safety (although some insurance companies require a factor of 5.5) would be 77, say 80 pounds; and, as all rules require that the pressure allowed shall be calculated from the weakest part, it will be necessary to reduce the pressure from 100 to 80 pounds, which certainly will not satisfy the owner.

Someone may suggest that the seam should be double-riveted, with the pitch of the rivets increased, which will also increase the efficiency of the joint. This is not advisable, as it is generally understood that a single-riveted seam is best because of the action of the fire on the rivets. In some instances insurance companies request that a single-riveted seam be used on this type of patch, notwithstanding the fact that double-riveted patches in some instances have given good service. It can be used successfully on types of boilers where the fire does not come in contact with the patches.

### Advantages and Disadvantages

The advantages of this type of patch are: It is easily riveted to the boiler; a good joint may be obtained by careful workmanship; ordinarily, only a few tubes, and sometimes none, have to be removed in order to apply the patch; and a small amount of metal is used.

The disadvantages are: All the rivets are exposed to the action of the fire; the shear on the rivets is much greater; the patch will usually give trouble under ordinary operating conditions; there are more than three rivets in line parallel to the longitudinal seam; the working pressure must be diminished; and some insurance companies would refuse to insure the boiler.

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## The Advantages of Co-operation Between the Boiler Manufacturer and the Insurance Company*

BY S. F. JETER†

Co-operation as a slogan has been overworked during recent years. It has been advocated in many instances by those who apparently had no conception of its meaning, or if they did have it was not their intention to really co-operate. The derivation of the word indicates that it means to "work with others." Many have used it apparently with the idea that it meant to "work for others." It should be understood that co-operation necessarily involves the viewing of the subject from the other fellow's standpoint, as well as your own. There are many ways in which the boiler manufacturer and the insurance company can work with each other, or co-operate, and the interests of both be served.

Insurance companies are frequently confronted with claims due to minor accidents. If in making repairs in cases where an insurance company is involved the boiler maker would keep the cost of the repairs that were actually necessitated by the accident separate from any general repairs that might be made at the same time, it would

* Paper read at the annual convention of the American Boiler Manufacturers' Association.

† Chief engineer of the Hartford Steam Boiler Inspection Insurance Company, Hartford, Conn.

be very advantageous to the insurance company as well as the assured, who is the boiler maker's patron. With a proper division of the items the possibility of controversy between the insurance company and its patron is avoided. Such co-operation should not cause the slightest friction between the boiler maker and his customer. All that is needed is that he so keep track of the items of repair that he will be in a position to make a correct division of the cost if called upon to do so. There have been many instances where co-operation of the boiler maker in such cases has been of the greatest aid to both the insurance company and its customer. However, there have been many such cases, more especially in connection with the small boiler maker, where lack of co-operation, if not actual antagonism, has been extremely detrimental.

The furnishing in case of explosions of prompt and proper bids or estimates by the boiler manufacturer covering replacements or repairs required is a class of co-operation that is welcomed by the insurance company.

The boiler manufacturer can, of course, aid the insurance company in informing his patrons or prospective patrons of the service that may be secured through the insurance company. Boiler insurance has been so widely advertised in one way or another that it would seem there could be no user of steam who was unacquainted with the facts. However, there appear to be many boiler purchasers who do not yet realize the service they can secure from boiler specialists to look after their boilers from the cradle to the grave, or, rather, from the plate mill to the scrap heap, even though the termination of the existence of their boilers is not of a more serious or spectacular nature. A suggestion from the manufacturer for inspection during construction, with its accompanying policy of insurance or certificate of inspection by an organization with which the manufacturer is not allied, cannot help but impress the purchaser with the manufacturer's good faith in meeting his contract obligations. I feel sure that the advantages of the service and co-operation rendered by the insurance company in this respect are fully appreciated by the members of the American Boiler Manufacturers' Association.

The insurance company can be a distinct aid to the manufacturer in seeing that the workmanship in his shop is kept up to the standard he desires to maintain. A manufacturer can, and does, of course, instruct his own employees as to the grade of work he desires to turn out and may institute a form of inspection service through his own employees for the purpose of maintaining this standard. However, an employee, particularly if he is faithful, cannot refrain from keeping in mind what he considers to be his employer's best interest. Notwithstanding the fact that some features of workmanship may not come up to the mark set, the faithful employee will always consider the cost involved before rectifying the trouble. The shop employee, as a rule, is not in a position to make a decision in such cases for the best interest of his employer. Often he will decide that the rectification of a mistake is unwarranted, owing to the cost involved, when the officials of his company would have decided that the cost should not be considered. The inspector of the insurance company, of course, is not directly concerned with the cost of rectifying a mistake. If a mistake is judged of importance enough he will condemn the work outright, or if of more minor importance the inspector may call it to the attention of the proper shop or company official, who can decide with the inspector whether a change should be made or not.

Another feature that is a detriment in securing adequate inspection by a representative who is paid by and under the direct control of the manufacturer is this: Mistakes are often made, which, if brought to the attention of the shop or company officials, are liable to cause a reprimand. It is natural, under such conditions, that an employee dislikes to be the cause of the reprimand of a fellow employee. For the same reason it is desirable that an insurance inspector, while enjoying the good-will and respect of shop employees, should not be on too intimate terms with them. This is a feature that the insurance company attempts to guard against in all cases.

The insurance company can co-operate with the manufacturer and his employees in determining if the standards for workmanship which have been established are in accord with those maintained by the better shops doing a similar class of work. Co-operation of this kind is very advantageous and tends to spur the employees to their best efforts to see that others do not exceed the grade of work which they turn out.

Another feature in which the insurance company has become extremely valuable to the manufacturer is in co-operating with him in meeting the legal requirements for construction where boilers must be built to come under boiler laws. This is becoming more important each day, since the states having boiler laws governing construction are constantly increasing in number. It was on account of this tendency for boiler laws to become more common that caused the manufacturers and insurance companies to co-operate in an effort to secure uniform rules governing boiler construction. The organization of the Uniform Boiler Law Society, which is sponsored by your association, and the introduction of the A. S. M. E. Code, the success of which is mainly due to the hearty support and unceasing labors of some of your members, are two tangible evidences of co-operation between the boiler manufacturer and the insurance company. Along this same line the insurance company can be of the greatest aid to the manufacturer in checking his designs before the commencement of work to see that the requirements of the law are met. Our company is constantly called on by the manufacturer to furnish this class of service.

Another way in which the insurance company can co-operate with the manufacturer is in securing modifications of rules or regulations that may tend to work a hardship on either party without compensating advantages to the steam user or public. I feel sure that those of your members who are directly concerned with the code work of the A. S. M. E. can vouch for the thorough co-operation which exists between the two interests in connection with such features.

The insurance company is in a position to co-operate with and aid the manufacturer in straightening out controversies that arise between the manufacturer and his customer in regard to construction details. The insurance company is often blamed unjustly by the manufacturer—though sometimes with justice—in connection with such controversies. There are several points in connection with this subject that the manufacturer should always bear in mind. The purchaser is prone to lay undue stress on any criticism that may be offered on equipment which he has bought. The insurance company realizes this as fully as the manufacturer. However, it is not practical or proper that the insurance company should make its report directly to the boiler manufacturer when any detail of construction does not meet requirements. Any criticism that the insurance company may have to make is necessarily furnished the purchaser who employs the insurance company. For the above reasons a criticism, if made, usually reaches the manufacturer in a form very distasteful to him and not at all necessarily in the way in which his product may have been criticised by the insurance inspector. Often a most harmless but truthful statement of facts is twisted into a real condemnation when it reaches the boiler manufacturer. To insure a thorough understanding of what an inspector may have said about a boiler it would be my suggestion that the boiler manufacturer always insists on seeing a copy of the inspector's report in all cases where his product is reported to have been criticised.

It must, of course, be realized by the boiler manufacturer that in all cases the boiler insurance company does not only co-operate with the user, but is paid by and works for him. Therefore, the insurance inspector must take as much pains to safeguard the interest of the boiler user as would any reliable consulting engineer who might be retained by him. Unless the insurance companies' representatives maintain this attitude and can impress the boiler user with the fact that his interest is thoroughly protected, co-operation between the boiler manufacturer and the insurance company would be of no value to the former. The insurance company must look at all questions from the user's standpoint.

As a matter of self-preservation, the insurance company must maintain a position of strict neutrality when it comes to recommendations as to the kind of boilers which a user should purchase. Boiler users constantly apply to the insurance company in an endeavor to secure some expression of opinion as to the relative merit of the product of one manufacturer over another. It is necessary at all times to be on guard that nothing is said that may be considered as unduly influencing the inquirer in making his selection. About the only advice that can be given is the type of boiler. In the case of certain uses, of course, particular types lend themselves to the conditions.

At the last annual meeting of your association in New York an attempt was made to determine the attitude of your members in regard to agreeing with the insurance companies that all shell constructions should be figured on the basis of 55,000 pounds tensile strength for the plate, unless the actual tested tensile strength was less. At that time it appeared that there was no great opposition to such a move. However, later on some of your members seriously objected to such procedure. It is respectfully urged that you reconsider this matter and see if such procedure cannot now be agreed on. This would appear to be a subject where the boiler manufacturer and the insurance company could co-operate to the distinct advantage of both. Certainly none of the members of the American Boiler Manufacturers' Association desire to compete with fellow members on any other than a fair and equitable basis. By not establishing a fixed maximum tensile strength to be used in calculating boiler pressures, as is done in the A. S. M. E. code, there is a possibility of unfair competition, even though it may be unintentional. We have often received complaints from a boiler manufacturer that we have passed, in the case of a competitor, a given boiler of certain dimensions for a few pounds more pressure than in his case. Almost invariably an investigation develops the fact that the tensile strength in one case was different from the other. A number of years ago our company arbitrarily fixed 60,000 pounds tensile strength as the maximum limit we would use in figuring pressures. All that is suggested now is to change this limit to meet the A. S. M. E. code requirements. Of course, it would be possible for the insurance companies to set a limit for the tensile strength that would meet their ideas, but it was with the idea that co-operation between the manufacturers and the insurance companies in such matters would be most desirable that prompted the submission of the question to your association. Will you not reconsider it? There are doubtless many other questions of a similar character that might be most profitably discussed and decided on jointly by the boiler manufacturers and insurance companies.

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# How to Design and Lay Out a Boiler—XXII

**Expansion of Steam in Boilers—Calculating Expansive and Contractive Stresses—Applying Stress Calculations to Boiler Design**

BY WILLIAM C. STROTT

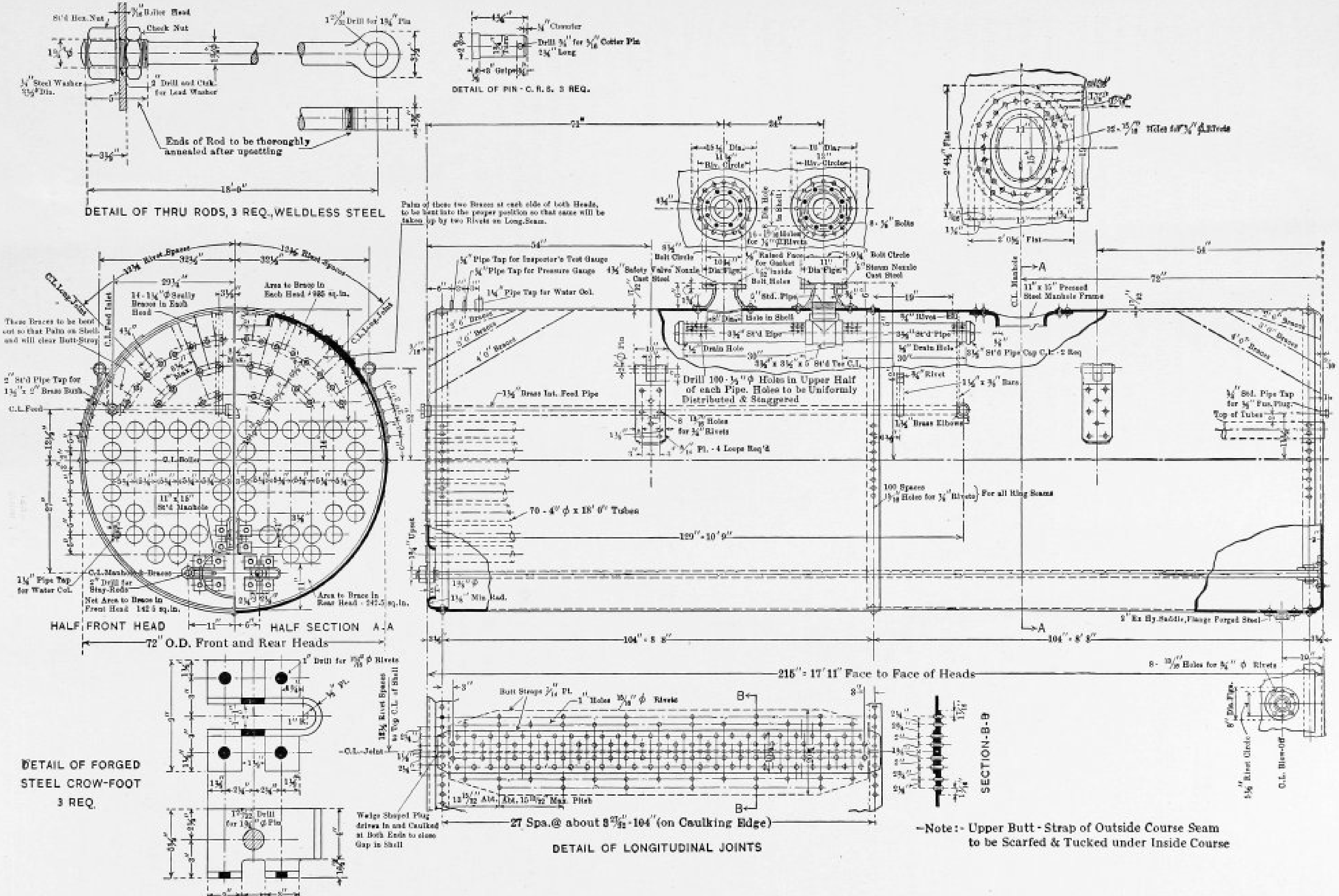
A steam boiler on being heated expands, and this expansion is greatest in the direction of its length. Therefore provision must be made for allowing the boiler to move freely in its setting, otherwise the walls of the setting will be cracked. To provide for this expansion, plates and rollers are placed under the rear brackets as illustrated diagrammatically in Fig. 85. No rollers are, however, placed under the front brackets; this securely anchors the boiler at this point, and forces the expansion to take place in one direction only, that being towards the rear. To prevent the boiler from cracking the rear wall on its rearward thrust, the roof of the combustion chamber must be built one inch away from the boiler head and the space between packed with asbestos or mineral wool. So as not to defeat the purpose of the rollers under the rear brackets, the draftsman should, by means of a note on the drawing of the boiler setting, call the bricklayer's attention to the fact that the walls must not be bricked up solid around these brackets, but that a clear space of at least one inch be left on each side.

Most of the severe cracks one sees in many boiler settings may be attributed to carelessness when building the settings. It is obvious that if the brick-work around the rear brackets is bonded in solid with the rest of the wall, that the expansion of the boiler will crack the wall. It should be realized that the force attendant to the expansion of a bar of metal is exactly equivalent to an external force that would have to be applied in order to stretch the bar that amount. One end of each span of a steel bridge rests on rollers, with sufficient clearance at the ends to provide for expansion. If this were not done, the force of the thrust caused by the increase in length of the bridge, due to the amount of expansion occurring between the winter and summer months, would be of sufficient magnitude to crack the bridge abutments or piers.

DETERMINING THE AMOUNT OF EXPANSION OR CONTRACTION OF BODIES BY CHANGES IN TEMPERATURE

So that there may be no "guess-work" in the future

* Engineering Department of The Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.




Design of 72-Inch Diameter by 18-Foot Horizontal Return Tubular Boiler, Having an Allowable Working Pressure of 150 Pounds, and Built According to the Boiler Code of the American Society of Mechanical Engineers concerning the matter of expansive and contractive stresses, the subject will be treated in a broader sense, and a few practical illustrations given to demonstrate the importance of the phenomenon as it relates to engineering.

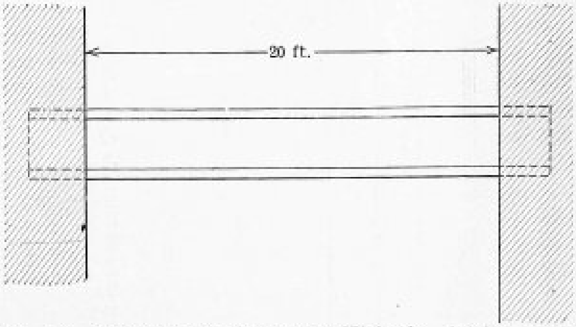



Fig. 88.—Illustration in Connection With the Application of Hooke's Law

When the temperature of a body is raised, it is found that its dimensions increase—not only in length but also in breadth and thickness. This is termed expansion, and the amount of expansion depends both on the rise in temperature and on the nature of the body itself, or in other words, on its material—that is, whether it is of steel, iron, wood or glass, etc.

TABLE 18.—COEFFICIENT OF EXPANSION FOR A NUMBER OF SUBSTANCES

| Name of Substance | Linear Expansion | Surface Expansion | Cubic Expansion |
|---|---|---|---|
| Cast iron | .00000617 | .00001234 | .00001850 |
| Copper | .00000955 | .00001910 | .00002864 |
| Brass | .00001037 | .00002074 | .00003112 |
| Silver | .00000690 | .00001390 | .00002070 |
| Bar iron | .00000686 | .00001372 | .00002058 |
| Steel (untempered) | .00000599 | .00001198 | .00001798 |
| Steel (tempered) | .00000702 | .00001404 | .00002106 |
| Zinc | .00001634 | .00003268 | .00004903 |
| Tin | .00001410 | .00002820 | .00003229 |
| Mercury | .00003334 | .00006668 | .00010010 |
| Alcohol | .00019259 | .00038518 | .00057778 |
| Gases | ......... | ......... | .00203252 |

Table 18 gives the average coefficient of expansion for various materials, and the use of the above table will now be explained.

For the linear expansion of bodies by heat, let

$L^*$ = initial length of the body.
$l$ = amount of linear expansion.
$t$ = initial temperature in degrees F.
$T$ = final temperature in degrees F.
$E_1$ = coefficient of linear expansion, as given by Table 18, for the material in question.

Then:

(28) $$l = L \times (T - t) \times E_1.$$

Example.—Given a bar of steel (untempered) 20 feet long, heated from 70 degrees F. to 500 degrees F., what is its increase in length?

Substituting in formula (28), we have:

$l = 20 \times (500 - 70) \times .00000599 = .0515$ feet, or .618 inches.

### Calculating the Magnitude of Expansive and Contractive Stresses

Although an increase of but ⅝ inch in the length of a 20-foot bar is almost negligible as far as its dimensions are concerned, the magnitude of the expansive stresses that may be set up in this bar due to its rise of temperature will now be demonstrated. It should be quite clear that in order to cause this bar to "stretch" an equivalent amount without the application of heat, an external force of sufficient magnitude would have to be applied to it.

Let us assume that the bar referred to above were a structural steel beam firmly imbedded in opposite brick walls with no allowance made in the brick-work for any increase in length of the beam. See Fig. 88.

In the very first installment of this series of articles, in which the strength of boiler plate material was discussed, a reference was made to "Hookes' Law" relating to the elasticity of metals. This law, it should be recalled, was to the effect that the "stretch" in a bar of metal was directly proportional to the magnitude of the force applied to it, providing that the force was not beyond the elastic limit or yield point for the particular material. In other words, if a pull of 10,000 pounds stretches a certain bar 0.1 inch, then a pull of 20,000 pounds would stretch it twice the latter amount, and a pull of 5,000 pounds would stretch it only 0.05 inch, etc.

*Within the elastic limit,* then, the ratio of the "pull" to the elongation is constant. It must therefore be true that the ratio of the unit stress to the unit deformation† is also constant. This latter ratio is termed the Coefficient of, or, more frequently, the Modulus of, Elasticity. This ratio may be more clearly expressed in the form of an equation, thus:

(29) $$E = \frac{S}{s},$$

in which:

$E$ = modulus of elasticity in pounds per square inch.
$S$ = the unit stress in pounds per square inch.
$s$ = the unit deformation in inches.

In the above formula $s$, or the *unit* deformation, is found by dividing the *total* deformation by the initial length of the body. Thus:

(29a) $$s = \frac{D}{L},$$

the same notations as in formula (28). But since:

$$D = (T - t) \times L \times E_1,$$

then it is also true that:

(29b) $$s = \frac{(T - t) \times L \times E_1}{L}.$$

It will be seen that $L$ appears in both numerator and denominator of the above fraction, whence it may be cancelled out of each term, and we finally have the equation as simply:

(29c) $$s = (T - t) \times E_1.$$

Expressed in words, this means that if we multiply the rise in temperature by the coefficient of expansion for the given material, the product will be the unit deformation. From this deduction it should be quite plain, therefore, that neither the length of the body nor its cross-sectional area has anything whatever to do with determining the unit stress in a body due to changes in temperature. It makes no difference whether a bar of steel is a decimal part of an inch or a mile in length, the *unit* stress due to a given variation in temperature will be the same.

The Modulus of Elasticity is practically a constant value for a given material, and Table 19 gives the average values of this constant for the most common materials employed in construction. More complete tables may be found in any good engineering hand-book.

TABLE 19

| Material | Modulus of Elasticity (in Pounds per Square Inch) |
|---|---|
| Steel | 30,000,000 |
| Wrought iron | 27,500,000 |
| Cast iron | 15,000,000 |
| Timber | 1,800,000 |

* $L$ may be expressed in any unit, i. e., inches or feet, etc., but whatever unit is employed for the value of $L$, the resulting value of $l$ must of course be read in the same units.

† By deformation in this sense is meant the change in the shape of dimensions of a body from its initial state. As employed here, deformation may mean either a reduction in its size due to contraction or compression or an increase in its dimensions due to expansion or tension.

In the case of the beam referred to in connection with Fig. 88, we have, then, the following known values relating to formula (29):

$$E = 30{,}000{,}000 \text{ pounds per square inch.}$$

$$s = \frac{0.0515}{20}, \text{ or } 0.00258 \text{ inch.}$$

Substituting in formula (29), we write:

$$30{,}000{,}000 = \frac{S}{0.00258},$$

whence:

$S = (30{,}000{,}000 \times 0.00258)$, or 77,400 pounds per square inch.

Now if this were a standard 15-inch I-beam weighing 60 pounds per foot, the cross-sectional area would be 17.65 square inches, it would be a fact that the total temperature expansion stress in this beam tending to force out the brick walls is $(17.65 \times 77{,}500)$, or approximately 1,365,000 pounds, which is a far greater load than even the beam itself could stand. Under these conditions it would buckle, providing, of course, that the resistance of the walls were greater than that of the beam. This should seem to clearly demonstrate the reason for the collapse of steel buildings during a serious conflagration by fire, unless the skeleton frame-work is efficiently fireproofed.

### Applying Temperature Stress Calculations

Although the shells or drums and also the tubes composing a steam boiler are not, literally speaking, solid bars of metal, the principle, or rather the conditions, are identically the same in either case. By way of a practical example, we shall apply the temperature stress calculations to the 72-inch by 18-foot horizontal return tubular boiler covered in this series of articles.

The atmospheric temperature at the time the boiler is bricked in we shall, for absolute safety, assume to be at the freezing point, or 32 degrees F. The highest temperature which the boiler plates will ever reach will be that corresponding to the maximum steam pressure to which the boiler may ever be subjected—say, 160 pounds per square inch by gage.

Now from a table of the properties of saturated steam we find that the temperature of saturated steam at a gage pressure of 160 pounds per square inch is about 372 degrees F.

The maximum rise in temperature is, therefore:

$$(T - t) \text{ or } (372 - 32) = 340 \text{ degrees F.}$$

Applying formula (28), we have:

$$l = (215 \times 340 \times 0.00000599), \text{ or } 0.4386 \text{ inch.}$$

This value, of course, represents the resulting deformation and is the very least clearance that could possibly be allowed between the rear brick wall of the setting and the face of the boiler head. In practice, however, the clearance should not be less than one inch for safety. Were the walls built tightly against the boiler, it will now be shown what enormous expansive stresses would be created in the material.

The value just found, viz., 0.4386 inch, is, of course, the *total* deformation, whence the unit deformation is:

$$\frac{0.4386}{215}, \text{ or } 0.00204 \text{ inch per inch of length.}$$

We may now apply formula (29),

$$30{,}000{,}000 = \frac{S}{0.00204},$$

whence the unit temperature expansive stress $S$ becomes $(30{,}000{,}000 \times .00204$ inch), or 61,200 pounds per square inch. Since the cross-sectional area of metal in a 72-inch diameter shell 17/32 inch thick is $(72.53125 \times 0.31416 \times 0.53125)$, or approximately 121 square inches, then the total magnitude of the expansive force would be equivalent to the amazing sum of $(121 \times 61{,}200$ pounds$) = 7{,}405{,}200$ pounds! Not only is this almost inconceivable, but in fact almost unbelievable, nevertheless it is true. When a body either expands or contracts, the resulting deformation *must* take place. If its movement is free and unrestricted there is no harm done, which means that temperature expansive or contractive deformations do not create stresses in the material composing a body, unless its movement is restricted. If it is restricted, then the body will thrust against the obstruction, thereby placing itself under a compressive force whose magnitude is equal to the total temperature stress created in the material. In the case of the boiler we have under conisderation, it is evident that no practically designed boiler wall could possibly resist a thrust of almost 7½ million pounds, whence the rear wall would be cracked and bulged out, due to this thrust. Possibility of such a failure may, of course, be entirely eliminated by simply providing sufficient clearance between the rear brick wall and the boiler head.

The intensity of temperature expansive or contractive stresses should by this time be well apparent to the reader, and from it may be deduced a very definite reason for all that has been stated in the past chapters of this treatise concerning the overheating and chilling of boiler plates.

It should be quite plain that severe local temperature stresses are set up in a steam boiler when unequal portions of the shell or tubes are subjected to wide variations in temperature. It is obvious that one section of the metal is pulling against another section, with the result, if allowed to exceed the elastic limit of the material, that rupture will occur, or else bagging and blistering of the material. This is, however, as bad as a rupture and is usually the forerunner of an explosion.

We are now also in an excellent position to understand the reason for staybolt breakage in internally fired boilers, like the locomotive and vertical firetube type. The firebox plate is exposed to the highest temperature, while the outer wrapper sheet or shell plate becomes no hotter than that corresponding to the temperature of the steam. It may be readily appreciated that the firebox plate expands a far greater amount than the outer and cooler plate, whence a strain is placed on the staybolts.

Each staybolt evidently becomes a cantilever beam of length $X$, with a force in the firebox plate represented by $W$, tending to bend the staybolt just inside the outer wrapper sheet, as indicated by the dotted lines in Fig. 89.

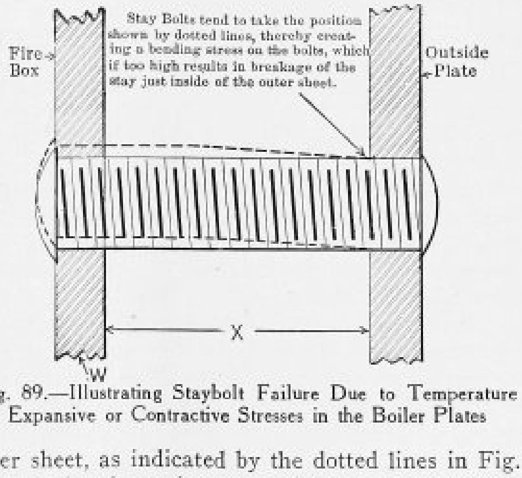



Fig. 89.—Illustrating Staybolt Failure Due to Temperature Expansive or Contractive Stresses in the Boiler Plates

Staybolt breakage has now been largely eliminated since the introduction of specially designed flexible staybolts. This subject will be fully treated in succeeding chapters, in which will be taken up the design of various types of boilers having staybolted construction.

Not only do the cylindrical shells of boilers expand lengthwise due to a rise in temperature, but their diameter also increases, as will now be shown. The mean circumference of the largest course of plate in our boiler is ($72.53125 \times 3.1416$), or very nearly 227.5 inches. For the same rise in temperature as previously assumed, or 340 degrees F., the lineal expansion of the plate will be ($340 \times 227.5 \times 0.000006$), or 0.465 inch. The new circumference of this shell course is therefore ($227.5 + 0.465$), or 228 inches, very nearly. This corresponds to a mean diameter of $\frac{228}{3.1416}$, or 72.6 inches. As the increased diameter is almost negligible, no account when building the setting need be taken for the expansion of the boiler in this direction, but the above calculation was merely presented to illustrate how the expansion of a cylindrical shell takes place. The novice is invariably inclined to believe that a cylindrical shell expands directly across its diameter.

*(To be continued.)*

## Inspection of Watertube Boilers*

BY C. A. ALLISON

The following instructions are for the annual external and internal inspection of certain types of watertube boilers:

Stop delivering coal to the boiler furnace that is going to be taken out of service. Burn out the fire in the furnace as quickly as possible and close the damper. Blow all water out of the boiler when the steam is down to 15 pounds. Blow and clean off all soot from the tubes, superheater and headers.

Take off all handhole plates on the front header and manhole plates on the back of the steam drums. Inspect for leaky handhole plates on the back header; if any are found, remove them and put on new gaskets.

Inspect the tubes inside the furnace for bags and blisters. If defective tubes are found, cut them out and replace by new ones; mark them when they are inspected. Inspect all tubes internally for mud or scale. If scale is found, remove the handhole plates on the mud drum and use a mechanical cleaner in the tubes.

Inspect the steam drums and water columns, and if scale or mud is found, wash out, clean and scrape. Inspect the superheater and its connections to the steam drums, also inspect the baffle plates of the feedwater distributor and the dry-pipe for the outlet of steam. After the scale or mud is removed, inspect the rivets and seams for corrosion, pitting or grooving of plates.

Inspect and clean the side walls, back walls and arches and back connections. If any defective bricks are noticed, have them renewed or repaired. Inspect the stoker and the furnace grates; if defective, repair or renew defective parts. Open the air vent on the steam drum and fill the boiler with water, taking notice while the boiler is being filled of any leaks and marking them.

After the boiler is filled with water up to the top of the steam drum, close the air vent valve and raise the water pressure to 100 pounds. Then inspect the boiler for any leakage. If there is any leak that cannot be stopped while under a water pressure of 100 pounds, remove the pressure and blow down the water.

After attending to the leak, put the boiler under water pressure again at, say, 100 pounds, inspect it, and if tight at that pressure raise the pressure to 200 pounds. If the boiler is found to be water-tight under 200 pounds pressure, open the blowdown valve and remove the pressure from the boiler. Open the vent valve on top of the drum and blow down the water until it shows one gage in the gage glass.

When steam begins to blow from the vent pipe on top of steam drum, close the vent valve and allow the pressure to rise to 20 pounds. When this pressure is obtained, blow out all water from the superheater, close the superheater valve and allow the pressure to rise slowly not to exceed 50 pounds per hour and allow the pressure to rise to within 5 pounds of the working pressure. When this pressure is obtained, open up the boiler stop valve and connect the steam main and the boiler together.

After the boiler stop valve is opened up, the boiler is ready for service, and a regular fire is to be maintained in the furnace. The task of external and internal inspection is now completed.

* From *Power Notes*.

## Locomotive Boiler Explosions*

The world was startled twelve months ago by one of the most violent locomotive boiler explosions on record, in which twenty-six people were killed. The engine in which the boiler was installed was oil fired and for some reason had been put in the shop for repairs. After the repairs were completed the boiler was fired up and the steam pressure raised to within twenty pounds of the working pressure. The last known pressure was 180 pounds per square inch. Above this point the gage refused to indicate and for fifty minutes the boiler was pushed to the limit to reach the maximum pressure, before the engine was sent out of the shop. Those who have handled oil burners can imagine what happened. The safety valve was screwed down hard and the stem was actually bent after the valve was fully seated. It is estimated that there was nearly 8,000 pounds pressure on this boiler. The wrapper sheet and dome, weighing approximately 16,000 pounds, were blown into the air and carried nearly 1,250 feet. The views of the explosion shown were of the ruined buildings and the barrel, wrapper sheets and dome of the boiler.

In the case of an oil burner of a somewhat smaller type than the first instance, a defective cast-iron cap allowed one course to be torn off. The cap let go when turning the water and the pressure being released at the dome opening was more than the course could stand, the result being that the sheets were ripped away. One man was killed in the accident and one injured.

Pitting and grooving are among the causes for boiler failures and an example of this was illustrated in which a boiler failed at a double riveted lap joint in the barrel sheet. Fortunately there are very few double riveted lap seam boilers in service today and their elimination has been well worth the cost of the locomotive boiler inspection service.

### Results of Bad Water

Serious disasters have been traceable to the use of bad water and the case of an explosion in which the firebox failed illustrates how serious this matter is. In the pictures shown the lines on the side sheet where the water was low were quite apparent, the result being that the side sheet overheated 8 or 10 inches from the mud ring.

* Compiled from the lecture on "Locomotive Boiler Accidents," delivered by J. M. Hall, assistant chief inspector, Bureau of Locomotive Inspection, at the annual convention of the Master Boiler Makers' Association.

The crown sheet proper, however, showed no evidence of overheating and, as a matter of fact, two fusible plugs in the crown sheet did not fuse. They were later tested, one functioning at 586 degrees and the other at 565 degrees.

### Defective Bracing

Defective bracing is seldom found in a boiler, but at least one case of such a failure caused a very serious collapse. Twelve crown bar braces in this particular boiler had seven pins missing, four pins broken and one entire brace broken. Scale was discovered in the crow-foot holes where the pins should have been, showing that they had been missing for some time. Naturally the crown sheet collapsed. The crown bars were found to be still attached to the sheet.

In going back to some of the earlier explosions coming to the attention of the Bureau, is one that happened in 1912, due to broken staybolts. Approximately 183 bolts were found which had been broken prior to the accident and 32 more either wholly or partially broken. Nine out of twenty crown bar braces were found to have been defective before the explosion. The locomotive happened to be operated by a logging concern in Louisiana and was not subject to any other inspection law than the insurance company's. Only nine staybolts were found still attached to the throat sheet, when the remains of the barrel were examined. It is very probable that these were the only good staybolts in the whole sheet.

Another instance of grooving and pitting along the line of cross braces on the right side sheet of a locomotive boiler caused a serious disaster in which two men were killed. These cross braces were of the crown bar type.

### Explosion of Reservoirs

Main reservoirs are subject to explosions as well as boilers and no doubt the association will be interested in hearing of instances in which this part of the equipment gave way. At the time when the head of one particular modern-type, reservoir was welded in place the metal was slightly burned after it had been crimped. This head was blown out with very serious results.

Another main reservoir that exploded killing one man had wasted away close to the longitudinal seam. A few hammer blows were sufficient to rupture the sheet and disclose the fact that it was only 1/32-inch thick. The particular locomotive on which this was installed had received class-3 repairs only six months before the accident. The law requires that main reservoirs shall be subjected to a hydrostatic test at least once each year. This accident illustrates why if we are held responsible for the inspection of the main reservoir we should insist on its being removed from the locomotive and put down on the floor, because if it is allowed to remain on the running board during the test it is impossible to examine the entire surface. The law is not satisfied by any means by rapping the tank two or three times with a hammer. As a matter of fact the condition of the reservoir in this example might have been discovered sixty days previous to the accident, if it had been loosened up and turned.

Still another reservoir tank exploded from the same cause of the sheets wasting away to the thinness of paper. In this instance the reservoir had been tested about nine months previous. Corrosion is rapid sometimes, but it is a question in my mind whether this particular reservoir would eat away from 5/16 or ¼ inch to practically nothing in that length of time.

### Arch Tube Accidents

Our records indicate that since the establishment of the Bureau 87 accidents, resulting in the death of six persons and the serious injury of 184 others, have been due to the failure of arch tubes which forcibly illustrates the necessity of proper inspection and maintenance of such parts. There is only one thing to do if you intend to operate arch tubes and that is to bend the tube so that both ends will enter the front and the back sheets at right angles. After they are installed there should be enough stock left so that the tube can be properly beaded. After that, the tube must be kept clean.

One very good example of the failure of a superheater tube in a locomotive that had just received repairs will demonstrate the necessity of properly maintaining such parts. A blowing leak had reduced the portion which failed to practically nothing. When the small leak had been repaired by building up the metal with welding material another part of the tube adjacent to it was just about as thin. It required only a very short time for the wasted metal to let go causing very serious injuries to the engineer.

### Defective Water Glass Cocks

It is absolutely essential that the water be allowed to circulate freely in the water glass tube. One low water case coming to the notice of the Bureau was caused by a rubber gasket at the end of the water glass tube which had been forced off and under the end of the tube, where the heat shriveled it up and where it prevented the water from circulating freely.

Scale will also close up the water glass cock if care is not taken to keep it clean. Water gage cocks should be cleaned out to the full diameter of the opening but, in spite of the fact that the necessity of this is very well understood, careless shopmen oftentimes simply work a piece of wire through the opening and enlarge it to about a quarter of an inch on one end and a sixty-fourth at the other.

### Washout Plugs

Grease and graphite have a habit of forming a shoulder at the end of the threads on a washout plug and if by chance a plug should be put in cross-threaded and jammed against the shoulder of graphite, the same result may be arrived at as happened in a similar instance in which the boiler washer went to the foreman and asked him to blow the boiler off so that he could tighten a leaking plug. The foreman refused to do this but took a wrench and started to tighten the plug himself. The boiler was carrying about 40 pounds pressure at the time and when the plug let go the foreman was very badly injured. The boiler washer realized the danger of trying to tighten a washout plug that might be cross-threaded or have some of the threads corroded, while the foreman was willing to take a chance and so reaped the reward of carelessness. Washout plugs should be kept clean and the threads sharp at all times. The graphite should be cleaned off whenever a shoulder forms.

### Welded Seams

Low water in combination with welded seams has caused serious disasters. In repairing the running seam on a certain locomotive boiler it was cut through the line of rivet holes and the plates made tight and filled in by welding. When the seam failed a portion of the crown sheet folded back, while part of the wrapper sheet folded on itself. Little damage was done to the crown sheet by overheating, so it is quite certain that the force of the explosion was increased by the weakness of the seam.

A number of crown sheet failures have occurred with practically new locomotives in which the combustion chambers and crown sheets have been attached by the autogenous welding process. In the illustration of one such accident very little cupping was apparent between the bolts showing that the sheet was not very hot when it let go.

It should be understood that all riveted seams do not hold in cases of low water for many of them fail, but from records in the Bureau which are made by absolutely disinterested individuals, about 80 percent of the crown sheets that have been welded have failed when the sheet was unduly stressed as happens in a case of low water.

Many other instances of the failure of welded seams were given. Most of these have already been illustrated and described in the report of the chief inspector of the Bureau of Locomotive Inspection appearing in the February issue of THE BOILER MAKER.

RELATIVE ACCURACY OF WATER GLASS AND GAGE COCK

It occurred to me eight years ago when I started investigating low water cases with the Federal Government that neglect of duty was not necessarily the cause of such accidents. This fact was demonstrated to my satisfaction when an engineer who had been for thirty-five years on the road without the scratch of a pen against him on his record suddenly, from some cause, allowed the water to get low in his boiler. The crown sheet was torn out and both he and his fireman were killed.

This and similar cases have made me believe that there is some fundamental device on a locomotive boiler that does not always function properly and I have been led to believe that the water gage devices may be classed under this head.

All of the inspectors have been of the same opinion and have been investigating the matter for years, slowly of course, for it is a big question and a radical one. The matter came to a head some time ago, however, and we had road tests made comparing the gage cocks and water glasses in determining the absolute water level. From a certain installation of tube gage cocks in the back head and the water column in its proper place with a connection to the wrapper sheet made in the knuckle, we were able to obtain a direct comparison of the two devices. The locomotive on which the tests were made carried 240 pounds pressure. While working steam the column was found to be full at all times. Testing the level in the glass at various positions we found that at certain points the level was accurate, but when shoved forward slightly the glass would fill up and stay full until the general level of water in the boiler was dropped. It was concluded that a roll of water was raised up four of the water legs and, when the locomotive was working very hard, the roll of water went clear up to the wrapper sheet. This conclusion sounded rather impossible, but it could be proved theoretically with an arrangement which will be illustrated in a later issue of THE BOILER MAKER, as it is not available for publication at this time.

It is sufficient to say that the tests conducted prove conclusively that the theory of this roll of water raised at the back flue sheet is correct and that, while the gage cock may indicate a level 4 inches to 8 inches above the water glass, the latter really indicates the true level.

Within a short time the bureau will issue instructions on the proper installation of gage cocks and water glasses in relation to each other and to the boiler in order to overcome the danger from former inaccuracies. No doubt many of the low water failures that have occurred during the past few years have been due to no other cause than the assumption by an engineer that he was carrying sufficient water in his boiler as indicated by the gage cocks while actually he may have been down to the danger level.

# Discussion of Papers Presented at the Master Boiler Makers' Association Convention

At the opening of the Thursday session of the Master Boiler Makers' Association convention the subject of firebox welding was brought up for discussion. No formal report had been prepared so the subject was opened immediately to the floor.

## Electric and Oxy-Acetylene Welding of Firebox Sheets and the Use of Welding in Locomotive Repair Work

Professor Alfred S. Kinsey, of the Stevens Institute of Technology: It was my good fortune to attend the meeting of the American Society of Mechanical Engineers at St. Louis recently. You know that that Society has a boiler code committee. It is that committee which controls the rules and regulations for the repair, and also the manufacture, of boilers in the different states of the country. That is, the state boiler inspection boards usually adopt the rules of this boiler code committee.

Now the boiler code committee have been considering for some time the welding of boilers. At the St. Louis meeting they were petitioned by a large boiler manufacturing concern for the privilege of welding heating boilers, not to sustain a greater pressure than 15 pounds—in other words, do away with the riveting and make the whole boiler by welding. This matter is before the committee now, and while I cannot speak for it, the matter is receiving very favorable consideration for lower pressures.

Now you also know very likely of the American Welding Society. The American Welding Society, realizing that its interests (and they are yours if you are interested in welding at all) and the interests of the boiler code committee of the American Society of Mechanical Engineers were the same in this matter, appointed a committee known as the boiler code conference committee, of which committee I have the honor to be chairman, to work in conjunction with a welding committee appointed by the boiler code committee of the American Society of Mechanical Engineers.

These committees have been in deliberation and have carefully considered some of these questions that interest you.

The boiler code committee has worked very slowly and carefully. They do not intend to make any rules to be unfair to any organization, or any company, or to any process. They are satisfied that welding has its good qualifications. They believe this so firmly that they have given, and encouraged the Hartford Steam Boiler Inspection and Insurance Company and the Travellers' Insurance Company to give, a rating to the old forge weld. Before we had any autogenous welding, forge welds were being made, some by machinery, but a great deal of the work by the sledge and the small hammer.

Now the old forge weld has been given a rating of 52 percent. This means that a vessel may be loaded up to 52 percent of the strength of the metal. Is there anybody that can tell me the difference between a forge weld and an autogenous weld—how much may you load an autogenous weld? Is it 60 percent, 75 percent, or what? As a matter of fact there is no rating at all It is not even one percent. You can't get insurance on it.

Does that say that autogenous welding is no good?

Decidedly not. I have studied this matter from the start, back 15 years ago—not one kind of welding only, but four: the forge weld, the endothermic weld, the autogenous weld and the gas weld—and in our shops our men must not only know the theories of all of them but they must know how to make good welds, to the extent that you might expect a technical graduate to do that kind of work.

If autogenous welding has no rating, then you and I are to blame for that. I am an advocate of welding, I want to tell you, if it is done properly; and it is high time that societies like yours should put themselves on record as to what they believe is safe in autogenous welding.

There are only two ways of making a weld, in principle. One is by heating the metal up to the plastic state and forcing one mass into the other. You can do it with hammer blows, or by rolling. The other method is by melting the two ends and running the two masses together.

Now when the first came into existence there was no welding rod used. It was just simply the same material—the word autogenous meaning self-generating, or self-constituting.

Now we really ought to drop the word, because a weld is not made without introducing a welding rod, and that brings in some other metal and so spoils the meaning of the word autogenous. Fusion welding fits the case better.

Now there are some people who believe, and I think most of you gentlemen believe, that fusion welding can be done just as well as the old forge method—that is, as plastic welding—but I have met some who say no, you can never make a fusion weld as strong as a forged weld.

If the forged weld has a rating, let us try to get a standard of rating for fusion welding, so that it may at least be recognized and accepted up to a certain point.

I have gone over all the detailed data of A. G. Pack's (Chief of Bureau of Locomotive Inspection of the Interstate Commerce Commission) report that upset so many people, and I think we are likely to do that gentleman an injustice if we are not careful. He is not prejudiced against welding, though some think that he is. I have found him very considerate and very generous, not only in showing me the original data from which he drew his conclusions, but in giving me a lot of other facts.

If any of you gentlemen are responsible for any of the welds that Mr. Pack has, I would suggest that you give up your positions. They are the worst collection of welds I ever looked at. And if you have welders who are doing that kind of work, you ought to get rid of them, or at least put them in a school where they can learn welding. The conclusions drawn in the report are based on that kind of welding.

Now I do not think there is much of that welding going on at the present time. I know of at least one railroad system that is operating a welding school for its welders, and in a little while they will have established a rule that not a man will be allowed to handle a torch until he has gone through this school, passed examinations and satisfied them that he really is a welder.

It has been my privilege to go around the country a great deal and see what kind of welding is going on, and I have seen some remarkably fine work.

What are you going to do about the subject of firebox welding? I believe if you put the work in the hands of men who really know how to weld, you can make just as good a weld as any riveted joint. That is my candid judgment as an engineer after investigating this thing carefully.

### Theory of Cohesion in Metals

Will you imagine with me, please, that in all of our engineering metals as steel, iron, cast-iron, copper, brass and so on, the grains are all flat-sided, with at least four sides—some have as many as eight sides. These flat sides touch one against the other, which is according to the law, which in physics we call cohesion.

In the case of one metal we have, I can destroy the law of cohesion by bearing on it with my finger. This metal is mercury, the liquid metal. Chrome steel, on the other hand, requires an enormous pressure to destroy the cohesion. I can take a torch, however, and reduce that law of cohesion until it is almost gone. At this point I must stop, for if I go on the law of cohesion will be entirely destroyed and the air will get in between the grains.

The air that we breathe contains both oxygen and hydrogen, and both of these are bad for the weld. When it gets in, it forms a separation film that almost completely destroys the law of cohesion. Then we say the weld is oxidized. If you want a good weld, do not heat it to this point and so keep out the oxide film. When you have heated metal to the molten state and allowed it to cool, a casting results. If you allow the metal to get cold after you have made your weld, heat it again and permit it to cool gradually, so the cohesion between grains will be stronger and the grains will come closer and closer together. There are two rules you should follow after welding: refine the grain so it will come back to its original size and keep its original strength, and be sure to anneal.

Now the fact of the matter is that the American Society of Mechanical Engineers will very likely establish a rule that will compel you to anneal your welds and steel after this, so it may be well to prepare yourselves for something of that kind.

Some people take the stand that an autogenously welded joint is weak because it is in the cast condition when finished, but if operations are carried out by competent welders and the welds are annealed, there is little doubt of the strength of the work. The American Society of Mechanical Engineers is considering very seriously this proposition: shall we license the welder, make him pass an examination and show that he is capable of doing good work? Or shall we license the man who employs him? Something of that kind will probably come up, so you ought to think about it.

C. P. Whalen, of the N. Y. C. R. R.: I would like to ask the professor one question. Which is the more efficient in a firebox and will give us the best service, the electric or the acetylene process?

Professor Kinsey: I am a professor at an engineering college. I am supposed to keep an unbiased mind on all of these subjects. It is not quite proper for me to say whether you ought to use the electric arc or the gas flame.

There is a great deal of money being spent by the big companies that are manufacturing devices for these two processes. They have their engineers, who will be glad to come to your plant and show you the best that can be done by their process. If I were in your place I would ask the electric arc apparatus manufacturers to send their best expert to show the best job that they think can be done in the welding of fireboxes; then have the gas people do the same thing, and draw your own conclusions.

Or, better still, if you do not want to stop there, go on and have those welds cut out and sent to some independent laboratory where they will give you an unbiased report.

Carl A. Harper, Cincinnati: May I ask Professor Kinsey the best method of making an inspection of welds?

Professor Kinsey: A committee from the different societies is now very busy trying to determine a practical way of testing welds. It is a most difficult thing. First of all, let me say it is almost impossible to know what is inside a weld. We have tried all sorts of things, the vibration test, the tension test, which is the essential test; if you have any kind of a vessel that has a breathing action, as in tanks, the ductility or bending qualities must be considered. Your scleroscope for testing the hardness will tell very well whether the metal will stand machining. We are trying to think of other ways now that would be practical in shop work.

You gentlemen who have been welding fireboxes for many years, if you get a chance, rip apart one of your old welds to see what it is like inside. In fact, if you have many of these welds, whether made by electricity or gas, I will stand the expense of transportation to your plant and suggest to you ways of cutting into the weld, and if it is good work we all want to know it.

### Safe-Ending of Boiler Tubes

There has been an impression abroad that the boiler code committee has taken a stand against the safe-ending of boiler tubes, so we have looked over the records to find if any ruling has ever been made against the welding of firetubes. We discovered that the association is on record against the safe-ending of boiler tubes for watertube boilers, but not against firetube welding. There is no rule against this practice so far as the boiler code of the American Society of Mechanical Engineers is concerned.

Charles Hempel, of the Union Pacific R. R.: There has been criticism relative to autogenous welding, both at this convention and at the last convention, and no doubt that criticism is just. I do not believe that it was offered with a view of condemning the autogenous process, but more for the moral effect that it would have, and I am satisfied that it has served its purpose. The question has been looked into very thoroughly since the criticism has been given. It has spurred us to a greater efficiency. The question of welding the safe-ends of flues has been agitated considerably by a number of large railroads.

First of all butt welding flues was tried. Butt welds will break from 25,000 to 29,000 pounds per square inch. Any of them could be considered absolutely safe for service. Inasmuch, however, as there was considerable criticism offered to the butt welding of flues, we naturally got busy to overcome that criticism.

The lap weld was then taken up, and I have yet to see the first lap-welded failure of a flue.

We have with the butt and lap together, 600,000 electrically welded flues. I do not mean to say electric welded on the bead, but electric safe-ended. In that number we have had two service failures, as against about 6 to the thousand of the old hand method. Every flue that we have pulled has given us more than 100 percent.

I do believe that if we will get down to business and get after this thing, that we won't have any criticism in the future.

I must frankly say that if the work continues as it has, and the government can show such defects as were mentioned in the annual report of the Bureau of Locomotive Inspection, we will have quite a job in having acetylene or electric welding officially recognized.

(At this point a paper on the electric arc process was read by Mr. Hempel.)

George Austin, Topeka, Kan., of the Santa Fe R. R.: The preceding speakers have practically covered all that I could say in the way of practical information or suggestions, except perhaps to describe briefly the Santa Fe methods as to determining the efficiency of the welders.

We realize that it is impossible to determine the efficiency of the weld as to its cohesion. It is not difficult at all where you have testing machines to pull the welds. In Santa Fe shops each month each welder makes a sample for test and sends it to the laboratory with his name stamped on it. If that test does not come above a certain percent of efficiency that man is called in and must explain why he sent in the poor weld.

This system is the nearest we have come to testing welders. I have no hesitation in making this statement, that according to our experience reliable welders can and do make welds in fireboxes or in other parts of boilers which are as strong as any single riveted seam, and a great deal stronger in most cases.

In reference to forge welded seams, I am going to ask Mr. Service, our welding supervisor, who keeps closer track of that than I do, to give you some figures as to the efficiency of our welding tests. And not only of recent welds, but of welds which have had perhaps four or more years of service—some of them not quite so much—taken out on account of sheet renewals or firebox renewals.

Our experience now leads us to believe that the autogenous weld can be compared favorably with forge welds.

We reinforce 20 percent. Now understand about these tests, we do not plane the metal down to a smooth surface, for it is the weld we are testing. If we find it necessary to reinforce a weld 20 percent to insure that we have an efficient weld, we add metal.

H. H. Service, Topeka, Kan., Supervisor of Welding, Santa Fe R. R.: It has been our practice on the Santa Fe to make a thorough investigation of all welds made by the welders. It is the practice to have them make at least one plate a month and send it in to our headquarters, where a disinterested party carries out the tensile tests. He does not know the man or where the work was done.

We also take the fireboxes that we have set out to be renewed and we cut out the plates and test them. We have a record of who welded a patch, where it was welded, and when. We have some that have been in the service 4½ years, and out of 29 specimens of these, 7 of them ran 71 percent. Out of the 29 there were 9 straightened before we discovered that some of them had deteriorated somewhat. Where a patch was applied a small check an eighth of an inch deep had penetrated into the metal.

I go from point to point along the line to watch the work. I ask the men questions on metallurgy, how the machine is working, question them on various points about acetylene, as well as electric welding, to see if they understand it. If they do not, I try to explain to the best of my ability. By so doing we help the welder along.

If the welder has any questions he did not think of while I was there, he sometimes writes me. We try to get them interested, so they will learn the game.

George G. Fisher, Chicago, of the Belt R. R. of Chicago: I have a specimen of a superheater tube welded by acetylene. This specimen was put under a hydraulic press with a 5½-inch ram and smashed down under 45 tons pressure, and there is not even a fracture in it.

Now after all the discussion in this convention a year ago about the different kinds of welding and the stand some of our Interstate Commerce Inspectors took against it, I personally was not skeptical of flue welding, because I had been using it. In laboratory tests we have had excellent results with our welds.

Charles Hempel: The professor said he would be very willing to give his own personal opinion of the value of a weld. I will ask him to give his opinion on the electric weld. He said the acetylene was good, and I know it is good. I would like him to just give you his personal opinion of the electric weld.

Professor Kinsey: The two processes are entirely different, one a plastic weld, the other an autogenous weld. The former is made by electric compression, not by electric arc, which would be fusion welding. The latter is made by the gas flame, which is fusion welding, so it is not fair to compare the two for strength. The electric ought to be the weaker because it is the plastic weld.

We know the great value of compression electric welding also. For example, the chain lengths, that used to be hand forged, are now made by the automatic welding machines by the plastic method of welding.

Mr. Hempel spoke of depreciation of 20 percent in the strength of a weld after a locomotive had been a day or two in service. That is due almost entirely to the fatiguing of metals. Can you imagine a piece of metal getting tired? It does not actually do so, but it does go through a state of losing its strength. The metal, because of the law of cohesion, might have a strength of 55,000 pounds per square inch at the start, but if oxidized the strength of the metal may be reduced to something like 45,000 or 50,000 pounds per square inch. All you have to do is send that joint out and let it get some vibrations. Does it encourage the flat surfaces of the grains to come together? Not at all. It discourages them.

Now the only way is to throw such a piece of oxidized metal in the furnace and burn out the foreign element. When the oxygen is present it is a case of poor welding. The vibration should strengthen the cohesion rather than decrease the strength, if you will leave the area in between the surfaces pure. There is an absolutely good engineering reason for this.

The President: Gentlemen, we have heard one side of the story. Now we want to hear the other. We claim that we do not know by the general appearance of it whether it is or whether it is not welded, and I know there are quite a number of other people in here who have had the same experience.

George W. Bennett, Albany, N. Y., District Inspector, Interstate Commerce Commission: I want to say that we are not against welding. Our interests are solely in protecting human life, and stopping snuffing them out day after day throughout the year.

Now any railroads that do any amount of welding are not making all good welds, and it is the extreme uncertainty of knowing when you have a good weld or a bad weld that we are fighting.

Now to show you that welds are failing, here are just a few notes that I took at one point from a railroad company's own work report. I will give the dates; it will show that the cases are recent:

March 2, two welds opened up in right side sheets, 12 inches long.

March 4, two welds opened up about 11 inches long, near center.

March 21, weld opened up about 9 inches long in throat sheet.

March 22, weld opened up 12 inches long, about 4 inches from throat sheet flange.

March 27, weld opened up in right side sheet 8 inches long; two welds in right back side sheets, 12 inches long.

March 28, weld opened up in sheet flange.

March 30, weld opened up 13 inches long.

And going further back in some of these locomotives I find that three or four weeks before that they have been sent to the repair shop to be welded.

After the sheets are in the boiler there is no way of testing the welds. Now I am only taking this side of it to explain to you that welds are failing, and there seems to be room for improvement along the lines of welding.

H. H. Service, Topeka, Kan., of the Santa Fe R. R.: We will have to agree with Mr. Bennett on some things. I have a staybolt diagram here. It shows a crack here on the right side sheet in the original plate, and it extends 5 bolts high. One of the test specimens with that crack had been welded. No allowance was made for expansion and contraction. We gave it a rating of 80.01 percent after it had been in service for a year.

Albert Stigmeier, Baltimore, Md., of the B. & O. R. R.: I think we should find out what is the cause of electrically welded flues cracking in from the butts. Is it due to electric welding, or is it due to the work being improperly done? If it cannot be settled I would like to have a committee appointed on this question, because it is coming up on every railroad, and it certainly is causing lots of trouble.

W. H. Simons, St. Paul, of the Chicago G. W. R. R.: With regard to this cracking of the electrically applied flues, I find we have considerable trouble, but it is confined to the superheater flues. The small flues do not crack. I wonder if it is on account of the copper being under the flue and causing some kind of foreign substance to form that will crack those welds.
The small flues never crack. The big flues crack within 16 to 18 months after they have been welded.

Lewis Nicholas, Indianapolis, Ind., District Inspector, Interstate Commerce Commission: I will say that small ones crack as well as superheater. We have had them in only six months and they crack.

Charles P. Whalen, of the N. Y. C. R. R.: When it comes to different methods of welding, especially electric and acetylene, either can be done proficiently provided the operator is good.

I claim that we can successfully weld flues, safe-end them, either way. In the past twelve months I have overhauled something like 35 to 40 superheater engines, and there is not a superheater flue in those engines but what has an acetylene welded safe-end on it, and I have not had a failure or complaint from any one of the engines since they have gone back into service.

The question has been asked, why do superheater flues crack that are electrically welded. I have taken the pains in our hard water district to try to ascertain why they crack. There are two causes for it. If you are in a hard water territory and you have an electrically welded flue and it shows a crack going through the flue hole, and that flue has never been prossered or worked in the past three or four months, you will see that there is a scale formation where the copper pin goes through the flue sheet. The flue not being worked allows no water to circulate around the joint. The fire becomes too strong and causes the metal to begin to crack. Scale is formed probably 1/8 inch thick, and in some cases if it has run very long it will be heavier. Having no water near the joint to cool it, the flue naturally cracks.

The same with the side cracks. Cracks form under the arch, where combustion takes place. In hard water districts a formation of scale will be found in the crotch. As a result, the engine's heat will cause the heads of your staybolts to loosen up, which will start the formation of a pin crack.

It works the same way with a superheater flue. It would, to my mind, be better if a flue were prossered, which operation cracks the scale and allows the water to get near the joint.

While I believe that there may be some cases in which the two methods of welding are not absolutely perfect, I do think that most welding troubles can be traced to an incompetent welder.

C. E. Elkins, Little Rock, Ark., of the M. P. R. R.: I want to say that flues can be electrically welded in the sheet. I do not know anything about safe-ending by the electric process, but they can be welded in the sheet so that they will hold. Superheater flues on our engines do not leak, and it is up to foremen to see that the work is properly prepared and properly applied. You cannot weld a flue if the copper is showing. You have got to have the flues properly pitted down. When you have that done and the work is clean, the flues will hold.

James P. Smith, Aberdeen, S. D., of the Milwaukee R. R.: We get engines right out of our back shops that have welded seams, the fire door welded to the back head, and I want to tell you gentlemen that they leak, and sometimes they do not make very many trips either until they leak. Now we all know that the fire door with the flange welded to the back head is one of the easiest welds there is to make, and I ask if you ever saw one leak that was put on with studs? Well now, men, they leak when they are welded. I have had them crack half way around, and I do not know whether it is an incompetent welder that is the cause of it or not.

Possibly welding is all right in a good water district. What I want to know, is it successful in bad water? We have water that runs about 67 incrustation grains to the gallon.

D. A. Lucas, Milwaukee, Wis., of the Prime Mfg. Co.: In my experience I have turned out side sheets in a welded condition, where possibly 10 or 12 inches would open up in the seam during the performance of the engine from one shopping to another. In other cases I have turned them out where it was impossible to detect any defect in the sheet during the performance from shopping to shopping.

I would like to know if there was ever a comparison in the failures in the firebox that we turn out at the present time with the original sheets.

Albert W. Novak, Minneapolis, of the Milwaukee R. R.: The locomotive that Mr. Sinclair had reference to at Aberdeen is the 2011. I happened to be at Aberdeen at the time, and I will admit that door hole broke half way around. The ends were just broken—in fact, against the back head—allowing so much mud and scale and incrusting heads to form in there that the door would not keep cool.

It was not reinforced, and I believe that is the only door hole I have run across in the last two years that opened up in that way. Now that was welded by a man who had only about three weeks' experience.

George Austin, Topeka, Kan., Santa Fe R. R.: We weld flues in a certain district where previous to welding the flues to the back sheet 9,000 miles between the shoppings was not uncommon, while 15,000 miles was uncommonly high. Now by welding the flues in the back sheet that mileage has been easily doubled—in some cases going as high as 40,000.

We are trying an expander for knocking the dirt away which causes this leakage. We take the standard expander and grind it out so that it has no bearings except in the prosser marks. It is our opinion so far that we have increased the mileage between the shoppings by using it. I believe it is the best thing we know of to relieve this scale which is causing trouble.

Thomas F. Powers, Oak Park, Ill., of the C. & N. W. R. R.: On the Northwestern we started to weld flues about eight years ago, and after trying the process for two or three years we made up our minds that it was not a success.

I will say you can weld flues in good water districts and make them hold, but you cannot in bad water.

T. P. Madden, St. Louis, Mo., of the M. P. R. R.: I happen to be in a position to check up this matter of welding on 7,000 miles of railroads. I want to say in self-defense that we started in welding flues previous to welding superheater flues. We could not get 90 days in bad districts when we started in welding flues. We were not successful at first. We have men now in some of our principal shops who can weld a set of flues, large and small, that will run 18 months.

We do not have a lot of cracks in our flues, for the simple reason that the men are instructed to use the torch to loosen the scale on the face of the sheet. If we do not use a torch to remove this scale we cannot keep our welded flues tight.

We do have trouble, but the process is not the cause of it—it is because the welder has not properly done his work.

Now our foremen have taken great pains in the welding of flues, and I hold that where the arc is used it can be done successfully providing you keep the sheets clean. If you are in a bad water district, and you do not keep your crown sheets clean, your radials will start leaking on you, as well as the welded flues.

F. J. Jenkins, Dallas, Tex., of the Tex. & Pac. R. R.: I guess we have as many electric welded flues as any railroad that has only 400 engines, and there is no worse water anywhere in the world than there is in western Texas. We are getting 60,000 miles out of an engine with welded flues that we only got 27,000 out of before.

It depends altogether on the way the flue is prepared for welding and the man that does the job.

John B. Feld, Marshalltown, Ia., Minneapolis & St. Louis: We have not got a riveted running seam in our engines. The ones we had we have cut out and welded them up.

It is true that we have had failures in a few cases, especially in the smaller locomotives; in all of our larger engines I have never known a time when I had to go back and weld the seams.

Frederick J. Howe, Aurora, Ill., of the Burlington R. R.: We have been following up the welding game for years. There is only one thing to it as far as I can see. That is if you have a good man handling the torch you will obtain good results. Out of all that have failed yet, I have not found one yet that was properly welded. The material has not been properly fused together.

James W. Kelly, Oak Park, Ill., Boiler Tube Expert, National Tube Co.: Mr. Walla suggested a moment ago that you appoint a committee to investigate the welding of flues in good and bad water districts. I move that a committee be appointed to visit the principal shops in the country and submit a complete report on welding at the convention next year.

This motion was held over until the business session Friday.

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The United States Civil Service Commission announces a series of open competitive examinations for local and assistant inspectors of boilers to be held in the principal cities throughout the country August 4-5, September 22-23, November 3-4. All who are qualified to take the examinations and desire detailed information in regard to the matter, may obtain it from the United States Civil Service Commission, Washington, D. C.

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The Thomas Spacing Machine Company, Pittsburgh, Pa., has purchased the patents and business of the Hill Drill Company and the Hill multiple drill will be manufactured at the company's plant in Pittsburgh.

In line with its policy to meet the ever-increasing demands for Airco oxygen and acetylene by constantly augmenting the facilities for the production of these products, the Air Reduction Sales Company has just completed the construction of a new acetylene plant at 560 Broadway, Gloucester, N. J.

# Reports Accepted by the American Boiler Manufacturers' Association

Among the reports given at the American Boiler Manufacturers' Association convention was that of the Committee which had been acting with the Stoker Manufacturers' Association formulating a series of boiler definitions which would apply to both industries. Definitions in some instances may seem rather broad but, as they are intended to cover the whole range of boilers, it was decided by the convention that their use was quite acceptable.

### Definition of Boiler Terms

At the June convention of the American Boiler Manufacturers' Association a report on the Definition of Boiler Terms in which the boiler manufacturers and stoker manufacturers are interested was given by E. C. Fisher, of the Wickes Boiler Company, Saginaw, Mich. A broad interpretation of the meaning of various terms has been adopted, for in most cases they apply more particularly to the usage of the stoker manufacturers.

A BOILER is a metal vessel capable of withstanding pressure and serving the purpose of transmitting heat, usually produced by the combustion of fuel, to a liquid contained in the vessel.

In power plant practice, boilers are usually divided into two classes, as follows:

(a) A FIRETUBE BOILER is so constructed that the products of combustion pass within tubes or their equivalent, these being surrounded by the liquid to be heated.

(b) A WATERTUBE BOILER is so constructed that the liquid to be heated is contained within tubes or their equivalent, these being surrounded by the products of combustion.

A BOILER BAFFLE is a plate or partition placed in such relation to the tubes or their equivalent of a boiler as to cause the products of combustion to move in predetermined paths.

A FURNACE is a partially enclosed space in which heat is produced by fuel combustion.

A FURNACE ARCH is made of refractory materials forming the roof of a furnace or so located within a furnace as to aid combustion.

A GRATE is a metallic structure designed to support solid fuel and so made that air for combustion can pass through it to the fuel.

A TUYERE is a nozzle constructed to direct air under pressure into a fuel bed.

A TUYERE BLOCK is a special form of grate containing a tuyère or tuyères.

A RETORT is a receptacle so constructed that solid fuel may pass through it and in which partial distillation of the fuel takes place.

A DEAD PLATE is an imperforate plate which supports fuel.

A DUMP PLATE is a movable plate, grate or combination of same for intermittently discharging refuse from a furnace.

A MECHANICAL STOKER is a device consisting of a mechanically operated mechanism for feeding solid fuel into a furnace combined with means for supporting the fuel and supplying air to same during combustion and for directing the deposit of refuse in a location from which it can be readily removed from the furnace.

AN OVERFEED STOKER is a mechanical stoker where fuel is fed onto grates at one end of same. Overfeed stokers are usually divided into three classes, as follows:

(a) A FRONT-FEED INCLINED-GRATE STOKER is an over-feed stoker where fuel is fed from the front onto grates inclined downward toward the rear of the stoker.

(b) A DOUBLE-INCLINED SIDE-FEED STOKER is an overfeed stoker where fuel is fed from both sides onto grates inclined downward toward the center line of the stoker.

(c) A CHAIN OR TRAVELING GRATE STOKER is an overfeed stoker where fuel is fed to the stoker from the front onto a moving grate forming an endless chain.

AN UNDER-FEED STOKER is a mechanical stoker having one or more retorts from which the fuel is fed from below the surface of the fuel bed.

DRAFT is a difference in pressure due to a difference in gas density, which tends to cause a flow of gas from the region of higher pressure to that of lower pressure.

NATURAL DRAFT is a draft produced by a chimney.

INDUCED DRAFT is a draft produced by mechanical means located at some point between a furnace and the point where the products of combustion are discharged.

FORCED DRAFT is a draft produced by mechanical means whereby pressure above atmospheric pressure is maintained under a grate.

Following this, A. G. Pratt of the Babcock & Wilcox Company, read a report outlining the future policy of the association which was accepted by the convention.

### Future Activities of the Association

At the meeting of this association on January 8, 1920, your executive committee was instructed to consider and make recommendations as to the future activities of the association. Your committee has given this matter a great deal of thought with the feeling that, although the association has made great progress during the past few years, the progress already made will be lost if the association does not continue to go forward. To be successful the association must become increasingly useful, not only to its members but to the community at large.

The programme herein laid down does not in any sense complete the work which remains to be done, but will, if carried out, enable the association and the boiler industry to more nearly take the position in American industry to which it is entitled and which it should occupy.

#### SUGGESTIONS OF THE COMMITTEE

It is essential that a method of procedure be established for the study of any activity which the association is to consider or to obtain such data as may be ordered by the association; it is, therefore, recommended that committees be appointed to follow up such activities as it may be decided to pursue.

It is recommended that an effort be made to enlarge the membership by securing new members of such character as will add to the strength of the association.

It is recommended that the association as a whole and the members of the association individually do everything possible toward the better design and safer construction of steam boilers, and as the boiler code of the American Society of Mechanical Engineers is recognized as the best set of rules on this subject developed to date, that the association urge the adoption of such rules by states and municipalities and recommend that all boilers built by its members and others be constructed in accordance with the code, unless local rules or laws differ from it. Approval, if voted, should include provision for the appointment of an A. S. M. E. code committee. This committee, in addition to its duties as outlined above, should be the body which will work with the American Uniform Boiler Law Society and the National Board of Boiler and Pressure Vessel Inspectors.

It is recommended that the association co-operate with association in other industries, particularly in those industries which are related to the boiler industry, Stoker Manufacturers' Association, material manufacturers' associations, etc.

It is believed that the association should consider the study of cost accounting and that a cost accounting committee be appointed to study and report on the different phases of the subject, and that one of the duties of this committee shall be the guidance in cost accounting methods of any member company which shall apply to the committee for assistance and aid.

It is believed that the Association should consider the question of ethics in the industry. It is not believed that a satisfactory code of ethics can be laid down which will cover all possible cases, and the following substitute is, therefore, recommended. A committee of three is to be appointed, one of the members to be the president of the association. In the event of what is considered to be a breach of ethics occurs, the injured member is to bring the matter to the attention of the offending member; if the two members concerned fail to reach a satisfactory conclusion, the party who feels himself injured may bring the matter to the attention of the committee. The committee will study the case, grant a hearing to both parties of the controversy and report its findings to both parties and to the executive committee, and the executive committee will, if deemed advisable, report the complaint and findings to the association. It is believed that publicity of unethical acts will be all that is necessary to correct such situations.

It is recommended that the business practices of the members of the association be standardized as far as possible in the matters of terms of payment, guarantees, warranties, responsibilities assumed by the manufacturers, cancellations, etc., etc.,

It is recommended that the statistics of the industry be studied and that the members contribute such information as will enable a study to be made. It is recommended that for the present the members report monthly to the secretary of the association the total number of stationary or land boilers sold and the total horsepower represented. (A horsepower is to be figured as 10 square feet of boiler heating surface.) It is suggested that these reports be made in the following form:

| | *No.* | *Total Horsepower* |
|---|---|---|
| Watertube Boilers: | | |
| Tubular Boilers: | | |
| Horizontal—40 horsepower or over, 50 pounds and higher; | | |
| Locomotive—40 horsepower or over, 50 pounds and higher; | | |
| Vertical—42-inch shell, 50 pounds and higher. | | |

It is recommended that each member report to the secretary of the association the total number of boilers sold and total horsepower represented each year for the period 1912 to 1919, inclusive; the secretary is to summarize such returns and report the total figures for each year to each company which makes the report to him. These figures, if at all complete, will show the trend of the industry; whether boilers are being required in greater numbers, whether the proportion of either the watertube or tubular type is increasing; whether the trend is toward larger units, etc.

It is recommended that the association hold three meetings a year, namely, an annual meet in June, other meetings in October and February; that the annual meeting be planned to continue two or three days, as the programme may warrant, and to be held at such places as will permit of both business and social sessions; that the other meetings be one-day meetings for business sessions only; that the place of meeting be changed from time to time to equalize as nearly as possible the amount of traveling of the different members, and that the date and place of meetings be determined by the executive committee of the association.

It is recommended that the association become a member of the Chamber of Commerce of the United States of America. The primary objects of the Chamber are the promotion of co-operation between chambers of commerce and other commercial and manufacturers' associations, increasing their efficiency and extending their usefulness, and in advancing the common purpose of its members; uniformity and equity in business usages and laws, and proper consideration and concentration of opinion upon questions affecting the financial, civic and industrial interests of the country at large. The Chamber is doing good work and should be supported by every association and individual.

These recommendations were unanimously approved by the members of the association.

Among other lines of thought which would undoubtedly prove of interest and benefit to the association may be mentioned the following:

The possibility of export trade to be done by the members of the association;

The establishment of a traffic committee to study and advise members concerning traffic problems;

A study of the trend of the steam boiler industry from the viewpoint of the users of steam boilers;

A campaign of education of steam boiler users from the standpoint that too little attention is paid to the maintenance and operation of steam boilers;

A study of possible developments which might lead to a decreasing use of equipment such as is manufactured by members of this association;

Publicity which would call favorable attention to the association and its members.

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The J. H. Williams & Company, Brooklyn, N. Y., has announced that the drop-forging business and plants of The Whitman & Barnes Manufacturing Company, at Chicago, Ill., and St. Catharines, Ontario, Canada, have been combined with and, beginning July 3, will be operated by this company, whose organization will include the individuals heretofore identified with both businesses.

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The Chicago Pneumatic Tool Company, New York, announces the election of Allan E. Goodhue as vice-president, in charge of sales. Mr. Goodhue, since May 1, 1919, has been managing director of the company's English subsidiary, The Consolidated Pneumatic Tool Company, London, England; also director of European sales for the Chicago Pneumatic Tool Company.

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Whitfield P. Pressinger, New York, vice-president of the Chicago Pneumatic Tool Company, died June 10 as a result of complications following an operation. Mr. Pressinger was actively engaged in the pneumatic tool and allied machinery industry for many years. He was general manager of the Clayton Air Compressor Company for seven years and became widely known through numerous activities in the American Society of Mechanical Engineers and the Compressed Air Society. He was born in New York City in 1871.

# The Boiler Maker

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WE GUARANTEE that of this issue 5,200 copies were printed; that of these 5,200 copies, 4,333 were mailed to regular paid subscribers, 85 were provided for counter and news company sales, 133 were mailed to advertisers, 37 were mailed to employees and correspondents, and 612 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 37,900, an average of 5,414 copies a month.

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 the paper read at the American Boiler Manufacturers' Association convention, by S. F. Jeter, on "The Advisability of Closer Co-operation Between the Insurance Company and the Boiler Manufacturer," which is published in this issue of THE BOILER MAKER, some excellent suggestions are made—and undoubtedly material benefits might be derived from a closer relation of the two.

It is important for the reputation of a manufacturer that his products be kept in efficient working order throughout their period of usefulness, and the insurance company exists to see that this condition is maintained. Since the interests of the two are fundamentally the same, any steps taken to promote a working agreement between them will aid the industry as a whole.

One very important service that the insurance companies' inspectors can accomplish is to put the plant inspection of boilers into the hands of disinterested individuals who are not under the control of the manufacturer. The insurance inspector is able to assist in keeping the standards of a shop on a par with the best practice in other shops. The logical result of a high standard is the attempt by everyone connected with the construction to turn out work that will maintain this standard.

In assisting the manufacturer to meet the requirements of State boiler laws and safety regulations, as well as in checking up the design of a boiler before actual construction has been commenced, to make certain that all laws are complied with, the service of the insurance company is of importance to the manufacturer and also to the ultimate user of the boiler for whom the insurance company acts.

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The record of the boiler inspection service for the year 1919, maintained by the Hartford Steam Boiler Inspection & Insurance Company, contains data which should be of the greatest interest to those either constructing or operating boilers.

So far as the work of the designer and the builder are concerned, weaknesses that might endanger the ultimate safety of the boiler should be eliminated in the shop. The list of serious defects in this report includes cases of improper bracing and staybolting, as well as the use of defective plates, all of which should have been corrected in the construction. Other instances are cited in which fractured heads and defective fittings were the cause of serious trouble. Many times the shop inspection departments grow a trifle careless, and mistakes are allowed to escape unnoticed only to be found later when the boiler has been in service for some time.

It is a fact, however, that the great majority of defects discovered in the boilers inspected occurred in the course of their operation and were not inherent. And this fact brings us to the duty of the power plant or heating plant operator to keep his equipment clean at all times; for, by so doing, he is eliminating about 80 percent of all chance for the development of dangerous weaknesses. Sediment, loose scale and adhering scale will promote leakage around the tubes and at the seams, as well as increase the possibility of overheating and burning the furnace plates.

External corrosion has been responsible for the deterioration of many boilers, but this trouble in most instances is more or less unavoidable. Every means, however, should be taken to protect the boiler from the weather and from the corrosive action of gases and liquids present in industrial and chemical plants where boilers are used for power purposes or for heating.

Out of a total of 202,276 defects discovered in the 371,285 boilers inspected by the Hartford Company in 1919, 20,603 were found to be dangerous and led to the condemning of 1,042 boilers.

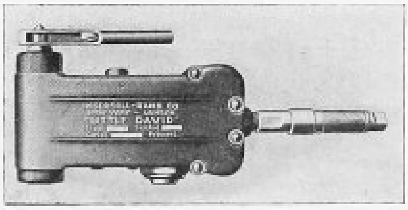
This number in itself of boilers totally unsafe is small, but some of the defects discovered in the units insured were serious and, if not found in time, would undoubtedly have increased the record of boiler disasters.

# Engineering Specialties for Boiler Making

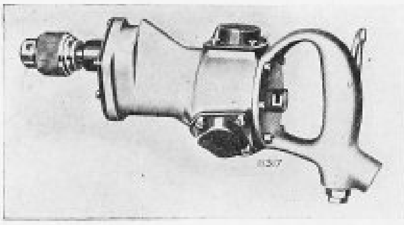
**New Tools, Machinery, Appliances and Supplies for the Boiler Shop and Improved Fittings for Boilers**

### New Sizes of Small Pneumatic Tools

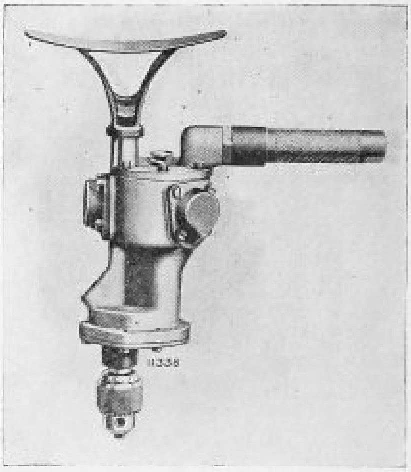
Several sizes of small portable pneumatic tools have recently been added to the line of "Little David" Pneumatic Tools manufactured by the Ingersoll-Rand Company, 11 Broadway, New York. The new tools include a small close quarter drill to be known as No. 8, a small high speed pneumatic grinder in two types, No. 601 and No. 602, and a lightweight drill furnished in two styles, No. 6 and No. 600.



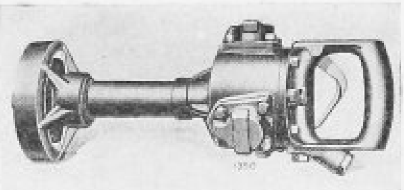
No. 8 Close-Quarter Drill



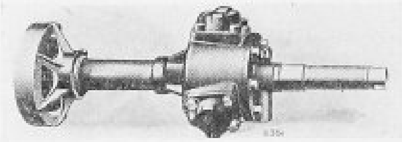
No. 6 Drill



No. 600 Drill



No. 601 Grinder



No. 602 Grinder

The No. 8 close quarter drill is as the name indicates—a machine for use where the ordinary machine is not suitable, as close to a wall or corner. This new machine has a fairly high speed, running at 250 revolutions per minute without load, but will handle drilling, reaming or tapping up to 1¼ inches diameter. The tool is throughout a special design for close quarter work and has several unique features. The spindle which turns the drill, reamer or tap is operated by three rocking levers connected directly to the pistons through connecting rods. The motor is of the three cylinder type with pistons acting at right angles to the levers. A very steady continuous movement of the spindle is obtained, as one ratchet pawl is always in contact with a tooth of the spindle.

The No. 601 and No. 602 grinders are lightweight, high-speed tools running with a free speed of 4,200 revolutions per minute and suitable for grinding, buffing or polishing work of a varied nature. Both machines have the same motor, but are equipped with different throttle and handle, the No. 601 having the closed type of inside trigger handle, while the No. 602 is fitted with the rolling type of throttle handle. A special feature of these tools is the three cylinder motor, which runs constantly in a bath of oil, insuring lubrication of all the parts. Lack of proper oiling has been one of the reasons for most grinder troubles in the past. The valve is made integral with the crankshaft, simplifying the design, and the piston and connecting rods are also of unique construction; ball and roller bearings are used throughout. The removal of a few screws enables the handle to be lifted off and exposes the entire mechanism to view, making easy the inspection of all parts.

The No. 6 and No. 600 drills are designed to drill small holes without breakage of drills. They will handle twist drills from the smallest size up to ⅜-inch diameter. The free speed at 90 pounds air pressure is about 2,000 revolutions per minute. The two machines differ essentially in the handle construction, the motors being the same. The No. 6 has the pistol grip type of handle, while No. 600 is furnished with breast plate and rolling throttle handle. Aluminum, reinforced with steel bushings, is used wherever possible and results in a very lightweight machine, the No. 6 weighing only 9 pounds. The motor is a three cylinder type somewhat similar to that used in grinders above. The cylinders are separate iron castings, easily accessible, renewable and interchangeable. A very sensitive throttle control has been obtained, which with freedom from vibration makes the tool well adapted for drilling with small drills. The bearings are all either ball or roller type.

### Water Softening

The hot process water softener is described in a book recently issued by the H. S. B. W. Cochrane Corporation, formerly the Harrison Safety Boiler Works, of Philadelphia, Pa.

The hot process softener is a modern development of the well-known lime-soda process softener, the difference being that the chemicals are added to the water only after it has been heated to 205 degrees F. or higher. This results in practically instantaneous and complete chemical reactions and in more rapid settlement of the precipitate. The result is a considerable reduction in the time required for the sedimentation, so that the apparatus can usually be installed within power plant buildings and without requiring special foundations or housing. The fact that the feed water heater is combined as part of the apparatus also reduces the complication and the expense of piping, etc.

It is also claimed that the maximum reduction of scale and sludge-forming matter is obtained with a minimum excess of reagents and that there is no after-precipitation or troublesome deposits of scale and sludge in pumps, piping, feed water heaters and boilers, while, due to the reduced solubility of the products in hot alkaline water, the minimum amount of sludge-forming solids enter the boiler and the tendency to priming and foaming is minimized. In the present publication these statements are supported by scientific data and by the results of practical operation. An improved type of a chemcial feeder designed to force the water into the softener against back pressure, and a system of pressure filters, are also described. The closing chapter enumerates the impurities found in boiler feed water and describes the kinds and amounts of chemicals necessary for their removal.

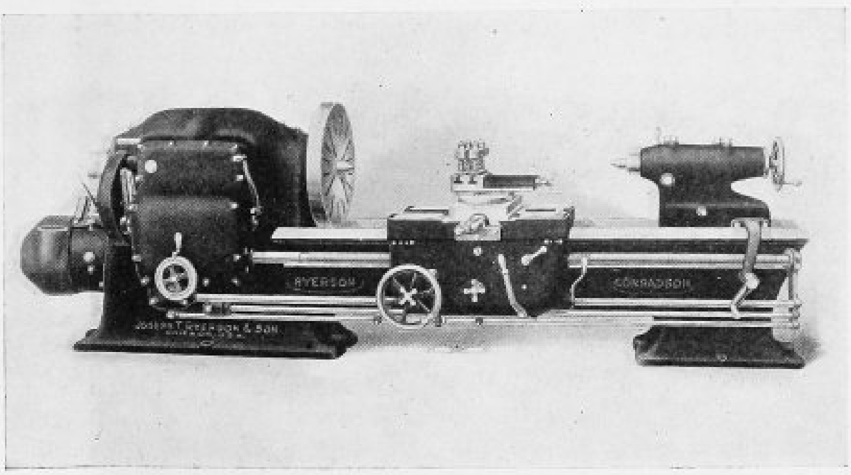
## Repairing Pneumatic Tools

With a greater demand than ever in the history of the pneumatic tool industry for new equipment, it has been found both economical and of great advantage to mechanical industries in general to repair their pneumatic tools when they have become worn out.

Chippers, riveters, sand rammers, etc., that have been discarded and sent to the junk pile may be reconditioned so that they compare favorably with new equipment. The Structural Tool Company, Cleveland, Ohio, has undertaken the reclamation of pneumatic tools, and otherwise worthless equipment has been made fit for service in their shops.

## Single Operator Electric Welding Outfit

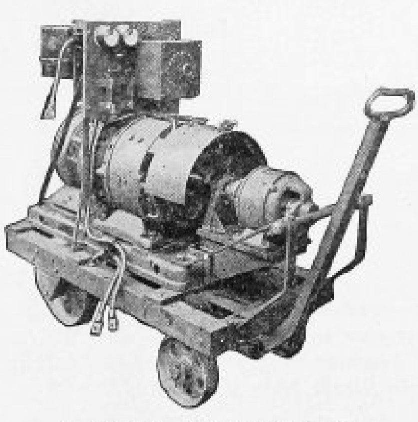
A single operator electric arc welding equipment manufactured by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., is claimed to be efficient because the generator operates at arc voltage and no resistance is used in circuit with the arc. The generator is designed to inherently stabilize the arc, thus eliminating relays, solenoid control resistors and other automatic moving devices.



Ryerson-Conradson Engine Lathe

The generator of the standard Westinghouse design has a rated capacity of 175 amperes and is provided with commutating poles and an exceptionally long commutator, which enables it to carry the momentary overload at the instant of striking the arc. The generator is mounted on a common shaft and bedplate with the motor. A pedestal bearing is supplied on the commutator end which carries a bracket for supporting the exciter which is attached to the common shaft of the set by means of a special coupling. Motors can be supplied for either direct or alternating current circuits. Where the alternating current motor is used, leads are brought outside the motor frame for connecting with 220 or 440 volt circuits.

Where the equipment is required for portable service,


Portable Electric Welding Outfit

the motor generator with the control panel is mounted on a fabricated steel truck equipped with roller bearing wheels. The control for the single operator equipment consists of a small ebony asbestos panel mounted upon angle-iron framework. A field rheostat for regulating the welding current, voltmeter and ammeter and a two-pole knife switch are mounted upon the panel.

The motor generators are supplied in capacities of 300, 500, 750 and 1,000 amperes.

## High-Power Engine Lathe Developed

Joseph T. Ryerson & Son, Chicago, Ill., announces the development of a high-power, precision, selective head engine lathe of Ryerson-Conradson design. Five different sizes of this type of lathe are being manufactured, with 15-inch, 18-inch, 22-inch, 27-inch and 33-inch swing, and with any length of bed desired. With hardly a change the lathes can be adapted to either a constant speed, single pulley drive, with or without a spindle reversing attachment, or a direct reversing motor drive. Special features embodied in the design are a head stock, cast integral with the bed, a splash oiling system (all gears run in an oil bath), extra large spindle and spindle bearings, a herring-bone gear drive to the spindle, 12 speeds with 28 different feeds. All operations are controlled from the apron, which has a special feed mechanism.

The New Jersey Zinc Company, 160 Front street, New York City, announces that the new plant of the subsidiary company, the Empire Zinc Company, is roasting ores preparatory to the actual production of zinc oxide at its new Canon City, Colo., 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 defitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Development of Retort Hopper

Q.—What is the most satisfactory method of developing the hopper layout as shown in the sketch Fig. 1? M. E.

A.—It is necessary to make three views, namely, a side view, a front view and a top view or plan. These views should be made to an accurate scale. There are different

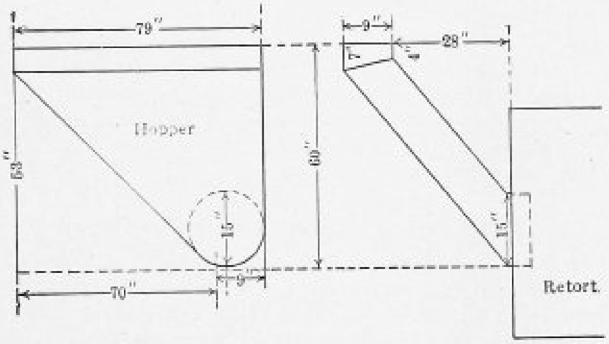



Fig. 1.—Retort Hopper Layout

methods of making the patterns, and therefore the method shown below gives the pattern for the entire construction laid out in one sheet. The layout can be cut up into as many pieces as desired and the seams made wherever most convenient. In addition to the general pattern, there will be needed 6 inches of 15-inch cylindrical pipe, and also two rectangular plates, both 6 feet 7 inches long, one of which is 4 inches wide and the other 7 inches wide. Then there are also needed two small end plates 9 inches long, 7 inches wide at one end and 4 inches wide at the other.

The circular opening in the transition piece is laid off into equal arcs, 12 being used in this case. From the division points on the circle a series of construction lines is drawn to the corners of the rectangular end of the hopper. These construction lines show that the pattern, if laid off in this way, will consist of 8 plates, which may be united or which may be cut separately. There is a large triangular plate forming the bottom. Then there is a triangular plate of considerable size forming the top. A small triangular plate forms the straight side of the construction and a long triangular plate closes in the sloping side of the construction. Finally there are four sheets that are rolled as partial surfaces of cones.

The part of the work requiring the most care is to get the true lengths of the various construction lines. It is necessary to measure the vertical height of each line as given in the side view, and also the horizontal projection of each of these lines as given in the plan. With these two measurements for each line construct a right angle triangle. The hypotenuse of this triangle will be the true length of the line.

The pattern is laid out by using these true lengths as radii and drawing arcs from the corners used as centers.

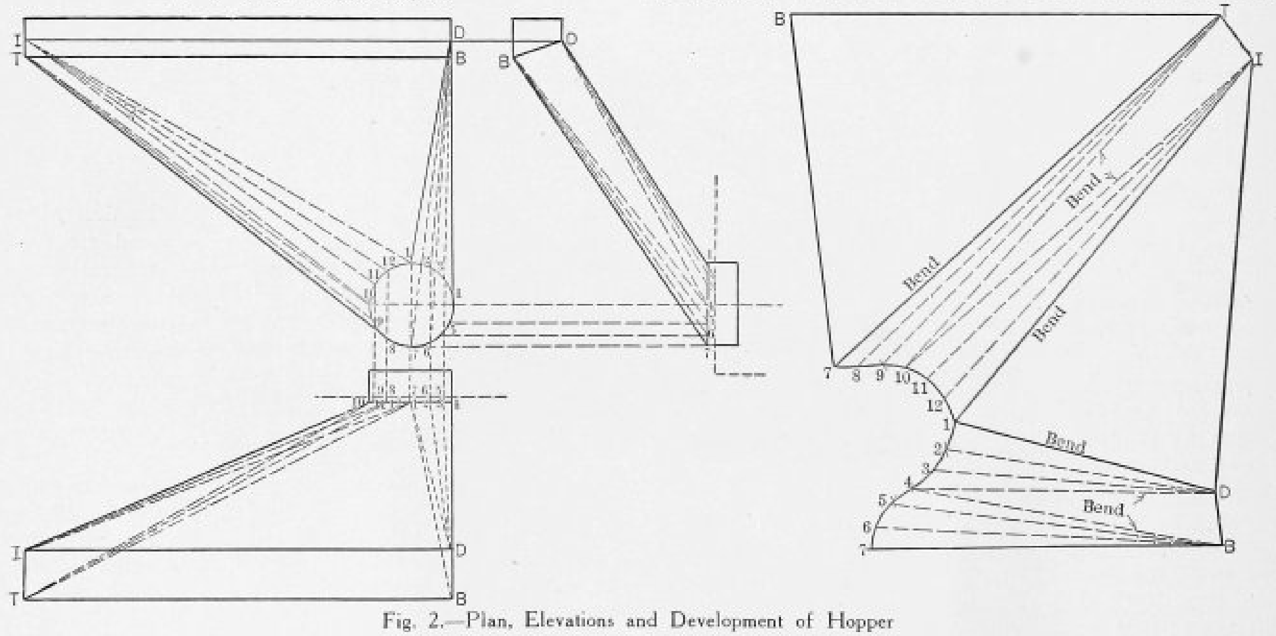



Fig. 2.—Plan, Elevations and Development of Hopper

Draw arcs with radii equal to the length of the arc divisions laid off on the circular opening. The intersection of these various arcs will give the points on the curve for the end of the pattern that is to be joined to the 15-inch circular outlet.

The pattern for this hopper could also be made by using a short transition elbow, one opening of which is circular and the other rectangular. If this were done, the body of the hopper could be made entirely of flat plates, so the elbow might be joined to the vertical opening.

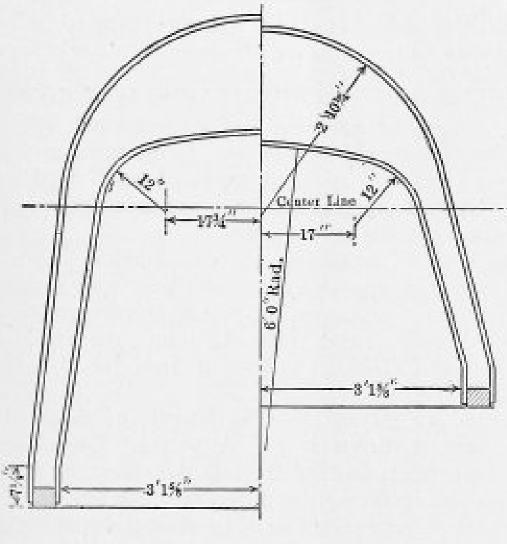



Fig. 2.—Cross Section of Firebox Wrapper Sheet

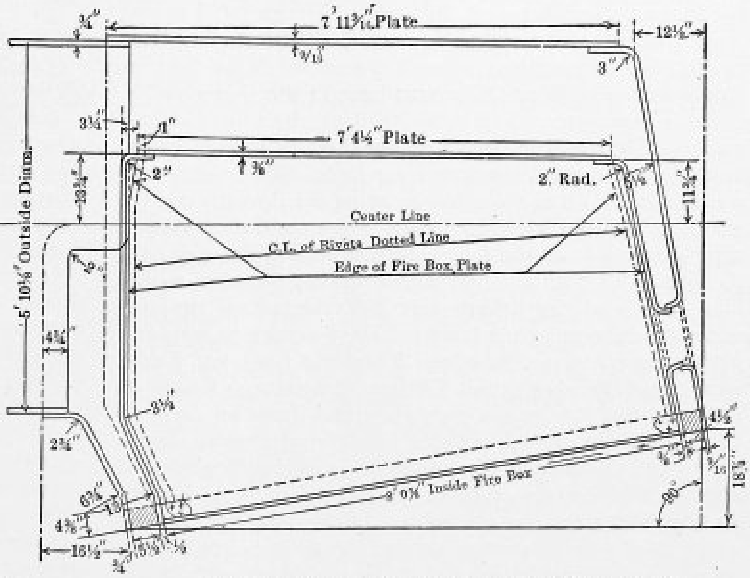



Fig. 1.—Longitudinal Section Firebox Wrapper Sheet

## Layout of Firebox Wrapper Sheet

Q.—I am sending sketches of a firebox wrapper sheet, Figs. 1 and 2. Will you please explain how it is laid out? Notice that the flanges are extended on the door and flue sheets, causing the wrapper sheet to be slightly inclined near the top. J. C. B.

A.—This is an advanced problem and requires a good general knowledge of the principles of triangulation as relating to constructions combining curved and flat surfaces joined at various angles.

The first thing to do is to make accurate end views and side views of the firebox with measurements of the distances between the lines locating the centers of the rows of rivets, as in Figs. 3 and 4. Next divide the curves as shown on the end view into equal arcs and join the corresponding points by a series of straight lines and project these lines and points onto the side view. In order to avoid confusion, make one set of these lines solid and the other set broken as shown. As the fire-door sheet has considerable slope, it is necessary to determine the true lengths of the arcs on the edge of the wrapper sheet at the small end, as shown in Fig. 5. Note that the true lengths, such as 7-6, 6-5, etc., of the arcs on the large end, Fig. 3, are given on the end view. The method of getting the true lengths of these arcs is to project lines from the various points, these projecting lines, *ff'*, *ee'*, etc., being square to the sloping end *g-n* of the firebox. On each one of these projecting lines lay off its respective length as taken from the lengths of the lines across the end from the curve to the centerline on the end view Fig. 3. Then draw a curve *gx* through these points and the various arcs will be the true lengths of the corresponding arcs in the end view.

In order to lay out the pattern it is necessary to get the true lengths of the long construction lines drawn on the side view. These are found after the method shown in Fig. 6. A perpendicular line is drawn, and on this a distance is laid off equal to the distance measured parallel to the centerline between the two ends of the sheet in the side view. This distance must be measured for each of the points, because the sloping point increases the lengths

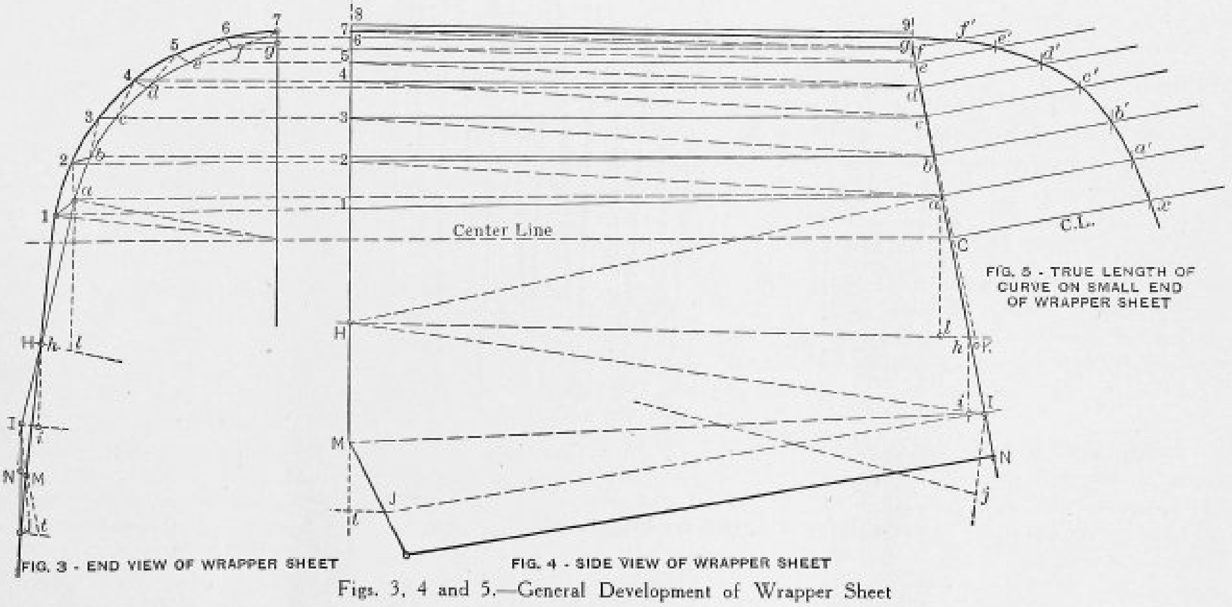



FIG. 3 - END VIEW OF WRAPPER SHEET

FIG. 4 - SIDE VIEW OF WRAPPER SHEET

Figs. 3, 4 and 5.—General Development of Wrapper Sheet counting downwards. Then draw a horizontal line through this point as laid off in Fig. 6. On this horizontal line lay off a distance equal to the length of the solid line *7-g*, *6-f*, *5-e*, etc., on the end view. Also lay off a distance equal to the length of the broken line, and on the horizontal measure off the broken line, as *7-f*, *6-e*, etc., from the end view. Then in each case the sloping lines in Fig. 6 between these respective points will be the true length of the solid or the broken lines in the side view.

Begin the pattern, Fig. 7, by drawing the centerline *7-g* representing the true length of the sheet at the top of the side view measured between rivet lines. Then with 7 as a center draw an arc 6, using a radius equal to the arc 6-7 given in the end view. Also with *g* as a center and an arc *f-g* taken from the true length in Fig. 5, draw the arc *f*. Also with 7 as a center and a radius *7-f* equal to the true length of the broken line *7-f* taken from the side view, describe an arc cutting the arc *f* on the pattern and giving one point on its edge. Then use the point *f* as a center and the long radius *f-6* equal to the true length of the solid line *f-6* on the side view and draw an arc cutting the arc 6 on the pattern and giving a point on its long edge. Continue this method, using the arc lengths and the line lengths as radii, until the point *a* is reached on the short edge and the point 1 on the long edge of the pattern. As the remaining part of the sheet is not curved, its pattern will be made of flat triangular pieces laid out by using the construction lines on the end and side views for radii, so as to get the areas *A, B, C, D* and *E* shown on the pattern in Fig. 7.

When getting the true lengths of each of the lines, special care should be taken to measure the different projections correctly and to apply these measurements properly, when constructing a right-angle triangle in which the hypotenuse will be the true length of the line required. Instead of using a single diagram as in Fig. 6 for getting the true lengths of several of the construction lines, lay out a special diagram for each line with letters corresponding to those taken from the different views. This method will avoid the risk of making mistakes in the measurements. It will be noted that some of the triangles, such as *Hak, Hal*, etc., have been laid off on the side and end views, Figs. 3 and 4, in cases where the true lengths of the pattern lines for the flat plates could be determined in this way.

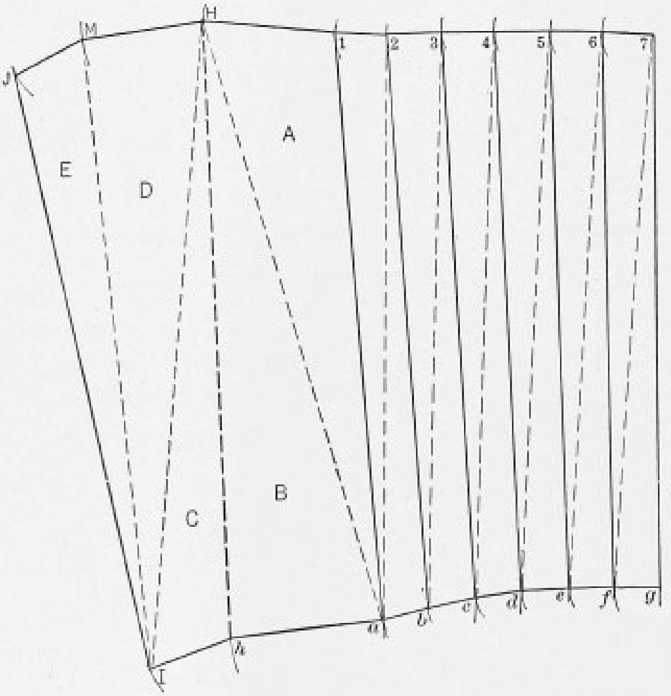



Fig. 7.—Half Pattern for Wrapper Sheet

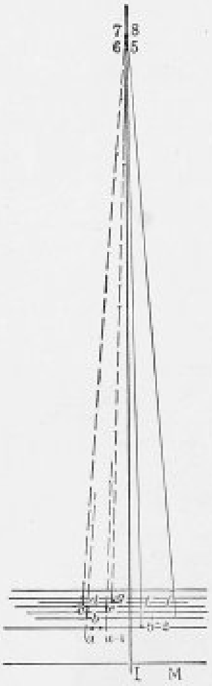



Fig. 6.—True Lengths of Construction Lines on Side View

## Pattern for Concrete Mixer Hopper

Q.—Please show me how to lay out the pattern for a hopper having dimensions as shown in sketch. J. B. L.

A.—Three accurate views should be made of the construction: a plan, an elevation and an end view, Fig. 1. The circular arcs should be divided into an equal number of spaces. In this case the quadrant has been divided into six parts. Certain construction lines are then drawn, and from these the pattern is laid out.

In order to avoid confusion, the construction lines are drawn in two groups, a group of solid lines and a group of broken lines. Corresponding points are connected in the different views. In the plan the solid lines are *A-F*, 6-1, 7-2, *H*-3 and *H-D*. The broken lines are *A*-1, 6-2, 7-3, *H*-4 and *H*-5.

The method of getting the true lengths of these construction lines is shown at *x*. A vertical line *O-a* is drawn and on this is laid off from *O* the elevation of the different points, or rather the difference between the elevations of the various points so as to show the true height of each point above the point at the other end of the same construction line. On the horizontal from *O* is laid off the lengths of the construction lines as projected in the plan. Then the sloping lines are the true lengths of the construction lines. For example, *a*-1 is the true length of *A*-1 because *O-a* is made equal in length to *A-B* in the elevation, and *O*-1 is made equal in length to *A*-1 in the plan. In the same way the line *O*-7 is made equal in length to *F*-7 from the elevation so as to get the true height of the point 3 above the point 7 in the elevation. The horizontal line from *O* in *X* is made equal to the length 7-3 in the plan, and the sloping line 7-3 in *X* is the true length. The pattern is laid out by using the true lengths of the line. Thus *c-d* is made equal in length to

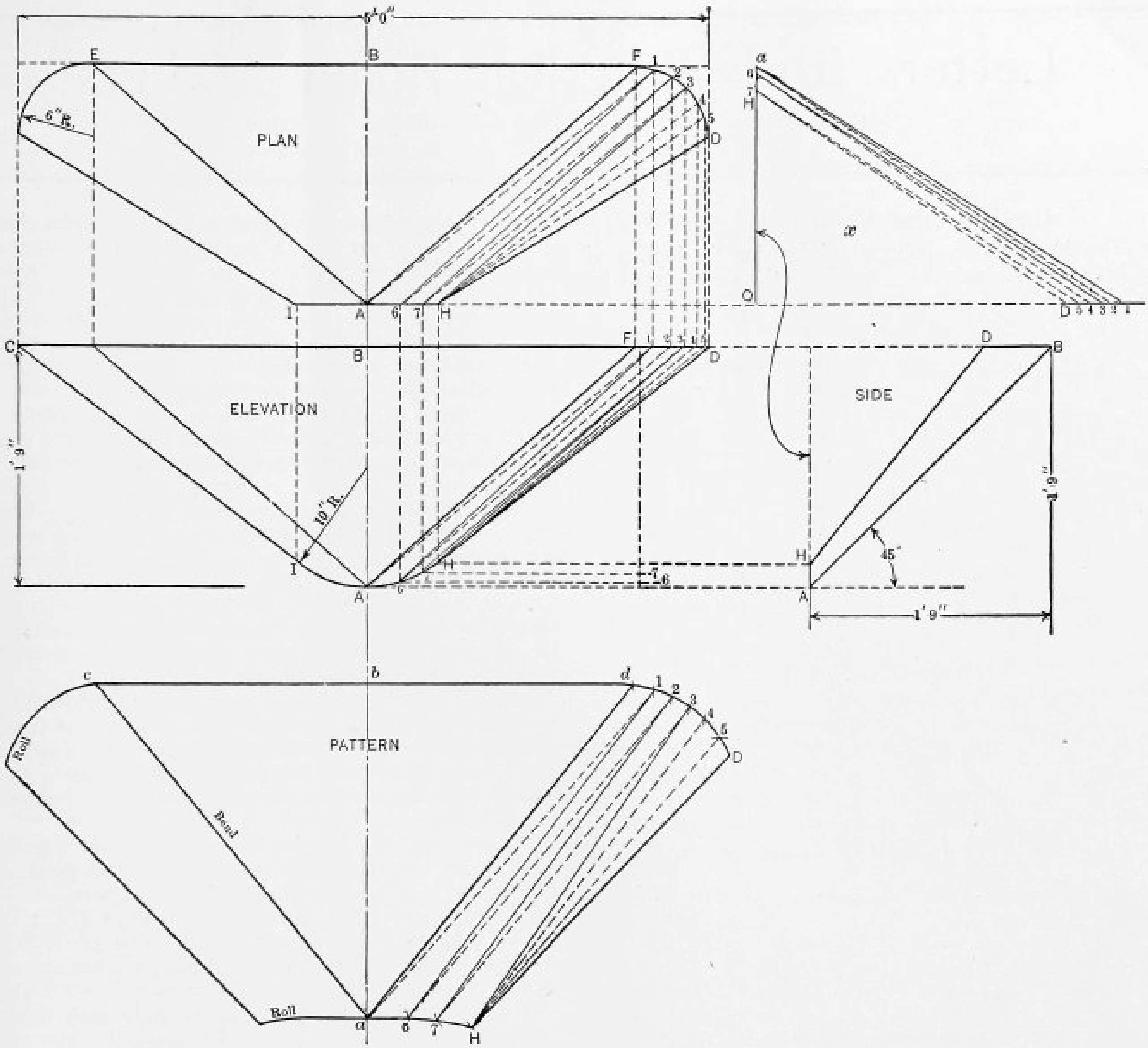



Fig. 1.—Development and Pattern for Hopper Spout of Concrete Mixer

*E-F* of the plan, and *a-b* is made equal in length to *A-B* of the end view. The central part of the pattern will consist of a large triangular plate. The edges will consist of an irregular spaced piece with curved ends. In order to construct the pattern for the edge proceed as follows:

With *a* as a center and a radius *a*-1 equal to *a*-1 taken from *X* describe an arc. Then with *d* as a center and a radius equal to the length of the arc *F*-1 in the plan describe an arc cutting the one just described with *a* as a center. This will give the point 1 on the curve forming the upper edge of the pattern. Then with 1 as a center and a radius 1-6 taken from *X*, describe the arc 6. With *a* as a center and a radius equal to the arc *A*-6 taken from the elevation, describe an arc cutting the other arc at the point 6, which will be a point on the curve at the lower end of the pattern. Proceed in like manner with the other true lengths taken from *X* and with the arc divisions taken from the plan and the elevation and thus locate the points from *d* to *D*, and from *a* to *H*. Draw *H-D* for the edge of the pattern and through the given points draw the curved lines, thus completing the pattern for the right-hand sheet. This same pattern will do for the left-hand sheet by using it reversed. Allow for laps if the construction is made of more than one piece.

## BUSINESS NOTES

B. F. Sarver, foreman boiler maker at the Fort Wayne shops of the Pennsylvania system and a member of the executive board of the Master Boiler Makers' Association, is dangerously ill at the Washington Boulevard Hospital, Chicago, Ill.

L. E. Summers has been appointed works manager of the Keller Pneumatic Tool Company's factory at Grand Haven, Mich. Mr. Summers is one of the pioneers in the mechanical end of the pneumatic tool industry, starting his career with Joseph Boyer in St. Louis in 1894. From St. Louis he went into the Boyer plant of the Chicago Pneumatic Tool Company at Detroit, was assistant manager for nine years, followed by eight years as works manager. He resigned in 1918, since which time he has been employed by various interests on the Pacific Coast, until he joined the Keller organization on June 1.

# Letters from Practical Boiler Makers

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

## Laying Out Helical Chutes

The development of the plates forming the bottom of a helical chute looks very simple to the novice, until he attempts to do it, when he generally spoils a few plates

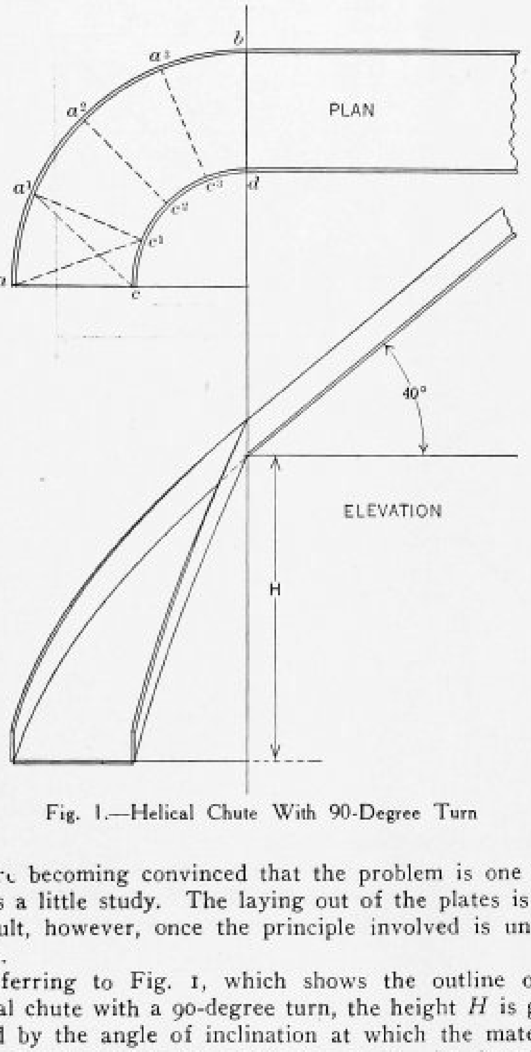



Fig. 1.—Helical Chute With 90-Degree Turn

before becoming convinced that the problem is one that needs a little study. The laying out of the plates is not difficult, however, once the principle involved is understood.

Referring to Fig. 1, which shows the outline of a helical chute with a 90-degree turn, the height $H$ is governed by the angle of inclination at which the material to be handled will slide down the chute. In the chute shown, this angle is assumed to be 40 degrees from the horizontal. The height $H$ then must be such that the inclination of the chute along the circumferential line $ab$ is not less than 40 degrees.

It is obvious that the inclination becomes steeper towards the center of the helix and reaches a maximum on the line $cd$, hence the reason for taking the inclination at $ab$ as the ruling gradient.

To determine the height $H$, lay off the length of the arc $ab$ on a horizontal line, as shown in Fig. 2, and from point $a$ draw a line forming an angle of 40 degrees with line $ab$. At point $b$ erect a perpendicular line to meet the inclined line, and the length of this vertical line will be the required minimum height $H$.

The same result can be obtained by the use of trigonometry, the formula being:

$$H = ab \times \tan 40°.$$

In passing, we may note that it is not essential that the inclination of the line $ab$ be the same as that of the straight part of the chute, so long as the inclination is sufficient to cause the material to slide.

We will now proceed to develop plate $abcd$. Lay off $cd$, as shown in Fig. 3, equal to the length of the arc $cd$, Fig. 1, and erect a perpendicular from point $d$, equal in length to $H$, and complete the triangle.

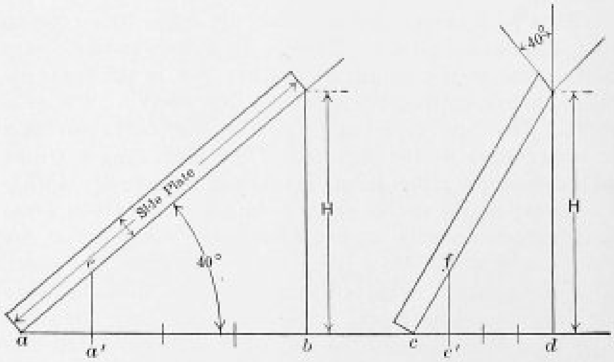
As a matter of interest, it may be noted that the inclined line in Fig. 3 is the true inclined length of the line $cd$ and is at the same angle to the horizontal as the chute is on line $cd$.

Now divide lines $ab$ in Fig. 2 and $cd$ in Fig. 3 into any convenient number of equal parts, say four, and erect perpendiculars from the first points as shown in the figures.

It is apparent that the four segments into which we have divided the plate $abcd$ in Fig. 1 are all equal to each other in every dimenion, and that lines $ac'$ and $a'c$ are equal, as are also the vertical heights of $a'$ and $c'$ above the horizontal plane through $ac$.

Now lay off $ac'$ as in Fig. 4 and set up a perpendicular from $c'$ equal in length to the perpendicular lines from $a'$ and $c'$ (both are equal to each other) in Figs. 2 and 3. The hypotenuse of the triangle in Fig. 4 is equal to the true inclined distance between points $a'$ and $c$, and also $a$ and $c'$ in Fig. 1.

We can now lay out the plate as shown in Fig. 5. First set out line $ac$, equal to $ac$ in Fig. 1, from points $a$ and $c$ describe arcs with radii equal to the hypotenuse of the triangle, and with $a$ as center, and $ae$ in Fig. 2 as radius, describe an arc to intersect the first arc drawn with $c$ as its center. Do the same with $c$ as center and $cf$ in Fig. 3 as radius. The lengths of the lines $ac$, $a'c'$ $a^2c^2$, $a^3c^3$ and $bd$ are obviously all equal to each other but it will be found that the length between the intersections of the aforesaid arcs does not equal $ac$. This is because in finding the length of the diagonal lines $ac'$ and $a'c$ we assumed they were straight lines, whereas the plate is slightly curved, and therefore the true length of these lines measured on the surface of the plate will be a little more than that shown in Fig. 4. This is compensated for by moving points $a'$ and $c'$ outwardly along their




Figs. 2 and 3.—Method of Determining Height H

respective arcs an equal amount from the points of intersection until $a'c'$ is equal to $ac$.

With $a'$ and $c'$ as the new points, repeat exactly what was done from points *a* and *c* until all four segments are laid out and the plate completed.

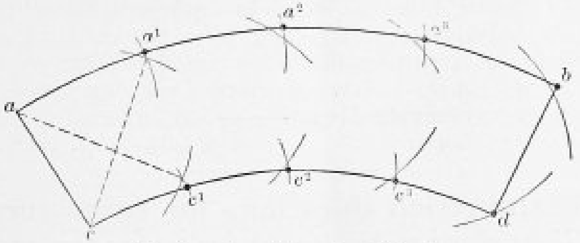


Fig. 4.—Actual Length of Bend

The side plate for side *ab*, Fig. 1, is shown developed on Fig. 2 and presents no difficulty.

The plate forming the side at *cd* is also developed on Fig. 3.

These two plates must be rolled with the axis of the rolls parallel to vertical line *H* in Figs. 2 and 3 respectively.

John S. Watts.

## Effect of Combined Stresses on Boiler Bracket Rivets

In further explanation of the effect that combined stresses have on the design of a boiler setting as given in the article "How to Design and Lay Out a Boiler," chapter XXI (page 159) in the June issue of The Boiler Maker, the author states that a combined stress is equivalent to the square root of the sum of the squares of any two stresses such as tension and shearing or bending and tension, etc. The combined stress is determined in the same manner as is the hypotenuse of a right triangle when the base and altitude are known. Expressed as an equation, the stress may be represented by:

$$M_c = \sqrt{M_t^2 + M_s^2},$$

in which:

$M_c$ = combined stress.
$M_t$ = stress due to tension.
$M_s$ = stress due to shear.

In the design of our boiler $M_t = 1{,}250$ pounds; $M_s = 500$ pounds. Substituting these values in the equation above, we have:

$$M_c = \sqrt{1{,}250^2 + 500^2}, \text{ or } 1{,}346 \text{ pounds.}$$

Allowing 6,000 pounds per square inch as the safe working strength of the rivets, each rivet should require a cross sectional area of $\frac{1{,}346}{6{,}000}$, or only 0.224 square inches. This area is obtainable in a commercial rivet diameter of ⅝-inch. However, no rivet smaller than ¾-inch should be employed in important construction work of any kind, so ¾-inch rivets should be used in the design of the boiler brackets.

## Boiler Inspection After the Hydrostatic Test

Some years ago the writer was testing an air storage tank which carried an average pressure of 110 pounds. The tank was built of ⅝-inch steel plate with lap-jointed seams, double riveted. The boiler was subjected to both a vertical and a circumferential hydrostatic test of 175 pounds with cold water. At this pressure everything was tight with the exception of one or two places in the vertical seams, which were sweating a little. It looked as if the tank were in fine shape, but upon making the internal inspection we found conditions as shown in the sketch Fig. 1. The edges of all the laps vertical and circular

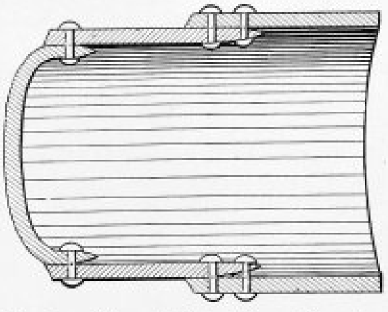


Fig. 1.—Edges of Plate Worn, Exposing Rivet Stems

were worn down to a sharp edge, exposing the stems of the rivets between both plates. Needless to say, the tank was discontinued in pressure service. As the writer has had quite a few years' experience in the hydro testing of boiler and pressure tanks, a word of advice to the beginner will perhaps not come amiss. On inspection work, take nothing for granted; see for yourself, even if you have to "skin the cat" to get inside, get in anyway.

Lorain, Ohio. Joseph Smith.

## Defective Boiler Plate

If the latest edition of the Board of Trade regulations which contain the well-known rules be carefully studied the following cannot fail to attract the notice of the boiler maker:

"The finished material (plates) should be sound and free from cracks, surface flaws and laminations, and no hammer-dressing, patching, burning or electric welding is permissible.

"Under no circumstances whatever is hammer-dressing allowed, and the means for removing a surface defect must be confined to chipping and filing. It is most necessary that the surveyor should carefully scrutinize the inner and outer surfaces of all cylindrical shell plates, with a view to detecting cracks, while the plates are being marked in the boilers. If he has any doubt about a part, a light chip should be taken off the surface, in order to see if the chipping divides at a crack. Boiler makers should be requested to examine carefully all shell plates in the various stages of working, as they have the best opportunity of discovering defects, and occasionally cracks develop when working the plates in the boiler shops. Such inspection does not in any way relieve the surveyor from his duty personally to inspect the plates.

"Every precaution should be taken by the steel makers to prevent a defective plate leaving their works, as they are responsible for supplying sound material. That a great deal can be done in this respect by the makers is clear from the fact that there are some steel makers manufacturing a large amount of plating with regard to which the Board has no record of a defective shell plate."

Some recent discussions with an engineer whose boiler production experience extends over thirty years led me to preface these remarks with the foregoing.

Position drilling was then introduced into one boiler shop which stood alone in the matter for quite a long time. Their plant system had another feature which is still in operation, but is by no means general, concerning the detection of faulty plate.

The individuals who handled the plates on arrival were expected to scrutinize both surfaces in a good light, the plates were then placed in the usual storage racks in a vertical position, assorted for size and shape. When needed they were selected and then passed to the layer out, who in turn was also expected to examine the material, and finally the roller was on the lookout for defects.

Whoever detected anything unusual had to bring it to notice, and those who previously missed the fault lost their pay for the work on that plate. It was the recognized policy of the firm to turn out the best made and now most reliable boilers in Great Britain, and the system was in effect in order to place a premium upon discovery. Detection of a real fault was rewarded by a small gratuity, and as reliable material was less usual then than now, it was frequently earned.

One case of a very grave fault which missed numerous processes was discovered by position drilling. A plate had been rolled, welded and flanged for one flue ring in a Lancashire boiler. The driller noticed that while an unbroken shaving was usual until the hole was finished, in several adjacent holes the shaving broke off and restarted. He drew attention to this, and the foreman investigated. Taking a file, the edge of the plate at the flange was brightened and a visible line existed. Using a set, this was opened and an area of a couple of square feet of central laminations discovered. As this was the first flue section, and so subject to the worst conditions in the whole boiler, the later results of such a defect may be easily imagined. Until then it had been customary to weld and flange the plates as received; subsequently all plate edges of whatever character were planed. Before this, although all shell plate edges were planed, the flue plates did not receive this attention, because it had been considered an excessive refinement when the plates had to be worked in the fire later. Such a defect would have resulted in discovery upon planing, for the broad tool would have shown two chips in the machine.

As the Board of Trade Rules point out, it is the clear duty of everyone in the business to keep out defective material irrespective of any considerations.

The instance related reveals a new merit of position drilling and also justifies planing edges; both tend to ensure sound material among their other many advantages.

It is the best practice and one followed by all good steel makers to take two tensile tests from each and every boiler plate, which is then stamped with an identification brand and number.

A duplicate copy of such tests properly certified should be a condition when the order is placed. If a record of the plates used in each boiler be kept, cross referenced to the actual filed test sheet, the boiler maker has legal evidence indisputable in the event of any trouble, for he can thus have the history of the boiler first to last with documentary proof. The trouble involved is small, the possible benefit great.

There should be a premium on the detection of faulty material in every boiler shop, for to ensure safety is beneficial to the trade at large. Methods and systems of the character indicated, faithfully observed, can be relied upon to impress the impartial investigator, whose confidence is thereby established.

Reputation is an asset of value, nowhere more valuable than in boiler connections. Every steel maker will cheerfully replace defective material, for although he may disclaim responsibility for the cost of subsequent work, replacement free of cost of defective material is his clear liability.

The time is certainly coming when position drilling, planing of plate edges and the other provisions of good boiler workmanship will not be optional: they will be statutory. The good old days of punched holes, flogged-up laps, drifting over holes and out-of-round plates in shells are gone; it is to be hoped past recall. When one-inch diameter holes, six inches in depth, in mild steel take sixty seconds to produce, and when the certainty and exactitude of position drilling is considered, the process is speedy, not slow. Why its universal adoption should lag is a mystery inexplicable to ——

London, England. A. L. HAAS.

## Examination Questions for Inspectors

Many of our readers have at one time or another requested information on the requirements for boiler inspectors. The preliminary training of an inspector should include a good theoretical knowledge of steam boilers in general and a very thorough practical training in their construction.

In order to give an idea of the ground covered in the examination of an inspector, the following test questions have been taken from a set of papers used in examining candidates for state inspection service:

1. If the boiler has a tendency to foam, what precautions should be taken?
2. If there is an overflow of water in the boiler, what effect would the blowing of the pop valve have?
3. How many pounds of coal will be burned per square foot of grate area per hour?
4. How many square feet of grate area will be required to burn 1 ton of soft or bituminous coal per hour?
5. What is (a) combustion, (b) evaporization, (c) heat?
6. Would perfectly pure water be desirable for use in a steam boiler?
7. What is the cause of scale forming in boilers, and what is the remedy?
8. What is (a) steam, (b) saturated steam, (c) superheated steam, (d) dry steam?
9. What is the function of a steam dome and why are they being done away with?
10. What is a steam gage, injector, non-return valve, steam trap, steam loop, and what are their functions?
11. What is one of the prime causes of boiler explosions and how can it be prevented?
12. What is a water glass, and where should it be located on a horizontal return tubular boiler?
13. Describe the functions of a blowoff pipe and where should it be located?
14. How would you make an internal and an external examination of a (a) new boiler, (b) old boiler?
15. What would you do in case you found the watertubes blistered slightly?
16. What would you do if you discovered a lap crack?
17. What is a fusible plug, and where should it be located in the following types of boilers: (a) horizontal return tubular, (b) locomotive, (c) vertical tubular, (d) Babcock & Wilcox, (e) Heine, (f) watertube, (g) Scotch marine?
18. What is the difference between a firetube and a watertube boiler, and which do you consider the safest and why?
19. Why do firetube boilers have the ends of the tubes beaded, and the watertube flared?
20. Why are brass pipes with a cross required in the installation of water column connections, also brass copper, or bronze required in siphon pipe to steam gage?

Try to answer the questions yourself, and find out how much you know about a boiler. A set of answers will be prepared by the editor of the Questions and Answers Department of THE BOILER MAKER, and these will be published in an early issue.

## TRADE PUBLICATIONS

Tumbling Mills.—Tumbling mills of all types, produced by the Whiting Foundry Equipment Company, Harvey, Ill., are described in detail in this pamphlet. Numerous illustrations show the machines in operation in various foundries throughout the country. The catalogue will be mailed on request.

Crane Comment.—The latest bulletin published by the Industrial Works, Bay City, Mich., contains the story of crane construction as carried out in Industrial Works shops. It also describes a variety of locomotive crane uses, both in wrecking work and new construction. A table of capacities, weights and radii, with different length crane booms, is also given.

Welding and Cutting Equipment.—A bulletin on oxy-acetylene and oxy-hydrogen welding and cutting equipment has been sent out by the Davis-Bournonville Company, Jersey City, N. J. In addition to the general specifications of torches, tips, regulating and reducing valves, welding and cutting machines, generating plants and the like, a complete outline of the uses to which each device is best adapted is also given.

Berwick Electric Rivet Heater.—Details of construction and operation, as well as the results accomplished by the electric rivet heater produced by the American Car & Foundry Company, 165 Broadway, New York, are given in a pamphlet recently issued by this company. Numerous illustrations indicate the wide application of this heater in structural work. The results of laboratory tests over a period of several months, as given in the catalogue, show that electric rivet heating is efficient.

Pneumatic Tools.—The Keller Pneumatic Tool Company, Grand Haven, Mich., has just issued its Catalogue No. Five, carrying illustrations, descriptions and specifications of their pneumatic riveting, chipping and scaling hammers, jam riveters, holders-on, staybolt riveters, rivet busters, sand rammers, valveless and Corliss valve drills and grinders, rivet sets, chisel blanks, hose, etc. An item of particular interest in this new book describes the Keller-Master Super-Hammer.

Electric Fixtures.—Products of the Benjamin Electric Manufacturing Company, Chicago, are described in catalogue 22 recently issued. The application of proper lighting principles to industrial plants has been carefully studied by the research department of this company, and the results of the investigations are given in detail together with the formulas and tables necessary to determine the proper lighting equipment to meet any particular requirement in the office or shop. Fixtures, plugs, sockets, fuses, switches, switchboards, in fact complete industrial electric lighting devices, are listed and illustrated.

Air Compressors.—The first edition of the Pennsylvania Pump & Compressor Company's (Easton, Pa.) Bulletin No. 100 has just been issued describing "Pennsylvania" Class 3-A power drive, single stage, straight-line air compressors. In the pamphlet the general specifications are listed, special attention having been given to the description of a new type ring plate valve and oil float gage used to determine the level of oil in the crankcase. Other features of these compressors, as noted in the *Bulletin*, are a solid forged crank shaft, a forged connecting rod with solid box eyes and removable bronze shell main bearing.

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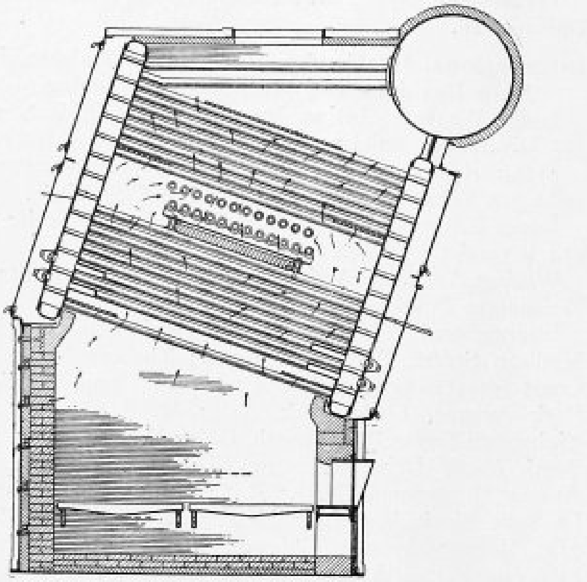
## Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,332,969. MARINE BOILER. JOHN E. BELL, OF BROOKLYN, N. Y.

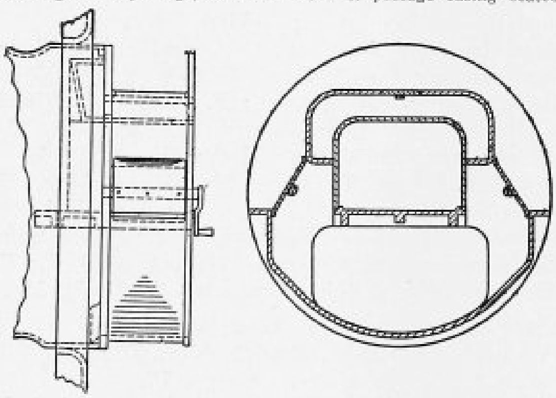
*Claim* 1.—In a boiler of the kind described, the combination with a bank of tubes separated at an intermediate point in said bank to form



a space, of a superheater located in said space and so that secondary combustion chambers or spaces will be left at the forward and rear ends of the superheater and baffling to direct the flow of gases over the tubes of the boiler, through said combustion chambers and the tubes of the superheater. Five claims.

1,335,194. FURNACE-FRONT AIR-VALVE SYSTEM. JOHN REID, OF NEW YORK, N. Y.

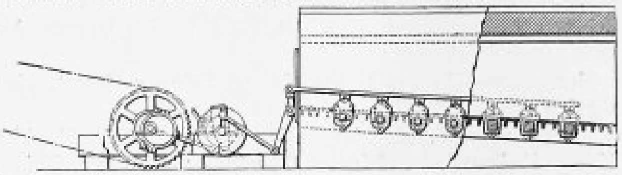
*Claim* 1.—In a furnace front having front and backplates provided with alining fuel openings, a removable fuel passage casing seated in



the fuel openings therein, an air chamber wall extending from the front plate to the back plate above the fuel openings and having downwardly directed parallel extensions, a flare forming the way to the ashpit and bridging the space betwen the front plate and the back plate and having upwardly directed parallel extensions spaced from said first-named extensions and from said openings, forming ports between the air chamber walls and the upper portions of the flare, and valves pivotally mounted between the front and back plates between said sets of extensions and at their ends abutting the respective extensions of the air chamber wall and flare to close the aforesaid ports. Four claims.

1,325,995. FURNACE GRATE. THOMAS PRICE, OF NANAIMO, BRITISH COLUMBIA, CANADA.

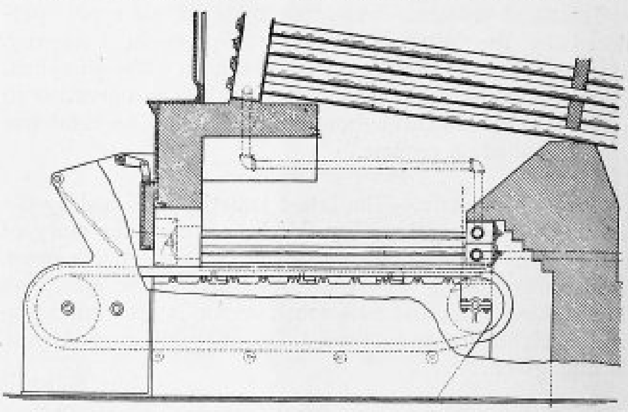
*Claim* 1.—A furnace grate, comprising the combination with a furnace



chamber, of fixed and rotatable grate bars spaced alternately across the chamber, said rotatble brs having rectangular flanges interspersed on a central core, and means for imparting a rotation movement to the alter nate bars. Five claims.

1,335,528. FURNACE. HERMAN A. POPPENHUSEN, OF HAMMOND, IND., ASSIGNOR TO GREEN ENGINEERING COMPANY, OF EAST CHICAGO, ILL., A CORPORATION OF ILLINOIS.

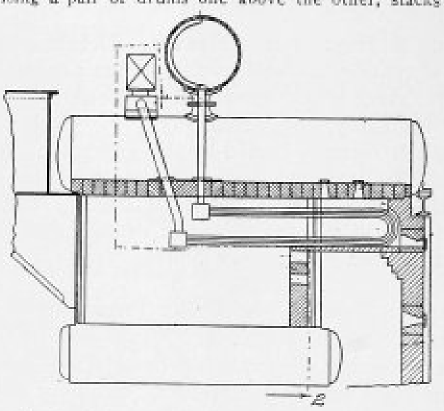
*Claim* 1.—In a furnace, the combination of a grate mounted in the



combustion chamber of the furnace, pairs of junction boxes mounted on opposite sides of the combustion chamber above the grate, transverse tubes connecting the corresponding junction boxes of each pair, a set of branch tubes communicating with each pair of junction boxes, tube extensions connected with said junction boxes and extended through the side walls of the furnace, and a junction box connecting the outer ends of said branch tubes. Seven claims.

1,337,653. STEAM GENERATOR FITTED WITH SUPERHEATER. JAMES HOWDEN HUME, OF GLASGOW, SCOTLAND, ASSIGNOR TO JAMES HOWDEN & COMPANY, LIMITED, OF GLASGOW, SCOTLAND.

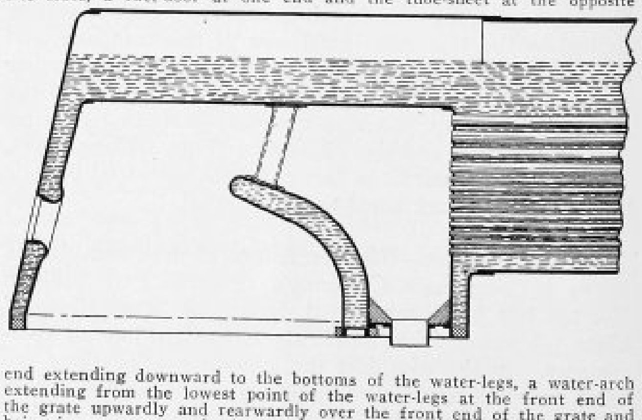
*Claim* 1.—In combination, a multi-sectional steam generator, each section comprising a pair of drums one above the other, stacks of upright



tubes connecting the drums of each pair, a combustion chamber beneath the upper drums and rearward of said tubes, said stacks of tubes being spaced apart to afford a horizontal flue between the tubes of adjacent sections, said flue communicating at its front end with the uptake, a checker brickwork wall between the rear end of said flue and said combustion chamber, said checker brickwork wall presenting readily closable openings for passage of combustion products from said combustion chamber to said flue, and a superheater located between two adjacent sections and comprising a series of U-shaped tubes contained at least partly in said flue. Two claims.

1,335,399. LOCOMOTIVE FIREBOX. CHESTER A. SIEGEL, OF NEWARK, N. J.

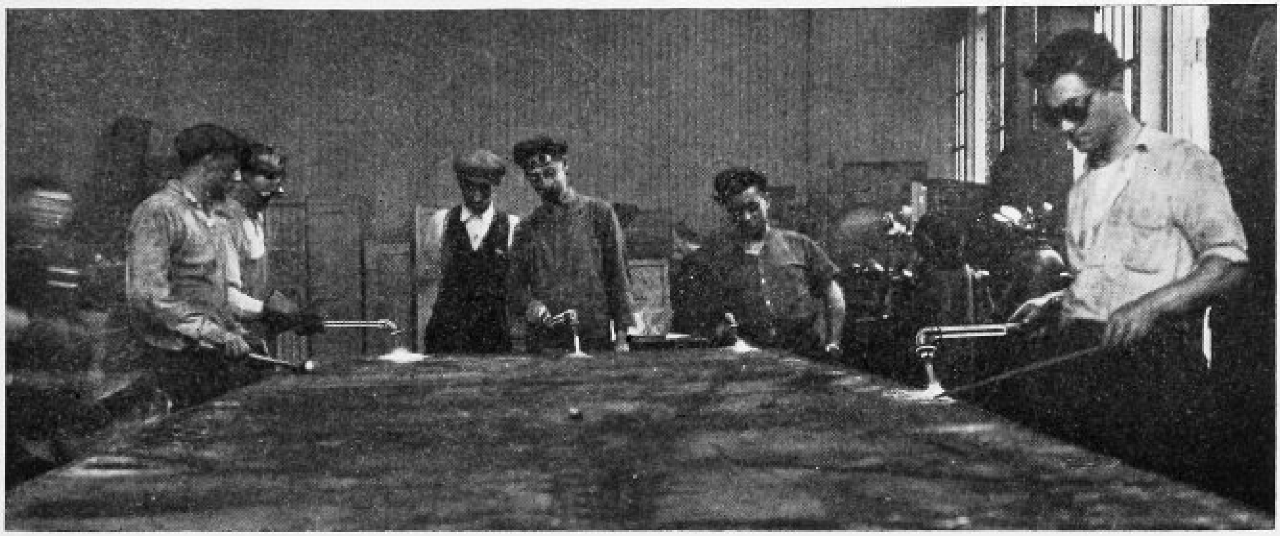
*Claim.*—A locomotive boiler having a firebox with water-legs at opposite sides, a fuel-door at one end and the tube-sheet at the opposite



end extending downward to the bottoms of the water-legs, a water-arch extending from the lowest point of the water-legs at the front end of the grate upwardly and rearwardly over the front end of the grate and being in open communication with the water-legs to the bottoms of said legs and producing a current of water outwardly from the bottoms of the water-legs, hand-holes and covers at the bottoms of the water-legs communicating with the lower part of the water-arch for cleaning out the same, and at least one water-tube extended from the top of the water-arch to the crown-sheet, whereby the water flows through the water-arch from the bottoms of the water-legs to the upper water-space over the firebox. One claim.

# The Boiler Maker

AUGUST, 1920

A Major Welding Operation on Boiler Plate

# Hand Tools for the Boiler Shop*

### Types of Light Tools Used in English Locomotive Shops for Carrying Out Ordinary Repair Operations

It is always interesting and usually instructive in any trade to consider the methods and equipment being used in shops other than those in which we happen to work. We may even go further than the neighboring shop for information and investigate the practices of other countries than our own, and in the process absorb a number of ideas that will help a little in solving our own shop problems.

The following article on hand tools is descriptive of the best English procedure in the use of repair tools commonly found necessary in the locomotive shop. In many ways this equipment is not materially different from our own, but some of the data will no doubt apply to shop work in this country.

#### Description of Stay Taps

The illustration in Fig. 1 shows the type of stay-hole tap which is used when a sufficient number of stays have to be renewed in a firebox to warrant the expense of lifting the boiler partially or wholly out of the frames, and at the same time, of course, necessitating the removal of the firebox clothing or lagging. The tap, as illustrated, is about 16 inches long over all, the end being tapered off for a distance of about 8 inches, this taper end of the tap having two or three flutings cut in it to form the necessary cutting edges. It will be seen from the illustration that the last few inches of the taper end of the tap are denuded of thread, and this portion will therefore form a sort of entering reamer, thus ensuring that the holes in the firebox shell are of exactly the right diameters for tapping purposes.

In the tap shown it will be noticed that for a length of about 1 inch in the middle of the tap the thread is turned off; the reason for this is that with a tap of this small diameter and proportionately extreme length there is considerable risk of the thread getting out of pitch during the process of hardening the tap. There is, however, a counteracting objection to this practice owing to the portion of the tap which is denuded of thread being liable to cause the tap to damage the newly cut threads in the plates when it is being withdrawn. For the above reason a number of tap makers do not remove the length of thread in the manner shown.

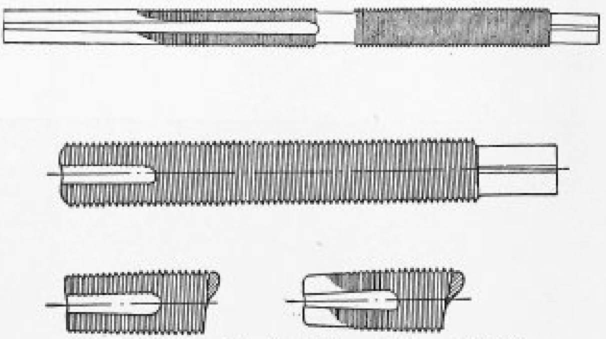
The pitch of the thread on this tap, and, in fact, on all boiler screwing or tapping tools, is eleven threads per inch, and the depth of the thread is 0.0582 inches.

#### Use of Steam-Tight Taps

A set of what are commonly known as steam-tight taps is illustrated in Figs. 2, 3 and 4. These taps are for use when the stay ends on the outer or steel shell of the firebox cannot be reached for riveting over. The practice of using steam-tight stays is, of course, not by any means as satisfactory as the use of stays with hammered-over heads at both ends. But in cases where an odd pair or a small group of a dozen or so stays have to be renewed, they answer their purposes sufficiently well, and obviate the expense of removing the lagging or lifting the boiler out of the frames. Steam-tight stays do not naturally hold the firebox shells together with the same security that ordinary stays do, and it is always advisable to limit the number of steam-tight stays which may be put into any one side or end of a firebox, this limitation being, of course, especially important with very high-pressure boilers. In general, steam-tight taps are very similar to the ordinary stay tap in Fig. 1. Their total length is, however, usually not more than about 8 inches, the fluting

* Data taken from the March, 1920, issue of *The Railway Engineer*.

being only 1½ inches long. As these taps, unlike the ordinary stay tap, cannot be carried right through both the

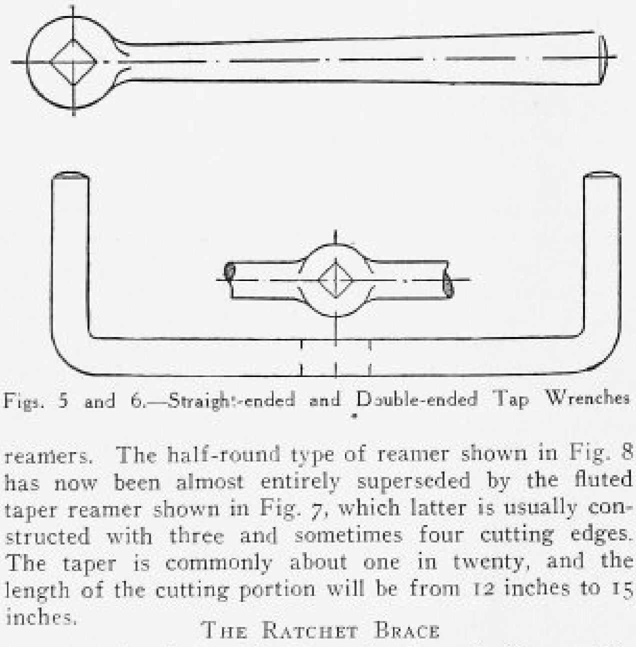


Figs. 1, 2, 3 and 4.—Staybolt and Steam-tight Taps

inner and outer shell plates, it is, of course, necessary to have them made in sets of three, namely, first, second and third taps.

In Fig. 5 is illustrated a straight-ended tap wrench, and in Fig. 6 a double-ended wrench with turned-up grips. Similar wrenches are also used for screwing in copper or bronze stays where the stays are issued from stock with the ends suitable squared up. Firebox stays usually vary so that a full stock of stay taps would comprise about five sets of each sort.

In Figs. 7 and 8 are shown two forms of stay-hole

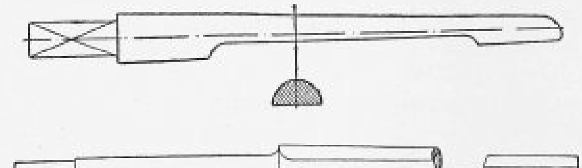


Figs. 5 and 6.—Straight-ended and Double-ended Tap Wrenches

reamers. The half-round type of reamer shown in Fig. 8 has now been almost entirely superseded by the fluted taper reamer shown in Fig. 7, which latter is usually constructed with three and sometimes four cutting edges. The taper is commonly about one in twenty, and the length of the cutting portion will be from 12 inches to 15 inches.

### The Ratchet Brace

A right-handed ratchet brace is shown in Fig. 9, this brace being illustrated in plan and section. The construction of a brace of this type is too well known to need any detailed description here. A boiler maker's equipment will usually require a large and small brace of the type illustrated in Fig. 9, and also a brace with a short forcing



Figs. 7 and 8.—Stayhole Reamers

screw, as illustrated in Fig. 10, this last-mentioned type of brace being particularly useful for working in a confined space. A brace similar in general outline to Fig. 9, but fitted with a shifting center or duplicating pawl and a right- or left-hand ratchet wheel, is also useful for special jobs where it may be necessary to reverse the movement of the brace.

The hollow socketed brace shown in Fig. 11 is another useful tool, and a brace of this type fitted with a set of sockets, both square and hexagonal, is extremely handy for use with large taps and for tightening up any bolts and nuts that may be located in awkward positions; it is, however, perhaps more useful as a fitter's than as a boiler maker's tool. The construction, as will be seen from the drawing, is very simple, the main stock of the brace being in one piece with the ratchet pawl. The necessary clearing action from the ratchet wheel is obtained by the small slot hole *A*, which allows the stock to swivel about bolt *B*. If, as not infrequently happens, any working parts of a ratchet brace have to be renewed locally, great care should be exercised in obtaining an accurate fit, and also, of course, in the hardening of such portions as the pawls and ratchet wheels. The teeth of the ratchet wheels will wear better if they are squared off slightly at the points. In Fig. 12 a drill post for use with a ratchet brace is illustrated.

Fig. 13 shows a very useful form of tubular extension for use with a ratchet brace when it is desired to drill out firebox stays or flange rivets, etc. The tube *C* is squared off at one end so as to fit into the socket of an ordinary ratchet brace as shown in Fig. 9, and a number of closely pitched holes are drilled through the tube and a drill bit *A* is made with a round shank pierced by one hole of a similar diameter to those drilled in the tube. The total length of the drill bit can be roughly adjusted to a required length by the coupling bolt *B*. A small piece of flat steel plate should always be used between the forcing screw of the ratchet brace and the firebox plate, so as avoid injury to the latter. The use of this tool is a great improvement over the common method of using an extension brace bit, as when this method is employed a lot of power is wasted in torsional movement in the stem of th bit. These very long bits are also far from handy when they require grinding, and if they break in use, as is not infrequently the case, there is a considerable risk of injury to the men using them.

### Construction and Use of Stay Driver

A common form of stay driver is shown in Fig. 14, one end of the tool being simply tapped out for a length of 1¼ inches or so, and the other end or head being fitted with tommy-bar holes. The tool is simply screwed home onto the end of the stay until it jams, and the turning movement is then applied with a short tommy-bar. A small lump of copper *C* is commonly fitted into the tool so as to prevent unnecessary injury to the end of the stay, and at the same time prevent the jamming action being too excessive. This tool is decidedly crude, and is liable to jam so tightly onto the end of the stay that it cannot always be screwed off without screwing the stay out again with it. The improved type of stay driver shown in Fig. 15 has been introduced to overcome this latter objection. The tool, as illustrated, is made in a variety of sizes usually running from 1-inch to 1¼-inch by 1/16-inch increments, the outside dimensions of the shell *C* remaining constant for all sizes. *A* is a mild steel screw with a square shank or end to fit a ¾-inch spanner. *B* is a hardened steel die piece with a serrated end, a steadying pin being passed through it and extending into the slots in the shell to prevent any rotary movement of the die.

In using the tool the stay is screwed some eight or nine threads into *C*, and *A* is then screwed home until the serrated end of *B* is forced into the end of the stay. The driver and the stay itself are now solid, and the screwing movement is imparted to the shell by means of a spanner or ratchet brace of the type shown in Fig. 11. When the stay is screwed home sufficiently far, the driver can easily be removed by easing back the screw *A* and then giving the shell *C* a light tap, which will cause the die *B* to release its grip of the stay end; the tool can then be easily screwed off the stay. A number of hand tools have been invented and patented for the purpose of cutting off the ends of the stays when in position, so as to leave only the necessary amount protruding beyond the plates for riveting or nobbling over to form the heads; none of these tools, however, has as yet met with any real success, and we shall not therefore illustrate any of them; the more so

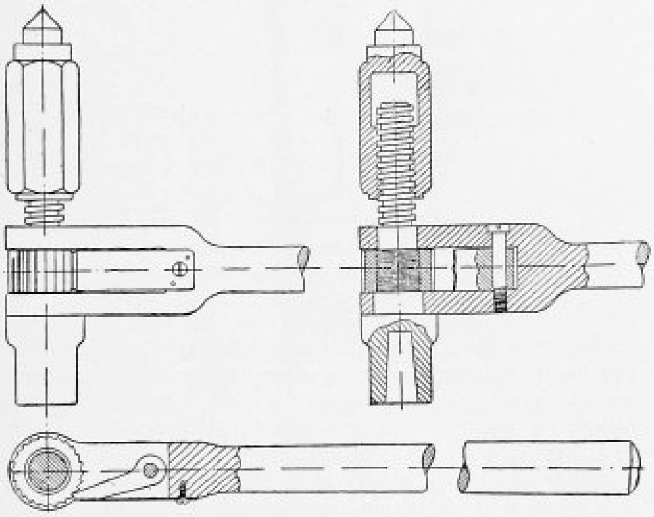


Fig. 9.—Right-Handed Ratchet Brace

as, in our opinion, they are none of them more expeditious than the practice of screwing the stay through the shell so that one end protrudes for the necessary length of about 1¼ inches and then cutting off the other end of the stay to the same length, with a broad, flat chisel, a heavy hammer or a holding-up tool being held underneatn while the end is cut off. While on the subject of stays, it may be worth noting that steam-tight stays are usually threaded a trifle tighter than ordinary stays, so as to ensure a good fit in the outer shell where it is impossible to form a head.

### Set of Die Nuts

A roof stay die nut is shown in Fig. 16, and the construction explains itself. A full set of such die nuts will be about five in number, advancing in increments of 1/16 from ⅞ inch to 1⅛ inches. These die nuts are used to form a new thread on that portion of the roof pin or roof stay which protrudes through the firebox crown. Roof nuts are frequently burned away by the action of the fire, and when a new nut has to be fitted it will frequently be found that the thread on the stay end has been damaged and a new thread of a slightly smaller diameter will have to be formed with a die nut. In fitting on new nuts, great care should always be exercised to see that the new nuts are of such a thickness that the end of the pin does not come within the nut; if this point be not carefully watched the action of the flame in the cavity formed by the nut standing away from the pin will very quickly eat away the nut. When, as not infrequently happens, incipient fractures make their appearance in the crown plate around the roof pins, thin copper washers with grommets

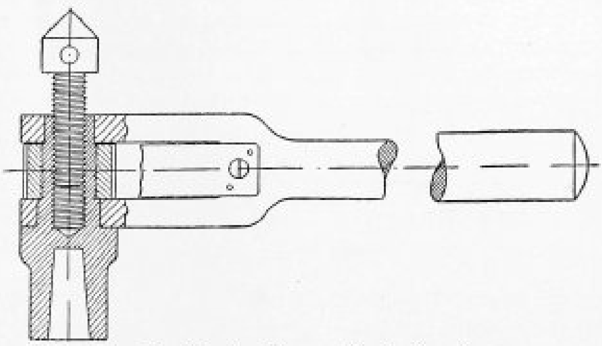


Fig. 10.—Ratchet Brace with Forcing Screw

made of hemp and red lead should be put on behind the nuts, the nuts, of course, being turned down to a suitable thickness.

### The Taper Reamer

In Fig. 17 a taper reamer for cleaning out washout plug holes is shown. Washout plugs are usually made with a

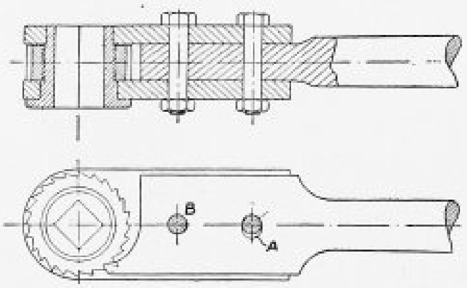



Fig. 11.—Hollow Socketed Brace

taper of one in twenty, and are constructed with a fine thread, the shell plates being tapped to suit. Each time that the plugs have to be removed, the threads on them become slightly worn, and when screwed in again the requisite tightness is ensured by the plug entering further into the shell. In course of time, however, it becomes necessary to fit a new plug of a larger size, and when this work has to be done the reamer in Fig. 17 is used to clear

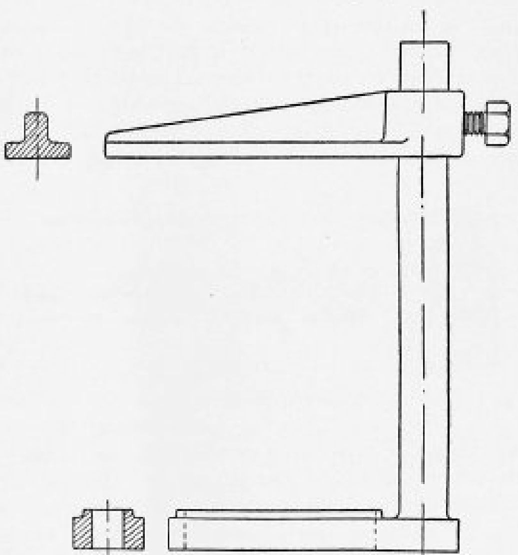


Fig. 12.—Drill Post

out the old thread prior to retapping with the special tapper tap shown in Fig. 18. It is usual to keep a stock of plugs increasing in diameter by increments of 1/16 inch from 1½ inches to 2½ inches, the diameter being measured at the greatest end of the plug. Care should be exercised in replacing plugs to see that all dirt is removed from them, as the thick oil or tallow, which is used as a lubricant when they are replaced, is apt to get baked hard onto the exposed portion of the thread, and if not regu-

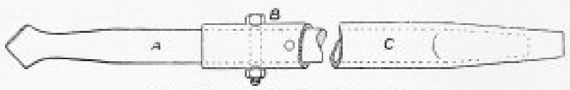


Fig. 13.—Tubular Extension

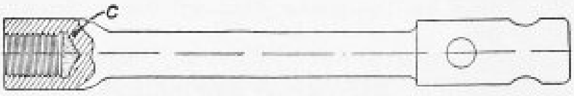


Fig. 14.—Stay Driver

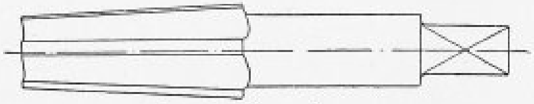


Fig. 17.—Taper Reamer

larly removed, quickly forms a solid mass and prevents the plugs being properly screwed home. The result is that leakage past the threaded portion of the shell plate is started and quickly becomes serious. An ordinary locomotive boiler will probably have a complement of at least fourteen mud plugs, one at each of the bottom four corners of the firebox, with a second one placed two or three feet above it, two above the fire-hole door and level with the firebox crown, and four in the smoke-box tube plate.

### The Bulging Pin

In Fig. 19 a tool commonly known as a bulging pin is illustrated. This tool, as its name denotes, is used for correcting the bulging or cushioning which is frequently found in copper firebox plates. This bulging takes place in an outward direction between the firebox stays. Before putting in new stays, notice should be taken of the condition of the plate in the area from which the old stays have been removed to see if any bulging has taken place, and if any be apparent the tools shown in Figs. 19 and 20 should be used in order to eliminate it as far as possible. The tool shown in Fig. 19 consists of *A*, the

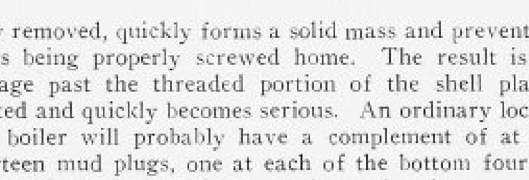


Fig. 19.—Bulging Pin

bulging pin proper, and *B*, a small, hard steel socket piece against which the end of the pin works. The socket *B* is constructed with a light groove *C*, at the small end of which a piece of fine cord with a loop at the far end is attached. This cord is passed into the water space from any conveniently situated mud plug hole and the looped end is fished for from a stay hole with a piece of light brass wire, until the string can be drawn through the required hole. The socket *B* is then drawn up and worked into position in the stay hole in the outer shell plate, as shown in the illustration. The pin *A* is then screwed hard up against the socket, and the bulged portion of the copper plate in the near vicinity is hammered with a light hammer; after a few blows the plate will give way sufficiently to allow the pin *A* to be screwed home a little

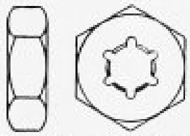


Fig. 16.—Roof Stay Die Nut

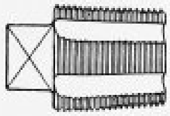


Fig. 18.—Tapper Tap

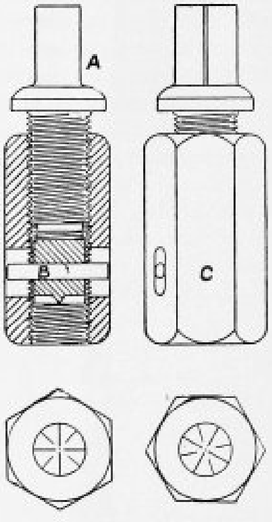


Fig. 15.—Improved Type Stay Driver

more. This process of tapping and screwing up is repeated until the plate has become sufficiently straight. A full set of bulging pins will, of course, comprise one pin for every size of stay kept in stock. The preliminary fishing for the socket piece is often a tedious process, but once having gotten it into position for one stay it is not a matter of great difficulty to shift it onto the next stay hole when a group of old stays are being renewed.

The apparatus shown in Fig. 20 is somewhat of an improvement on the tool just described. It consists of a cast-steel horseshoe piece *A*, the feet of which are spaced about 8 inches apart, a screwed spindle *B* a nut *C*, and a

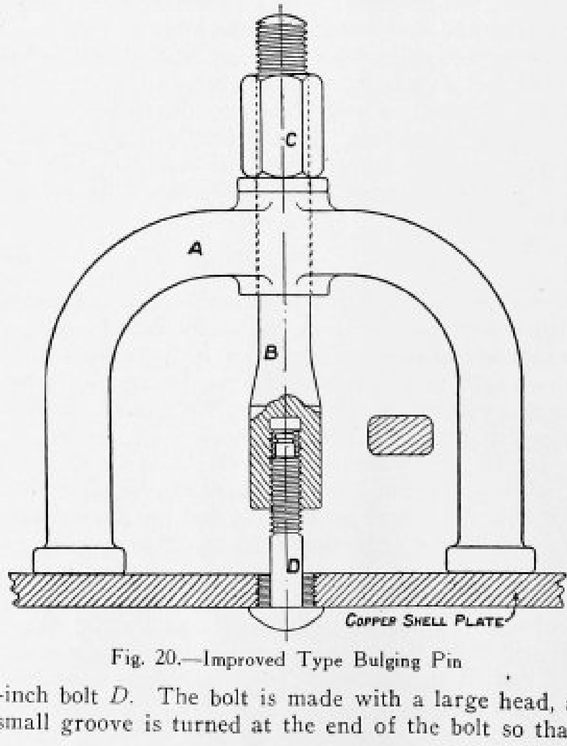


Fig. 20.—Improved Type Bulging Pin

⅝-inch bolt *D*. The bolt is made with a large head, and a small groove is turned at the end of the bolt so that it may be secured to a piece of string and fished for in a similar manner to the socket piece of the tool previously described. Having put the bolt *D* in position, the hollow end of spindle *B* is screwed onto it (the thread in this socket being made an easy fit), and the necessary straining motion is applied by tightening up the nut *C*, the hammering and straining of the plate being carried out as previously explained. One of the principal advantages of this tool is that there is no liability of damage occurring to the threads in the copper plate, while the straining effort is distributed over a greatly increased area of plate.

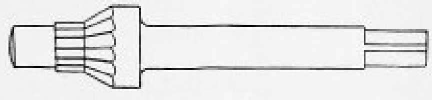


Fig. 21.—Special Type Reamer

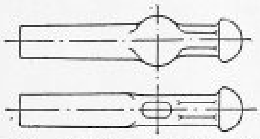


Fig. 22.—Riveting Hammer Head

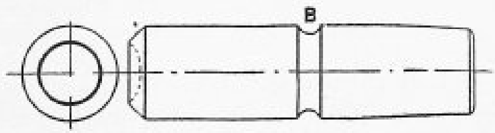



Fig. 23.—Rivet Stamp

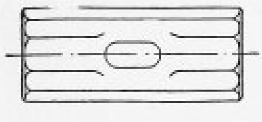


Fig. 24.—Boiler Maker's Hammer Head

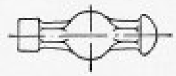


Fig. 25.—Fitter's Hammer Head

Special Form of Reamer

Fig. 21 illustrates a special form of reamer designed for use when it becomes necessary to renew some of the copper firebox flange rivets with countersunk, headed studs. When studs have to be put in to replace rivets it is of the greatest importance that there should be no thread left in the flanged plate, and at the same time the thread in the other plate must be as good as possible. After cutting off the head of the old rivet and knocking the stem of it out with a punch, the hole is cleaned out with a long taper reamer similar to the one illustrated in Fig. 7. After this the hole is tapped through both plates and the usual method employed to countersink the flanged plate with a brace bit and chip out what is left of the thread in the flanged or outer plate with a round-nosed chisel. This method is, however, very crude, and the reamer shown in Fig. 21 is so constructed that it will cut out the necessary countersink and at the same time remove the unnecessary thread from the outer plate. Unless the thread in the outer plate is removed, it is of course quite impossible to pull the two plates tightly together and secure a good joint.

Fig. 22 illustrates the head of a flogging or riveting hammer used by boiler makers in riveting over stay heads, etc. Fig. 23 shows a rivet snap, which is simply a piece of round steel with a half-round recess at *A*, this end of the tool being carefully hardened. After a rivet end has been roughly hammered up with the hammer shown in Fig. 22, the snap is held over it and a few blows with a heavy hammer on the head of the snap tool will produce a regularly formed head. A set of these snaps is, of course, required for different sized rivets. Fig. 24 shows a boiler maker's double-ended heavy hammer head. Fig. 25 is an ordinary fitter's hammer head used for such work as chipping, calking, etc.

The types of welding and cutting tools in general use in England are quite similar to those employed in the shops of this country.

## Meters and Inches

BY PROFESSOR C. H. PEABODY*

A man has five fingers on his hand; hence the decimal system, which in ways is inconvenient. If a man had four fingers, we should have the binary system; if he had six fingers, we should have the duodecimal system. Each of the two systems last mentioned is so convenient that they are persistently used and will continue to be. It is probable that either, once established with its proper notation and means of computation such as multiplication table and logarithms, could dominate the mathematical world. So much for the sacrosanct decimal system. But the decimal system now established will always remain dominant, though enthusiasts may dream of reformation.

The apotheosis of the decimal system is found in the metric system, which truly has its inconsistencies and inconveniences; but it serves where it is in use and will continue, probably squeezing out the remnants of older systems, though the process is less rapid and perfect than its protagonists represent. It is most amusing to compare the maps issued by the propaganda for the metric system and the maps of the defenders of the dominant industrial system of Britain and America. The aberration of statistics seems to have run wild in these maps.

Without going into statistics, it may be claimed that the English inch is now the dominant unit of length in the industrial world; roughly, its dominance can be represented by the fraction three-fourth. This does not mean that it will become universal; we are probably doomed to have two systems of weights and measures and to get along as best we may under that condition. But most of the world knows one system or the other; and using habitually one system and having no knowledge of the other has little occasion to worry. In fact, nobody appears to worry except certain reformers and those whom they worry by threatening legal enactments.

Let it now be boldly said that the system of weights and measures of the British Empire and the United States cannot be changed. Congress has great power and Parliament is not even limited by a written constitution, but singly or both together they cannot change the practical use of the systems of weights and measures of their countries. Both deliberative bodies have in them men of information and common sense, and it is most unlikely that either will attempt legislation looking toward the substitution of any other system in place of the one now in use. But there is just enough chance that something may be slipped over to worry the engineering world and make it necessary to meet propaganda with propaganda because the mass of people do not know that it can be done. In fact, a considerable number of scientists and enthusiasts think it can be done.

There are three arguments in favor of a change: (1) that the metric system is scientific, (2) that it is more convenient, and (3) the advantage of uniformity. Taking

* Head of the Department of Naval Architecture and Marine Engineering, Massachusetts Institute of Technology, Cambridge, Mass.

the last first, we can but admit it; it would be a good thing if we could get it. There is no evidence that meters are more convenient than inches; perhaps the latter have the advantage. Scientists use the metric system and for their purpose it is convenient, but its advantages are too much extolled. Probably, if scientists were trained on the English units, they would get along very comfortably.

At one time the United States army had a practical cap, a sensible cap, such as a civilian would wear. It came between the old civil war style and the English style now in use. The only fault found with it was that it was not military. A hard-headed American officer gave the real reply to this criticism. He said that a military cap was a cap worn by military men. Now the writer has had occasion to use both systems of measure and to transform from one to the other, and after a study of the original pretensions of the metric system and its real status he is of the opinion that it is scientific because scientists use it.

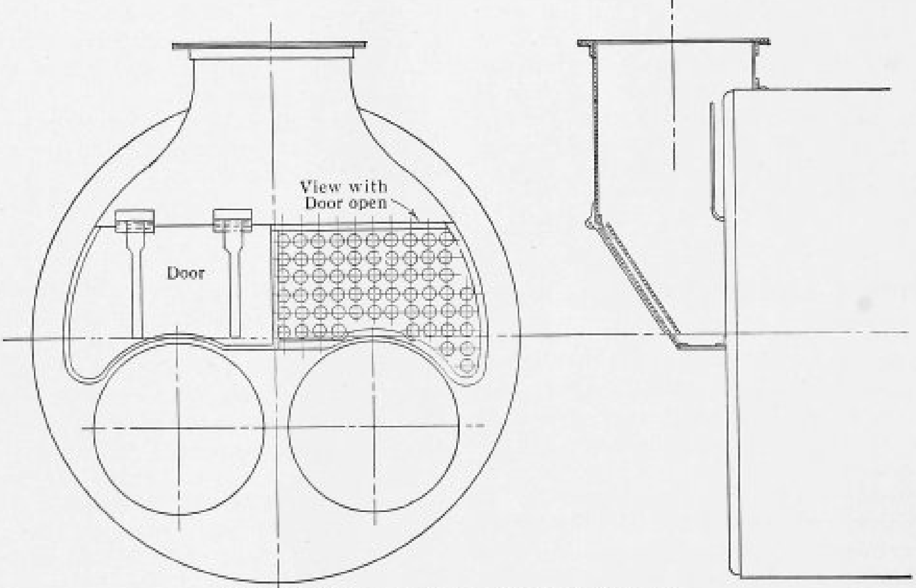
Three centuries ago tramways were laid in England for hauling coal. The wagons then in use had a gage of four feet eight inches and a half. So in 1814 Stevenson's locomotive had the same gage, and now the standard gage of England and America is four feet eight inches and a half. Let the proponents of the metric system undertake to increase this gage by the amount of two inches and a half, to 1.5 meters, and then let them pause before attacking the standard airbrake fittings.

There are three English institutions that need reformation. Naming them in the order of difficulty (if such an expression is proper concerning what cannot be done), they are the English language, the English weights and measures, and the English money. An English commission has just reported adversely concerning a proposed change of money to a decimal system.

# Design of Smokeboxes for Scotch Boilers

BY JOHN S. WATTS

The correct principles of design for smokeboxes is a subject that has been neglected by the technical publications, and therefore a few words upon the general procedure of smokebox construction should prove useful to the younger members of the craft, and may help them to avoid making blunders because of insufficient information.




General View of Uptake Fitted to Scotch Boiler

We must first decide upon the size of the stack, which should be about one-sixth of the area of the grate surface. Proceed with the layout of the tubes in the front head, and draw the outline of the smokebox around the tubes, leaving room between the outer tubes and the shell of the smokebox for the 2-inch angle which is to be used to connect the smokebox to the boiler. The shape in general is about as shown in Fig. 1, but may be altered slightly if the changes are so made as not to baffle the draft.

The bottom of the box should be sufficiently deep horizontally to allow space for the accumulation of soot and ashes, which would soon fill up the box to a point where the lower tubes would be choked if the box were too shallow at this point. An average depth is 12 inches.

From the bottom up, the front of the smokebox should be tapered outwards to a horizontal depth of about 2 feet. This is to keep the front away from the direct impact of the flame. This depth must, however, be sufficient to give an area for the flow of the gases at least equal to the area of the stack, and care must be taken to see that at no point in the smokeoox is the transverse area reduced below that of the stack.

The upper portion of the smokebox is made square for easy manufacture, the side of the square being equal to the diameter of the stack. By reason of the area of this part being greater than the area of the round stack, it is possible to have a portion of the square set directly on top of the boiler and still have the required sectional area inside. The placing of part of the smokebox directly on top gives a substantial base upon which to rest the weight of the stack.

The body of the box and the doors should be made of plate 3/16 inch to 1/4 inch in thickness, connected at the corners and to the boiler by 2-inch by 2-inch by 5/16-

inch angles, using ½-inch rivets with a pitch of 3 inches. No calking is necessary, but the plates should be well fitted in order that they may be nearly airtight.

There should be at least two doors, and in the larger boilers three, so that each will be small enough to be easily handled.

A hook-and-eye bolt should be riveted to each door to act as a hanger while the tubes are being cleaned.

Sufficient handles and catches of the usual smoke-door type should be fitted to hold the door tightly closed.

Particular care must be exercised to see that every tube can be swept through the door opening, and also that every tube can be withdrawn and replaced if necessary. In some boilers it will be impossible to have the doors arranged to permit the removal of every tube through the door openings without making the doors an unwieldy size. In this case a tee bar can be fitted for the doors to clamp against, and this tee bar bolted to the box, instead of riveted, so as to be easily removable when the tubes need renewal. The tee bar should be made narrow enough not to interfere with sweeping the tubes.

The box is bolted to the boiler by ¾-inch studs spaced about 10 inches on centers. These studs pass through the 2-inch angle that is riveted to the shell of the smokebox.

The doors should be fitted with ⅛-inch baffle plates on the inside, with an air space of about 1¼ inches between the door plate and the baffle plate, to prevent the heat warping the door.

For good work, and where the fireroom would be uncomfortably hot, the whole box should be lined inside with baffle plates in the same way as the door.

Indeed, for tropical climates, it is sometimes necessary to fit another set of plates outside the boxes and doors to keep the heat from radiating into the fireroom.

The upper part of the boiler head having steam in contact only on the inside should be protected from overheating by a baffle plate about ¼ inch in thickness and well fitted to the boiler at the bottom. This plate can very conveniently be held by check nuts on the through stays, provided that these stays are made sufficiently long for the purpose.

When two or more boilers are connected to the same stack, it will be necessary, for the control of the fire in each boiler, to fit a damper in the upper part of the smokebox. Otherwise the draft can be controlled by means of the ash pit doors on the furnaces.

## Rules for Locomotive Boiler Welding

Standardized practice in locomotive boiler welding with oxy-acetylene and the electric arc has been formulated for the Kansas City Southern Railroad under the direction of G. M. Calmbach, supervisor of welding. The following abstract, taken from *Autogenous Welding* emphasizes five essential points that must be considered in boiler welding:

1. Condition of sheets.
2. Bevel of sheets.
3. Position of sheets.
4. Provision for expansion and contraction.
5. Welding rod or adding material.

The success or failure of boiler welding depends on how carefully these are considered. The rules are in part explanations and applications of the foregoing:

When sheets or patches are to be applied, all defective parts must be cut out and the cuts must be made where a sound foundation for the welds will be provided.

All sheets and patches should be cut on straight lines, avoiding staybolts wherever possible.

Never cut out sheets or patches through an old weld, when avoidable.

When cutting out side sheets or three-quarter door sheets, extend the new sheets at least one staybolt row higher, and when cutting out crown sheets extend one staybolt row lower. Patches should be extended at least one staybolt row larger all around, and flue sheets one row lower.

Do not cut out sheets or patches and bevel the sheets at the same time. Chipping is necessary to insure uniform lines and proper fit.

Remove all scale, rust or grease before making a weld. Foreign substances on welding surfaces produce seamy welds.

Bevel all joints to be welded to an angle of 45 degrees with the surface of the sheets. The total or included angle between the beveled faces must be 90 degrees in all cases, even if one sheet has to be beveled more than the other.

All sheets and patches must be made to fit with an opening of ⅛ inch—no more, no less—between the beveled edges. Less than ⅛-inch opening will not permit the welding flame to penetrate properly and a greater opening requires too much welding material, not only making the weld cost more, but producing a rough surface on the opposite side. This rough surface causes lamination and seaming on the water side and rapid deterioration.

Provide for expansion and contraction, either by means of curves in the adjacent sheets or corrugations in the sheet or patch. Neglect of this means failure.

The corrugations of side and door sheets should be about 4¾ inches wide and the maximum height not more than ⅝ inch. Corrugations for patches should have an overall width of 3 inches and a height of ⅝ inch.

Corrugated sheets or patches should be bolted securely into place with ⅝-inch bolts, using close-fitting drift pins when they extend to the mud ring, to hold against upward movement due to contraction.

When side sheets are to be welded at the ends it is necessary to remove the adjacent row of staybolts to the edge of the flange of the door or flue sheet before welding is started. It is also advisable to remove all staybolts adjacent to welds after welding is completed.

When welding corrugated sheets or patches with the oxy-acetylene torch, the operator must stop and heat a line one inch wide through the center of the corrugation to a red heat for every 12 inches of welding completed. This operation must be repeated for each 12 inches until the weld is finished.

No firebox weld should be reinforced more than 1/16 inch, as too great a reinforcement is injurious to the weld because of overheating when in service.

Welding of cracks in side sheets, firedoor sheets, crown sheets, bottom and top of flue sheets, should never be attempted except in emergencies.

Welding over a staybolt or welding a staybolt is strictly prohibited by law.

A crack extending along a row of staybolts may be repaired only by cutting out a circular section around each staybolt hole and welding in a new piece. The crack between adjacent welded-in sections may be welded.

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James T. Lee has been recently added to the sales engineering staff of the Southwark Foundry and Machine Company of Philadelphia, Pa. It is the purpose of this company to broaden its field of activity by adding to its present line of hydraulic and power machinery a full line of pneumatic and hydro pneumatic riveters and foundry molding machines.

# Are We Competitive?

BY L. W. ALWYN-SCHMIDT*

*Industrial organizations of the United States seemed for a time to realize the infinite possibilities in developing the demand for American goods in foreign markets, particularly in South America. Just the position this country holds as a competitor of the European nations in the world's trade is described in the following article.*

Exporting boilers and selling boilers at competitive rates in our own market or abroad are only very insignificant parts of the great problem. But the boiler industry is an essential of the great equipment industry, and as such is one of the key industries of the nation. If the boiler industry is busy, all other American industries will be busy. You cannot very well expand the industrial activities of a country without providing at first for the motive power. Boilers have not in the past played a big part in our export trade; nevertheless, we cannot very well imagine a well-balanced foreign commerce without the boiler industry having a look-in.

Manufacturing boilers has not been a very joyful occupation during the last few years. The industry has worked under great difficulties, and it does not seem to have arrived yet at the end of its troubles. Every manufacturer knows how much more it has cost him for materials during the present year than in the year 1914. He also has a fair inkling as to the cost of labor, although the latter factor has proved exceptionally elusive in recent attempts at cost finding.

For a while at least it looked as if the American industry had broken that ring which encircled it and would not permit it to take its just share of the foreign trade of the world. For a very short while, at that, American exports of industrial merchandise have flown freely to all markets. During this period our industry has been able to compete in prices and grade of production successfully with other nations. Is this development now to come to an end? Are we to throw away the great advantages that have been gained during the last few years and return again to the pre-war policy of letting the customer come to us? Are we again to let our industry be overtaken by the more adaptable industries of other countries? Are we again to return to a policy of social adjustment that will not permit us to produce at competitive prices. These are questions well worthy of consideration by all those interested in the future of the American foreign trade and in the future of our nation itself.

### European Adjustments

We have, further, a fair knowledge of conditions in Europe. When is the present forward movement in production cost to stop, and will it stop at a point where we can compete with European prices? The answer will have a material bearing not only upon the future development of our foreign commerce but also upon the fate of the boiler industry in our own market. If Europe should prove more able to adjust its manufacturing costs than our own manufacturers, the boiler business of the world will return to the European makers. If American cost of production should exceed the European rates materially, there is even the danger of European boilers being imported into this country. No tariff will in any case protect us against such an eventuality.

Considering the difficulty of shipping boilers and the comparative absence of European competition from the American markets in the boiler trade, such a statement may sound rather strong. We must, however, take into account the fact that conditions just now are more than favorable to the import of heavy commodities of European origin in the United States. During the next years we are bound to ship much more to Europe than Europe is liable to send to us. Vessels will return frequently from European ports to ours under ballast, and their owners may think it worth while to carry certain heavy and bulky freight at low costs, so as to employ at least part of the empty return tonnage. This will immediately foster the shipment of merchandise of just the character represented by the boiler.

### Problem of American Costs

Naturally such a development can only take place if American boilers should prove much more expensive in production than the European, but this is just the problem we have here under consideration.

Granted a still further increase in the cost of materials as steel, etc., it may be assumed that this will hit the industries of the world in practically an equal degree. We cannot imagine Europe producing iron and steel much cheaper than the United States. It is, in fact, an old rule of international commerce that staple commodities as steel, etc., are costing approximately the same all over the world. This rule has even not ceased operation under the very upset money conditions of today. Copper, for instance, costs in Germany its American value, plus freight expressed in the varying low exchange rate of the German mark. If we buy copper at a certain price, we can assume as correct that the English, French or German boiler industry will not buy it much cheaper. If the German iron works should lower the price of steel, it is certain that the American producers will follow suit. So nothing is gained by an industry in any country with respect to materials.

### Labor Costs

It is different with labor. The cost of labor, as already mentioned, is very elusive. Every manufacturer knows approximately what he spends in the matter of labor in his own factory, but he has no perfect control over the wage movements in all the other industries upon which he is dependent in the matter of supplies. Taking even the boiler industry independently, it seems that it has had more than its just share of wage troubles. The work in a boiler factory is so specialized now that it is difficult to give exact instances of wage increases. The writer, however, has seen the employment sheet of a boiler factory in the state of New York, which shows that wages in this factory have risen during the last five years at the rate of 258 percent. This case is certainly not very exceptional.

* New York Economic Service Bureau.

considering that the wage scales in the iron industry as a whole have grown at a rate of 263 percent. Translated into practice, this means that a job costing $100 five years ago is now costing $258 in that particular factory in labor alone.

### Effect of Competition

Competition seems to have made it impossible in this particular instance to add as much to the total price of the job, with the result that its owner is considering at the present moment the problem of a general reorganization of the plant, entailing a considerable outlay for new equipment and possibly a reduction in certain departments.

### Industry in Europe

The European boiler industry, of course, has not escaped the influence of the high cost of living, resulting in higher wages all around. The German case probably is the worst, because Germany has not only seen a very rapid rise in the cost of all essential commodities, but also a very extensive devaluation of its money. There is at the present moment no means to establish anything like a proper wage scale for any industry in Germany, outside the fact that all wages have risen. The German industry, however, is striving hard to re-establish itself again on a working basis, and it demands as part of this progress a reorganization of its money exchange. What adjustment will be reached is not known at present. It is, however, certain that the mark cannot remain as low as it is now. Wages, then, will be established in Germany on the basis of the new currency value, which, in turn, will have to be measured by the purchasing value of that money unit. In the meantime the German workman has known the sweetness of liberty and comparatively high wages, and he will naturally claim a larger share in the profits of the German industry, which most likely will be conceded to him by the government.

We may assume with some certainty that German wages will not be low. Will they be at the equivalent of present-day American wages? Hardly! The German workman does not demand from life the same luxuries and conveniences as the American. Therefore he may be satisfied with less payment. This would mean that the wage-screw will come to an end of its turning in Germany for some time, and it is then up to ourselves to see how far the German wages are below our own standards and how far we have to adjust our production methods to meet their competition. The chances are that the difference will not be so great and that German competition in the boiler field will be limited to the markets in its immediate neighborhood, including Russia, the Balkans and the states of Central Europe. We may meet this competition by granting favorable freight rates to the shipment of boilers on our own vessels and by interesting ourselves extensively in industrial enterprises in the countries in question, with a view to affect favorably our own exports in their direction.

### French Competition

France most likely will not be a large competitor individually, at least not for a number of years. The French boiler industry no doubt will grow very rapidly in the future. Before she can do so, however, it will be necessary that France set her own house in order. This does not mean, however, that France will have to wait until her own factories are built. She has taken over a very extensive slice of the European iron and steel industry and cannot be expected to operate this industry immediately as efficiently as was the case in the past. The French owners will have to familiarize themselves with the uses of the new implement which has come into their hands. In the meantime the French boiler industry may be satisfied to handle such business as comes its way without making special efforts to get more. The labor problem is as great in France as in all the rest of Europe. Wages also have risen in France, but the rise does not seem so extensive as in Germany. Also, the French workman started upon a comparatively lower basis than the German. Whether the wage movement has come now to an end is difficult to say.

We must consider, also, that the French workingman is easily satisfied with the conditions of his life if they permit his comparative comfort and a certain easiness in his expenditure. France, no doubt, has today the making of a large iron manufacturing country, having plenty of iron and the certainty of finding at its disposal a fairly efficient labor force at comparatively low cost after it has once gotten over the aftermath of the war. There is something in France that may make her the most intense competitor of our own boiler industry in many of the world's markets and further developments in this direction certainly need watching.

### Conditions in England

As to England, it seems that the wage movement in the iron industry has come definitely to an end, unless it breaks out again in a yet unexpected direction. It has ended with an increase in wages that brings the English wage scale very near to own own. England has always manufactured at a comparatively higher cost than any other European country, and it will not be able to change this in the future. Taking for granted that its prices will remain approximately where they are now, there should not be much in favor of either an American- or an English-made boiler if sold in another country on the count of raw material and wages. Overhead expenses may be smaller in England than in the United States in the future as they were in the past. But England has to pay off a very big debt, for which she will find only an incomplete compensation in the German indemnity. This must influence all overhead expenses in the future, and the effect probably will show more and more as time goes on.

If, therefore, there should be little to choose between our own boilers and the English in price and quality, the competitive ability of the two will center largely upon the methods employed in each instance in the distribution of the product.

### English Export Trade

England has done quite an enormous export in boilers before the war, making a very good use of her merchant marine for that purpose. It must be understood in this respect that, as far as bulk is concerned, England had normally a larger inward freight movement than outgoing. To increase the bulk of the outward freight, English exporters and shippers commenced the system of employing forced freights, which were taken by the shippers at low rates. In this way English coal came very handy, and heavy industrial machinery also was often shipped at the favorable rates offered for such cargoes. Heavy machinery is not easily carried in foreign trade, owing to the high freight rates ordinarily charged for such traffic England has always had a good export trade in all these heavy freights, owing to the reason given. The influence of the English merchant marine no doubt will again be exerted with all force in favor of machine exports, and the English boiler industry should benefit by this policy.

### Problems for America to Solve

The problem for the American boiler industry is now how to neutralize to a reasonable extent the effect of the higher wages governing the production throughout this country.

There is one lesson to draw from this statement. As far as this country is concerned, the recent forward movement in the wage payments must stop if we want to survive in the coming commercial period as an industrial export country. This does not mean that labor desiring new wage increases at the present time is entirely at fault, but it means that a complete readjustment has to take place in our whole economic life. Prices somehow will have to come to a standstill so as to permit the boiler industry to adapt its cost accounting to the situation now governing the world's market. Our customers have been very lenient with us during the last years, accepting our very indefinite quotations with a fair amount of good will. But we cannot expect this to continue for any length of time. If we prefer to run our industrial life on the lines of the last year with permanently mounting costs, we must at least exclude the foreign customers from the effects of this situation and permit them to buy in our markets under conditions they are accustomed to meet from other countries. We must stick to our cost estimates, even if we should prove the losers. We are certainly able to do so as soon as we have found means of stabilizing labor cost. The cost of material then will take care of itself.

### Outlook for Shipping

There is every reason to expect in the near future a considerable improvement in the shipping situation. Every week new vessels are released for ordinary foreign-carrying. With the return of these ships to their former routes and the coming of the new ones into the service, shipping rates will not only be more stable than they have been during the last few months, but the greater supply of ships will itself prove an inducement to lower the rates. Many of these vessels will have deck space available for carrying a few boilers, and we shall then be really able to go after our foreign business with some sort of success.

At the present moment we seem to be still fairly competitive. There is a hope that we shall remain so in the future.

## Work of the American Society of Mechanical Engineers' Boiler Code Committee

*The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th 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.

Case No. 253 (previously annulled).—Is it permissible under the requirements of the Boiler Code to use for boiler construction tubes or flues that have been formed into the desired lengths by welding together at their ends, short lengths of such tubing by the electric pressure welding process, provided the metal upset at the weld is immediately rolled down to the proper thickness while under the heat of the weld?

It is the opinion of the Committee that, while there is no objection to the safe-ending of tubes for firetube boilers by a suitable forge or pressure welding process, the suggested method of making the tube from a number of short pieces would be an objectionable practice. The Committee does not consider the practice of safe-ending tubes to be a suitable one for watertube boilers.

Case No. 268 (reopened).—a. Inasmuch as the discharge of feed water into vertical firetube boilers in accordance with the requirement of paragraph 316 of the Boiler Code has caused serious difficulties from leaky tubes in the lower tube sheet, a reconsideration is requested of Case No. 145, in which the opinion of the Boiler Code Committee is given that the discharge of feed water in the water leg of a vertical firetube boiler is not permissible.

b. In case it is ruled that such discharge of feed water into the water leg of a vertical firetube boiler is not allowed, is it permissible to protect the feed water discharge through a feed water pocket riveted within the shell at a point above the water leg, with handhole opening for cleaning?

In the case (a) above, it is the opinion of the Committee that paragraph 316 does not permit of discharging the feed water in the water leg of a vertical firetube boiler, and that difficulties with leaky tubes may be avoided by the use of an internal feed pipe which does not discharge into the water leg.

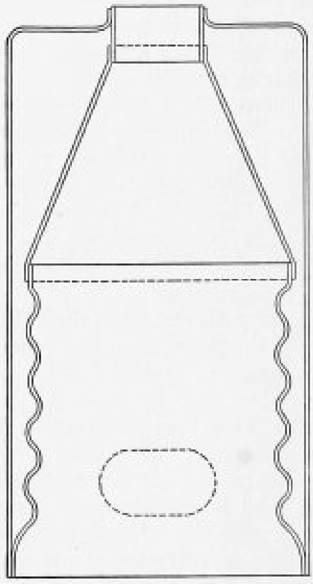

Fig. 1.—Vertical Single Flue Boiler with Corrugated Firebox

It is the opinion of the Committee in case (b) that such a method of delivery of feed water to a vertical tubular boiler through an internal pocket or baffle above the water leg, with handhole opening for cleaning, is in full accordance with the requirements of the Boiler Code.

Case No. 275.—Is autogenous welding permissible for the longitudinal joint of the firebox of a form of vertical boiler as shown in Fig. 1, where the furnace section is, after welding, heated and corrugated by rolls? The corrugations are rolled to a depth of 1½ inches on 8-inch centers, and the weld shows no fracture or distress after either corrugating or flanging.

It is the opinion of the Committee that the construction referred to fully complied with the requirement of paragraph 186 of the Boiler Code, and the thickness of the furnace for a given maximum allowable working pressure should be determined in accordance with paragraph 243.

Case No. 278.—What would be considered the lowest permissible water level for a vertical watertube boiler of

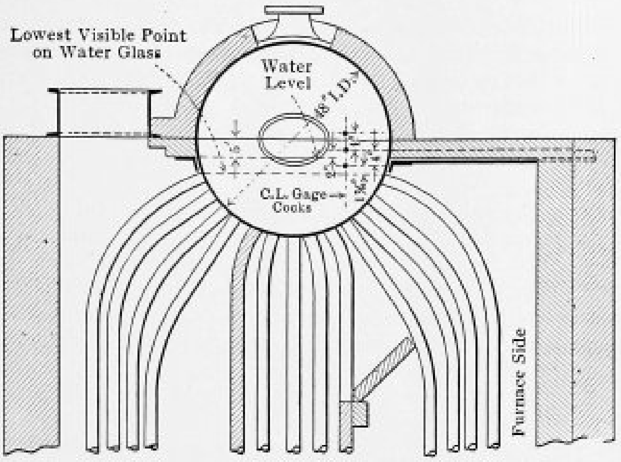


Fig. 2.—Location of Lowest Permissible Water Level

the type shown in Fig. 2. Paragraph 430v of the Boiler Code to which reference is made in paragraph 291 relative to the lowest permissible water level leaves the location rather problematical, as there may be a difference in opinion as to what the lowest permissible water level may be.

It is the opinion of the Committee that for a watertube boiler of the design illustrated a location for the lowest permissible water level such as referred to in paragraph 430i would be a suitable and safe construction.

Case No. 283.—In the construction of a watertube boiler in which the tubes enter the tube sheet at an angle as great as 20 degrees from the normal, may the requirements of paragraph 252 of the Boiler Code be fulfilled if the least projection of the tube be not less than ¼ inch or more than ½ inch?

It is the opinion of the Committee that paragraph 252 applies to tubes which enter normally to the sheet and that where the tubes are at an angle the least projection of the tube should not be less than ¼ inch or more than ½ inch, which may result in the tube projecting more than ½ inch at other points around the tube. The rule given in paragraph 251 for flaring should apply to the true diameter of the tube hole measured in a plane at right angles to the

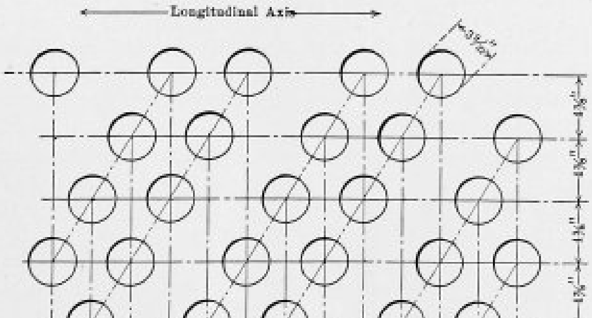


Fig. 3.—Special Spacing of Tube Holes in Drum of Watertube Boiler

tube end and not to the maximum diameter of the elliptical opening in the tube sheet.

Case No. 287.—Is it permissible to burn off the edges of boiler plates and use them without any finish where sheared edges would be permitted by the rules in the Boiler Code?

The Code does not prohibit the practice suggested.

Case No. 288.—Where a manhole is applied to the head of a dome and an opening for access to the boiler is placed in the shell under the dome, is it necessary to reinforce this opening in accordance with the requirements of paragraph 260?

It is the opinion of the Committee that such an opening should be reinforced in accordance with the requirements of paragraph 260. The reinforcing effect of the base of the dome may be included in calculating the reinforcement.

Case No. 291.—In the case of a special arrangement of spacing of tube holes in the shells of the drums of a watertube boiler with the pitch unequal in every second row, but shifting the adjoining rows to an exact stagger as shown in Fig. 3, is it proper to calculate the efficiencies of ligaments under the requirements of paragraph 192 or 193 of the Boiler Code?

It is the opinion of the Committee that the efficiency of the tube sheet should be obtained by employing the method outlined in paragraphs 192 and 193 of the Code for diagonal ligaments. All possible methods of failure should be assumed and the lowest value obtained through any one of the methods should be used.

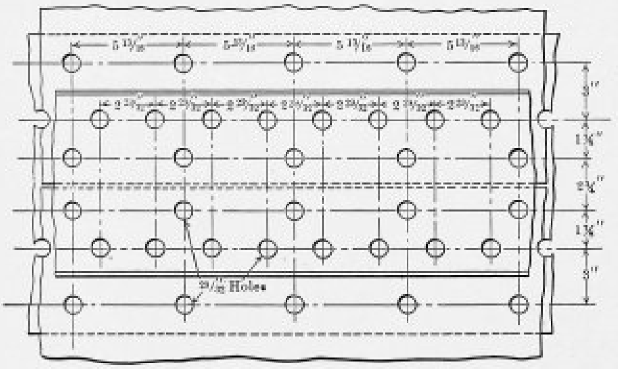

Fig. 4.—Triple Riveted Joint with Wide Rivet Spacing in Inner Rows

Case No. 292.—In the case of a triple-riveted butt and double strap joint with the pitch of rivets in the first and third rows one-half of that of the second row, as shown in Fig. 4, what is the proper method of determining the back pitch between the first or inner and second or middle rows of rivet holes?

It is the opinion of the Committee that the efficiency of required between the first or inner and the second or middle rows of rivet holes in such a design of joint shall be governed by the rules of paragraph 182 for determining the back pitch between the second and third or outer rows of rivets.

Case No. 294.—Is it the intent of paragraph 331 of the Boiler Code that at least one complete set of the four stamps specified for boiler plate in paragraph 36 remain visible after the completion of the boiler, or if the slab or melt number is invisible, are the remaining markings sufficient to meet the Code requirements?

It is the opinion of the Committee that all of the information which the Code requires to be stamped on the plates at the mills must be obtainable from the finished drum structure for each plate. All four stamps need not be visible at a given point if the fragments from various sets can be pieced together so as to give the desired information.

Case No. 295.—How may an inspector in the field know the range of tensile strength of boiler plate?

Attention is called to the fact that the range for all classes of steel specified in the Code is 10,000 pounds per square inch and the tensile strength stamped on the plate indicates the minimum of this range, which under the rules must not exceed 55,000 pounds per square inch.

Case No. 296.—Will a watertube boiler of a type largely used in marine service, the heating surface of which is constructed mainly of iron pipe screwed into malleable iron and steel fittings, meet the requirements of the Boiler Code, if the pipe used is a special quality of redrawn lap-welded iron pipe of puddled stock and tested to 1,000 pounds hydraulic pressure?

There is nothing in the Boiler Code to cover the use of iron pipes for the tubes of such a boiler with screwed joints. Until such a time that the specifications for piping have been formulated, the Boiler Code Committee would consider that if the other requirements of the Boiler Code are met, special redrawn pipe not to exceed 1½-inch standard pipe size made from lap-welded iron of puddled stock and tested to 1,000 pounds hydraulic pressure may be used for a working pressure not to exceed 200 pounds per square inch, provided the wall thickness is at least 50 percent greater than the wall thickness required by the Code for tubes of watertube boilers.

Case No. 297.—Will the requirements in the Boiler Code for automatic water gages be met under the terms of paragraph 427*e*, if the shut-off valve in the upper fitting has a projection which pushes the ball away from the seat for a distance of ⅛ inch, causing the ball to drop to a position considerably greater than ¼ inch away from its seat?

It is the opinion of the Committee that the intent of the requirements of the Code will be met in the construction described.

Case No. 298.—Is it permissible in the case of a forged steel steam outlet riveted to the boiler shell to use a wrought steel flange screwed to the outer end of the endneck, the neck being properly threaded and peened over into a beveled part cut away from the flange?

It is the opinion of the Committee that this method of forming a steam outlet connection meets the requirements of the Rules in the Boiler Code.

Case No. 299.—In using paragraph 212 to determine the maximum allowable internal working pressure that may be allowed on a staybolted surface under the Code rules, it is stated that the weakening effect produced by drilling the staybolt holes must be considered. Cylindrical surfaces of the character referred to in this paragraph usually contain a riveted joint that weakens the structure more than does the drilling of staybolt holes. Should not the weakening effect of such joints be considered in the applying paragraph 212?

Where the curved staybolted surface referred to in paragraph 212 contains a riveted longitudinal joint or other construction except hand-holes, and the strength of the surface through such joint or other construction is less than through any line of staybolt holes in the same direction, the weakening effect of the joint or other construction instead of that produced by the drilling of the staybolt holes is to be considered in making the calculations for pressure by this paragraph.

Case No. 301.—Is it the intent of the Boiler Code under paragraph 182 that the back pitch of tubes and rivets on drums which have a relatively high ratio of shell thickness to diameter of drum shall be measured on the inside surface, the outside surface, or the medium line of the shell?

It is the opinion of the Committee that in measuring the back pitch of tube holes or rivets the measurements should be made on the flat plate before rolling, so that in checking up these measurements after construction the result would correspond to the dimensions on the median line, or the mean of the measurements on the outside and inside surfaces.

Case No. 302.—Is it the intent of paragraph 278 of the Boiler Code, which requires a full-sized direct connection to the boiler for each safety valve, that the exact meaning of this term shall be applied to small brass pop safety valves with male inlet connections. It is impossible to maintain the nominal threads on the inlet of these valves if the inlet opening is maintained full-sized in a male connection.

It is the opinion of the Committee that the rule given in paragraph 278 of the Code applies to the connection leading to the safety valve and not to the safety valve itself. There need not be a full-sized opening through the valve itself, as the stamping of the capacity thereon by the manufacturer indicates in any case what is actually guaranteed for the valve by the maker.

Case No. 303.—Is it the intent of the Boiler Code Committee in its references to commercial lap-welded pipe in Case No. 218 that the weld therein may be considered as conforming to the requirements for welded joints in paragraph 186 of the Boiler Code?

For calculations of the maximum allowable working pressure to be permitted in open-hearth, lap-welded pipe used in connection with boilers it is the opinion of the Committee that the weld may be assumed as meeting the requirements of paragraph 186.

Case No. 304.—What amount of cooling and shrinking under pressure is necessary in the driving of rivets under the requirements of paragraph 256 of the Boiler Code? Is it consistent with the intent of this paragraph to release the pressure while the rivet shows any degree of heat redness in color?

It is the opinion of the Committee that the pressure should be maintained upon the rivet after it is driven until no part of the head shows red in daylight.

Case No. 306.—Is it the intent of paragraph 20 that the minimum thicknesses of tube sheets there specified for horizontal return tubular boilers is applicable also to vertical firetube boilers and to locomotive type boilers?

It is the opinion of the Committee that while this paragraph refers specifically to horizontal return tubular boilers, it is equally applicable to boilers of the vertical firetube and of the locomotive types, and its application to these two latter types is recommended by the Committee.

## Locomotive Exports

Domestic exports of steam locomotives from the United States by countries during May, 1920, as reported by the Bureau of Foreign and Domestic Commerce, Department of Commerce, were as follows:

| Countries | Number | Amount |
|---|---|---|
| Belgium | 62 | $3,589,700 |
| France | 28 | 840,000 |
| Canada | 3 | 51,292 |
| Mexico | 6 | 60,550 |
| Cuba | 5 | 113,640 |
| Brazil | 9 | 179,810 |
| Chile | 2 | 36,330 |
| Colombia | 5 | 136,479 |
| Ecuador | 3 | 98,025 |
| Peru | 3 | 30,450 |
| China | 7 | 232,764 |
| Japan | 7 | 54,420 |
| Philippine Islands | 2 | 5,186 |
| British South Africa | 6 | 358,500 |
| Total | 148 | $5,787,146 |

# How to Design and Lay Out a Boiler—XXIII

## Supporting Boiler by Means of Suspension Loops—Calculations for Hanger Pins—Types of Suspension Bolts

BY WILLIAM C. STROTT*

The outside suspension type of setting has much to recommend it. It relieves the brick walls of all strain due to the expansion of the boiler, and in case of repair, particularly when a large part of the brick work must be torn out, it is not necessary to first block up the boiler, as must be done when the latter rests on its enclosing walls.

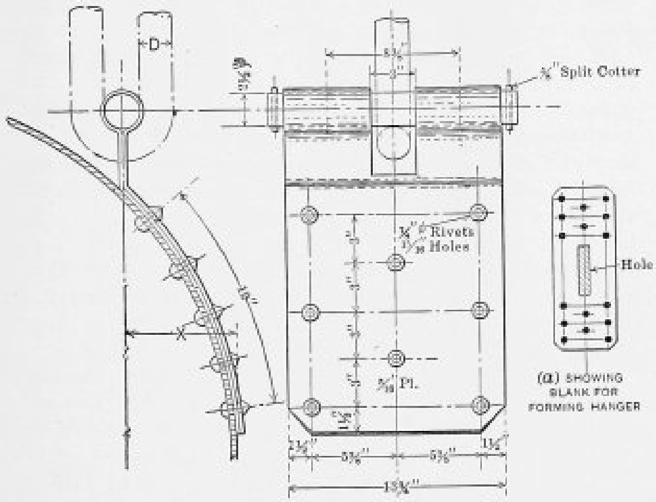


Fig. 90.—The "Hartford" Suspension Loop

### Design of Suspension Loops

Fig. 90 gives the details for the steel plate loop, usually referred to as the "Hartford" hanger. It was first presented and recommended by the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn. This form of hanger is made from a single piece of boiler plate 5/16 inch thick by doubling the plate over on itself to form the "eye" and through which a round steel pin is inserted. A rectangular slot, cut in the center of the blank plate before bending, as shown at (a), forms an opening in the loop at the center of the pin for attaching the hanger bolt.

A simplified form of plate loop which the author has used with success is illustrated in Fig. 91. It consists of a single thickness of steel plate usually ⅝ inch thick. The section of plate through "x" should be investigated for combined shear and crushing, or the unit strength may safely be taken at not to exceed 6,000 pounds per square inch. The net section through "y-y" should be good for a working stress not over 10,000 pounds per square inch. In bending the hanger bolt for this form of plate loop it is advisable to adopt the form shown at "X," Fig. 92. This construction will eliminate any possibility of the "U" form straightening out, and also provides a better bearing surface between plate and hanger.

For either form of suspension bolts, heavy steel plate or cast iron washers and two nuts are provided at the top of the bolts for anchoring them to the overhead supporting beams as indicated in Fig. 92.

* Engineering department of The Koppers Company, Pittsburgh, Pa.; formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

### Stresses in Suspension Loops

During the previous discussion on boiler side brackets it was stated that the Code allows only 8 percent of the ultimate shearing and crushing values of the rivets attaching such brackets to the boiler. This rule also applies to boiler suspension loops. These rivets being in single shear, have an allowable working stress of $(0.08 \times 44{,}000)$ or 3,520 pounds per square inch. The weight of the boiler which we have designed is 40,000 pounds when completely metaled and assumed as *filled* with water, whence the load on each lug is $\frac{40{,}000}{4}$, or 10,000 pounds. Then the total rivet cross-sectional area required is $\frac{10{,}000}{3{,}520}$, or 2.84 square inches. Figuring on ¾-inch-diameter rivets, whose area after driving is $(0.8125^2 \times 0.7854)$, or 0.516 square inch, we find that a total of $\frac{2.84}{0.516}$, or 6 rivets. The actual working strength of the rivets is evidently not a governing factor, as the above result will show. There are other requirements which probably have more bearing on the result, as follows:

The Code further states that the distance measured girthwise of the boiler—from the centerline of the lower row of rivets to the centerline of the upper row of rivets in the hanger—shall not be less than 12 inches. This requires a long plate, and with the hanger located as far down towards the centerline of the boiler shell as possible, it will be found that rivets are in almost direct shear, which is, of course, desirable. Were the loop placed high up on the shell, the rivets would be subjected to severe tension, the moment-arm being the distance "X" as indicated in Fig. 90. It should be quite plain that this distance, or moment-arm, be as small as possible.

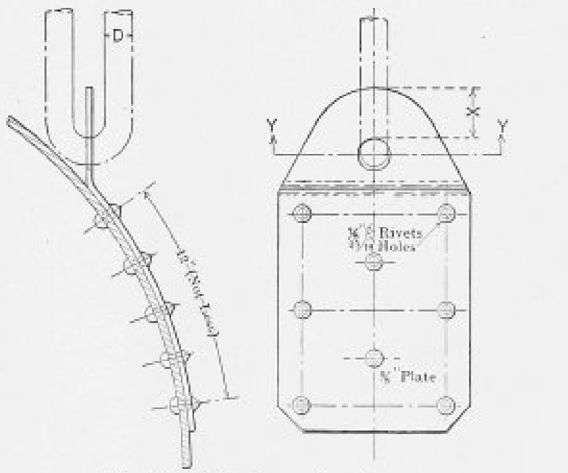


Fig. 91.—Plain Suspension Loop

A requirement in this connection deals with the manner of rivet distribution. Not more than two rivets are permitted in any horizontal line on any supporting member, be it a side bracket or a suspension loop. This point was not fully covered in the last instalment dealing wth side brackets, so the matter will now be explained in detail.

### Rivet Requirements in Side Lugs

In the chapters relating to the design of riveted joints, it was learned that if the net section of plate between the rivets in the outer row of a longitudinal joint is deficient, the plate ligament will fail. This theory must certainly apply to any portion of the boiler shell wherever holes are cut comparatively close together, for it should be understood that the hoop stress in a cylindrical shell exists at every infinitestimal section of the shell plate. Consequently, wherever reduced plate sections are in evidence, such ligaments are liable to rupture, provided that their efficiency with regard to an equal length of solid plate falls below the efficiency required in the main longitudinal seam. This also presents another reason why openings in the shell, such as manholes, pipe connections, etc., must be heavily reinforced to prevent splitting of the plate around the opening.

Recalling that the required *minimum* efficiency of the longitudinal seam of this boiler was 92.4 percent, it follows that the rivets in the side lugs or hangers must be so spaced that the efficiency of the plate between the rivets will be at least equal to that in the longitudinal seam. For 17/32-inch shell plate, and 13/16-inch diameter rivet holes, it will be found after trying several different pitches that the minimum pitch required is 10¾ inches. Proof:

$$\text{Plate efficiency} = \frac{P - d}{P}, \text{ or } \frac{10.75 - 0.8125}{10.75} = 92.5 \text{ percent.}$$

The author has frequently been criticised in regard to his apparent severe treatment of this subject. The argument may be advanced that, inasmuch as the rivet holes in a fastening of this kind represent so small a net section as compared with the total length of shell plate, that the theory of riveted joints cannot be correctly applied thereto. From first principles such reasoning is evidently quite true. Even though two rivet holes are located comparatively close together in a direction parallel to the length of the shell, it is unreasonable to assume that the plate ligament between the holes will break through, for the reason that the small loss in plate strength due to the rivet holes will be taken up by the long sections of solid shell plate

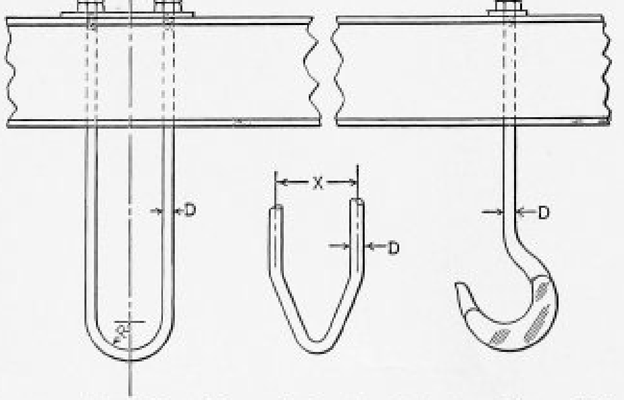


Fig. 92.—(a) U-Type Hanger Bolt. (b) Hook Type Hanger Bolt

at each side of the holes. Were this not true, then it would have been proven long ago that the practice of attaching the palms of diagonal crowfoot braces to the shells of boilers by means of two rivets not more than 4 or 5 inches center to center is unsafe. In the case of side lugs or suspension loops, however, we have not only to provide sufficient strength of plate ligaments for the steam pressure, but must also remember the fact that since such attachments are subjected to a high external load due to the weight of the boiler, the shell plate in the region of such fastenings is obviously subjected to a very high combined stress.

Although the A. S. M. E. Code makes no mention of the minimum horizontal pitch of rivets in boiler supports, it merely states that not more than two rivets shall come in any horizontal line, nevertheless, it is assumed that the rivets be located sufficiently far apart as not to seriously affect the strength of the boiler shell. That the author's contention with regard to this subject as presented in the foregoing is not unreasonable may be gleaned from the fact that some, if not all, of the Canadian provinces in their rules covering the construction of steam boilers require that the shells of boilers be heavily reinforced wherever supporting lugs or brackets are riveted thereto, and that the rivets attaching such reinforcements be independent of the rivets attaching the supporting member to the boiler. This rule is more clearly illustrated in the accompanying illustration, Fig. 93.

It should be quite plain that the effect of such a reinforcement is to compensate for any weakness that may exist in the shell plate by assisting the latter in overcoming any disproportionate stresses that may develop.

In conclusion, the author wishes to state that, although he does not believe in resorting to such radical construction as the above, he firmly believes that the pitch of the rivets in such members be such that the efficiency of the net plate ligament be at least equal to that required of the longitudinal joint of the boilers. Unlike practically any other piece of apparatus, a pressure vessel after a violent explosion cannot be examined with a view to positively determining the cause of its failure, and it is therefore highly probable that many disastrous explosions of pressure vessels may be traced to carelessness in the design of the supporting members, or any other riveted connection for that matter.

### Pin Calculations for Hartford Hangers

It may be assumed that the pin is a simple beam, supported at its ends and having the load concentrated at the center. The true points of support in this case are at the center of pressure in the "eye" of the hanger, and for the proportions given in Fig. 90 the distance for this particular design is 8⅜ inches. The load on the pin is, of course, 10,000 pounds, being one-fourth of the total weight of the boiler. The formula for the maximum bending moment for a beam of this class may be obtained from Fig. 86, which appeared in a previous chapter. It is:

$$M_b = \frac{W \times L}{4},$$

where:

$L$ = the length of the beam in inches.
$W$ = the load on the beam in pounds.
$M_b$ = maximum bending moment in inch-pounds.

Substituting and solving, we get:

$$M_b = \frac{10{,}000 \times 8.375}{8}, \text{ or } 10{,}469 \text{ inch-pounds.}$$

If we divide the bending moment by the section modulus of the pin, the result will be the actual working fiber stress in the pin, which should not exceed 10,000 pounds per square inch. Expressing this in the form of an equation, we have:

$$S = \frac{M_b}{Q}, \text{ or } Q = \frac{M_b}{S},$$

where:

$S$ = safe working fiber stress in the pin, pounds per square inch.
$Q$ = required section modulus.
$M_b$ = bending moment.

Substituting and solving, we get:

$$Q = \frac{10{,}469}{10{,}000}, \text{ or } 1.05 \text{ (approximately)}.$$

From Fig. 87, also given in a previous chapter, we find that the section modulus of a round section is:

$$Q = 0.0982d^3,$$

where:

$d$ = the diameter of the section in inches. Therefore,
$1.05 = 0.0982d^3$, or
$d = 2.2$, say $2\frac{1}{4}$ inches diameter.

Although there is no possibility of the pins becoming dislodged after the boiler is slung into position, it is advisable to provide split cotters in the ends of the pins. The proper diameter of cotters to employ with pins of various sizes was also given in a table which appeared in a recent chapter.

### DESIGN OF SUSPENSION BOLTS

The logical design to adopt is evidently the "U" bolt. It requires lighter stock than a hook bolt carrying the same load, and may also be bent to fit snugly around the pin on the hanger. The bent portion of the hook bolt is very liable to straighten out if not properly designed, thus lowering the boiler and throwing a strain on the steam headers. The author knows of one instance when such hooks broke off completely and dropped a watertube boiler onto the foundations. An examination of these bolts disclosed the fact that in forming the hook the metal was crystallized either by overheating during the forging process or else due to chemical impurities in the steel. This presents another reason why the hook form of construction should not be employed. If used at all, the hook should have the form and section illustrated in Fig. 94, since such a section (trapezoidal) is stronger than a "round" of equal cross-sectional area.

This is in reality a crane hook and would require special forging dies in its manufacture, whence its high cost does not warrant its use at all for other than hoisting service.

### DETERMINING THE DIAMETER OF THE "U" BOLT

The weakest part of the "U" form is at the bend which is subjected to a bending stress. The bending moment is represented by the equation:

$$M_b = \frac{Wl}{20},$$

where:

$M_b$ = bending moment in inch-pounds.
$M$ = load on bolt in pounds.
$l$ = inside diameter of the bend.

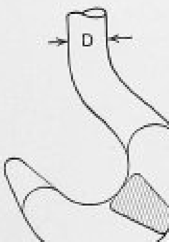

Fig. 94

Substituting in our case, we get:

$$M_b = \frac{10{,}000 \times 2.25}{20}, \text{ or } 1{,}125 \text{ inch-pounds.}$$

Dividing this by a safe unit working stress of 6,000 pounds per square inch, we find the required section modulus to be $\frac{1{,}125}{6{,}000}$, or 0.187. Transposing the formula for section modulus as given in Fig. 87 for a round section, we have:

$$d = \sqrt[3]{\frac{Q}{0.0982}} \text{ or } d = \sqrt[3]{\frac{0.187}{0.0982}},$$

whence $d$ is found to be $1\frac{1}{4}$ inches, very nearly, which is the diameter of stock required for the suspension bolts. The bolts are threaded at their ends to receive the nuts, as is clearly shown in Fig. 92. The net cross-sectional area of the rods at the root of the threads should also be investigated for strength. The least diameter required may be found directly from the following formula:

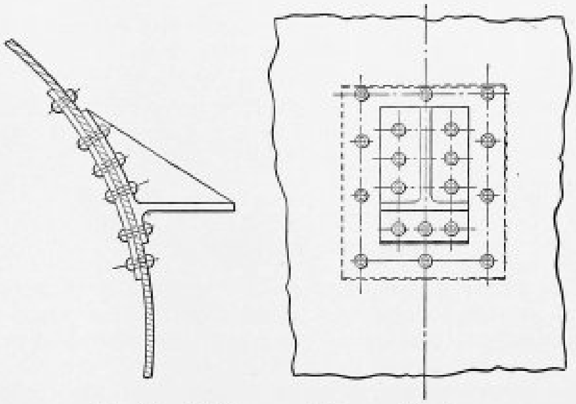
Fig. 93.—Reinforcement Lug or Bracket

$$d = \sqrt{\frac{W}{0.7854 \times S}}, \qquad (30)$$

where:

$d$ = the least diameter of the bolt.
$W$ = load on *one rod*.
$S$ = allowable unit working stress in the bolt, pounds per square inch.

**PROPORTIONS OF THE UNITED STATES STANDARD SCREW THREADS, NUTS, AND BOLT HEADS**

| Diam. of Screw. | Threads per In. | Diam. of Core. | Width of Flat. | Inside Diam. | Outside Diam. | Diagonal. | Height of Head. |
|---|---|---|---|---|---|---|---|
| 1-4 | 20 | .185 | .0062 | 1-2 | 37-64 | 45-64 | 1-4 |
| 5-16 | 18 | .240 | .0070 | 19-32 | 11-16 | 27-32 | 19-64 |
| 3-8 | 16 | .294 | .0078 | 11-16 | 51-64 | 31-32 | 11-32 |
| 7-16 | 14 | .344 | .0089 | 25-32 | 29-32 | 1 7-64 | 25-64 |
| 1-2 | 13 | .400 | .0096 | 7-8 | 1 1-64 | 1 15-64 | 7-16 |
| 9-16 | 12 | .454 | .0104 | 31-32 | 1 1-8 | 1 3-8 | 31-64 |
| 5-8 | 11 | .507 | .0113 | 1 1-16 | 1 15-64 | 1 1-2 | 17-32 |
| 3-4 | 10 | .620 | .0125 | 1 1-4 | 1 7-16 | 1 3-4 | 5-8 |
| 7-8 | 9 | .731 | .0140 | 1 7-16 | 1 21-32 | 2 1-32 | 23-32 |
| 1 | 8 | .837 | .0156 | 1 5-8 | 1 7-8 | 2 19-64 | 13-16 |
| 1 1-8 | 7 | .940 | .0180 | 1 13-16 | 1 23-32 | 2 9-16 | 29-32 |
| 1 1-4 | 7 | 1.065 | .0180 | 2 | 2 5-16 | 2 53-64 | 1 |
| 1 3-8 | 6 | 1.160 | .0210 | 2 3-16 | 2 17-32 | 3 3-32 | 1 3-32 |
| 1 1-2 | 6 | 1.284 | .0210 | 2 3-8 | 2 3-4 | 3 23-64 | 1 3-16 |
| 1 5-8 | 5 1-2 | 1.389 | .0227 | 2 9-16 | 2 31-32 | 3 5-8 | 1 9-32 |
| 1 3-4 | 5 | 1.490 | .0250 | 2 3-4 | 3 11-64 | 3 57-64 | 1 3-8 |
| 1 7-8 | 5 | 1.615 | .0250 | 2 15-16 | 3 25-64 | 4 5-32 | 1 15-32 |
| 2 | 4 1-2 | 1.712 | .0280 | 3 1-8 | 3 39-64 | 4 27-64 | 1 9-16 |
| 2 1-4 | 4 1-2 | 1.962 | .0280 | 3 1-2 | 4 3-64 | 4 61-64 | 1 3-4 |
| 2 1-2 | 4 | 2.175 | .0310 | 3 7-8 | 4 15-32 | 5 31-64 | 1 15-16 |
| 2 3-4 | 4 | 2.425 | .0310 | 4 1-4 | 4 29-32 | 6 1-64 | 2 1-8 |
| 3 | 3 1-2 | 2.628 | .0357 | 4 5-8 | 5 11-32 | 6 35-64 | 2 5-16 |
| 3 1-4 | 3 1-2 | 2.878 | .0357 | 5 | 5 25-32 | 7 5-64 | 2 1-2 |
| 3 1-2 | 3 1-4 | 3.100 | .0384 | 5 3-8 | 6 13-64 | 7 19-32 | 2 11-16 |
| 3 3-4 | 3 | 3.317 | .0410 | 5 3-4 | 6 41-64 | 8 1-8 | 2 7-8 |
| 4 | 3 | 3.566 | .0410 | 6 1-8 | 7 5-64 | 8 21-32 | 3 1-16 |
| 4 1-4 | 2 7-8 | 3.798 | .0435 | 6 1-2 | 7 1-2 | 9 3-16 | 3 1-4 |
| 4 1-2 | 2 3-4 | 4.027 | .0460 | 6 7-8 | 7 15-16 | 9 23-32 | 3 7-16 |
| 4 3-4 | 2 5-8 | 4.255 | .0480 | 7 1-4 | 8 3-8 | 10 1-4 | 3 5-8 |
| 5 | 2 1-2 | 4.480 | .0500 | 7 5-8 | 8 13-16 | 10 25-32 | 3 13-16 |
| 5 1-4 | 2 1-2 | 4.730 | .0500 | 8 | 9 15-64 | 11 5-16 | 4 |
| 5 1-2 | 2 3-8 | 4.953 | .0526 | 8 3-8 | 9 43-64 | 11 27-32 | 4 3-16 |
| 5 3-4 | 2 3-8 | 5.203 | .0526 | 8 3-4 | 10 7-64 | 12 3-8 | 4 3-8 |
| 6 | 2 1-4 | 5.423 | .0555 | 9 1-8 | 10 35-64 | 12 15-16 | 4 9-16 |

The threads have an angle of 60°, with flat tops and bottoms, and are of the following proportions:

*Notation of letters. All dimensions in inches*

$D$ = outside diameter of screw;
$d$ = diameter of root of thread, or of hole in the nut;
$p$ = pitch of screw;
$t$ = number of threads per inch;
$f$ = flat top and bottom;
$o$ = outside diameter of hexagon nut or bolt head;
$i$ = inside diameter of hexagon, or side of square nut or bolt head;
$r$ = diagonal of square nut or bolt head;
$h$ = height of rough or unfinished bolt head;

The height of finished nut or bolt head is made equal to the diameter $D$ of the screw.

$$p = \frac{\sqrt{16\,D + 10} - 2.909}{16.64}, \qquad t = \frac{1}{p}, \qquad r = 1.414i,$$

$$d = D - \frac{1.299}{t}, \qquad i = \frac{3\,D}{2} + \frac{1}{8}, \qquad o = 1.155\,i, \qquad f = \frac{p}{8}.$$

Table 20

Substituting and solving, we get:

$$d = \sqrt{\frac{5{,}000}{0.7854 \times 6{,}000}}, \text{ or } 1.06 \text{ inches,}$$

which proves that the strength of the hook in this case is the governing factor.

DETERMINING THE DIAMETER OF THE HOOK BOLT

For the size of stock required for the hook bolt we apply formula (30) direct, but use 10,000 pounds as the load because there is but one rod in tension.

$$d = \sqrt{\frac{10{,}000}{0.7854 \times 6{,}000}}, \text{ or } 1.45 \text{ inches diameter.}$$

From the preceding table of proportions of U. S. S. threads we find that 1¾-inch diameter stock is required, which, after threading, will have a diameter at the root of the threads 1.49 inches, which is a trifle over the minimum required.

## Tests on Welded Pipe

The recent gas show at Buffalo brought together men in all branches of the welding industry from every part of the country. In the course of informal discussion on oxy-acetylene welding of oil pipe lines, a big Kansan questioned the strength of the welded line to hold up under the service pressures in his field. Of course, there are abundant instances where welded lines are in service in oil districts, carrying pressures of 800 to 900 pounds, but the skeptic was not entirely satisfied. What he wanted was a pressure test to determine just where the welded pipe would give way under a breaking strain.

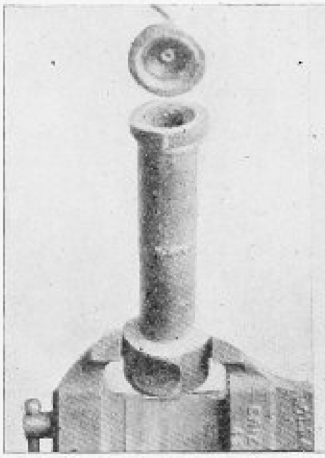

Fig 1.—3-Inch Iron Pipe with Welded Cast-Iron Cap which was Blown Off in Test at 6,200 Pounds Pressure

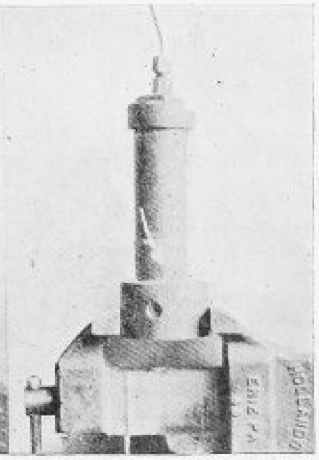

Fig. 2.—3-Inch Iron Pipe with Welded Steel Caps That Held Under Pressure which Split the Pipe

To settle discussion on the matter, certain tests on welded pipe were arranged at the Buffalo laboratory of the Linde Air Products Company.

The Linde engineers first welded together two short sections of standard 3-inch iron pipe, threaded the ends and screwed on two standard cast-iron caps. When the cold water pressure test was applied to the breaking point it was found that the top of one of the caps had blown out, leaving the pipe and the weld intact. The undamaged cap and the remaining portion of the broken cap were then removed and two extra heavy iron caps were screwed on. At a pressure of 6,200 pounds per square inch one of these caps let go, still without injury to the weld or the pipe.

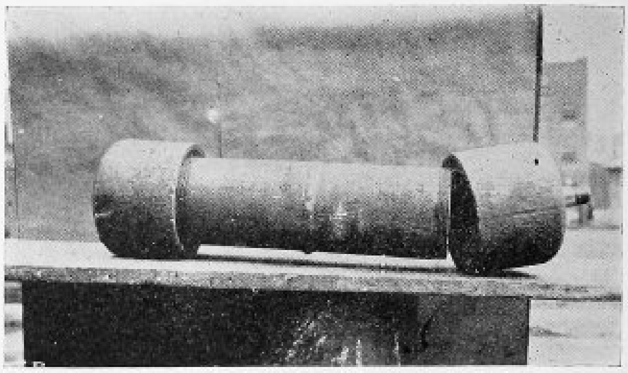

Fig. 3.—4-Inch Pipe with Screwed Caps which Tore Away at Threads Under a Pressure of 4,200 Pounds, the Weld Holding

Again the uninjured cap and remnant of the broken one were taken off and extra heavy steel caps screwed on. This time the caps held, but the pipe split and ripped under the added pressure upon passing its elastic limit, tearing up to and being effectually stopped by the weld, which refused to give. The pipe was distinctly bowed out at the rupture.

The next test was made with 4-inch pipe. Two lengths were welded together as in the case of the 3-inch pipe, the ends threaded and two extra heavy standard caps screwed on. In this test one of the cap heads blew out at 4,400 pounds, which gave a total end pressure on the cap of approximately 33 tons, proving that the broken cap was not in any respect defective. The weld was not impaired at all. After this test it was suggested that an entirely new weld with other pipe lengths of the same diameter be tried. Accordingly, two more lengths of 4-inch pipe were welded, threaded and sealed, this time with extra heavy steel caps made to withstand a working pressure of 3,000 pounds of air. The pressure was applied and the pipe gave way in the threads at 4,200 pounds. In all of the tests the welds held securely.

## Discussion of Paper on Grate Openings at Master Boilers Makers' Association Convention

President: The box grate is a good all-around serviceable grate and will give good results when about 9 inches to 9½ inches wide. I believe that the percentage of grate opening should be about 30 or 40 percent.

I also believe the time is coming when the dump grate will be eliminated from both ends of the firebox. I do not feel that with a proper grate made sufficiently wide to get

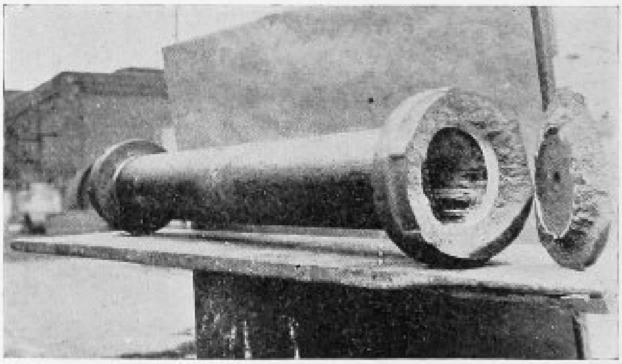

Fig. 4.—4-Inch Pipe with Oxy-Acetylene Welded Cap which Gave Way at 4,400 Pounds Hydrostatic Pressure, the Weld Still Holding

rid of the cinders and clinkers that a dump grate is necessary, and many roads at this time are eliminating them entirely, which will be a big saving at the clinker pit, in the shop and all round.

The ashpan opening, I believe, should be at least 13 to 15 percent of the grate area.

Charles P. Whalen, N. Y. C. R. R.: We have been using fingered grates, but have found that they waste fuel. We are now using the box grate about 9 inches wide to some extent. I want to say they are far superior to the fingered grate. They are the best grates, in my opinion, that I have ever had any experience with.

As to the position of the dump grate with ordinary mine run coal that doesn't clinker too badly, you don't need any dump grate. We have them in our engines, but hardly ever use them, because they open wide enough so that you can punch out everything that is inside.

If you are going to have a dump grate in the firebox, keep it from under the flues. There never was a fire clean, and if you drop the dump grate the fireman is going to open the blower; then you have a big hole right under the grate.

My experience is that out of the thirty-nine new locomotives we bought years ago, we changed everyone of the dump grates from the flue sheet to the door sheet, and we had less engine failures, and less leaky flues.

As to the ashpan opening, Mr. McManamy at Chicago has made tests on different railroads, I believe, along these lines—to save fuel. I had this matter impressed on me both at the fuel convention and at our own convention last year, so that when I went home I checked up every engine we had. I found some with as low as 8 percent ashpan opening compared to the grate area. I went to work and changed them according to the government recommendation, as Mr. McManamy said the best results obtained were never with less than 15 percent ashpan opening. We have had excellent results since.

C. E. Elkins, Little Rock, Ark., M. P. R. R.: On our road at present we are using a blow-out style of pan—a hopperless pan—and we figure on giving the engine not less than 15 percent air opening.

We use the rocker style of finger grate and place the dump grate at the back end of the firebox. I believe that this is the place it should be. A dump grate on the front end of the firebox has to be connected with a long reach rod, which is very apt to burn through.

I do not think an engine ought to have less than 15 percent ashpan opening, and it is pretty hard to get too much air. We have had a great deal better success with the pans we have now than when we used the old style hopper pan, because we do not have near as many grates burned out.

H. J. Wandberg, Milwaukee, Wis., C. M. & St. P. R. R.: As far as our road is concerned we are applying the box grate and doing away with the dump grates. As far as dump grates are concerned, if engines have to have them I would favor their being placed on the back end of the firebox for reasons that have already been stated.

Now, as far as the ashpan opening is concerned, I would say to give all the opening possible—not less than 15 percent of the grate area, but even more if you can get it.

I have found on a great many of our engines it is a hard matter to get air opening enough, due to the fact that the firebox is set rigidly onto the frame, so there is no room for an opening lower down. To overcome this difficulty we have cut openings in the side of the hopper and built out a pocket, so that the fire can't fall out or blow out.

Mr. Monks, Grand Trunk R. R.: I do not think that the ashpan area, the 15 percent, controls the whole matter in the locomotive. I believe that you need enough flues in the locomotive, not all plugged up with units and other things, to carry off the gases and provide proper combustion.

You can have a 15 percent opening or more, but if you haven't the tubes to carry the gases away it won't do you any good. We have found it necessary to alter our wagontop boilers and make them straight to get more tubes on account of improper combustion. A decided improvement has resulted. In addition we put the ashpan down an inch; then we put it down 2 inches, and yet the boiler did not steam. We have installed perforated plates. We have put furrows in 4 inches wide and placed the pan so that the air could go up, and we have tried all kinds of schemes, but still our engines did not steam, and we have come to the conclusion that the tube area must be great enough to carry off the smoke and the gases.

John O. Crites, Williamsport, Pa., G. Cent. Div., P. R. R.: On our division we have all kinds of ashpans, but we experimented on the passenger engines with great success. We have a piece of netting 10 to 14 inches wide at each end of the ashpan. We also cut out the side of the ashpan 6 inches wide the whole length of the pan and put the netting on, and the engine does a great deal better. Of course, we have some pans that are cast-iron, but I believe, as this member that just took his seat, it is a good thing to have all the opening you can in the ashpan. It will certainly make an improvement in the engine steaming.

John J. Mahoney, Cheyenne, Wyo., Union Pac. R. R.: We use the box grate and have had very good success with it. We previously had dump grates in the front and had a great many engine failures because of grates coming down, so we cut them out in front and now install them in the back. We have to use back dump grates on account of coal clinkering very badly.

In regard to the ashpan opening, we cannot get too much. We went over our engines about three months ago and found a few of them with only about 10 percent. We opened up as many as we could to 15 percent. We are having very good success with the 15 percent opening.

Mr. Monks, Grand Trunk R. R.: In the Grand Trunk System we have adopted a movable lug. In times gone by the lug has been cast on the grate bar, and in taking the bars out and putting them in the lugs would get knocked off. We have now an iron lug put in with a pin, so that the grate bars can be saved instead of scrapped when the lugs are knocked off.

John R. Zureick, Cincinnati, Ohio, B. & O. R. R.: We have been using an 11-inch box type grate the last three years, and we have done away with the dump grate and are having good success. I believe the box type grate is saving railroad companies lots of money, in maintenance as well as preventing failures.

We give our ashpan not less than 18 percent grate area, and as much more as we possibly can.

## Boiler Explosions

Due to inaccuracies of the official stenographer's report of the lecture of "Locomotive Explosions" given by J. M. Hall, assistant chief inspector, Bureau of Locomotive Inspection, at the annual convention of the Master Boiler Makers' Association, several of the paragraphs of the published report on page 200 of the July issue of The Boiler Maker were slightly in error. The first two paragraphs should have read as follows:

"Now, gentlemen, the world was startled eight years ago by one of the most violent locomotive boiler explosions on record. This was the first big case handled by this Bureau, and it was necessary that it be investigated thoroughly. There were twenty-six people killed in this explosion and thirty-two injured. This was an oil-burning locomotive. It had just received repairs and was being fired up. They had succeeded in getting up to 20 pounds of the working pressure. The last known pressure was 180 pounds, as indicated by the steam gage. They forced the fire for fifty minutes in an endeavor to get the other 20 pounds. You, gentlemen, who handle oil burners know what that means, and the explosion was the result. The steam gage was not indicating properly for some reason. As a result, the Rules now require two steam gages to be used on the boiler when setting safety valves, so that one gage will act as a check against the other. The estimated steam pressure on the boiler at the time of the explosion was about 800 pounds.

"This was another small boiler. One course was torn out, due to a defective cast-iron dome cap. There was one man killed in this instance and one injured. When the dome cap failed, the pressure rushing for the dome opening with the entrained water was more than the dome course could stand, and naturally it opened up and tore the sheets."

During the first few years of the Federal Locomotive Boiler Inspection many cases of defective bracing were found, and this statement should have been inserted at the beginning of the paragraph on defective bracing.

## System of Cost Finding for the Boiler Industry*

During the early part of the present year the cost committee of the American Boiler Manufacturers Association prepared and sent out a questionnaire which covered a large range of questions, the answers to which would make it possible to determine to what extent cost finding was conducted throughout the industry along more or less standard lines and also determine to what extent there were variances from the best accepted standards of cost accounting practice.

The cost committee are confirmed in the opinion that most of the larger manufacturers in the association are conducting cost finding systems that will make it possible for them to determine their cost of production, but that among the smaller manufacturers there are many who have not as yet appreciated the necessity for better costing methods.

In this report we will endeavor to outline in a simple manner a procedure that if followed will make it possible for any manufacturer, large or small, to compute his cost of production with a reasonable degree of accuracy.

A general accounting system is the essential basis for any cost accounting plan, as the data and statistics on which costs are based must be obtained from the general accounting books, and the cost accounting should be made a part of and be controlled by the general books.

It is necessary in connection with any cost accounting procedure to consider four general divisions of cost, as follows:

Direct Materials,
Direct Labor,
Factory Expense,
Administrative and Selling Expense,

and in the following we will proceed to define each one of the factors entering into the cost of production and outline briefly the application of each.

* Abstract of report received at the annual convention of the American Boiler Manufacturers' Association.

The term direct materials applies to all materials and parts that are purchased or made for use in and become a part of the boiler, the tank, the stack or other article manufactured for sale in the plant.

### Direct Materials

Included in this classification are such materials as plates, tubes, angles, bolts, rivets, castings, valves, or, in fact, every item of material that can be identified to the job and which can be included as a part of a complete bill of material.

The cost of direct material is the invoice cost plus transportation charges.

We recommend that whenever possible a complete bill of material be made for each job or order, on which should be listed the kind and quantity of each material that will enter into the article. A complete bill of material is the best means for checking the accuracy of the estimate and the final cost of direct material entering into a job or order.

All direct material received should be charged to a job or to direct material stores. In order to determine where to charge an invoice for direct material it will be necessary to consider whether the purchase is made for use on a specific job or whether it was purchased for stock and then charge it accordingly as follows:

Account "A" jobs in process.
Account "B" direct material stores.

The cost of any article charged originally to account "B" will, when used on a job, be charged to account "A" and credited to account "B."

Direct labor (or productive labor) consists of wages paid for labor performed upon (and that can be charged directly to) a job or order.

All labor paid for as shown by the pay-roll should be accounted for by time reports furnished by or for the employees of the plant, and should be classified into three general divisions as follows:

Direct Labor,
Indirect Labor,
Consisting of wages paid for supervision, foremanship, truckers, oilers, repairmen, etc.
Labor on additions or improvement in plant (to be capitalized).

In applying the cost of direct labor to jobs and orders, either one of the following plans may be adopted:

Under this plan the hours reported against the job, multiplied by the actual rate paid to the respective employees engaged upon it, will represent the charge for direct labor.

Applying on basis of an average rate per hour for all the direct labor, the hours reported against the job by any employee, multiplied by the average rate per hour paid to all employees for direct labor will represent the charge for direct labor.

In order to arrive at the rate per hour to charge under this plan, divide the monthly direct labor pay-roll by the total hours reported on all jobs for the month, and the result is the rate to use in costing all jobs for the month.

The recording and charging of "time" (labor) is very important and every safeguard should surround this part of cost accounting.

The best plan is to locate one clerk, or more, in the factory where he is easily accessible to the workmen, and also provide him with some good mechanical time stamp for recording the "start" and "finish" time on jobs.

The "Job Time Card for Direct Labor" should provide a space for recording the following:

Name of Workman,
Workman's Number,

as well as the items listed below:

Date,
Job Number,
Description of Operation,
Time Started,
Time Finished,
Elapsed Time.

Another card, preferably of another color to distinguish it from the first, should be provided for recording the idle time, time expended in non-productive labor or indirect labor, and time expended on special plant orders, such as additions or betterments. It should provide spaces for recording the following:

Name of Workman,
Workman's Number,
Date,
Order Number or Expense Account,
Description of Work Done,
Time Started,
Time Finished,
Elapsed Time.

There are several good methods used for posting or recording the labor charges against jobs, and one of the simplest methods is to use a form where the time of a workman covering several weeks can be entered on one sheet and distributed in columns according to the jobs he works on. In this manner it can readily be seen that the total amount of wages or hours of the workman for a given period is allocated to jobs, expense accounts or additions and betterments, as the case may be.

After the job time cards have been posted to the cost sheets, they should then be filed away according to the job numbers until the job is complete, when they should be sorted according to operations and the time and cost of operations computed and compared with estimates. The statistics on operation time should be of great assistance to the superintendent of the plant in his determination of the efficiency of the workman and also furnish him with a basis for guidance in future work of a similar nature.

### Factory Overhead Expense

Factory overhead expense represents expenditures made for wages, materials and supplies that cannot be charged directly to a job or order, and consists of such items of expenses as are enumerated in the following:

Supervision and Clerical Wages (Foremen, Timekeepers, Clerks).
Indirect Labor (Janitors, Watchmen, Truckers, etc.).
Supplies.
Drayage and Cartage.
Fuel (Coal, Oil, Gas, etc.).
Small Tools.
Electric Power.
Repairs to Machinery and Equipment.
Repairs to Buildings.
Automobile Expense and Repairs.
Insurance—Fire.
Insurance—Liability.
Taxes on Real Estate and Buildings.
Water.
Depreciation on Automobiles.
Depreciation of Buildings.
Depreciation of Machinery and Equipment.
Depreciation of Patterns.

It is the concensus of opinion of the members of the cost committee that for the purposes of the manufacturers for whom this report is intended we will not recommend the distribution of expense according to manufacturing departments. We want to leave this open for the discretion of the individual. In other words, we are not recommending a system of cost accounting that will require the use of a number of different overhead expense rates in computing costs, as it is our opinion that among the smaller manufacturers this step is a development of the future and should be undertaken only after a good basis has been laid down by them or for them in their cost accounting procedure. It is customary among the larger plants to recognize five producing departments, as follows:

Boiler Shop,
Machine Shop,
Smith Shop,
Pattern Shop,
Erection,

and this necessitates the proration of power and general factory expense over these departments.

Factory overhead expense can be applied either as a percentage upon the amount of direct labor or upon the hours of direct labor charged to a job or order.

If applied as a "percentage," the percentage rate to use can be obtained by dividing the total direct labor into the total factory expense.

If applied on "hours of labor" the rate per hour can be obtained by dividing the total direct labor hours into the total factory expense.

### Administrative and Selling Expenses

Administrative and selling expenses are those expenses incurred in connection with conducting a business and which do not contribute directly to the operation of the manufacturing department.

In the larger plants in the industry and in conformity with recognized accounting practice, administrative and selling expenses are applied as a percentage on the total factory cost, or in other words on the total of the direct material, direct labor and factory expenses.

In the smaller plants, however, we are of the opinion that the administrative and selling expenses may be added to the factory expenses and both factors figured on one rate (either as a percentage on direct labor or rate per hour).

The questionnaire referred to in the foregoing developed that the average rate of overhead prevailing was about 180 percent of the direct labor, but several plants reported an overhead ranging from 60 percent to 125 percent, and on further investigation it developed that certain expenses had not been included in arriving at these lower rates.

### Depreciation

Depreciation may be briefly described as a provision in accounting for the amortization of capital represented in fixed assets that are wasted, consumed or become obsolete; also, an element in the cost of production that should never be overlooked. It represents an accruing expense as inevitable as taxes.

There are two principal elements that govern in the determination of the amount of depreciation to apply on property. The first is the element that considers the estimated years of service, without regard to obsolescence. The secondary element considers obsolescence as a factor for consideration, but it should rarely be given preference over the former.

The rate of depreciation should be the reciprocal of a useful life which is fixed to take into account "years of service" as well as "obsolescence" and other factors all combined in the most intelligent life forecast obtainable.

There are a number of different plans for applying the depreciation charge, but on account of the complexities of some and the inequalities in others, we are influenced to accept and recommend a plan that provides for a regular annual charge of an equal amount to provide for the refunding of the original cost over a predetermined period of years.

The following rates of depreciation seem to be used generally throughout our industry:

| | Percent |
|---|---|
| Buildings | 3 to 5 |
| Fixed Machinery | 10 |
| Patterns | 25 |
| Erection Tools | 50 |
| Automobiles | 25 |
| Furniture and Fixtures | 10 |

It is possible that the representatives of the internal revenue department may have disallowed depreciation deductions made in tax returns on figures that may correspond closely to those given in the foregoing; however, in computing your expense for depreciation you should not be influenced altogether by what the treasury department may allow, but rather on what sound business judgment dictates.

### Production Order Numbers

Order numbers should be assigned to each job just as soon as the order is entered.

The order number becomes the medium to which is identified all charges for material and labor.

Where parts are made for stock, such as drums, headers, etc., ahead of the time when they will be used on a job, they should be kept separately identified by an order number. It is a good plan to use a distinct series of order numbers or letter prefixes to indicate the different classes of work being done in the plant.

### Estimating

A sound basis of estimating cost for the determination of selling prices is the most important factor in the success of any manufacturing enterprise and particularly for a boiler manufacturing business.

Estimates of cost should be made on exact information based on all the factors of cost that can be obtained and a systematic procedure should be followed.

## Drilling Records Made at Altantic City

Drilling demonstrations with Cleveland milled high speed drills were conducted during the annual June convention of the American Railroad Association. Sections III and VI, at Atlantic City. Several records were made in these tests and it is reported that records made in 1911 were completely shattered. On June 15 and 16 milled high speed drills were forced through cast iron at the rate of 6 feet per minute and through machinery steel at the rate of 2½ feet per minute. Details of speed, feed, etc., are given below:

| Material | Diameter of Drill, Inches | Revolutions per Minute | Feed, Inches per Revolution | Number of Inches Drilled | Volume Pounds Removed |
|---|---|---|---|---|---|
| 3-inch cast iron....... | 1 | 720 | .100 | 9 | 14.74 |
| 3-inch machinery steel.. | 1 | 600 | .050 | 3 | 6.60 |
| 3-inch cast iron....... | 1¼ | 720 | .100 | 15 | 23.01 |
| 3-inch machinery steel.. | 1¼ | 500 | .040 | 3 | 7.00 |

It is evident that the above records could not be recommended for commercial shop practice, as few, if any, shops would have the press equipment or power to duplicate them. For example, in making the record in cast iron with a 1-inch drill, a feed of 0.100 inch per revolution and speed of 720 revolutions per minute were used. Good shop practice would indicate a speed no greater than 267 revolution per minute and a feed of 0.015 inch per revolution.

In the tests shown above, both the feed and speed exceeded normal practice. The same statement applies to the record in machinery steel. Demonstrations like the above show the tremendous reserve in the modern high speed milled twist drill. Stock drills were used in the tests and the drills were driven by a Foote-Burt heavy duty drill press.

Additional drilling tests were conducted in open hearth chrome nickel steel using Hercules high speed drills made by the Whitman & Barnes Manufacturing Company, the power being furnished by a 6-foot American radial drill. The results of these tests showed conclusively that hard and tough alloy steels can be drilled on a production basis and economically. The chemical analysis of the steel showed 0.50 percent carbon, 0.90 percent chromium, 1.00 percent nickel, and 0.75 percent manganese. Holes 3 inches deep were drilled in nine seconds with 1-inch, 1⅛-inch and 1¼-inch drills, attaining a penetration of 1 inch every three seconds. The following is a summary of the data secured in these tests:

| Material | Diameter of Drill, Inches | Revolutions per Minute | Feed, Inches per Revolution | Time per Hole, Seconds | Average Number Holes per Grinding |
|---|---|---|---|---|---|
| 3-inch alloy steel.... | 1 | 500 | .040 | 9 | 32 |
| 3-inch alloy steel.... | 1⅛ | 500 | .040 | 9 | 24 |
| 3-inch alloy steel.... | 1¼ | 500 | .040 | 9 | 27 |
| 3-inch alloy steel.... | 1½ | 500 | .029 | 12½ | 29 |
| 3-inch alloy steel.... | 2 | 206 | .040 | 22 | 27 |
| 3-inch alloy steel.... | 2½ | 206 | .022 | 40 | 12 |

## Committees Appointed By the American Boiler Manufacturers' Association

Certain standing committees were authorized at the June convention of the American Boiler Manufacturers' Association to handle the various activities of the association. The secretary has recently announced the names of members who will serve on these committees:

*Membership:*

H. N. Covell, 191 Dikeman Street, Brooklyn, N. Y.
W. H. S. Bateman, 122 Commercial Trust Building, Philadelphia, Pa.
B. F. Bart, Standard Seamless Tube Co., New York City.
F. C. Burton, Erie City Iron Works, Erie, Pa.
T. F. Schlade, Ames Iron Works, Oswego, N. Y.

*A. S. M. E. Code:*

E. R. Fish, Heine Safety Boiler Co., St. Louis, Mo.
E. C. Fisher, The Wickes Boiler Co., Saginaw, Mich.
F. G. Cox, Edge Moor Iron Co., Edge Moor, Del.

*Related Industries:*

A. G. Pratt, The Babcock & Wilcox Co., New York City.
G. E. Ryder, Locomotive Superheater Co., New York City.
C. Cunningham, C. Cunningham Co., Brooklyn, N. Y.
E. R. Fish, Heine Safety Boiler Co., St. Louis, Mo.
Starr Barnum, The Bigelow Co., New Haven, Conn.

*Cost Accounting:*

G. S. Barnum, The Bigelow Co., New Haven, Conn.
F. G. Cox, Edge Moor Iron Co., Edge Moor, Del.
W. C. Connelly, D. Connelly Boiler Co., Cleveland, Ohio.

*Ethics:*

A. D. Schofield, J. S. Schofield's Sons Co., Macon, Ga.
George W. Bach, Union Iron Works, Erie, Pa.
Isaac Harter, The Babcock & Wilcox Co., Bayonne, N. J.

*Commercial:*

W. C. Connelly, D. Connelly Boiler Co., Cleveland, Ohio.
E. C. Fisher, The Wickes Boiler Co., Saginaw, Mich.
C. V. Kellogg, The Kellogg-MacKay Co., Chicago, Ill.
R. D. Meier, Heine Safety Boiler Co., St. Louis, Mo.
W. A. Drake, The Brownell Co., Dayton, Ohio.

# The Boiler Maker

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There are certain indications in various industrial quarters that productive efficiency in the shops has increased to a marked extent in the past four or five months. The Merchants' Association of New York, for example, has received reports from forty-nine manufacturers on this question who all state that whereas in September, 1919, the general efficiency of the men in their employ was about 70 percent normal, it has improved until now the pre-war standard of efficiency has very nearly been reached.

One reason given by these manufacturers for the increase is the change from a time work basis of production to piece work. As the amount and quality of the work turned out improves those who are not doing their best are eliminated. The piece-work system makes this possible without injustice to anyone, for the efficient man gains the direct benefit of his efforts.

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With the gradual improvement of construction and maintenance facilities in railway shops, the necessity of installing the latest types of machine equipment has become increasingly apparent. The shortage of experienced men makes it essential that both old and new machinery be arranged and operated in the most efficient manner possible. As new shops are erected, or as additions are made to existing plants, the placing of machines for the best production can easily be arranged. So, too, can the methods of operating power tools be planned in the mechanical department, but these methods of increasing the output of a shop are only partially effective unless the men carrying on the work study not only the jobs assigned to them but also the general scheme of operations.

No two shops have exactly the same problems to meet, so that before placing equipment the individual requirements for efficiency should be carefully studied to produce the maximum result. The general principle to follow in the shop layout of machinery is to carry material from the raw to the finished state through the various processes of fabrication without any lost motion.

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In connection with the foreign requirements for power equipment, some valuable suggestions have been brought to the attention of American manufacturers by the United States Chamber of Commerce in the Argentine Republic. Although the specific needs of this Republic are dealt with, the same conditions may be assumed to exist throughout South America and, in fact, throughout the world wherever European products have been in greatest demand.

The close relation with European methods for many years has made the application of American designs in many countries rather difficult. If standard units can be used as they are produced here, without extensive alterations to meet the changed operating conditions, it is profitable to develop the export business in these lines. On the other hand, if it becomes necessary to fundamentally change the products in order that they be adaptable to foreign service, such business ceases to afford a profit.

Among other points brought out for the guidance of American producers is the fact that the details of construction as specified by a foreign buyer must absolutely be complied with if future business depends on the transaction. In any case, the general good-will and satisfaction of the purchaser towards American products is of prime importance.

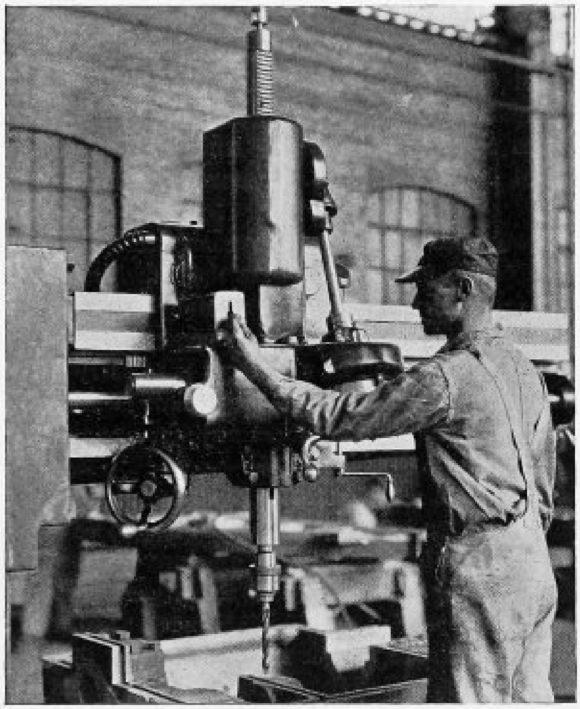
The most difficult and unprofitable feature of the export trade is the education of foreign countries in the use of American products. The least trouble in developing the foreign market might be expected in the field of power equipment, especially where extensive replacements are necessary.

# Engineering Specialties for Boiler Making

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

### Right Line Radial Drilling Machine

Among recent machine tool developments the Niles-Bement-Pond Company, New York, has produced a right line radial drilling machine which is built in either the



Electric Column Clamp Control of the Right Line Radial Drilling Machine

full universal or plain types and with 5 or 6 feet swing. The drive for this drill is simplified so that a high percentage of the horsepower is delivered to the spindle.

A feature of the new drill which adds to its rigidity and to the simplicity of the drive is the double column arrangement which allows for direct drive from the motor to the spindle through the double column. This column is a single casting formed of two box section members cast integral at the top and bottom, the arm saddle being mounted between them. The motor is mounted on the back of the arm saddle and drives the spindle through a single horizontal shaft running between the column members.

Since the column is not of the stationary type but rotates with the arm, it has been possible to place the metal to the best advantage in the form of a beam section which is much stiffer than a circular section of the same weight. The advantage of this type of column is that it permits the use of V-type tracks at the front and back for guiding the arm saddle.

A motor-operated device permits the column to be instantly clamped rigidly to the pedestal so that the operator need not leave his working position at the drill, but may engage and disengage the clamp by throwing a switch located on the drill head. A hand clamping lever is also provided. Because the entire weight of the arm and column are supported on a ball-bearing at the bottom of the column in addition to two roller bearings which take the side thrust, the arm may be easily rotated. The arm is of a patented section designed to give great resistance to the drilling pressure. The most important features are an upper, narrow guide for the saddle and a lower bearing set in a plane back of the front surface, which brings the driving shaft closer to the spindle and gives a greater depth from the front to the back of the arm. Under heavy drilling strains this fact tends to eliminate the deflection of the column and arm structure.

The arm is raised and lowered by power from the driving motor, the mechanism being engaged by throwing a clutch lever located on the driving gear box. The machine is controlled by means of a lever on the control head. The elevating and clamping mechanisms are interlocking and cannot be engaged simultaneously, thus preventing possible damage to the machine. If the arm is run to the limit of its travel in either direction, an automatic stop is provided to prevent accident. This same device also stops the arm in case an obstruction is met in lowering. The elevating screw is hung at the top of the column on a friction ring, and when the spindle arm meets an obstruction in lowering the screw is lifted and turns freely, thus stopping the arm.

Only four driving gears and one double-faced pinion are used between the motor and spindle, and friction clutches have been eliminated for reversing and tapping operations of the spindle. Spindle reverse is provided by means of a motor controlled through the operating lever; the spindle counterweight is geared to the spindle at its center of gravity in order to eliminate friction. A depth gage with an automatic feed trip is provided for drilling to any desired depth. The spindle is rapidly traversed by means of a lever, which, when pulled down, engages the power feed. Eight positive geared feed changes are provided by means of a graduated disk as well as a fine hand feed. The drill head is moved along the arm by means of a hand wheel conveniently located at the front of the head. On universal machines this hand wheel can be swung out of the way when the spindle is to be swiveled.

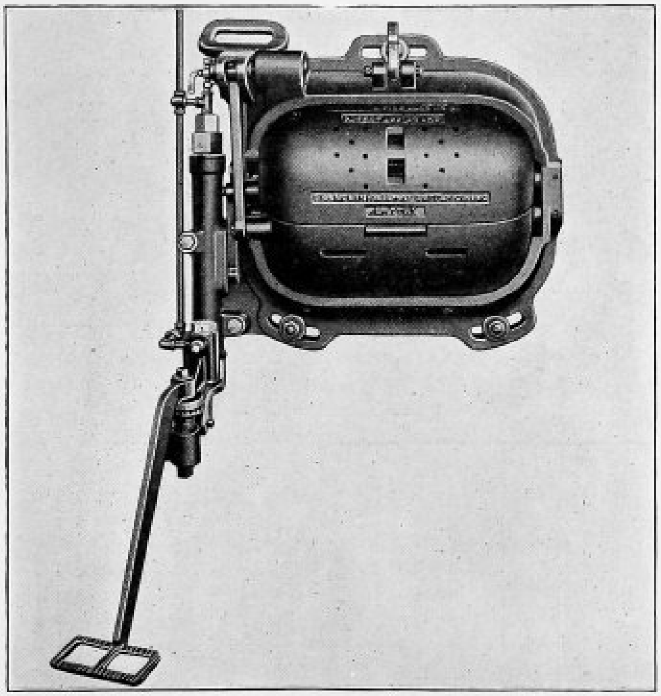
For direct current drive a 10-horsepower, 4 to 1 variable speed motor is required, while for a machine that is to utilize alternating current a gear box is included to give the additional speeds. In either case an automatic brake is provided for stopping the machine quickly in tapping operations.

### Easily Applied Automatic Fire Door

Pneumatically operated fire doors are sometimes troublesome to apply because of the additional room required for opening. The back head of a modern locomotive has little unused space, and to avoid interference with the various devices and their connections, that are necessary for efficient and safe locomotive operation, is often difficult. The Franklin No. 9 fire door, produced by the Franklin Railway Supply Company, New York City, was designed to permit of application where space is limited.

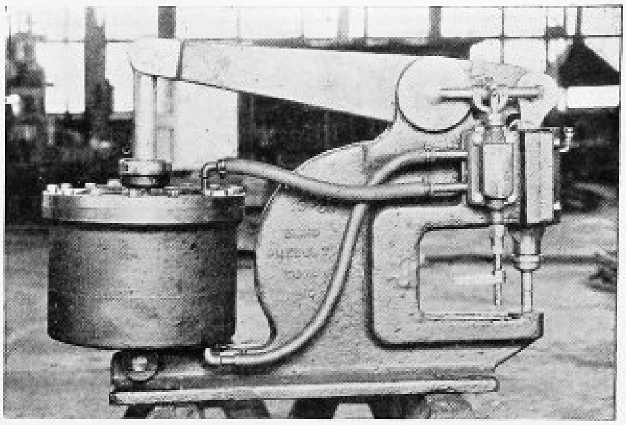
It takes approximately the same space as an ordinary hand-operated swing door and can be applied without relocating other boiler accessories. It is simple in construction and has few wearing parts. It consists of a door frame, semi-rotating door plates and operating cylinder with a foot pedal to provide power operation, and a hand grip for manual operation. A latch is provided to hold the door open in three different positions—wide open and two smoke notch positions. Air pressure both opens and closes the door; therefore it is positive in its movements. The movement of the upper door plate is actuated by the power cylinder, the motion being transmitted to the lower door plate by links. In opening, the door plates telescope inside the door frame, providing full unobstructed opening for firing. This telescopic action forms the opening without taking space on the back-head outside of the door frame. The door plates rotate on pin bearings on either side.

In operation, pressure on the pedal admits air to the operating cylinder and the piston moves upward, transmitting motion to the upper door to rotate it around its pivots. This door is connected by a link to the rocker at the top of the frame, which in turn is connected by a link to the lower door, so that the movement of the upper plate is transmitted to the lower plate to rotate it on pivots to the open position. At the top of the cylinder a small poppet valve is opened by the upward movement of the piston; this admits air to the cylinder and cushions the upward stroke of the piston at the same time the links are assuming a position which reduces the leverage on the doors and brings them to the full open position without slam or shock.



Franklin No. 9 Automatic Fire Door Closed

When pressure is removed from the foot pedal, air is exhausted from the lower end of the cylinder and the air in the upper end forces the piston downward and starts the doors toward the closed position. After the piston has traveled about one-third of its movement the valve in the top of the cylinder seats, cutting off the air supply entirely. At this time the top door has traveled to a point where its weight is effective to raise the lower door. This, with the trapped air in the top of the cylinder, brings the doors to the closed position. As the piston travels downward, the lower end of the cylinder acts as a dash pot and prevents slamming.



Baird Portable Pneumatic Punch and Riveter

## Portable Pneumatic Punch and Riveter Combined

The accompanying illustration shows a new combination punch and riveter designed and built by the Baird Pneumatic Tool Company, of Kansas City, Mo. This tool is adapted to the punching of light structural shapes in shops where the range of work is of small dimensions. By taking out the punch and die and inserting rivet dies of the proper size, the machine may be operated as a riveter as well as on the fabrication of light frame work. The air cylinder is cushioned to prevent injury to the mechanism when used as a punch. It is operated by the Baird four-way valve, permitting it to be controlled by a foot pedal or hand movement, depending on whether it is stationary or portable.

The machine is made with both one and two-inch die travel and has a punching capacity of ⅛-inch to ⅝-inch holes in cold ⅜-inch plate and has a riveting capacity of ⅜-inch cold or ⅝-inch hot rivets. It delivers 35 tons pressure on the rivet and punching dies and weighs complete 500 pounds.

This punch and riveter, according to the manufacturer, is well adapted for use where the nature of the steel fabrication does not require an extra heavy duty riveter and also in plants where quantity production on small shapes is desired coincident with economical air consumption and small machine space occupied.

## Lubrication of Hack Saws

To prolong the life of hack saw blades and to increase their cutting speed, it is necessary to use some form of lubricating compound. The purpose of a lubricating liquid is not so much to lubricate the work as it is to keep the blade cold. The blade is comparatively thin and loses its temper easily, especially since high cutting speeds on machine-driven saws are maintained. For this reason there should be a constant flow of water or compound over the work except in the case of iron castings.

In order to determine the best lubricant for the efficient operation of hack saws, the L. S. Starret Company, Athol, Mass., recently conducted a series of tests which resulted in developing a compound consisting of one quart of sal-soda thoroughly dissolved in ten gallons of cold water, to which was added a mixture of four quarts of mineral and lard oil.

An overloaded man does about the same kind of work as an overloaded machine.—*Combustion.*

# 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

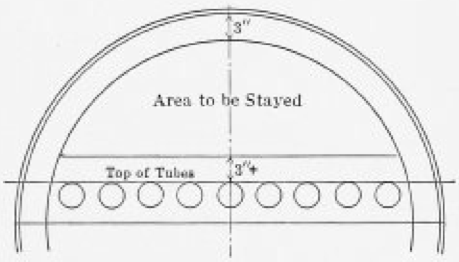
*This department is open to subscribers of* THE BOILER MAKER *for the purpose of helping those who desire assistance on practical boiler shop problems. All questions should be definitely stated and clearly written in ink, or typewritten, on one side of the paper, and sketches furnished if necessary.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Staying Back Heads of Locomotive Boilers

Q.—I would thank you to kindly furnish me formulas for computing the area to be stayed on the back heads of locomotive boilers of conical and Wooten designs. W. D. G.

A.—The method applied to the back heads of other boilers would be a safe one to use in this case. The formula prescribed by The United States Board of Supervising Inspectors of Steam Vessels is as follows:




Area of Back Head to Be Stayed

$$D = \sqrt{\frac{C\,T^2}{P}},$$

in which:

$D$ = maximum pitch in inches.
$T$ = numerator of fraction expressing plate thickness in sixteenths of an inch.
$P$ = working pressure in pounds per square inch, and $C$ has various values depending upon the form of the stay that is used. Some of the values of $C$ as prescribed by the Board are as follows:
$C$ = 112 for plates up to and including 7/16 inch in thickness and for screw stays with riveted heads, and also for rivets in tension attaching staying.
$C$ = 120 for plates above 7/16 inch in thickness; for screw stays with riveted heads; for rivets in tension attaching staying; and also for screw stays with nuts fitted to plates up to and including 7/16 inch in thickness.
$C$ = 125 for screw stays with nuts and plates above 7/16 inch and under 9/16 inch in thickness.
$C$ = 135 for screw stays with nuts and plates 9/16 inch and over in thickness.
$C$ = 140 for stays having double nuts, one nut on the inside and one nut on the outside of the plate, without washers or doubling plates.

It is assumed that the flange around the head supports the flat plate for a radial distance of 3 inches. Also a width of 3 inches is allowed above the top of the tubes as shown in the sketch. This is considered to allow ample safety because the flange actually supports a greater width than 3 inches. The width of flat plate that is supported depends upon the thickness of the head, the steam pressure and the pitch and arrangement of the stay.

### Length of Shell Plates

Q.—Please describe a system for laying out heavy tank shells 54 inches inside diameter and 12 feet long, made of 1¼-inch plate. We have not been able to apply the standard rules in determining the length of plates when heavy metal is used in the tank. R. S. W.

A.—Make all the calculations on the neutral lines in the case thick plates. The neutral diameter in your problem is $54 + 1\frac{1}{4}$ inches $= 55\frac{1}{4}$ inches, and the circumference, or theoretical length of the plate for the tank, is $55\frac{1}{4} \times 3.1416 = 173.8$ inches.

Describe the neutral circumference full size, and design the lap and joint with the required bevel of edges of the plate. Then cut the stock according to the length of the neutral line.

### Cone Connected to Round Pipe

Q.—I would appreciate your kindness if you could inform me of a practical way to lay out a cone connection running from 2 feet 1¾ inches diameter into a round pipe 5 feet 8 inches in diameter. The cone is to be connected to the round pipe by four fish or gusset plates. R. S. W.

A.—In order to make this pattern it is necessary to construct three views of the connection, namely, the plan, the end elevation and the side elevation, Fig. 1. It is next necessary to draw a system of construction lines on these three views and then to get the true lengths of these construction lines and to use the true lengths to lay out the pattern. In order to make it as easy as possible for the reader to follow the method, the same point in each of the three projections is denoted by the same letter or number. Also a series of broken lines is used and a series of solid lines so as to avoid confusion.

A quadrant representing the end of the small pipe in each of the three views is divided into six equal arcs, and the division points are marked with numbers from 6 to 10. The intersection of the gusset with the large pipe is an ellipse, as shown at $BC$ in the plan. This quadrant is also divided into six equal arcs which are numbered from 1 to 5. In order to get the true lengths of these arcs on the ellipse it is necessary to revolve the ellipse to a horizontal position in the side view and to project it onto the plan. In this way the point $C$ is moved outward to $C'$, and the other points on $BC$ will be projected horizontally as shown. The ellipses are laid out according to the rules for curves of this kind. The division points on the ellipse $BC$ in the plan are projected to the line $BC$ in the side elevation, and from these points projections are made in the end view. Also from the points on $BC$ in the side elevation construction lines are drawn to the points on the line $AD$, and this same system of lines is drawn on the end elevation and on the plan.

The next thing to do is to get the true lengths of the solid and broken construction lines. The method of doing this is shown in $S$. It will be noted that the vertical height of each of the construction lines in the end elevation is shown in $S$ by the vertical lines. Also from the foot of each vertical line is measured a horizontal distance equal to the lengths of the given lines in the plan. Finally the sloping lines are the true lengths of the construction lines.

The stretchout for the long curve on the pattern is equal in length to the ellipse $BC'$ plus the allowance for

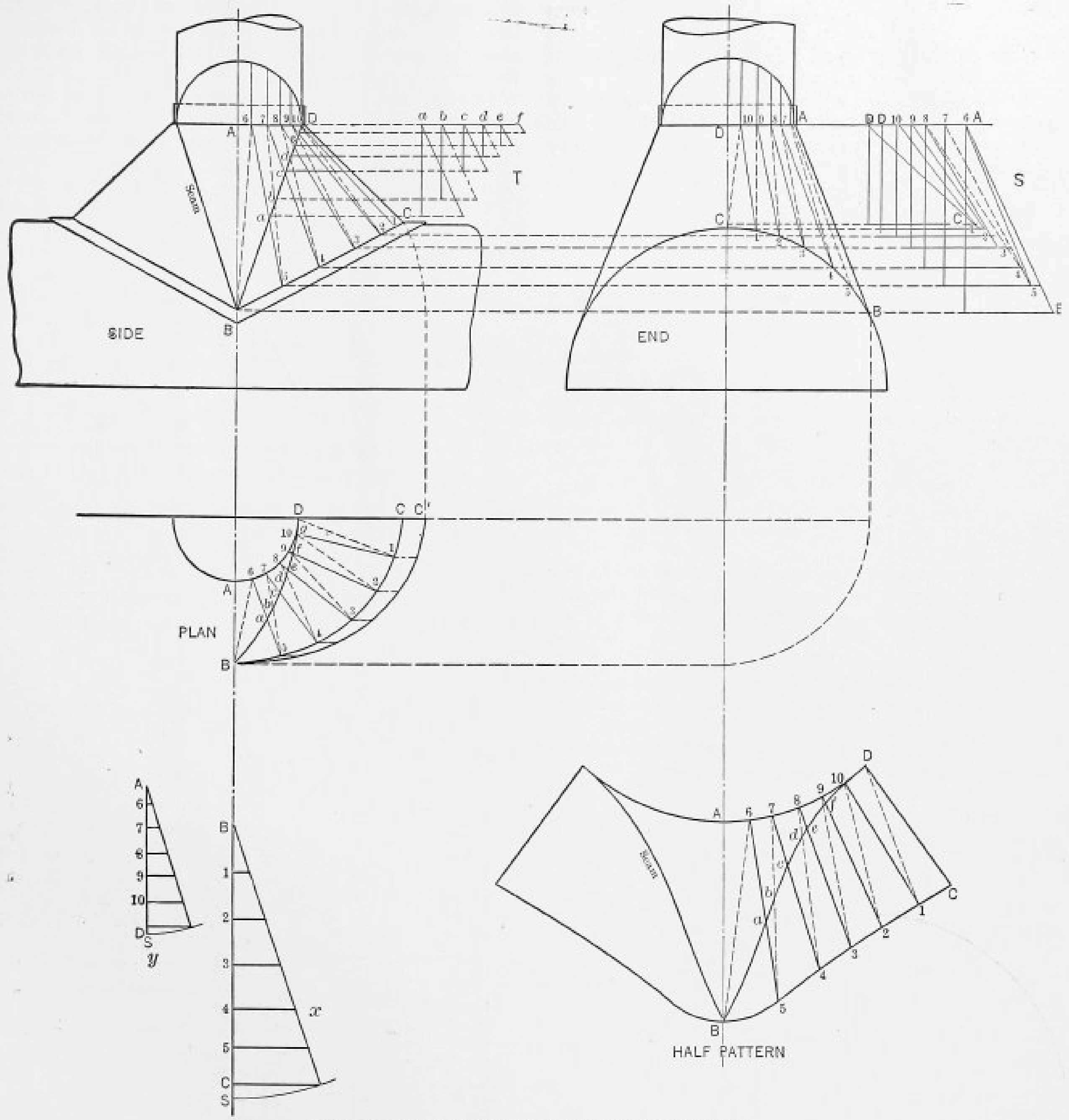



Fig. 1.—Development of Cone Connection to Round Pipe

the thickness of the metal. The method of getting the true length of the stretchout is shown at *X*. A vertical line is drawn and the length *B*-1 is made equal to the length *C*-1 in the plan. In like manner the other arcs are laid off until the point *C* is reached. Then the distance *Cs* is laid off equal to the thickness of the metal multiplied by 7 and divided by 4. It will be noted that a quadrant is being considered so that one-fourth the total allowance for the thickness of the metal for a complete circle is taken. With a radius *Bs* and a center *B*, describe an arc, and where the horizontal line from the point *C* intersects this arc draw a line to the point *B*. The horizontals from each of the points on *BC* to the sloping line will intercept spaces that are the true lengths of the radii to be used when laying out the long edges of the pattern. In the same manner at *Y* is shown how the quadrant for the small end of the gusset is laid out to allow for the thickness of the metal. The true lengths of the radii to be used may be obtained when laying out this edge of the pattern.

The pattern is started on the line *AB*, which is given in its true length in the end elevation and also at *S*. With *A* as a center and a radius *A*-6 taken from the sloping line in *Y*, describe an arc 6. With *B* as a center and a radius *B*-6, which is the true length of this line as given at *S*, describe an arc intersecting the arc 6 and thus locating the point 6 on the edge of the pattern. With *B* as a center and a radius *B*-5, which is equal to the space taken from the sloping line in X, describe an arc 5. Then with 6 as a center and a radius 6-5 taken from *S*, describe an arc cutting the arc 5 and thus locating the point 5 on the long edge of the pattern. In like manner continue locating the points from *A* to *D* and from *B to C* and draw the lines and curves as shown so as to complete one-fourth of the pattern. This can be duplicated to give the half-pattern as shown.

It is next necessary to locate the seam line *BD* on the pattern. In order to do this the true lengths of the lines in the side elevation extending from the line *AD* to the seam line *BD* must be found. These lengths are given at *T*. The method used is similar to that at *S*. The true lengths of these lines, such as 6-*a*, 7-*b*, etc., are laid off on the pattern, and the seam line *BD* drawn through the points *a*, *b*, etc. The lines of the flanges are indicated by the outline of the different parts of the pattern. Add these flanges to the pattern lines and cut the metal accordingly.

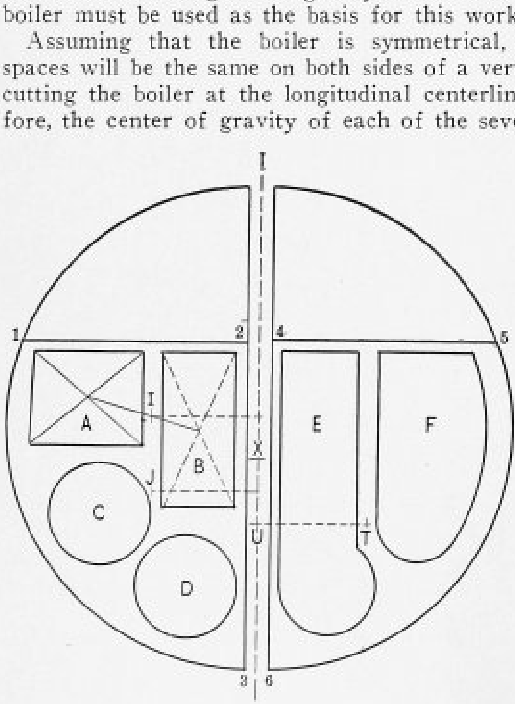
## Determination of Center of Gravity of Water in Scotch Boiler

Q.—Which is the easiest way of finding the center of gravity of water in a Scotch marine cylindrical return tubular boiler (single and double ended, combustion chambers common and separate), both when full and to working height? Any length and diameter will serve to demonstrate the procedure. L. T.

A.—There is no *easiest* method of finding a center of gravity of this kind. The one method that could be used is a tedious one that depends upon the expertness of the draftsman or the designer. The problem is one that requires considerable imagination. There must be a mental picture of the water as it would appear with the boiler removed from it, the water being in a solid state so as to hold together and have the same form as when in the boiler.

In this case we would have a number of bodies of water of different sizes and shapes and all connected together. The center of gravity of this aggregation would be the point at which the entire mass would balance in every position if supported. As this point cannot be found in a physical way the theoretical location of it must be found by various calculations. These calculations are made on the areas of various cross-sections of the boiler, and therefore a drawing showing fully the construction of the boiler must be used as the basis for this work.

Assuming that the boiler is symmetrical, the water spaces will be the same on both sides of a vertical plane, cutting the boiler at the longitudinal centerline. Therefore, the center of gravity of each of the several bodies of water on one side of the center plane may be located, and a similar location be assumed for the centers of gravity on the other side. The center of gravity of each body of water may be found in the following way: First take such bodies as have uniform cross-sections such as circles, rectangles, etc., and get the center of gravity of each one by construction. Thus in Fig. 1 the tube areas *A* and *B* have their centers where the diagonals cross. Then the center of gravity *I* of the combined areas is on a line joining their centers.




Figs. 1 and 4.—Water Area at Front of Boiler

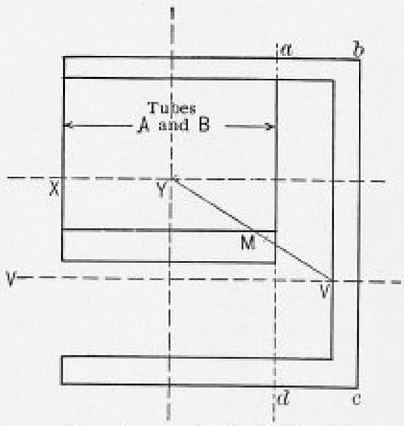



Fig. 3.—Longitudinal Section of Boiler

The method of getting the center of gravity of two or more connected bodies may be explained in connection with Fig. 2. Let the bodies be located at the points represented by *A*, *B*, *C* and *D*.

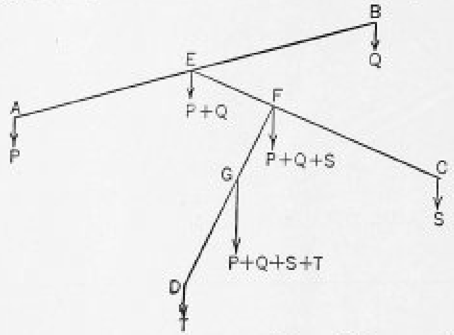



Fig. 2.—Center of Gravity of Several Connected Bodies

Then join any two of the bodies, as *A* and *B*, and represent their weights by *P* and *Q* respectively. The point *E* will be the center of gravity of the two bodies when $P \times AE = Q \times EB$. In order to get these proportions the following calculations must be made:

$$AB = AE + EB.$$

Then,

$$EB = AB - AE,$$

and in order that the weights may balance on the point *E*,

$$P \times AE = Q\ (AB - AE),$$

from which

$$AE = \frac{Q \times AB}{P + Q}.$$

When the point *E* is found it means that the weights *P* and *Q* may be considered as centered or concentrated at *E*. Next consider that the combined weights at *E* are connected to the weight *C*. Then in this case the center of gravity of the combination is on the line *EC* at some point *F*, such that $EF\ (P + Q) = FC \times S$. In this case the three weights are combined at *F*. Finally draw from *F* a line to *D*, and the center of gravity of the combination will be at some point *G*, so that $FG\ (P + Q + S) = DG \times T$.

After getting the center of gravity *I* of the water spaces *A* and *B* in Fig. 1, it is necessary to get the net water area in these spaces. Suppose that the tubes occupy nine-tenths of the areas, then the water space is one-tenth, and this area multiplied by the length of the tubes as shown in Fig. 3 will give the volume of the water. Finally multiply by 62.5 (weight in pounds of 1 cubic foot of water) to reduce this volume to pounds. Next get the center of gravity of the irregular area occupied by the water that surrounds the tube areas *A* and *B* and the furnaces *C* and *D* in Fig. 1. One method of getting this center of gravity would be to cut out a paper pattern and pass a pin through it at some point to test its balance. If the irregular form does not balance on the pin, then change the pin to some other location and continue this method until the correct center is found—for example, at point *J*. Next project the centers *I* and *J* to the vertical centerline of the boiler and then find the center of gravity *X* of the combined areas of the water. Referring to Fig. 3 it will be seen that the center *X* is projected horizontally until the line crosses the middle line of the tubes, giving the point *Y* as the center of gravity of the water at the left of the line *ad*.

In order to get the center of gravity of the water that surrounds the combustion chamber and which is back of the line *ad* in Fig. 3, refer to Fig. 4 and get the center *T* by means of the pin method. The areas *E* and *F* are cut from the paper and the center of the skeleton 4-5-6 found at *T*. Then project this center to *U* on the vertical centerline and draw a horizontal line through *V*, as in Fig. 3. Also cut out the area *abcd* of the rear water space in Fig. 3 and find the location of its center of gravity *V* by the pin method. Finally join *Y* and *V* and find the center of gravity of the combined bodies at some point *M* after the manner described in Fig. 2. This point *M* will be located in the vertical plane through the center, and it is the theoretical center of gravity of the water in the boiler when at the level 1-2-4-5 in Figs. 1 and 4. If the water is at any other level, then the centers of gravity of the skeleton areas 1-2-3 and 4-5-6 of Figs 1 and 4 must be located accordingly.

### Corrosion of Boiler Tubes

Q.—What is the reason why tubes in the watertube boilers blister and then, of course, blow out at that place? This is a common occurrence in ships fitted with watertube boilers.

My experience is as follows: Clean boilers to start with; had a leaky condenser; density went up to 1/32. After six days brought the density down to ⅛ of 1/32; tubes started to blister and blow out. I had one boiler out of four that never gave any trouble.

A.—Your case is very interesting but not new.. There have been recently a number of boilers, both Scotch and watertube, which have required retubing although less than a year old. Because of war emergency conditions it is undoubtedly true that the quality of materials has not been as good as formerly, nor has the inspection been as thorough. The Navy Department has lately put through a number of tests on boiler tubes, and in a paper by W. F. Worthington states that the following agents are responsible: fatty acids, hydrochloric, galvanic action, salty water, carbonic acid, air in feed water.

The feed water especially should be watched. The writer has found cases where the heating coils leaked and drains from the coils deposited oil in the filter tank, no observation tank being fitted.

The density stated in your figures should not of itself be sufficient to cause tube trouble, if, however, coupled with non-homogeneous metal in the tubes, electrolytic action might be set up. Especially is this likely to occur if the mill scale has not been removed by pickling in dilute sulphuric acid. The fact that the tubes in one boiler gave no trouble would indicate that they had received entirely different treatment.

A very interesting example of electrolytic corrosion is cited by Mr. E. I. Palmer in the *Journal of the American Society of Naval Engineers*, 1907, page 54, in which it was claimed that copper was deposited in the tubes, appearing in the pit marks. These deposits (about 3 percent copper) seemed to come from the composition blading of the main turbines, the blades showing the effect of erosion. It would be advisable to have a metallurgist compare etched sections of the faulty tubes under the microscope with those of new tubes.

## Obituary

B. S. Sarver, a member of the executive board of the Master Boiler Makers' Association, who was elected for a third term of three years at the Minneapolis convention, died July 23 in Chicago. The funeral took place July 26 at Pittsburgh.

## BUSINESS NOTES

After August 1, 1920, the publicity department of the Chicago Pneumatic Tool Company will be located in the Chicago Pneumatic building, 6 East 44th street, New York City. H. W. Clarke is manager of the publicity department.

The American Car & Foundry Company has recently purchased two additional pieces of real estate for its contemplated $2,000,000 plant extending from Blue Island avenue, along Paulina street to the Chicago river at Chicago. The land, now occupied by the company, was formerly under lease.

The Minnesota Supply Company, with offices at 802 Pioneer building, St. Paul, Minn., has been appointed sales representative of the Falls Hollow Staybolt Company, Cuyahoga Falls, Ohio. The business will be in charge of W. H. Hooper, well known in railway and railway supply circles for the past twenty-five years.

T. D. Slingman has joined the sales organization of the Keller Pneumatic Tool Company in the capacity of special representative, with headquarters at the Pittsburgh office. Mr. Slingman has for many years been identified with the selling organization of the Chicago Pneumatic Tool Company, for the past nine years as district manager at Detroit, Mich.

The export department of the Oxweld Acetylene Company, which was formerly located at the company's factory in Newark, N. J., has been removed to the Carbide and Carbon building, 30 East Forty-second street, New York. The department has been reorganized and is now under the direction of R. G. Noble, who will co-operate with the general sales department of the company.

The Air Reduction Sales Company has recently completed the construction of a new acetylene plant at 560 Broadway, Gloucester, N. J., to meet the increasing demands for Airco oxygen and acetylene. The buildings making up this new unit in the Airco service system consist of a gas house, carbide storage building and a generator house. The gas house is the main building of the plant and contains the compressors and filling lines. It has a brick addition which is used as a locker room and heating plant. All the buildings are of fabricated steel and are supported on concrete foundations and have concrete floors.

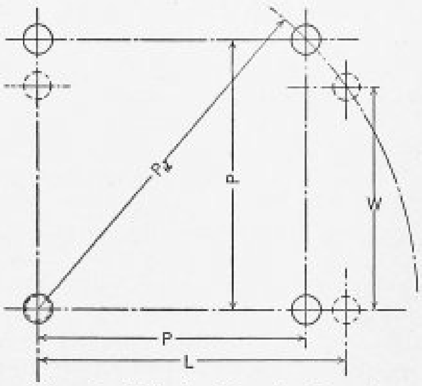
Several appointments have been made in the organization of the Westinghouse Electric International Company. At East Pittsburgh they are as follows: H. F. Griffith, assistant to general manager; R. W. Everson, manager of merchandizing department; H. C. Soule, manager apparatus department, and H. S., Reisenstein, manager price department. In New York they are: G. H. Bucher, assistant to general manager; H. Payne, supervisor of agencies; F. M. Sammis, manager of incandescent lamp department. In New York they are: G. H. Bucher, as- of publicity, Westinghouse Electric and Manufacturing Company, has been placed in charge of the advertising and promotion work for the Westinghouse International Company.

# Letters from Practical Boiler Makers

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

## Irregular Staying of Flat Surfaces

In laying out the stays for flat surfaces of boilers it is occasionally necessary, or at least more convenient, to make the pitch of the stays in the rows unequal to the pitch between the rows.



General Method of Spacing Stays in Flat Surfaces

When doing this, the designer should bear in mind that the strength of a flat plate to resist deformation depends upon the diagonal pitch of the stays—that is $P_d$ in the accompanying illustration.

This is proved by the fact that it is along this line that the plate will elongate the most under a pressure sufficient to cause deformation.

This being the case, and having calculated the pitch of stays required by the usual rules for equal pitches $P$, it only remains to keep the diagonal pitch $P_d$ the same, and we can lay off the stays to any combination of pitches $L$ and $W$, which will have a diagonal pitch $P_d$ not greater than it would be if $L$ and $W$ were each equal to $P$, the pitch as calculated.

This can be accomplished graphically, as indicated in the drawing, or calculated by the formula:

$$\frac{L^2 + W^2}{2} = P^2,$$

where $P$ = pitch of stays as calculated according to the rules for stays equally pitched. The above formula is derived as follows:

Where the pitches are equal,

$$P_d^2 = 2 \times P^2.$$

To change $P$ to $L$ and $W$, with $P_d$ equal to the above,

$$P_d^2 = L^2 + W^2.$$

But,

$$P_d^2 = 2 \times P^2.$$

Therefore,

$$2 \times P^2 = L^2 + W^2,$$

and

$$P^2 = \frac{L^2 + W^2}{2}.$$

The disadvantage of the irregular staying is that it requires more stays for a given area than where the stays are spaced equally each way.

New Glasgow, N. S. JOHN S. WATTS.

## Why Practical Boiler Makers Should Be Employed as Boiler Inspectors

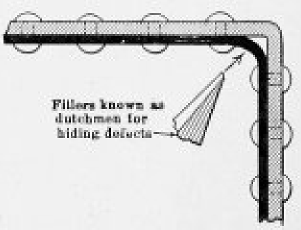
Practical boiler makers should be employed as boiler and shipyard inspectors. When I say boilers I mean all classes and types of boilers as well as steam drums and reservoirs. In former years even mechanical engineers who possessed no practical experience in the construction, repair and maintenance of steam boilers were not considered sufficiently qualified to fill the positions of inspectors.

The mechanical engineer may have a technical knowledge of boiler design; he may be able to develop the proper thickness of shell plates in order that they may contain a given pressure safely and to design a seam whose whose efficiency would readily conform to the factor of safety of such a boiler; he may have the ability to tell how to stay a flat surface correctly or give the diameter and pitch of rivets, the strength of stays and their fastenings by means of applied mechanics. In a word, his function is to design a boiler scientifically and mathematically so that it will withstand a given pressure of steam or conform to the factor of safety which is prescribed by the boiler laws. Only when he properly confines himself to this field of mechanical endeavor is he efficient. Why does he, therefore, sometimes desire the position of boiler inspector, and why is it that the inspection bureaus and insurance companies employ such men to inspect boilers?

In answer to the first query I will say that the only reason that men other than practical boiler makers seek the position as boiler inspector is due to the fact that it does not require much exertion and is a lucrative position. Then, too, the possibilities are very great.

Another class of men seeking the same positions have no other qualification than that they have held steamboat licenses for three years. It is not because they are more competent than practical boiler makers that they are fitted to become inspectors. It is not because they possess a broader knowledge of machinery as well as boilers, for they usually are as ignorant of the practical construction of the engine as of the boiler.

The sole reason, as the writer sees it, why they are chosen for the place is due to the fact that the steamboat inspection law states that licensed engineers only are eligible as steamboat boiler inspectors. This ruling, I am glad to say, does not apply to locomotive inspectors, for the practical boiler maker, if permitted to compete and make the examination, can be chosen as a locomotive inspector without any discrimination whatever.



A Common Practice of Hiding Defects in Plate Work

Referring again to marine boiler inspection, it is quite evident that if a practical boiler maker is the only competent man to employ in the supervision and construction of boilers, then it logically follows that he is the only man who really knows when a boiler has been properly constructed.

Now I am thoroughly convinced that there are boiler men in this country who posses the ability to become good inspectors and who could, if given an opportunity, pass the examination and qualify for the position. I would suggest that the boiler men all over the country get together and see if this law cannot be modified so as to include the practical boiler maker as an inspector of steamboat boilers. Men with a knowledge of the trade are necessary now to hold down the foremen in trying to get production at the expense of quality.

It is almost a universal fact that the inspectors are never on the job except when the final tests are applied. They do not know whether each operation has been performed correctly or not, and, of course, there are numberless defects discovered by the workmen in the course of construction. All sorts of devices are resorted to to cover up these defects, which should not be permitted and would not be allowed by a practical boiler maker who was constantly on the job. For example, the accompanying illustration shows a corner on ship work where the sheet has not been properly layed up. In such cases, the customary practice is to substitute an iron wedge commonly known as a "dutchman." This is driven in between the sheet and angle and worked over by calking tools. This practice of using dutchmen in so-called up-to-date boiler shops is very popular and resorted to extensively by calkers. Having been worked over by a skilled calker, these fillers can hardly be seen except by someone familiar with the work. Now there are numberless other substitutes being used in various operations which the steamboat inspector will never discover unless he is a practical man.

Jersey City, N. J. H. A. Lacerda.

## The Apprentice and the Flange Fire

There cannot be too much said about the apprentice question, especially when it comes to a knowledge of the flange fire in a small shop. How many boiler makers of today can go to the flange fire and turn out a first-class piece of work? A lot more work would be lost, if it were not possible to have a first-class helper to build and take care of the fire.

Heating is considered a helper's job in most places, but it is one of the first things an apprentice should endeavor to learn, because to have the heat right and in the proper place is just as important as getting the work on the block properly. The oil fires used in many shops today require just as much study, if not more, than the coal fires. The writer has seen some very irregular work turned out in an ordinary oil fire just about as it could have been done in a coal fire. In some shops there are no more coal fires, everything being heated with oil burners. Of course, in the oil fire as well as in the coal, the edge of the flange that is being heated should never be out of sight where it cannot be watched. You should be able to see the edge of the sheet when the cover is lifted.

The best results are obtained if the heat can be kept within an inch or so of the back of the bend. All metal to be bent should have a uniform heat.

After the heat on the block it is usually best to make the heel first. If the flange is long and requires a second heat, it can be gotten into position so much quicker when the heel is made first. The eye should be trained so that you can tell exactly where the center marks belong.

When replacing the sheet in the fire, the flange turner should watch so as not to get too much or too little of the newly made flange in the fire. If too little is in the fire, there is liable to be a bump along the heel, which may require another heat to straighten out. If too much of it is in the fire, and the block is not exactly the right size, then the part of the flange, already shaped, will go down further under the second heat.

The flanger should always endeavor to keep his sledge hammer handle parallel with the part he is hitting and to have the faces of his hammers rounded a little so that there will be no sharp corners to cut the sheet. Likewise the face of the flatter should be slightly rounded.

Straightening up a flanged head without a furnace is quite a problem for most men. Even if the head is almost straight right after being flanged, the cooling off will usually throw a belly in it one way or the other. The best way to get a hump out which has gone down is to tap it around the heel. Stretching the head here brings up the center.

If it has gone the other way, the flange will have to be stretched on the edge to bring in the center.

## More of the Hydrostatic Test

In continuance of the subject of the hydrostatic test, the writer wishes to relate a very interesting incident which occurred while engaged in testing out a locomotive boiler. This boiler had been given a general overhauling, the interior of the boiler had been scaled and carefully inspected for defects, the exterior of the shell had been cleaned and inspected and there was no evidence of leaking at the calking edges or rivets.

The longitudinal seams were of lap joint, double-riveted construction with a thickness of shell about ⅝ inch with 13/16-inch rivets. All repairs were completed and the boiler was filled with water at a temperature of between 80 degrees and 90 degrees, pressure being supplied by a portable pump. At 175 pounds the throttle leaked so badly that we decided to shut off the pressure until repairs were made. As we signaled to the man at the pump to shut off, a machinist standing on the running board alongside of the dome struck the boiler shell with his hand hammer, supposedly to emphasize our signal to man the pump, when rip—bang went the seam in the front course next to the flue sheet, tearing the sheet wide open at the bottom rivet line and extending for a distance of 6 inches into the solid plate of the middle course. An examination showed that at four rivet holes in the center of the rivet line there was a small check or crack which extended through about half of the thickness of the sheet, and which, from all appearances, had been there for some time.

We have often wondered, if it had been possible to register the amount of shock or vibration set up by the blow, whether it would have shown that the boiler could have stood up under excess service. Of one thing it convinced me, and that is the fact that water is absolutely non-elastic.

Lorain, Ohio. Joseph Smith.

## Bending Action in Channel Beams

Tanks 30 to 150 feet in diameter involve structural section stiffening rings in sections welded together, dished and riveted or lapped. It is safe to assume that the bending will be done in rolls to the required curvature.

The deformation resulting from bending to curvature is complicated by the fact that rolling of any kind results in stretching the material and reducing its cross-section while extending its length. In other words, the extension of the outer circumference is certain to exceed the contraction of the inner circumference by an amount only to be determined by practical experiment. If the bending is done hot by rolling, such alteration will be greater than if done cold. The balance of the section relative to its deformation is another factor. A channel or I-beam will give more even results than an angle section, the latter, when being curved, gives little resistance on the flat and considerable resistance on the edge or flange. As a consequence, the neutral axis in the change of shape is difficult to determine practically, although mathematical expressions are given for this purpose in any hand book. The theoretical neutral axis of a channel is its mean centerline midway between the two flanges.

While for small tanks up to 6 or 8 feet diameter punching the angle rings in the flat and rolling up is impracticable, in the case of the very large tanks cited it should certainly prove feasible to follow this practice.

Space punching can be held to very small limits certainly well within the accuracy required for tank work.

To take up the matter on a practical basis, leaving the mathematics of the subject alone entirely, why not carefully measure one length of section, prick punching at 6-inch intervals, bending up one length to exact curvature and noting results? Plot the results and see how the stretching varies. It is most likely that there will be a want of uniformity dependent upon position, and it should be feasible to average this. In any case, the section length so treated remains unspoiled. The extension found will determine the extra pitch required to match plate holes.

Another method open would be the use of the steel tape to determine the correct circumference without locating the ring in place for marking, and the preparation of a flexible template to correspond with the spacing in the plates. Punching is done subsequent to bending and assembly of the rings on the floor. The whole operations for their success depend upon considerable care at every stage, small errors even in automatic spacing become cumulative in so long a division, the error becoming multiplied. The circumference covered by a single plate will obviously be much less than that covered by a segment of the stiffening ring, and it is not stated whether the plates are lapped or butted, the latter being the more accurate method for separate fabrication.

If the tank plates are multiple holed at a single operation, great exactitude is assured so far as they are concerned and similar methods with the rings, due allowance for stretch having been determined by experiment should prove feasible. As the rings are so much longer, a pilot punch into the terminal hole will be needed. It is obvious that owing to the stretch the same pitch cannot be used for both. The methods used will have to possess some precision and normal single hole punching is ruled out entirely, while using the existing method described the most primitive plant will serve.

Tanks 150 feet in diameter are unusual; normal run of tank work done in tank shops is within a much smaller compass and the size alone justifies special methods and the resultant saving by quick assembly would be considerable.

London, England. A. L. HAAS.

## Causes of Crown Bolt Failures?

It has no doubt been the experience of practically every boiler maker, both in new construction and in repair work, to have some particularly strange accident come to his attention without any apparent reason existing for the condition of the boiler. One such case was brought to our attention recently by a locomotive inspector, and possibly some one of the readers of THE BOILER MAKER will be able to offer an explanation for the failure. An L. 1. S. engine while being examined in the shop for general repairs was found to have four staybolts and crown stays broken and one crown bolt cracked. In renewing these bolts it was of course necessary to install new bolts adjacent to each of the cracked and broken ones, so that twenty-four crown bolts in all were renewed. This particular defect was rather peculiar, for crown bolts seldom break, but the following description of the installation may possibly furnish an answer to the trouble. There were twenty-four ½-inch spaces between the crown sheet and the roof sheet, so that the stay had plenty of flexibility. The crown bolts were 1⅛-inch diameter, and on testing after removal were found to be in good condition. The writer has heard various explanations for the failure of crown bolts, but none of them seemed to fit this particular case.

Any information that the readers of THE BOILER MAKER are able to furnish will aid materially in clearing up the question of crown bolt failures, which is a matter of very general interest in the locomotive shops.

Olean, N. Y. CHARLES W. CARTER, JR.

## PERSONALS

Clark T. Dickerman, sales agent for the American Car & Foundry Company at New York, has been transferred to the Chicago office.

Don C. Wilson has been appointed assistant sales manager for the Edison Storage Battery Company, of Orange, N. J., in charge of its railroad department.

J. W. Chandler has been appointed master mechanic of the Kansas City Southern Railway, with headquarters at Shreveport, La., effective July 20, succeeding A. D. Williams, assigned to other duties.

Elmer R. Larson, supervisor of apprentices of the Delaware, Lackawanna & Western, has been appointed special motive power inspector, and John Murray, assistant supervisor of apprentices, has been promoted to supervisor of apprentices, succeeding Mr. Larson.

A. T. Pfeiffer has been appointed assistant superintendent of fuel and locomotive performance on the New York Central, with headquarters at New York City. Robert McGraw has been appointed fuel instructor, with headquarters at Syracuse, N. Y. J. C. Brennan has been appointed supervisor of fuel and locomotive performance of the first district, with headquarters at Utica, N. Y. C. W. Wheeler has been appointed supervisor of fuel and locomotive performance of the second district, with headquarters at Syracuse, N. Y., succeeding L. F. Burns.

G. Lamberg has been appointed superintendent of shops of the Chicago, Milwaukee & St. Paul Railway, effective June 16, with headquarters at Minneapolis, Minn.

W. J. Hughes has been appointed master mechanic of the R. & S. W. division of the Chicago, Milwaukee & St. Paul Railway, effective June 16, with headquarters at Milwaukee, Wis., succeeding E. W. Hopp, transferred.

E. W. Hopp has been appointed division master mechanic of the Aberdeen division of the Chicago, Milwaukee & St. Paul Railway, effective June 16, with headquarters at Aberdeen, S. D., succeeding G. Lamberg, promoted.

H. K. Fox has been appointed engineer of tests, effective June 16, with headquarters at Milwaukee shops, Wis., due to the return from the United States railroad administration of C. H. Bilty to his former position.

C. H. Bilty has been appointed mechanical engineer in charge of mechanical design of the Chicago, Milwaukee & St. Paul Railway, effective June 15, with jurisdiction over physical and chemical tests, including shop engineers and test department and their respective staffs, with headquarters at Milwaukee shops, Wis., succeeding H. K. Fox, transferred.

## TRADE PUBLICATIONS

Twist Drills and Reamers.—In a catalogue issued by the Whitman & Barnes Manufacturing Company, Akron, Ohio, specifications of carbon and high-speed twist drills and reamers of all types are given.

Material Handling.—The Buffalo Hoist & Derrick Company has issued a pamphlet giving the specifications and a few of the uses to which the clamshell buckets, locomotive cranes, derrick and hoisting engines, produced by this company may be put.

Turret Lathe Practice.—The reference book on vertical turret lathe practice in railroad shops has been issued by the Bullard Machine Tool Company, Bridgeport, Conn. The book is valuable as a reference for quick, efficient methods of setting up locomotive parts and performing the necessary machine operations.

Hoisting Hints.—The Machine Shop issue of the booklet describing chain blocks and trolleys produced by the Yale & Towne Manufacturing Company, Stamford, Conn., contains illustrations and descriptions of these devices used in various machine shops. Specifications are also given for "Yale" spur-geared chain blocks, screw-geared chain blocks, differential chain blocks, electric hoists and "Brownhoist" trolley and I-beam track equipment, overhead traveling cranes and floor cranes.

Pneumatic Tools.—Pneumatic tools and shop equipment, produced by the Keller-Pneumatic Tool Company, Grand Haven, Mich., are completely described in Bulletin No. 5. These tools include equipment for use in shipyards and boiler shops, structural steel works, foundries and the like. Specifications of each tool are listed and illustrated with a special section devoted to the tabulation of repair parts and prices, together with sectional drawings of the tools which are intended to simplify the ordering of parts.

Pneumatic Tools and Electric Drills.—Bulletin No. 11, recently issued by the Independent Pneumatic Tool Company, Chicago, Ill., reviews pneumatic tool products of this company with special features and new equipment given prominence. New additions to the line of "Thor" tools found in this catalogue are: motor-driven air hoists, pneumatic sand rammers, a universal device for pneumatic drills, hose couplings, power screw driver, hose clamp and hose mender. Specifications are given for each tool and many illustrations show "Thor" products in operation.

Thermit Pipe Welding.—The thermit process of pipe welding as carried out by the Metal & Thermit Corporation, New York, is completely described in a catalogue recently made available. The pamphlet contains reports on successful tensile strength and vibration tests of thermit pipe welds conducted by the Stevens Institute of Technology. Among other tests described is one on 700 feet of 4-inch pipe which was ten years in service at West Albany, N. Y. This pipe was subjected to a hydraulic pressure of 1,500 pounds per square inch without any defects being discovered.

Bolt, Nut and Rivet Machinery.—A complete line of equipment for the manufacture of bolts and nuts is described in catalogue No. 20 issued by the Akron Machinery Company, Cleveland, Ohio. The machines include single and multiple bolt cutters with or without power feed and lead screws, special staybolt cutters, bolt pointers, nut tappers, nut burring machines, nut machines, bolt machines and upsetting and forging machines. The die head manufactured by this company is also described and instructions are given for making and recutting dies. Data pertaining to screw threads, bolts, nuts and rivets are also included.

## ASSOCIATIONS

**Boiler Makers' Supply Men's Association**

President—Frank J. O'Brien, Globe Seamless Steel Tubes Co., Milwaukee, Wis.

Vice-President—William B. Wilson, Flannery Bolt Co., Pittsburgh, Pa.

Secretary—George Slate, The Boiler Maker, 6 East 39th Street, N. Y.

Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

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Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte Building, Kansas City, Kans.

James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte Building, Kansas City, Kans.

William Atkinson, Acting Assistant President, suite 315 Wyandotte Building, Kansas City, Kans.

International Vice-Presidents—Joe Reed, 1123 East Madison Street, Portland, Oregon; Thomas Nolan, 700 Court Street, Portsmouth, Va.; Joseph Flynn, 111 South Park Avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth Street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth Street, Columbus, Ohio.

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Secretary—Harry D. Vought, 95 Liberty Street, New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood Avenue, Columbus, Ohio.

Executive Board—John F. Raps, gen. B. I., C. R. R., 4041 Ellis Avenue, Chicago, Ill., chairman.

## Selected Boiler Patents

Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,

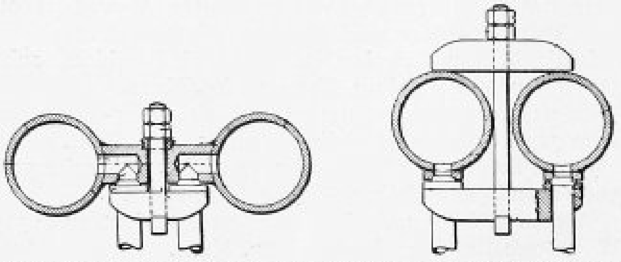
Washington Loan and Trust Building,

Washington, D. C.

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

1,328,364. SUPERHEATER HEADER. BENJAMIN BROIDO, OF NEW YORK, N. Y., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

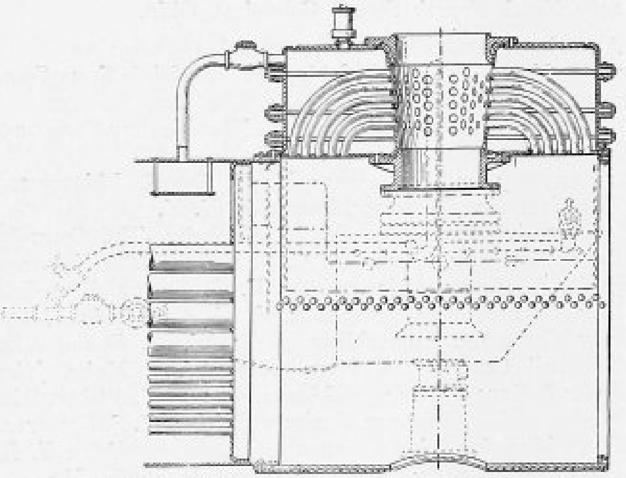
*Claim* 1.—In apparatus of the class described, the combination of a header having a plurality of openings through its wall; pipe ends cor-



responding in number to the openings; a bar parallel and adjacent to the header and with a like number of correspondingly spaced holes extending between two of its faces, said bar being secured to the header so that the holes in one of the faces communicate with the openings through the header wall; and clamping means holding a pipe end against each hole in the second face of the bar, said clamping means engaging the pipes and the bar. Six claims.

1,335,439. FEED WATER HEATER FOR LOCOMOTIVE BOILERS. ALLAN R. HODGES, OF CHICAGO, ILLINOIS, ASSIGNOR OF ONE-HALF TO CYRUS A. McALLISTER, OF MEMPHIS, TENNESSEE.

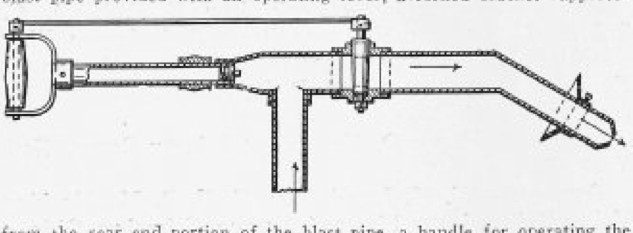
*Claim* 1.—A feed water heater for locomotive boilers comprising a casing arranged in external association with the boiler smokebox and



having a feed water inlet and outlet, said casing utilizing as its inner shell the shell of the smokebox and having an outer shell arranged transversely over the inner shell and end heads extending between said shells, the shells forming a crescent-shaped inclosure, an open ended cylinder extending between said shells, said cylinder taking the place of the usual smokestack, and a plurality of open ended tubes arranged radially of said cylinder at regular intervals throughout its circumference, and disposed in courses or tiers, said tubes extending through the casing between the smokebox and the cylinder, and serving to conduct the gases of combustion into said cylinder and to effect the heating of the water in said casing. Two claims.

17,325,543. TUBE CLEANER. LUSTER STILES, JR., OF EVANSVILLE, IND.

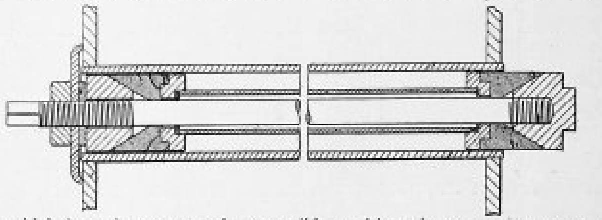
*Claim* 1.—In a tube cleaner, a blast pipe, a regulating valve in the blast pipe provided with an operating lever, a forked bracket supported



from the rear end portion of the blast pipe, a handle for operating the blast pipe mounted to oscillate in the forked bracket and provided with a lever which is oscillated by it, and a connecting-rod between the two levers whereby the valve is operated by the said handle. Three claims.

1,335,117. TUBE-STOPPER. AXEL P. KOFOED AND NIELS P. NIELSEN, of COPENHAGEN, DENMARK.

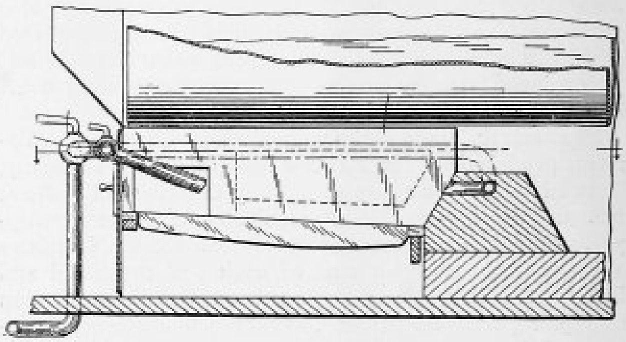
*Claim* 1.—A tube stopper comprising a bolt, an expanding head fixed to said bolt at its inner end, a second expanding head slidably carried



by said bolt at its outer end, expansible packing elements adjacent said expanding heads, said packing elements having a plurality of plane surfaces, thrust collars adjacent said packing elements, said thrust collars having a plurality of plane surfaces adapted to coact with the plane surfaces on the said packing elements to afford tight closure, a cylinder surrounding said bolt, the ends of siad cylinder being seated in recesses formed in the said thrust collars, packings in said recesses, a nut on said bolt for operating said expanding head, a guarding shield carried on said bolt behind the said nut, said guarding shield being adapted to temporarily close the opening of the tube to be stopped, and means on said bolt for keeping the same immovable while said nut is being operated. Two claims.

1,318,782. DRAFT APPARATUS FOR FURNACES. JAMES TENNANT McKEE, OF NEW BRUNSWICK, CANADA, ASSIGNOR OF ONE-HALF TO JOHN RUSSELL THORNBERRY, OF SEAFORD, ENGLAND.

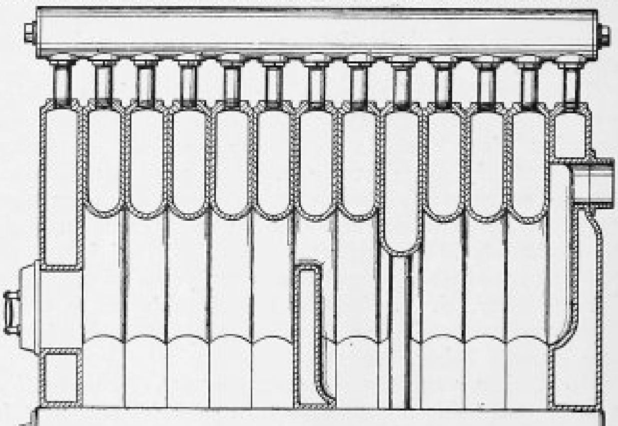
*Claim* 1.—In a furnace, the combination with a plurality of fuel chambers, each having a grate and a free outlet at the bridge wall thereof,



and a partition wall between and separating two adjacent chambers, but having in it an opening near the front or fire-door end of the wall, of forced draft devices, one opening into the rear or bridge end of each fuel chamber and directed along the grate therein for causing the draft over the grate normally flowing directly toward the bridge wall, to be reversed along that grate and forced to flow through the said opening into the adjacent fuel chamber, and over the grate therein toward the bridge wall thereof, and means for controlling the forced draft devices. Two claims.

1,334,676. BOILER. RICHARD D. REED, OF WESTFIELD, MASSACHUSETTS, ASSIGNOR TO THE H. B. SMITH COMPANY, OF WESTFIELD, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS.

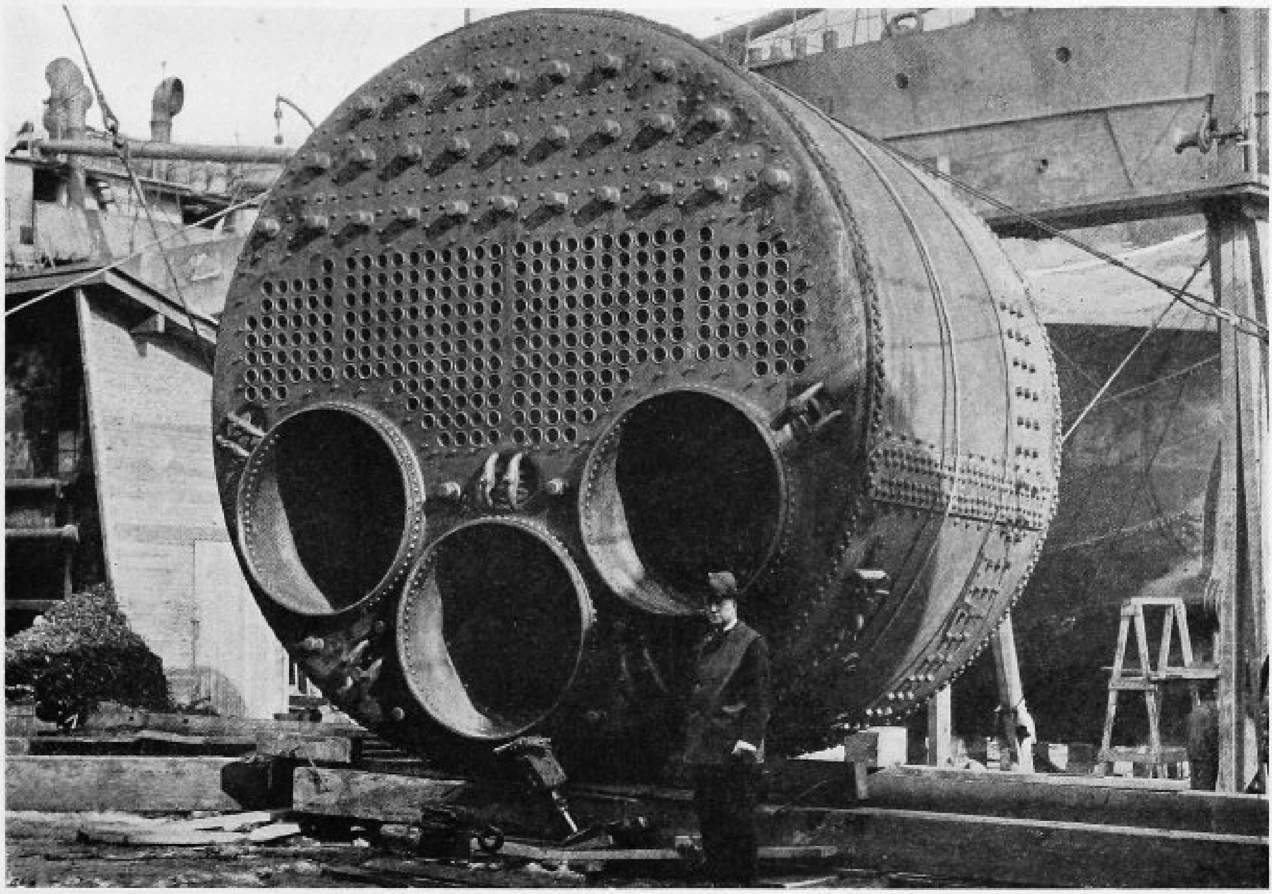
*Claim* 1.—In a combined boiler and furnace, the combination with a series of abutting hollow water sections, of a firebox, a combustion cham-



ber and a mixing chamber between said firebox and combustion chamber, a wall forming a partition between said firebox and mixing chamber and provided with a horizontally extending comparatively narrow flue opening, and a second wall forming a partition between said mixing chamber and combustion chamber and provided with a vertically extending comparatively narrow flue opening, said water sections being of such size and so constructed as to be interchangeable to thereby vary the relative sizes of the mixing chamber and the combustion chamber to adapt them to burning different qualities of soft coal, both of said partitions being hollow water carrying walls formed integral with said sections. Two claims.

# THE BOILER MAKER

SEPTEMBER, 1920



Scotch Boiler Built at the Winnisimmet Shipyard, Chelsea, Mass.

# Boiler Construction Under Difficulties

*The following story of the fabrication of six Scotch type marine boilers by the Winnisimmet Shipyard, Inc., at their plant in Chelsea, Mass., is an interesting one because of the fact that the work was accomplished in an open field in the winter of 1919-1920.*

Conditions under which the Winnisimmet Shipyard, Inc., Chelsea, Mass., built six Scotch type marine boilers during the past winter without a boiler shop were in many respects quite similar to the difficulties of boiler construction in the old days of the trade.

It had been intended to have a modern boiler shop in which to build and assemble the boilers, but as it was necessary to have them completed before a shop could be put up and properly equipped, it was decided to commence construction in the open as soon as the material was received. Under these circumstances the work was carried to completion in spite of the handicaps imposed by one of the worst winters on record.

### Largest Single Piece Heads in the World

All six of the boilers have an inside diameter of 15 feet 3¼ inches and are approximately 12 feet long. Each boiler is equipped with three Morison removable type furnaces having a minimum inside diameter of 48 inches, an outside diameter of 52⅝ inches, and a length of 8 feet 7⅜ inches. Two hundred and sixty 3½-inch tubes, 8 feet 2 inches long, are installed in each boiler. Fifty-four of the tubes are stay tubes ¼ inch thick, which are upset at the back end to 3¾ inches outside diameter and at the front to 4 inches diameter.

The front and back heads of the boilers are of 1 11/16-inch metal and are made in one piece. The outside diameter of 15 feet 3¼ inches makes them the largest single piece heads in the world, having been rolled by the Lukens Steel Company, Coatesville, Pa. The flanges around the periphery of these heads are 8¾ inches deep to allow for double riveting. The three furnace holes in the front heads have an inside diameter of 52⅝ inches, and five 11-inch by 15-inch manholes are flanged into each head.

The shells of four of the boilers are 1⅜ inches thick.

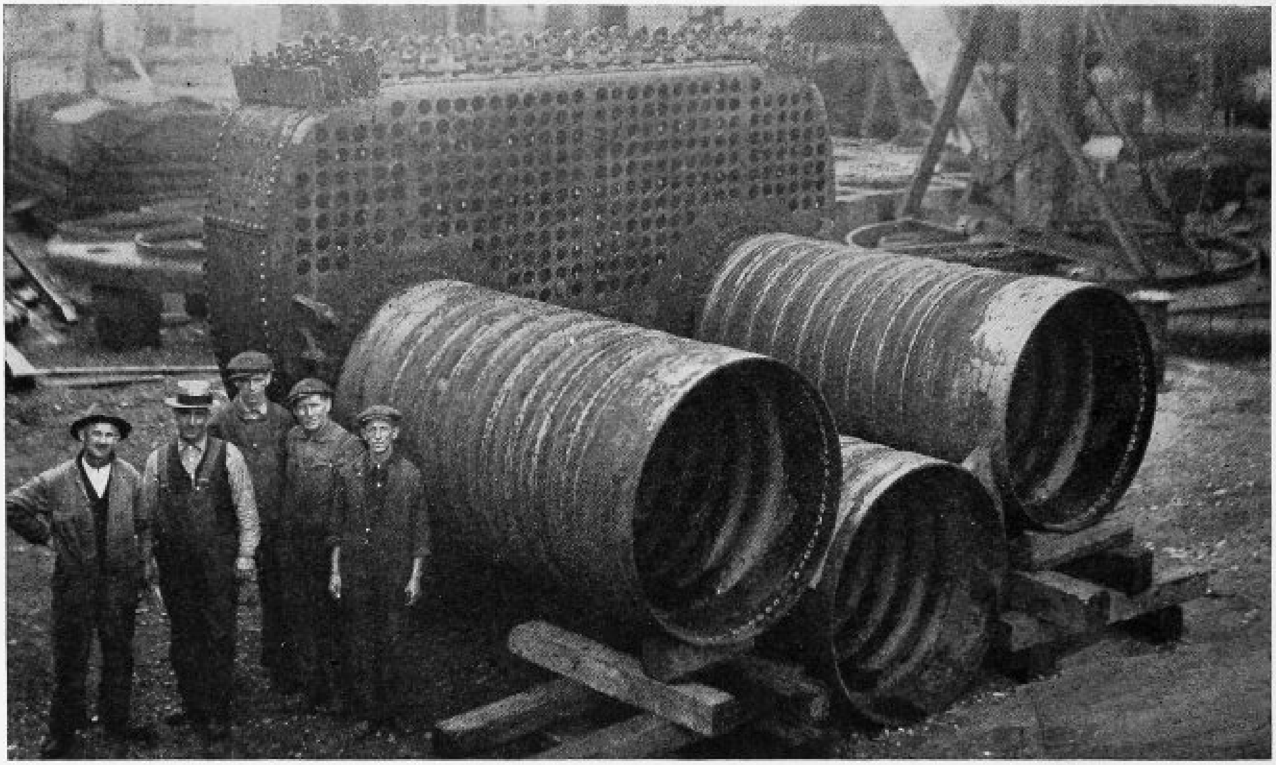
made in one course and with two plates to a course.

All girth seams are double riveted, while the longitudinal seams have butt straps with outside and inside covering plates 1 inch thick. These seams are of the triple-riveted type. All rivets in the shells and straps are 1⅜ inches diameter driven in 1 7/16-inch holes. Rivets in the back connection and furnaces are ⅞ inch in diameter and are driven in 1 5/16-inch holes. The top of the combustion chambers at the extreme ends are supported by six double crown bars, while the center is supported by "T" pad sling stays attached to angle irons riveted inside of the shell.

### Details of Boilers

Four boilers were designed and built for a working pressure of 175 pounds per square inch and were tested under a hydrostatic pressure of 263 pounds per square inch. The remaining two boilers were designed for a working pressure of 180 pounds per square inch and were tested under 270 pounds per square inch hydrostatic pressure. These two boilers have shell plates 1 7/16 inches thick and rivets 1 7/16 inches in diameter driven in 1½-inch holes. The plates for the boilers were furnished by the Lukens Steel Company, and the flanging on the outside heads and the combustion chamber heads was done at the Coatesville plant of this company. The shell plates were laid out by men from the Winnisimmet shops at the mills and the shell plates and butt straps were rolled to shape before shipment. One feature of these boilers to be specially noted is the fact that the longitudinal joints on the shell are brought together metal to metal, thus eliminating the misused and overused wedge that is often resorted to in order to fill the gap. All screw staybolts in the boilers are 1½ inches in diameter with nuts on both ends.

Fortunately, before the work had progressed very far three motor-driven Dallet shell drilling heads were received and set up in time to help out in drilling the main shell. To drill the tube holes, the mechanical department of the company designed a special drill table having a lateral and transverse movement, and this was very efficiently used in combination with a drill suspended from a cantilever extended from the outer wall of the building. This drill table was particularly useful, as the front heads weighed more than 3 tons apiece. The remainder of the work was accomplished with pneumatic drills, hammers and chippers. Some doubt was expressed about driving 1⅜-inch and 1 7/16-inch rivets with pneumatic hammers and making them tight, but no trouble was experienced in this direction. Great care, however, was taken in the design of holding-on apparatus and in closing up the plates, bringing the metal together and holding the work tight with sufficient bolts before commencing to do the riveting in the assembly of the boiler.



Furnaces Assembled Ready for Installation

Very few leaks developed in testing the boilers, and these were very easily corrected without any special difficulty.

The men who did the work deserve a great deal of credit, for they stuck to the job with determination through all kinds of weather, and it was only on extremely rainy days that they were obliged to hold up; for the extreme cold they had only contempt.

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Publicity is the forerunner to all successful enterprises. Point out a single legitimate business that forged ahead without publicity and I'll show you an organization that is satisfied with but a portion of the success it rightfully should enjoy, a firm limited in its progress by the lack of a clear-visioned helmsman.—*Inprint.*

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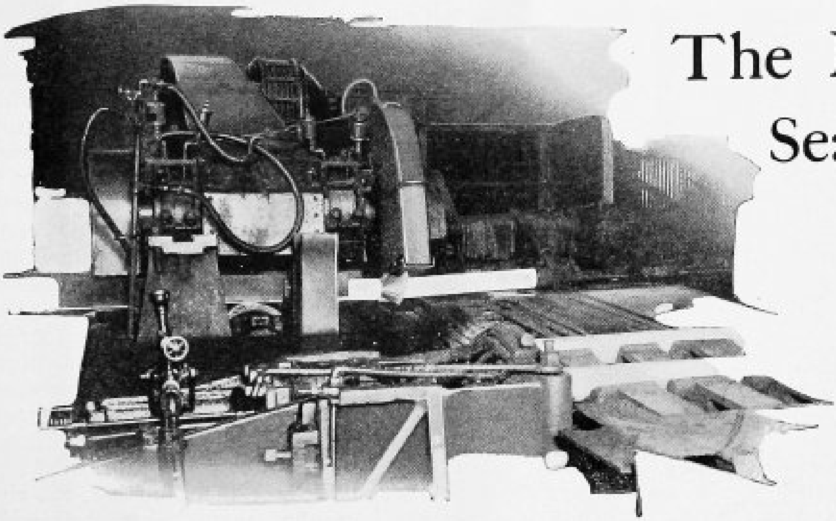
Thousands of boards of directors, thousands of executives in governmental and industrial organizations, doctors of law and medicine, prelates the world over—all bow in reverence and respect to that prerequisite to successful accomplishment—honesty. And the man who isn't honest cheats himself of their good will!—*Inprint.*



# The Manufacture of Seamless Steel Tubes*

**Details of the Production of Seamless Steel Tubing for Boiler and Locomotive Work, with a Description of the Hot Finished and the Cold Drawn Processes**

The early efforts of experimenters in making seamless steel tubes show the influences of the old methods followed in making tubes from the more ductile metals, brass and copper.

What seems to be the first attempt to make seamless tubes appears in 1837, under the English patent of Hanson. This provides a thick, short cylinder of cast steel, which is raised to a very high temperature and placed in a matrix, and then, by means of an hydraulic ram, the metal is squeezed through a small orifice around a punch, a seamless tube being the result. This method, with a few modifications, was again patented in England in 1867. A similar process was patented under Elliott in 1882. Under this specification plastic or molten steel was to be forced hydraulically through a suitable orifice so that a tube with fibers arranged helically would be produced.

The swedging mill patented by Church & Harlow in England in 1841, and modified by various subsequent patents, had in view a more economical means of lengthening hollow billets of cast or drilled steel, preparatory to cold drawing.

Sometimes solid bars of steel were drilled from end to end to make a tube-shape suitable for the cold drawing operation, but this process was slow and expensive.

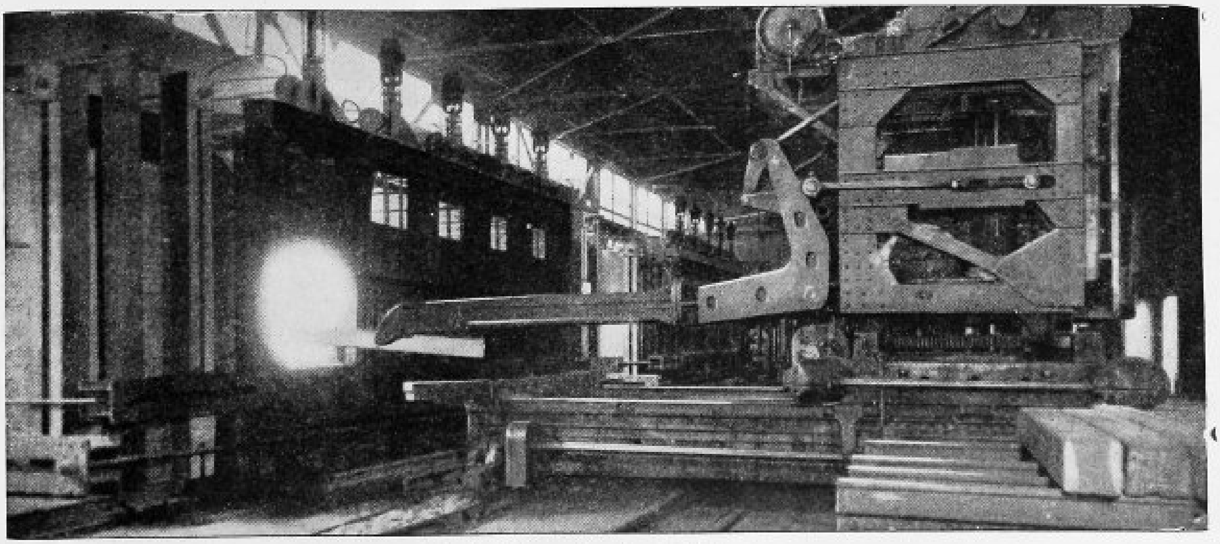
* Data supplied by the National Tube Company, Pittsburgh, Pa.

One of the first attempted processes, while not successful for small tubes, has since been satisfactorily developed for tubes larger than 5 inches outside diameter. This is the "cupping" process, which consists in pressing a cup or cap from a flat plate, or disk, and progressively elongating it into a tube by decreasing the diameter while it passes through a series of reducing dies. This method is generally practised in the manufacture of tubes from 9½ to 20 inches in diameter, and is also practical for tubes 5½ to 9½ inches in diameter.

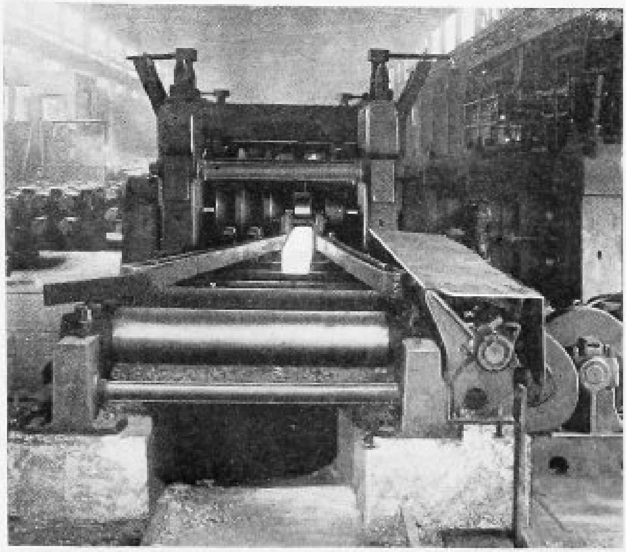
### Difficulties Encountered in Early Processes

All of these early processes had their limitations. In making seamless tubes from cast steel cylinders it was found that the material was not always homogeneous, and developed blow-holes while being drawn. Furthermore, it was not uniform in hardness and texture. The drilled bars yielded very high costs, and the cupped plates did not permit the manufacture of tubes in all desired commercial lengths and thicknesses.

Twenty-five years ago seamless steel tubing from the first operation to the finished tube was not being made in the United States. As long as the piercing operation was left undeveloped it was a simple and relatively inexpensive matter to start a seamless tube plant, and the



Charging Bloom Into Bar Mill Furnace



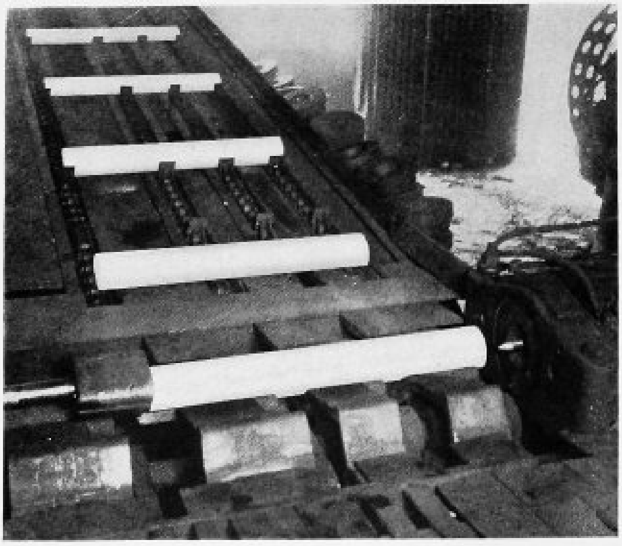
Rolling Table of Bar Mill

natural result was a draw-bench or two here and there in the manufacturing sections, where tubes were made to meet the steadily increasing demand.

It was well known that greater production and lower costs would result from an improvement of the piercing devices then in use, and while the much-sought object was finally developed and being perfected, steelmakers, were engaged in producing a uniform quality of mild steel which would permit satisfactory piercing and cold drawing and also yield a finished tube with all the required physical attributes. Both quests—for a machine to do the work and for a steel that could be satisfactorily worked—were an important branch of the steel industry in America. The application of seamless steel tubes to marine and naval boilers gave a substantial impetus to the business and directed it along new lines, and when the leading railroads began to specify this type tube for locomotive purposes the success and future of the material were finally assured.

### First Stages of Process

The steel from which the tubes are to be drawn is delivered to the heating furnace in blooms of several sizes and weights, some of these being 6, 7, 8 and 10 inches

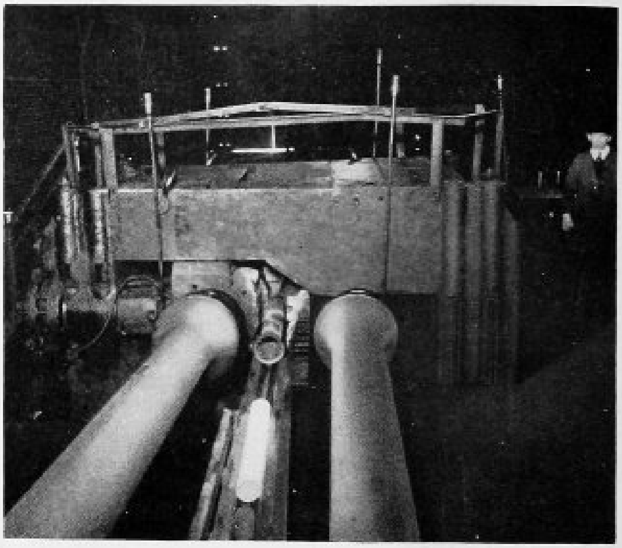


Billet in Pneumatic Centering Machine

square, about 11 feet long and weighing 1,300 to 3,750 pounds.

After the blooms have been carefully inspected for surface defects, and any irregularities chipped off with pneumatic chisels, they are conveyed by a crane to a furnace room where an electrically operated charging mechanism picks them up one by one and places them in a heating furnace.

When the proper temperature for rolling has been reached, the bloom is pulled from the furnace by the long arm of the crane or transfer mechanism and placed upon a small electric buggy; this buggy transfers it to the rolling table of the bar mill, where it passes through a series of rolls, which changes the square bloom into a round bar of smaller size and greater length. Different sizes of round bars are thus rolled according to the size of tubes required to be made from them; some of the bars are 8 inches in diameter when finished, while others are as small as 3 inches. While still at rolling heat, the round bars are cut to different weights (according to the length and wall thickness of the finished tube) by a circular saw and centered while still hot. They are then allowed to cool off, after which they are inspected, marked with a die to



Heated Bar Entering Piercing Mill

identify the steel, and sent at once to the piercing mill.

The bars are now known as billets, or "rounds," and contain just enough metal for making tubes of the desired length, thickness and diameter, and to compensate for normal losses incident to manufacture of the tube.

### Centering the Billets

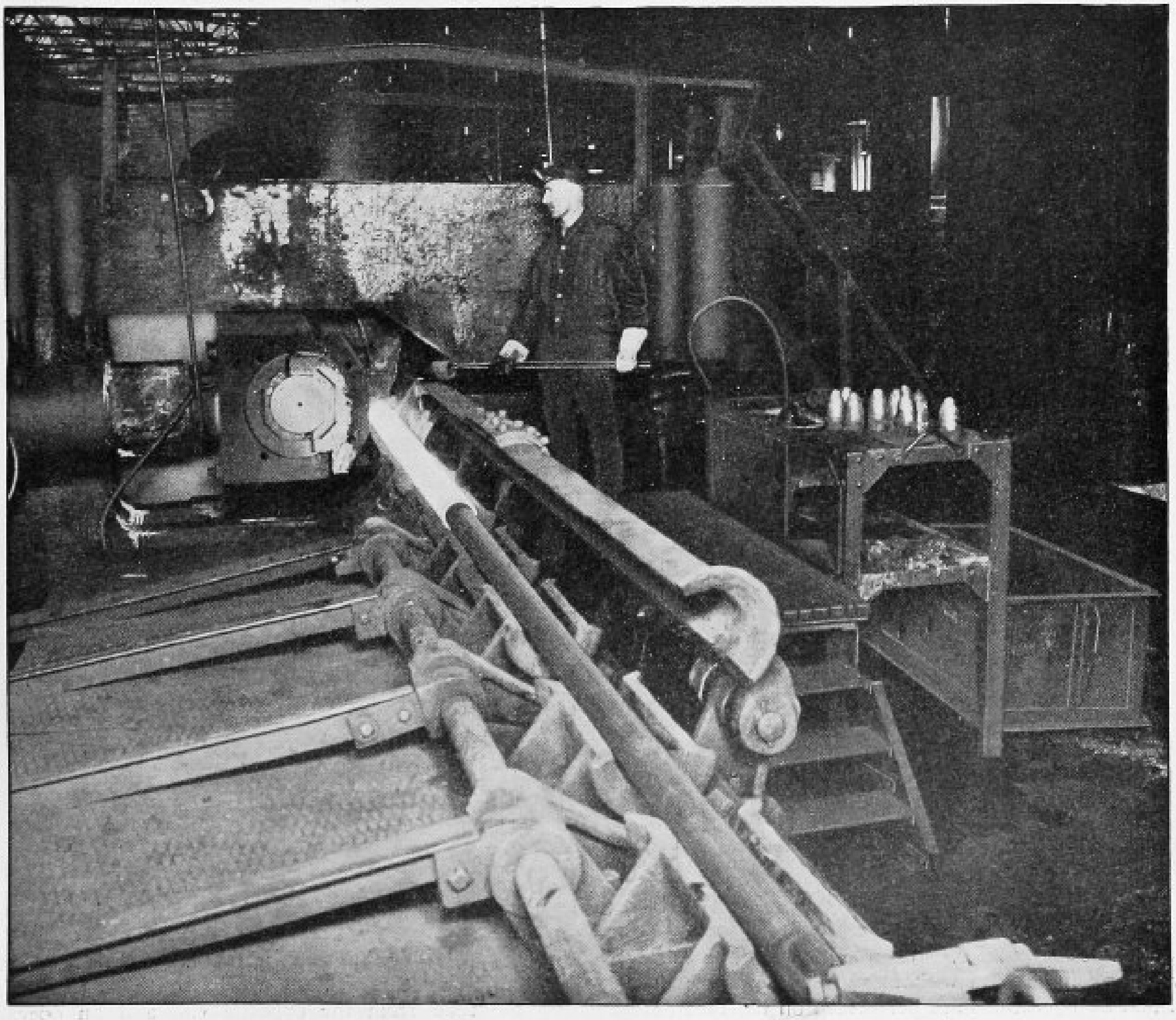
The first operation in making a seamless tube from the billets, or "rounds," is known as "centering." In this operation, which is performed by a pneumatic-driven machine while the billet is still hot from the rolling mill, an indentation is made in the center of one end of the billet by a punch, in much the same manner as preparation is made for drilling holes in metal by center-punching. The cavity, or countersink (about 1 inch deep) thus produced insures proper starting of the hot billet in the piercing operation, permits insertion of the piercing point at its most effective position in relation to the piercing rolls, and makes for an equalized displacement of metal from the center of the billet.

After the billets have been centered, inspected and marked they are placed in a heating furnace of special construction. The bottom of the furnace is inclined, and centered billets of the proper length are fed into the upper and cooler end, from which they roll by gravity to the lower end, where the temperature is high enough to render the steel soft and semi-plastic.

### Billet Assumes Tubular Form in Piercing Mill

The piercing mill is located close to the discharging end of this furnace and the billets are fed into it, centered end foremost. The solid billet, almost white hot, is pushed forward until it is caught by the revolving rolls of the piercing machine, which force it over the piercing point of a mandrel. As the billet is forced over this bullet-shaped point by the combined forwarding and rotating action of the heavy revolving rolls, a dull, grinding sound is audible. While enormous force is required to operate the piercing machines, there is nothing spectacular about the operation, nor much suggestion of the enormous power required to displace the metal from the center of the hot billet toward the outside. So powerful are the revolving rolls of the piercing machine, and so carefully planned is each part of the massive machinery, that the billet is transformed into a tube with apparently the same freedom as a lump of dough would be manipulated by a pastry cook.

The newly pierced billet is simply a rather rough, thick-walled, seamless tube. It is raw in appearance and not particularly true to size, and it retains the knurl marks of the piercing rolls on its battered surface. But it is positively without seam or weld, the round bar of steel having been pierced quite through its length as a potter would force a pointed rod through a cylindrical mass of moist clay. It is short, because of the thickness of its walls, and to change this thickness into length is the next requirement. Accordingly, it is rolled through adjustable rolls and over a mandrel held in the roll groove by a long steel bar where the wall thickness and diameter are reduced, and in this manner it is converted into a longer tube with walls of uniform thickness having a fairly smooth finish.



Rough Tube Coming Through Piercing Mill

### Finishing Processes

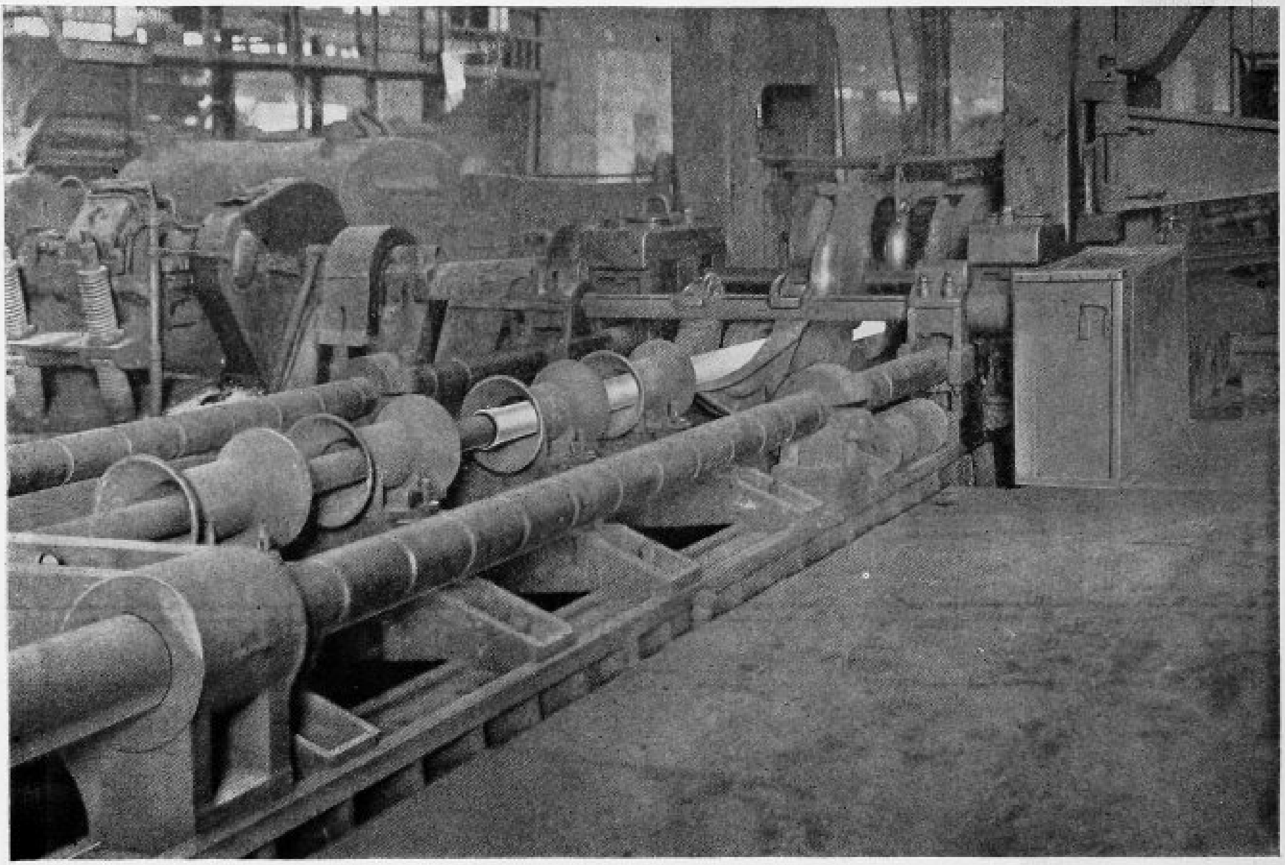
While still at suitable working temperature, the rolled tube passes on through the reeling machine. This is another form of rolling machine, consisting of two heavy rolls of special design, set with axes askew, which may be adjusted to a thousandth of an inch. As the tubes are fed through these rolls, any mill-scale is removed and they are given a smooth, burnished surface, and the outside diameter of the tube is corrected to some extent.

From the reeling machine the tubes pass to the sizing or finishing rolls, which give the exact outside diameter required.

From the finishing rolls the tubes travel to an inclined cooling table, up which they slowly roll, and after being sorted and inspected are dropped into racks, ready for removal by electric cranes. The electric cranes transfer the hot finished tubes to cutting-off machines, where the rough ends are trimmed from the tubes and the tubes cut to proper length. Any slight straightening necessary is then done, the tubes thoroughly inspected (if boiler tubes, a hydrostatic pressure test is also applied), then stencilled, put in stock or sent to the shipping room.

Tubes which have passed through the operations described up to this point are known as "hot finished" tubes.

The term "hot finished" is used to distinguish these tubes from hot rolled tubes, which are intended for cold drawing to smaller sizes. When tubes are "hot finished" they are ready for use without further treatment in the mill, and all operations are performed on the tube before it becomes cold, thus differing from the manipulation of cold drawn tubes, which are allowed to become atmospherically cold before reaching the draw benches.



Rough Tube Passing Through Rolling Mill

### Cold Drawing of Seamless Steel Tubing

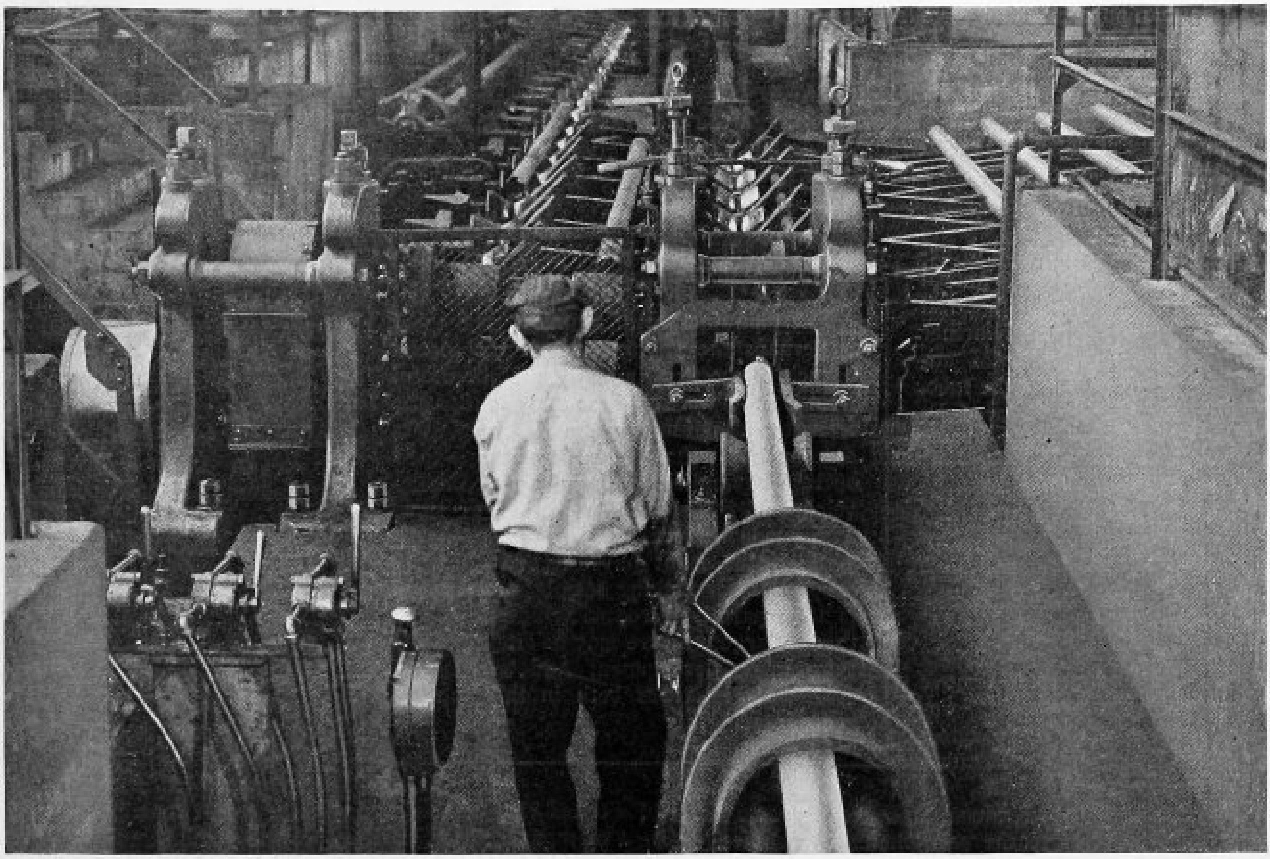
Hot rolled tubes that are to be cold drawn are given the same piercing, rolling, reeling and sizing operations as tubes that are to be hot finished. The first operation preliminary to cold drawing is pointing the tubes. One end of each tube is heated and then pointed in swaging dies under a power hammer. Pointing the tube furnishes a "bait" which is grasped by the heavy tongs of the draw-bench in which the tube is to be cold drawn.

In this way an even distribution of the pulling force is effected when drawing the tube through the die.

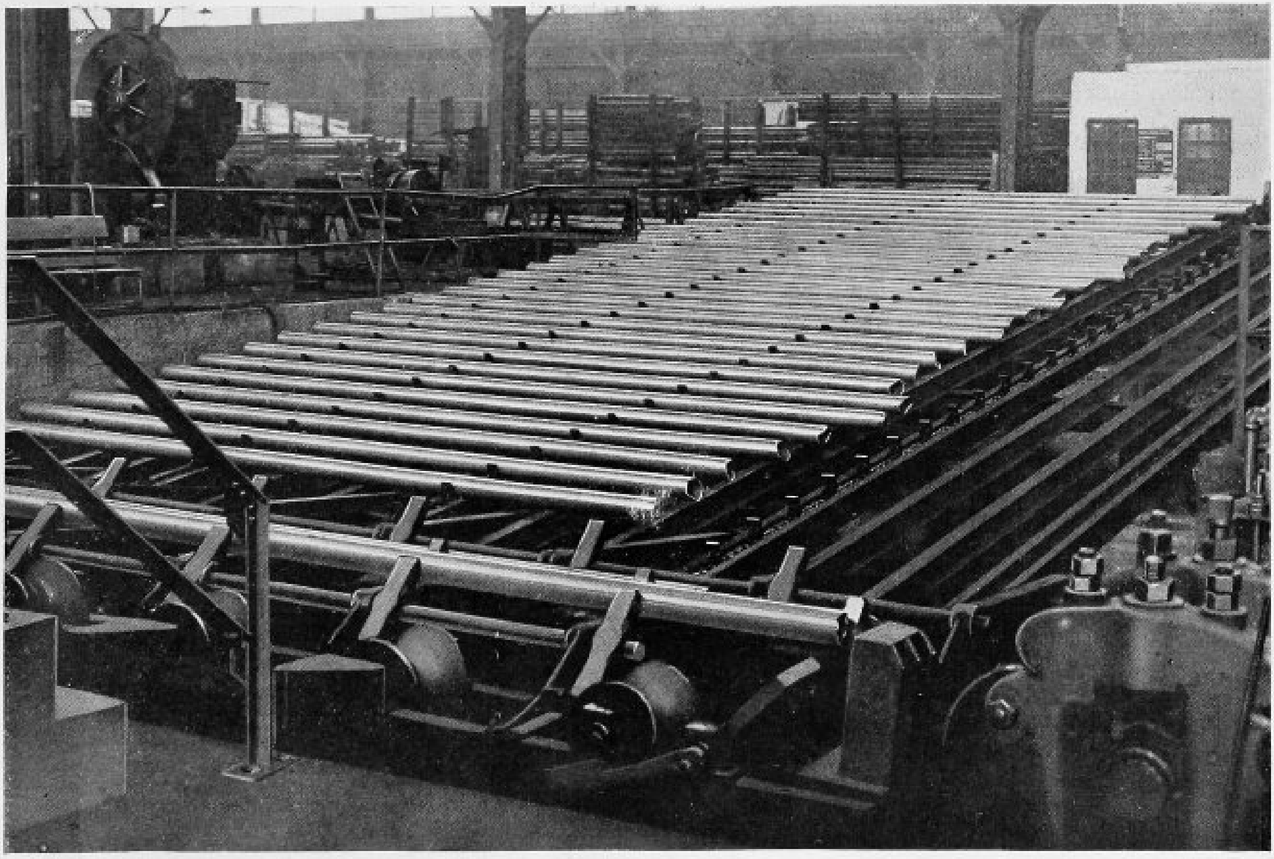
Before tubes can be cold drawn they must be clean and free from mill-scale. They are therefore pickled in an acid bath which is heated and kept in constant agitation by jets of steam.

While the operation of cold drawing is simple in principle, expert mechanical supervision is necessary to secure uniform, accurate results. The operation is practically the same for steel tubes as it is for brass and copper tubes. The apparatus used consists of a heavily constructed steel draw-bench, in the center of which is positioned the die through which the tube is to be drawn. A heavy, square-linked, endless chain runs over a wheel located underneath the die and travels along the top of the bench for a distance of from 15 to 40 feet to a sprocket which is geared to a suitable source of power. The chain returns underneath the draw-bench.

In the operation, a hot rolled tube (now preferably cold) is partially inserted in the die with its pointed end projecting through. A workman slides a mandrel into the tube from the opposite end and an operator seizes the pointed end of the tube with heavily constructed tongs which run on wheels along the bed of the draw-bench. The tongs have a strong hook that catches on the traveling chain. By a tremendous pulling force the tube is drawn or literally squeezed through the die, or between the die and the mandrel previously inserted. All tubes except those of ½ inch inside diameter and less, and those in which the wall is very heavy relatively to the diameter, are drawn over mandrels. The mandrel is kept in position by a long bar which goes inside of the tube and holds the mandrel just even with the die while the tube is being drawn. Dies are made from the very best grade of crucible steel and are machined to the thousandth of an inch, to govern the outside diameter of the tube that is to be drawn. The finest seamless steel tubes are drawn from two to twenty times through dies of varying diameter to obtain the required dimensions. Some tubes are drawn still more by the manufacturing consumer, and the fact that they retain their uniform qualities through all



Reheated Tubes Passing Through Sizing Rolls



Cooling Table Receiving Tubes from Sizing Rolls of this manipulation is an excellent demonstration of the general high quality of the material.

### Necessity of Annealing Cold Drawn Tubes

After the tube receives the final pass through the dies, which brings it down to the desired outside diameter and thickness, the point is cut off and the tube passes to the annealing furnaces.

Cold drawing makes the tube hard and brittle, and therefore after each cold drawing pass it is necessary to anneal the tube in order to make it soft enough to withstand further drawing. The process of annealing forms scale on the tube, and this must be removed by pickling, otherwise the scale would scratch the tube and score the die on subsequent cold drawing passes.

After the last drawing operation, the tube is subjected to one of various anneals, according to the use for which it is intended. This anneal may vary from a "light" anneal to remove drawing strains to a "long" anneal in a closed box (retort anneal), which makes the tubes extremely soft and ductile.

After the required anneal has been given, the cold drawn tube passes to the straightening machines, where any deviations from straightness are corrected. These straightening machines are of different types, some of them based on a planetary system of roll-rotation, others consist of horizontal and vertical rolls together, and still others being nothing more nor less than presses designed for the purpose. In the two first-mentioned types the straightening of the tube is practically automatic, while the human element enters to some extent in straightening tubes with the press type of machine. Small tubes are sometimes straightened by hand in a bending rack, the workman's eye and expert judgment being the main factors in securing the result.

> The manufacture of seamless steel tubes is perhaps the youngest important special branch of the steel industry. While useful welded tubes were made as early as 1812, the present modes of making seamless steel tubes date back less than half a generation, their success having hinged largely upon the development of a suitable quality of steel. The production of uniform, homogeneous steel of the right physical and chemical properties for making seamless steel tubes is a comparatively recent achievement, and to it in large measure may be attributed the remarkable development and success of seamless steel tubes both in this country and abroad.

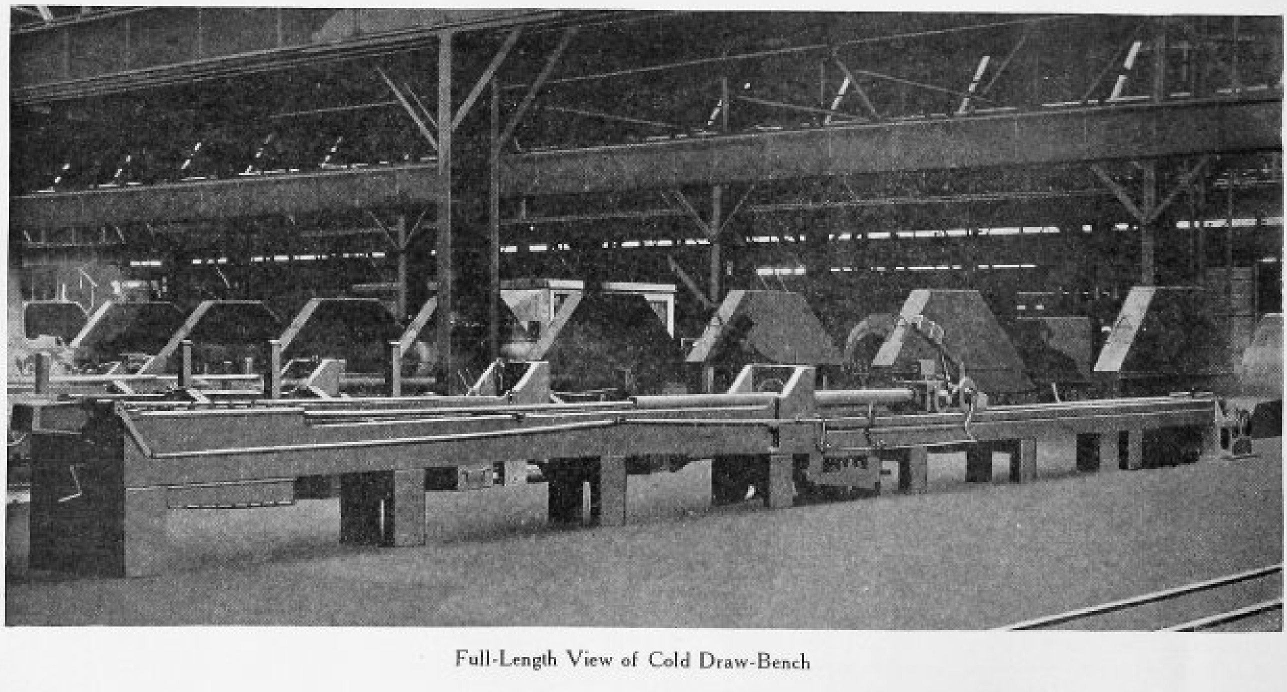
After leaving the straightening machine the tube passes to a cutting-off machine, where it is either cut to specified lengths or multiples, or to the best advantage in random lengths. When this has been accomplished the tube (if for mechanical purposes) is given a final inspection and sent to the stock rack or shipping room.

### Hydrostatic Test

If the tube is intended for boiler installation, it is given an internal hydrostatic pressure test immediately after it leaves the cutting-off machines and has been inspected. The test pressure applied to tubes under 5 inches in diameter is 1,000 pounds per square inch, and to tubes 5 inches in diameter or over an internal hydrostatic pressure of 800 pounds per square inch, provided the fiber stress corresponding to these pressures does not exceed 16,000 pounds per square inch. In certain cases where the fiber stress is over 16,000 pounds per square inch, tubes of standard thickness over 6 inches in diameter are tested to 500 pounds per square inch at the mill. After the tubes have been fully tested they are marked with a stencil showing the name of manufacturer, the test pressure used, kind of material of which the tube is made, and how finished.

### Manufacture of Tubing from Flat Plates

The method of producing seamless tubes from flat plates, known as the cupping process, is utilized in manufacturing tubes from 5½ inches to 9¼ inches in diameter. By this cupping process large heavy-walled tubes result which are practically the same as would result from the piercing of very large solid billets if this latter process were feasible. It is interesting to note that high pressure cylinders such as those used as gas containers in the oxy-acetylene process are made in this way.



Full-Length View of Cold Draw-Bench

# Correct Application of Water Level Indicators in Locomotive Boilers

BY A. G. PACK*

*This report, prepared by the Chief of the Bureau of Locomotive Inspection, is the result of exhaustive investigations conducted by the Bureau to determine the effect of water circulation on the accuracy of indicating devices. It is undoubtedly true that in the report lies a solution for many of the violent boiler explosions for which no apparent causes other than the incorrect indication of the water glasses and gage cocks could be determined.*

In the locomotive boiler, which usually has a sloping back head and is generally equipped with arch tubes and a brick arch, the heat is severely impinged on the door sheet and back end of the crown sheet, creating severe agitation and rapid circulation up the back head and through the arch tubes. The water glasses and gage cocks, as generally applied, only indicate a corresponding level of water while the locomotive is at rest and with no steam escaping, but when the safety valves lift or with the throttle valve open and the locomotive in operation, the gage cocks, when applied directly in the boiler, indicate a higher level of water than do the water glasses when they are properly applied and maintained. This discrepancy between the registrations of these devices has, heretofore, been taken as a matter of natural consequence, and little consideration given to the cause or the result of the conflicting registrations, one or the other of which must be wrong.

Practically all enginemen and others having to do with the operation of the locomotive, true to a common understanding, believe that the correct height of water over the crown sheet is always indicated by the gage cocks, and that the level indicated by the water glass is unreliable and not to be depended upon; therefore, it is reasonable to believe that enginemen have frequently depended upon a level of water indicated by the gage cocks as being correct, when, in fact, the true level was much lower, and as a consequence, damaged crown sheets have resulted.

With this thought in mind, and realizing that this variation creates an unsafe condition and that its cause should be determined and a remedy applied, experiments have been made with different devices on a number of locomotives of different classes, on fourteen railroads in various sections of the country, for the purpose of determining the action of the water in the boiler and its effect upon the gage cocks and water glasses.

> The development of the locomotive has created new difficulties in design, construction, maintenance and operation. One of the perplexing problems which has presented itself is that of securing a correct indication of the height of water over the crown sheet under all conditions of service.
>
> The grave importance of this matter is evidenced by the number of crown sheets damaged, due to low water, where careful investigation fails to disclose any contributory cause. These failures have been forcibly brought to the attention of the Bureau of Locomotive Inspection by their serious and fatal results, and have indicated the necessity for careful inquiry into the action of the water in the boiler and its registration by the water glasses and gage cocks under actual operating conditions.

### Tests Conducted on Locomotives

Excerpts from tests made on five railroads on which the most extensive tests were conducted will serve to briefly describe the surprising conditions disclosed. During all of these tests and observations the representatives of the Bureau of Locomotive Inspection were accompanied and ably assisted by representatives from the mechanical departments of the various railroads interested.

The locomotives on which the first series of tests was made were of the 2-8-8-2 Mallet compound type, used in bad water districts, equipped with boilers of the crown bar type, with wide fireboxes and superheaters, and using oil for fuel. The devices for indicating the water level consisted of three gage cocks spaced 3 inches apart and applied directly in the back head near the knuckle, at right angles to the sloping sheet, and one water glass with the bottom connection entering the back head approximately 3 inches below the back end of the crown sheet, and the top connection entering the back head 2 inches below the knuckle. The lowest reading of the water glass and gage cocks was 3⅝ inches above the highest part of the crown sheet.

The back heads of these boilers were braced by "T" irons, extending crosswise, at approximately the same level as the back end of the crown sheet.

In order to determine the action of the water as indicated by these appliances, observations were made during five trips in freight service, covering a distance of 680 miles, under varying operating conditions and on varying gradients.

With the locomotive running or standing on straight track and with no indication of foaming, water would issue from the top gage cock when it was opened, while the safety valves were open or the throttle valve open, regardless of the water level in the boiler as registered by the water glass.

At the completion of the fifth trip, three additional gage cocks were applied in the back head, parallel with the horizontal centerline of the boiler, the top one entering the back head 10½ inches below the top knuckle and 10½ inches to the right of the vertical centerline, with the same vertical reading as the standard application. These "experimental gage cocks were applied for the purpose of determining the effect of changing their location toward the vertical centerline of the back head and away from the knuckle, where the upward circulation of the water was believed to be greater than near the center.

An experimental water glass was also applied on the

* Chief of Bureau of Locomotive Inspection, Interstate Commerce Commission.

left side of the boiler, opposite the back flue sheet, the top connection of which entered the wrapper sheet on the top centerline, 15 inches back from the throttle dome, while the bottom connection entered the wrapper sheet on the side. The lowest reading of this glass was 1 inch above the highest part of the crown sheet. This glass will be designated as the "experimental water glass."

With this arrangement, observations were made during five additional trips, when the same conditions were found to exist that had been noted in the previous tests, with respect to the original gage cocks, namely, full water showed at the top gage cock, regardless of the level indicated by the water glasses, while the experimental gage cocks indicated a level approaching that indicated by the water glasses while operating with open throttle or safety valves blowing.

While operating with the throttle wide open and the water glass three-fourths full, the bottom connections to both water glasses were frequently closed and drain valves opened, when dry steam would steadily flow through the experimental water glass and solid water would flow through the original water glass, which glass also showed the water in severe agitation while the locomotive was in operation. These experiments demonstrated that the level of water indicated by the gage cocks and water glasses varied with their point of connection with the boiler, and indicated that a higher level of water prevailed at the back head than existed further ahead.

It is believed that the transverse "T" iron, which was applied to the back heads of these boilers, hindered the movement of water up the back head near the center and consequently decreased the variation between the level of water indicated by the experimental gage cocks and that registered by the water glasses.

As a result of these experiments, which were brought about by the large number of crown sheets being damaged and fusible plugs being melted, the gage cocks and water glasses were moved toward the vertical centerline of the boiler, which seems to have relieved the situation to a considerable extent.

### SECOND SERIES OF TESTS

It having been concluded that the false registration of the gage cocks, when screwed directly in the boiler back head, and the agitation of the water in the water glass when the top connection was made near the knuckle, were due to the rapid circulation of the water upward, carrying it a considerable distance above the level further ahead, a number of locomotives of the following description were equipped with water columns, as shown by Fig. 1.

These locomotives were of the Santa Fe or 2-10-2 type, equipped with superheaters, stokers, used bituminous coal for fuel, carried 180 pounds steam pressure and had fireboxes 132 inches long and 96 inches wide, with brick arches supported by four arch tubes and back heads sloping 15 degrees from the vertical.

The water column applied on these boilers was 1¾ inches inside diameter and 16 inches long, applied in a vertical position on the back head, 18 inches to the right of the vertical centerline. The top connection was made by means of an angle valve with an extension handle, extending through the top of cab, and a copper pipe 1 1/16 inches inside diameter, entering the wrapper sheet 12½ inches in front of the back head knuckle and 14½ inches to the right of the top centerline. The bottom connection was made of copper pipe of 1 1/16 inches inside diameter, and entered the back head, through a three-way cock, 16 inches to the right of the vertical centerline and 28 inches below the back end of the crown sheet. Three standard gage cocks with ⅜-inch openings were attached to the right side of this column, 3 inches apart. One water glass with standard fittings, having ¼-inch opening, was also attached. The lowest reading of both water glass and gage cocks was 4½ inches above the highest part of the crown sheet.

By this arrangement it was believed that when entering the boiler far enough ahead of the back knuckle to obtain dry steam at all times through the top connection to the column, and by taking water from well below the crown sheet and below the agitated portion of water which was believed to exist near the back end of the crown sheet and back head, a more correct reading could be obtained than when the gage cocks were screwed directly in the boiler head. During an approximate six-month period, however, that these locomotives were operated with this arrangement, very considerable trouble was encountered due to the extremely erratic and unreliable action of the

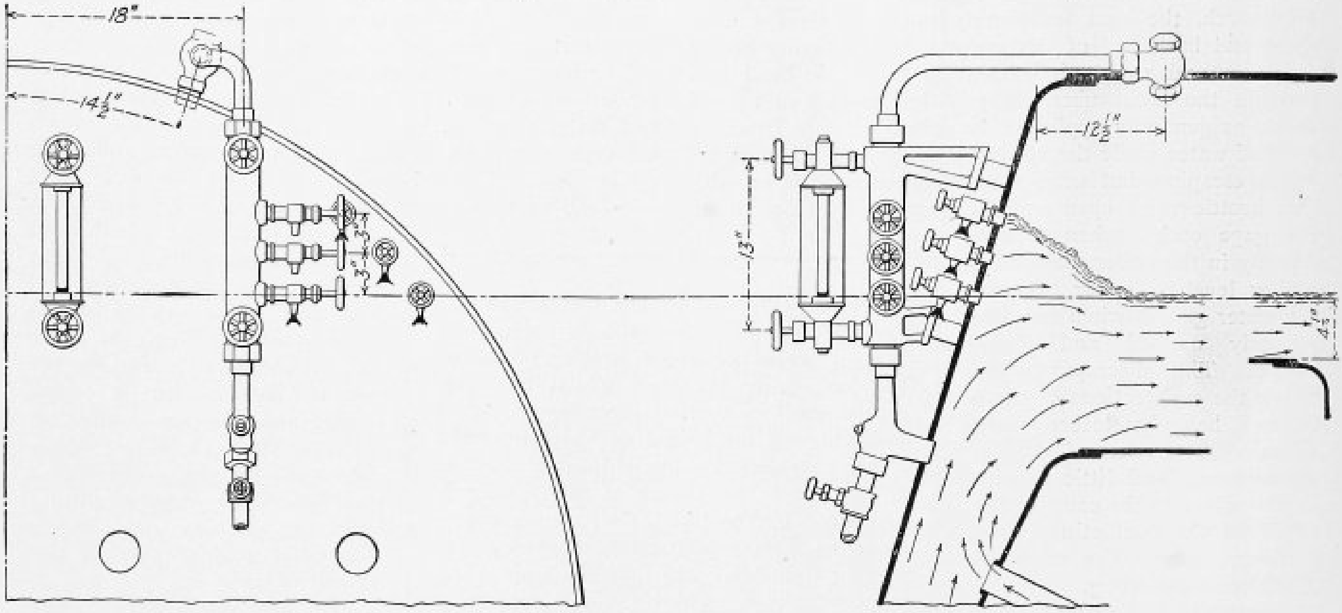


Fig. 1.—Arrangement of Water Column in First Test on Water Level Indication

water indications by the gage cocks and water columns.

It was determined that something should be done to learn just what caused the trouble. Therefore observations were taken under actual operating conditions to discover a possible remedy.

### CONDITIONS OF TEST

During these tests the temperature of the atmosphere was below zero, which caused the water in the column and in the long pipe by which the bottom connection was made to cool rapidly, and this in turn caused the level of water in the column to lower. It was demonstrated by experiments that this lowering of water in the column was due to the volume of dead water contained in the long pipe through which the bottom connection to the column was made and which was evidently due to the density and weight of the water at different temperatures, the temperature being much lower than that of the water in the boiler, because of the pipe and column being exposed to the cold atmosphere without circulation.

After noting these results and for the purpose of comparison, another water glass and set of three gage cocks were applied as in Fig. 1, the water glass connections entering the back head at the left of column and the gage cocks entering near the knuckle. The comparative readings of all gage cocks and water glasses corresponded. For reference purposes the gage cocks and water glass applied to the column will be referred to as No. 1, while those applied in the usual way will be referred to as No. 2.

With the indicating devices arranged as outlined, it was noted on three successive trips that, previous to starting, all devices indicated a corresponding level, but, when the throttle was opened or the safety valves lifted, the water in No. 1 glass would recede approximately 2 inches, while that in No. 2 glass would rise. No. 2 glass indicated a level of water from 1 to 3 inches higher than that indicated by No. 1 glass. In some cases, however, the water was out of sight at the bottom of No. 1 glass, while No. 2 glass indicated a level of from 3 to 5 inches.

### EFFECT OF RAISING BOTTOM CONNECTION

After noting these results, the following change was made: The bottom connection to the water column was raised 28 inches and moved to the right 2½ inches. This new connection was made midway between the two right arch tubes and approximately 10 inches above them, about in line with the back end of the crown sheet. The object of this change was to move the bottom connection up as close to the lower end of the column as possible, and to reduce the volume of dead water in this connection in order to eliminate the lowering effect referred to. After this change had been made, the following general results were obtained:

When starting, the level in both water glasses rose slightly and both glasses worked normally, and when the throttle was closed, the level would recede slightly, the readings of both glasses corresponding under all conditions of service.

A comparison of the No. 1 gage cocks with the No. 2 water glass showed that they registered the same level when the gage cocks were opened moderately, or a sufficient amount to obtain a correct reading, but by opening the No. 1 gage cocks an excessive amount the water in the column and the attached glass would rise from the bottom to the level of the cock opened. When the gage cock was closed, the water would instantly recede to its original working level and correspond with that shown in No. 2 glass. The receding action, as noted in the previous tests and before the bottom connection was raised, was entirely absent and the water registered a corresponding level in both No. 1 and No. 2 glasses under all conditions of service.

Tests of the No. 2 gage cocks, located as they were near the knuckle of the back head, proved that they were wholly unreliable for the purpose of registering the correct level of the water in the boiler while the locomotive was working, as they showed full water at all times throughout the entire test, regardless of the level indicated by the water glasses and No. 1 gage cocks while steam was being rapidly discharged from the boiler, due, no doubt, to the rise of water up the back head. While standing, and with no steam escaping, the readings of both water glasses and all gage cocks registered alike.

### TESTS ON HEAVY GRADES

Further observations and tests were made while on heavy grades, but no unusual or improper conditions could be noted except that No. 2 gage cocks registered full at all times and the water in the column glass could be raised to the height of the gage cock, when opened excessively.

The opening in the bottom connection to the water column was then reduced to ¾ inch and observations continued. It was thought that by restricting the inlet at the bottom of the column it would prevent the water from rising in the column and attached glass when the gage cocks were opened excessively. The opening in the gage cocks was also reduced from ⅜ inch to ¼ inch inside diameter, so as to disturb the equilibrium of the water in the column as little as possible.

On this trip particular attention was given to the action of the water, as registered by the water glasses and No. 1 gage cocks, by comparison, and it was particularly noted that the level of the water corresponded at all times under the varying conditions of service, while the standard gage cocks registered full water at all times with a high evaporation taking place.

### THIRD SERIES OF TESTS

The locomotives on which these tests were made were railroad administration standardized heavy Mallet 2-8-8-2 B type, with boilers and fireboxes of the following dimensions:

| | |
|---|---|
| Boiler, type | Straight top |
| Boiler pressure, pounds | 240 |
| Firebox, length, inches | 170⅛ |
| Firebox, length of grate, inches | 143⅝ |
| Firebox, width, inches | 96¼ |
| Combustion chamber, length, inches | 37 |
| Heating surface, tubes and flues, square feet | 5,685 |
| Heating surface, firebox, square feet | 386 |
| Heating surface, arch tubes, square feet | 49 |
| Heating surface, total square feet | 6,120 |
| Grate area, square feet | 96 |

The crown sheets were 15 feet 7 inches in length; the fireboxes were equipped with Gaines furnaces and brick arches extending to within 68 inches of the door sheet and within 22½ inches of the crown sheet, supported by five 3½-inch arch tubes. The engines used bituminous coal for fuel and were fired with duplex stokers. The boilers were each equipped with one water column to which three gage cocks and one water glass were attached. Two gage cocks were applied directly in the back head and two water glasses applied in the usual manner, one on each side of the vertical centerline of the back head, as illustrated by Figs. 2 and 3.

The lowest reading of the gage cocks attached to the water column, and all water glasses, was 8 inches above the highest point of the crown sheet and 13⅛ inches below the top of the boiler back head. The limited dry steam space at the back end of this boiler had a marked effect on the readings of these devices when connected in the back boiler head.

### Comparing Gage Cocks and Water Glasses

Numerous observations were made on other locomotives of the same type, for the purpose of comparing the action of the water in the gage cocks and water glasses as originally applied and after certain changes were made. For the sake of brevity, however, the tests made on only one of these locomotives will be described, inasmuch as the results obtained were the same in all cases.

Each of the connections was fitted with a valve and extension handle, so they could be easily opened and closed, allowing changes from one to the other at will. The top connection to the right water glass was changed from its original location which corresponded to that shown for the left one to the location shown at B1 on the highest part of back head knuckle.

It will be understood that when water from any cause reaches the top connection it destroys the proper registration of these devices, and the idea in mind when arranging the top connections in the manner illustrated was to determine whether or not the reading of the water glasses and water column would be altered when changing from one connection to the other, which were in line with the upward flow of water between the door sheet and the back head, the object being to obtain dry steam to balance the volume of water in the water glasses and water column. The result of changing from one connection to the other was indeed surprising.

The locomotive equipped with water glasses and gage cocks, as shown in Figs. 2 and 3, was used in pusher service on an ascending grade of 61 feet per mile, during five successive trips, occupying a period of time aggregating 4 hours and 25 minutes.

While the locomotive was standing, with no steam escaping, the registration of all devices showed a corresponding level of water. A total of 121 readings was taken and recorded while on straight track and while the locomotive was working with heavy throttle and about the same firebox temperature and steam pressure.

For reference purposes, the water glasses and water column, with their connections, are referred to by letters and figures as follows:

A—Water column to which three standard gage cocks were applied.

Ax—Water glass applied to water column.

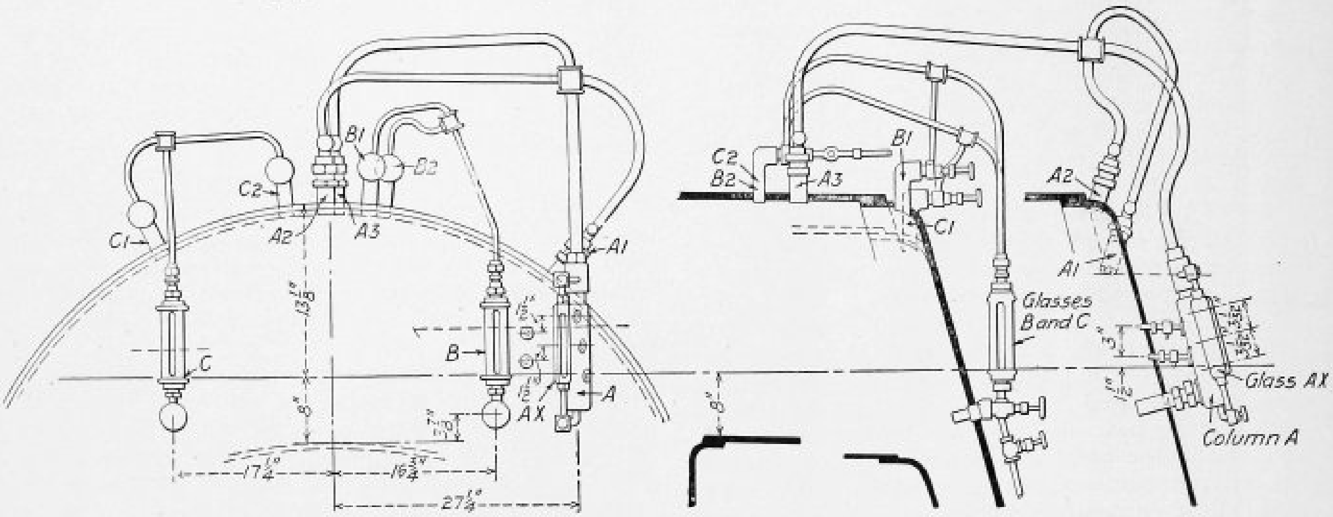
A1—Water column connection where it entered boiler on back head knuckle ½ inch higher than the top gage cock and 6⅝ inches below the highest part of the back head as originally applied.

A2—Water column connection where it entered boiler at highest point of back head knuckle.

A3—Water column connection where it entered boiler on top centerline in front of back head.

B—Right water glass.

B1—Right water glass connection where it entered boiler in back head knuckle.




Figs. 2 and 3.—Gage Glasses and Cocks Arranged for Test on Mallet Locomotive

B2—Right water glass connection where it entered boiler in front of back head.

C—Left water glass.

C1—Left water glass connection where it entered back head knuckle 4½ inches below highest point of back head, measured vertically, and 2⅛ inches above top water glass reading, as originally applied.

C2—Left water glass connection where it entered boiler in front of back head.

With the locomotive working heavy throttle, column A and glass Ax, connected to A1, the original connection, would be completely filled, while glass B, connected at B1, indicated 1 inch of water. By changing the connection A1 to A2, the water would instantly recede to a level in A and Ax corresponding with that indicated by glass B, or 1 inch, when A, Ax and B would continue to correspond while connected at A2 and B1, until the reading approached 4½ to 5 inches, at which point the water would become erratic and soon fill column A and glasses Ax and B if the injector was slightly over-supplying the boiler, or would recede and correspond if the water was slightly lowering in the boiler. This indicated that the water was moving up the back head, with a fountain effect, to a point reaching the connections A2 and B1 where they entered the top knuckle of the back head, 8⅛ inches higher than they registered when connected at A3 and B2 on the wrapper sheet. This was illustrated by changing the connection to column A and glass B from A2 to A3, B1 to B2, when the water would instantly recede to its former reading, and the readings would then continue to correspond as long as the connections remained at A3 and B2, without regard to condition of service or height of water indicated.

These readings could be varied as often as desired, by shifting the connections to the boiler by use of the valves; that is, when the column connection was changed from A3 to A2, the water would immediately go from 5 inches to out of sight in glass Ax, and the top gage cock would show full water; or, when changed from A2 to A3 the water would recede from out of sight to a level of 5 inches and correspond to the reading shown by glass B connected at B2.

With glass B connected at B1, the reading would correspond with column A and glass Ax when connected at A3, until the level approached 5 inches, when the water in glass B would become erratic and soon fill the glass, while column A and glass Ax, connected at A3, retained their level of 5 inches.

These experiments illustrated that column A and glass Ax were incorrect when connected at A1, the original connection, with 1 inch or more of water; and, when connected at A2, were incorrect when the level indicated exceeded 4½ to 5 inches; and correct at all times when connected at A3; and that glass B was correct when connected at B1, until the reading indicated 4½ to 5 inches, and incorrect when more water was shown, until the connection was changed to B2.

With glass B registering 5 inches of water, the connection was changed from B2 to B1, when the glass immediately filled. With the bottom water glass cock closed and the drain valve open, solid water flowed steadily through the drain pipe, which indicated that the flow of water up the back head, with fountain effect, reached the connection B1 where it entered the back head knuckle 8⅛ inches higher than the correct level of water in the boiler or that registered by glass B when connected at B2, and by A and Ax when connected at A3.

### Comparing Glass C with Glasses Ax and B and Column A

With glass C in communication with the boiler at C1, its original connection, the water registered a level corresponding to that indicated by column A, glass Ax when connected at A3 and with glass B when connected at B2, until the water registered 2½ to 3 inches, at which time the water in glass C would become erratic, rising and lowering and quickly fill completely, providing the injector was more than supplying the boiler, notwithstanding column A and glasses Ax and B, connected at A3 and B2, worked normally and indicated 2½ to 3 inches of water.

When glass C communication was changed from C1 to C2, the water would instantly recede from out of sight at top to a level of 2½ to 3 inches and give a corresponding reading with column A and glasses Ax and B, which was true at all times when all connections were made ahead of the back knuckle, regardless of the condition of service or the level of water in the boiler.

The reading of glass C, when it indicated 3 inches or more of water, could be changed as frequently as desired, by changing the communications from C1 to C2 or vice versa.

It was noted on one occasion, with column A connected at A1, glass B connected at B2 and glass C connected at C1, the locomotive moved to a left-hand curve, at which time water glass B registered 2 inches of water while column A and glasses Ax and C were completely filled.

Sixteen readings were taken on the fourth trip, with column A connected at A1, the original connection, glass B at B2 and glass C at C1, the original connection, during which time glass B indicated a level of from 1¼ to 4¾ inches, while glasses Ax and C and all gage cocks in both column and back head showed full of water. In fact, the gage cocks applied directly in the back head showed full of water at all times during these tests, while the locomotive was being operated or when the safety valves were open.

By referring to Fig. 3 it will be noted that connections to water glasses are made to the boiler through "ell" connections. In changing the "ells" from their original location on the back head to the location shown at B2 and C2, the C2 connection was tapped so as to drain thoroughly, while B2 was leaned sufficiently to cause a trap to be formed. This trap caused the water in B glass to rise 2 to 3 inches higher than that registered by the left glass; and when this trap was removed, the water indication in all three glasses corresponded. This condition has been found in a number of the locomotives under investigation, when, as soon as the traps were removed, the discrepancies were obviated.

### Fourth Series of Tests

For the purpose of determining if possible the general outline of the flow of water which evidently existed at the back head when high evaporation was taking place, tests were made on one of the railroad administration standardized 2-10-2 type locomotives, equipped with five arch tubes and a brick arch extending to within 51 inches of the door sheet; fired with a duplex stoker and using bituminous coal for fuel. The test apparatus used in these tests is shown by Figs. 4 and 5. The sliding tubes illustrated were graduated so that correct readings could be taken.

During two round trips many readings were taken while the locomotive was in operation. It was found during these tests that with the top connection to the water column at its original position, the column would entirely fill when 4 to 5 inches of water was reached in the column glass. When changing from this connection to the highest point on the back head, the water would immediately recede to 4 inches, but when changing from one connection to the other on the highest part of the boiler, the readings were not affected, which indicated that dry steam was being obtained both at the back knuckle and further ahead.

*(To be continued)*

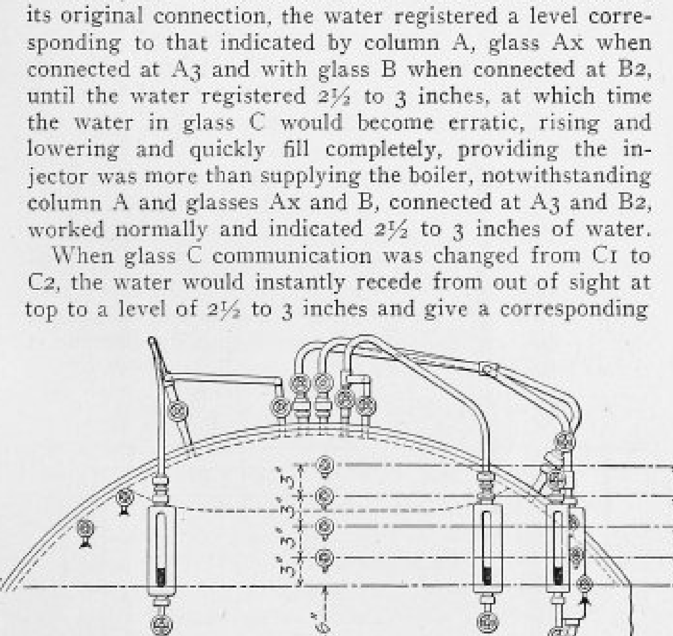



Fig. 4.—Arrangement of Sliding Tubes Used for Determining Contour of Water in the Back Head of Santa Fe Locomotive

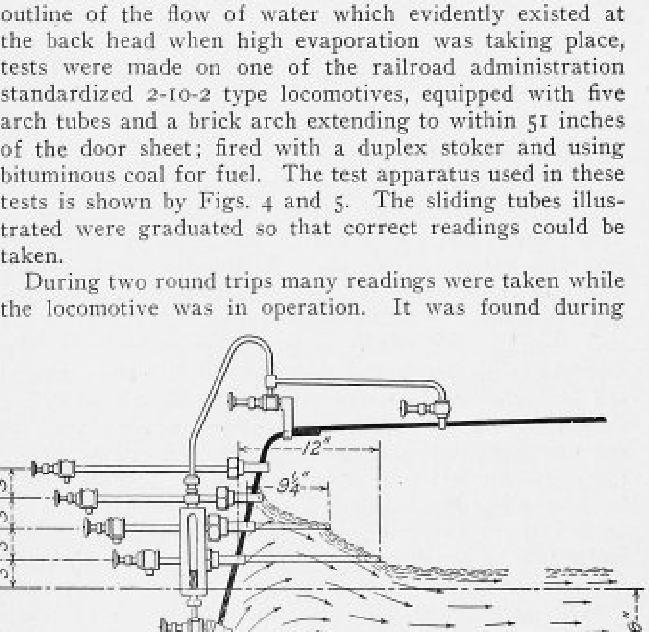



Fig. 5.—Outline of Water Surface at Back Head of Santa Fe Locomotive

# How to Design and Lay Out a Boiler—XXIV

## Method Followed in Designing Structural Work for Boiler Settings—Discussion of Various Type Beams and Columns

BY WILLIAM C. STROTT*

Although structural engineering is not directly connected with the design of steam boilers, a working knowledge of the subject is nevertheless an essential part of the boiler draftsman's education. For small steam power plants, where the purchaser does not usually care to stand the expense of the services of a consulting engineer, the boiler manufacturer is generally called upon to design and furnish the structural supports, or "gallows frame," and also the foundation and brick setting for the boiler or boilers.

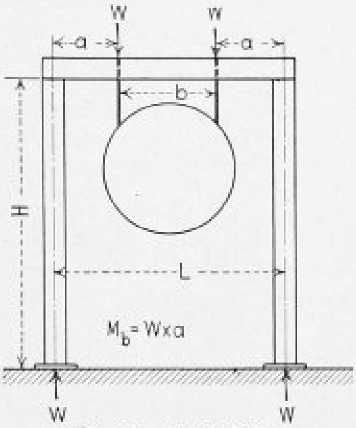



Fig. 95.—Single Boiler

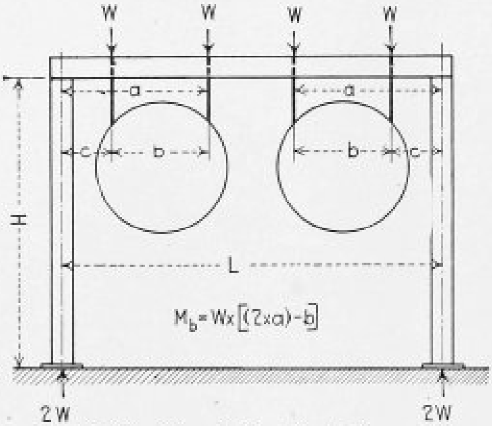



Fig. 96.—Two Boilers Set in Battery

### Structural Work for Steam Boilers

Too much stress cannot be laid on the importance of a well-designed suspension system for the boilers. One may walk into any isolated power plant and see the steam headers leaking at many points. The engineer may say that, despite all his efforts at renewing gaskets, etc., "he can't keep the joints tight." Does anyone ever stop to consider whether the beams, columns or hook bolts composing the suspension system are deflecting ever so slightly, just sufficient, however, to strain the steam headers? In other cases, again, it may be the settling of the foundation under the boilers; in fact, many cases of cracked and sprung boiler walls may be attributed to poorly designed foundations.

With these facts in mind, the author believes that a few notes on the design of the structural work for our boiler will be well received. Although a thorough discussion of structural engineering formulae will be impossible here, a few practical ones, together with their application to an individual problem, will be given and explained.

In Figs. 95, 96 and 97 are illustrated diagrammatically the usual arrangements of one, two and three boilers set in one battery and suspended from a structural framework without center columns. Center columns should not be used, as it is necessary to brick them into the center walls of the setting, between a pair of furnaces. The high temperature which such columns attain results in enormous expansion stresses, and, furthermore, the strength of the material is reduced when it reaches the temperature ordinarily present in the center walls of boiler settings. The strength of cast iron, however, when subjected to high temperature, is not greatly impaired, and center columns made of this material are frequently employed.

### Calculating Reactions in Structures

The calculations bearing on the design of structural steel evidently involve the use of such terms as bending moment, reactions, section modulus, radius of gyration, etc. The dimensions *b*, *L* and *H* should be known.

For a single setting, as in Fig. 95, having 24-inch brick walls, the span "L" of the overhead girders may be taken as (72 + 24 + 24) = 120 inches, and height "H" of the columns we shall here assume as 11 feet, both of which figures will be close enough for all practical purposes. The maximum bending moment may be obtained direct from the equations given in connection with each of the methods of setting as illustrated. These equations are reduced to their simplest form, having been derived from scientifically correct beam formulae. The calculations to follow will be based on the single form of setting, illustrated in Fig. 95.

The total weight of the boiler is 40,000 pounds, whence the reaction on each of the four supporting columns is 10,000 pounds.

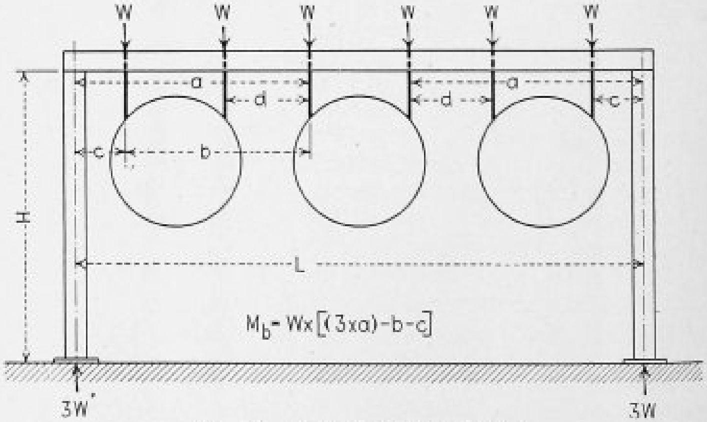



Fig. 97.—Three Boilers in Battery

Dimension "b" (center to center of hangers) is 65 inches, as given on the detail drawing of our boiler, which appeared in a recent chapter (July, 1920). Dimensions "a" may then readily be found to equal 27.5. Applying the formula for the maximum bending moment in the overhead beams, we get: $M_b$ = 10,000 × 27.5 = 275,000 inch-pounds.

* Engineering Department of The Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

It is the general practice to employ two beams over each pair of columns, whence the bending moment for each beam will be only one-half the above, or $\frac{275,000}{2} =$ 137,500 inch-pounds.

We next wish to select a beam that will be strong enough to safely withstand this bending moment, and to do this we first determine the least section modulus. We have learned that:

$$S = \frac{M_b}{Q},$$

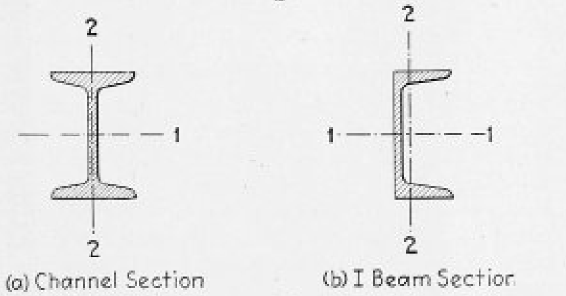



Fig. 98.—Types of Structural Sections in Common Use

when:

$S =$ fiber stress in the beam in pounds (not to exceed 16,000 pounds per square inch).
$M_b =$ maximum bending moment in inch-pounds.
$Q =$ required section modulus.

Therefore:

$$Q = \frac{M_b}{S},$$

whence, substituting figures for letters, we have:

$$Q = \frac{137,500}{16,000}, \text{ or } 8.6 \text{ inches}^3.$$

It is now a very simple matter to refer to a table of the "elements" of structural steel shapes as may be found in the Carnegie Steel Company "Pocket Companion," "Cambria Steel Handbook" or in most any good mechanical or civil engineer's handbook and find the most economical beam section whose section modulus is equal to or greater than the minimum desired.

Because the Carnegie Steel Company's "Pocket Companion" is so widely distributed, a copy of it being available in most any engineering office, that handbook will be referred to in this chapter.†

## EXPLANATION OF THE ELEMENTS OF STRUCTURAL SHAPES

Some of our readers who are not familiar with structural designing must expect to have difficulty when first attempting to use these tables, so an effort will be made here to thoroughly explain the use of the proper terms.

The elements of structural beams, channels, angles, etc., may be found in pages 166 to 180 inclusive. An examination of the tables covering beams and channels will disclose two sets of "elements," one having reference to axis 1-1 and the other to axis 2-2. When using the tables it is, of course, very essential to know which axis applies for the case in hand. This point we shall now proceed to explain. For immediate reference purposes, Fig. 98, (a) and (b), is appended.

These axes are always taken through the center of gravity of the section and are known as the "neutral" axes.

† The page numbers given refer to the 17th edition of Carnegie, dated April 1, 1915.

It should be apparent to the student that a channel or beam section will bend more easily when loaded perpendicular to axis 2-2 than to axis 1-1. A reference to the tables will also disclose the fact that the elements of the sections are in all cases considerably less with relation to axis 2-2 than with relation to axis 1-1. Therefore it should be evident at once how nonsensical it would be to place a beam as illustrated in Fig. 99.

The correct application of beams is illustrated in Fig. 100, in which case the elements of the section about axis 1-1 are employed. The values of the elements about this axis are very high as compared with those about axis 2-2, and it might be interesting to note that a 15-inch "I" beam when used as in Fig. 99 would carry only about one-twelfth the same load as when used in the proper manner indicated in Fig. 100. In the case of columns and struts, however, which are subjected to compressive stress, the elements of the section about axis 2-2 must always be employed, because such members will bend in the direction of their least resistance, which is at right angles to axis 2-2. Therefore the elements of lesser value, which are of course about that axis, must necessarily govern the strength of the section.

## CHOICE OF BEAM SECTION

The choice of sections—that is, whether channels or "I" beams should be employed—depends invariably on which is the more economical. It should be understood that it is better to employ a lighter section than one of greater weight, even though its strength be the same. Referring now to "Carnegie," page 167, we find that 7-inch "I" beams, 15 pounds per foot, have a section modulus equal to 10.4 inches$^3$ (column headed "S" with relation to axis 1-1). These are evidently the most economical beams of that class available in our case, but before deciding we shall investigate the possibilities of channel sections. On page 168 we find that 9-inch channels weighing 13.25 pounds per foot, section modulus 10.5 inches$^3$, are the lightest obtainable, consistent with the greatest strength. As there would be a considerable saving in the cost of the channels as compared with the "I" beams, the former would be preferred, although the 7-inch "I" section is equally as strong.

## DEFLECTION OF BEAMS

Our choice of beam sections is so far only tentative, and a check will have to be given them with regards to deflection. Such deflection, if excessive, will, as was previously pointed out, throw severe strains on the steam

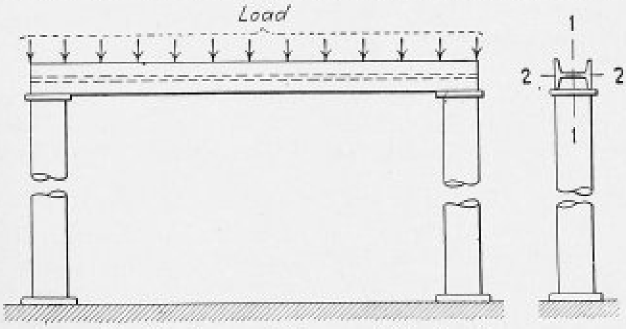



Fig. 99.—Incorrect Manner of Placing Beams

headers unless the piping is carefully designed to compensate for any such deflection of the boiler suspension system.

There are no available data for the allowable maximum deflections of girders used in boiler suspension systems, but in building construction where the floor beams should be stiff enough to prevent their bending action from cracking the plaster the deflection is usually limited to 1/360th of the span. Assuming about 1/400th of the span for boiler installations, the maximum deflection allowed in our case would be:

$$\text{Maximum deflection} = \frac{120}{400}, \text{ or .3 of inch.}$$

The vertical deflection of beams is given by the formula:

$$D = \frac{Wl^3}{76.8 \times E \times I},$$

where:

$D$ = deflection in inches.
$W$ = total load on beam in pounds.
$E$ = modulus of elasticity.
$I$ = moment of inertia.

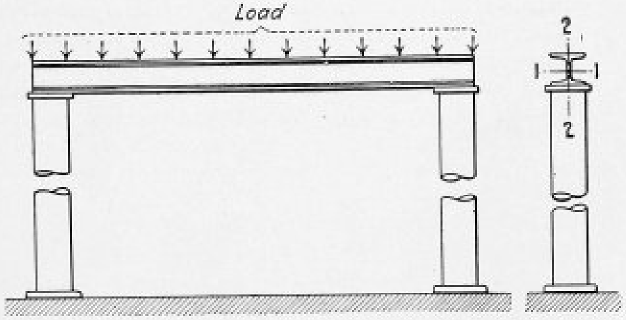



Fig. 100.—Proper Method of Placing Beams

Referring again to page 168 of "Carnegie," we find that the moment of inertia (column headed $I$ under axis 1-1) of a 9-inch channel, 13.25 pounds per foot, is 47.3 inches$^4$. The term "Modulus of Elasticity" was discussed in a recent chapter‡, in which a table also appeared giving the modulus of elasticity of a number of substances. The modulus of elasticity for steel is 29,000,000. We now substitute in the above formula:

$$D = \frac{10{,}000 \times 120 \times 120 \times 120}{76.8 \times 29{,}000{,}000 \times 47.3} = \text{approximately 0.2 inch.}$$

As this figure is well below the assumed maximum deflection of 0.3 inch, we may now definitely decide on the use of two 9-inch channel beams over each pair of supporting columns. Channel beams are usually placed "back to back" with just sufficient clearance between them to admit the suspension bolts.

For the purpose of securely tying the beams together, thereby forming a girder of great strength, bolts and separators are provided at various points in the length of the beam. The separators are usually pipe nipples or cast iron thimbles, just large enough to receive the bolts. Whenever two "I" beams instead of two channels are employed, special cast iron separators are required. These are illustrated on page 236 of the Carnegie "Pocket Companion."

### Design of the Supporting Columns

The size of the column is next to be figured. The strength of any column is a function of its least radius of gyration. This element of a section is denoted in the tables by the small letter "$r$." The quotient obtained by dividing the height of the column in inches by the least radius of gyration of its section is known as the "ratio of slenderness."

Construction specifications limit the maximum ratio of slenderness to 120 for main members under steady stress, which ratio would seem to apply equally as well to boiler settings where the steel work is nearly always under a constant load* and never subjected to shocks and vibrations as is the case with buildings and bridges.

Denoting the ratio of slenderness by $\frac{l}{r}$, in which $l$ is the unsupported height of the column in inches and $r$ is the least radius of gyration. Then in our case:

$$\frac{l}{r} = \frac{132}{r} = 120, \text{ whence } r = 1.1 \text{ inches.}$$

This value is the least radius of gyration that any beam section composing the supporting columns of this boiler setting may have.

### Selecting the Proper Type Beam

In the tables of elements of beam and channel sections, we now refer to the properties with relation to axis 2-2, about which axis the sections are, of course, the weakest. We cannot find a channel section large enough to give the least radius of gyration required in our case, so we must resort to "I" beams. A glance through the tables covering elements of "I" beams should quickly show the student that 15-inch "I" beams weighing 36 pounds per foot and having a least radius of gyration of 1.13 inches is the most economical section to employ from a standpoint of weight of material. But a reference to page 63 of "Carnegie" discloses the fact that this section (B-35) is a supplementary beam, and is not, therefore, a standard "stock" section. To the purchaser this simply means that such beams are not rolled except on special order, and if only a small tonnage is required at one time, considerable extra charge over the cost of standard sections is made by the mill.

It should therefore be quite clear that the most economical section we can employ is the standard 12-inch "I" beam, weighing 40 pounds per foot. Its least radius of gyration is, however, only 1.08 inches, but since there is so small a difference between this value and 1.1 inches, the discrepancy may be disregarded.

The next requirement is to check the compressive strength of this section. On page 282 of "Carnegie" will be found various formulae for determining the allowable unit compressive stress in steel columns for varying ratios of slenderness. The American Bridge Company's formula† is probably the one most widely employed except where it conflicts with local building codes. Hence we shall adopt that formula for our purpose.

American Bridge Company formula for steel columns:

$$S_c = 19{,}000 - \left(100 \frac{l}{r}\right),$$

where:

$S_c$ = allowable unit compressive stress on the column section in pounds per square inch.
$l$ = unsupported height of column in inches.
$r$ = least radius of gyration in inches.

Substituting in the above formula, we have:

$$S_c = 19{,}000 - \left(100 \times \frac{132}{1.08}\right) = 6{,}700 \text{ pounds per square inch.}$$

Referring again to the tables of elements of structural beam sections, we find that the cross-sectional area of a 12-inch "I" beam at 40 pounds per foot is 11.84 square inches, whence the total compressive stress to which these columns may be subjected under the existing conditions is found to be:

$$11.84 \times 6{,}700 \text{ pounds} = \text{approximately } 80{,}000 \text{ pounds.}$$

‡ July, 1920, installment.

* Frequent and rapid fluctuations in water level may have some effect, but such fluctuations are more general downward than upward.

† See page 151 of Carnegie Steel Company "Pocket Companion."

As this value is equal to eight times the actual load which will be carried by one column, it follows that the same beam section could be used to carry a load eight times as great, and should also serve to show the student how the radius of gyration governs the strength of any column.

For very high boiler settings such as in vertical water-tube installations, radii of gyration of so high a value are necessary that they may not be obtained in a single rolled section. In such cases specially fabricated (commonly designated as "built up") sections are necessary. Such members are usually box-shaped, composed of two channels with covering plates, or else lattice bars. In building construction, columns and girders, frequently two or three feet in depth, are composed of plates and angles and fabricated to the shape of huge "I" beams. In this manner it is possible to increase the radius of gyration to any value required, with a minimum of weight consistent with the desired strength. It is not within the scope of this treatise to attempt the calculations of compound structural sections. For these the student is referred to a study of any of the steel handbooks previously referred to.*

*(To be continued.)*

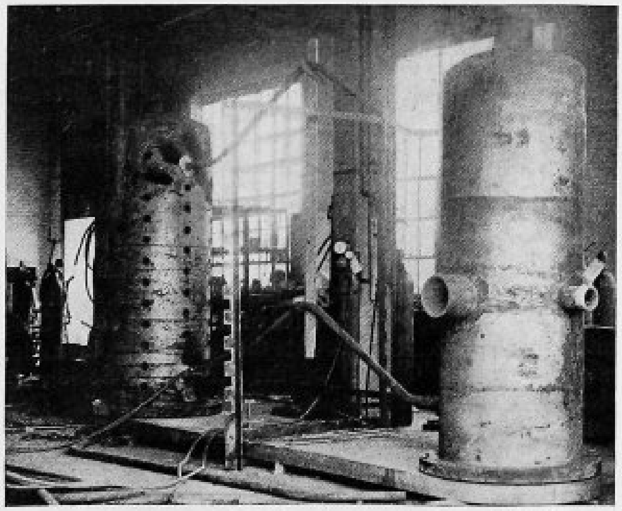
## Solving a Problem in Contraction

An unusual contraction problem arose recently in connection with the pipe welding on fifty-four large gasoline condensers for the Texas Company, New York. Each condenser consists of four large forge-welded drums and seventy lengths of extra heavy 2-inch pipe. The drums are open at one end and flanged so that they may be bolted or riveted together after the pipes are welded in.

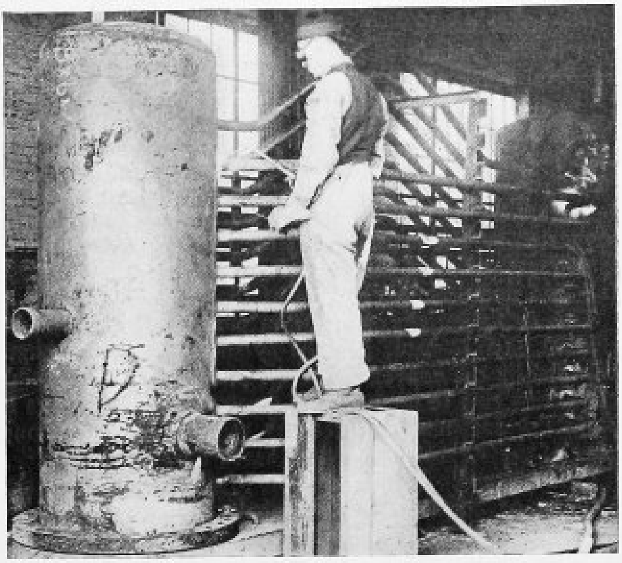
The pipe welding is being done by the Oxweld Acetylene Company at the welding shop of that company's Newark plant. The original plan called for straight piping in the line of centers between each lateral pair of drums and bent or bowed piping to connect the sides. As the distance between the drums had to be exact to meet the foundation specifications and to insure coincidence of the flanges and bolt or rivet holes of one set of drums with the corresponding points in its mates, the importance of properly handling the contraction problem is at once apparent.

Engineers on the job recommended the substitution of bent piping for the straight piping noted. The theory as to contraction control was tested on both the straight and the bent pipe. Accordingly, a heavy cast iron jig was made, to which the drums were fastened in the proper positions with heavy bolts. The contraction when the straight pipe was used was so powerful that the bolts were sheared off by the pull on the drum, the contractions amounting to several inches. When the bent pipe was used instead of the straight pipe, this did not occur, the bent pipe accommodating itself to the contraction so completely that when the drums were removed from the jig they were found to be in the correct position, fitting perfectly with the mating pairs.

* One of the best reference works on structural engineering to appear in recent years is Ketchum's Handbook for Structural Engineers, McGraw-Hill Book Company, New York City.



Gasoline Condensers in Position for Installation and Welding of Tubes



Welding Bent Pipes in Gasoline Condensers

The application of the bent piping is clearly shown in the accompanying illustrations. After the welding, the condensers were tested to a hydraulic pressure of 500 pounds per square inch. In one of these tests a 3-inch cast iron cap bolted to one of the drums gave way, but the pipe welds in every instance stood the test without a break or a leak appearing, clearly demonstrating the remarkable strength of the welds to resist unusual pressure strains. There are 35 pipe welds in each drum and 140 in each complete condenser, a total of 7,560 welds in the fifty-four condensers.

When completed, the fifty-four condensers will be shipped by water to Galveston, Texas, from which port they will be transported inland a distance of 150 miles to the oil fields, where they will be used in the distillation plant for recovering gasoline from natural gas and crude oil.

## 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. Anyone desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th 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.

Case No. 269 (Reopened).—If, under the provision made in paragraph 212 of the Boiler Code, advantage is taken of the opportunity to increase the pitch of the staying for a cylindrical furnace, is it to be assumed that a portion of the increased load on the staybolt is to be supported by the resistance of the outer cylindrical shell to collapse, or must the staybolt be designed to carry the full load upon the stayed area of the furnace sheet?

The special provision made in paragraph 212*c* for increased pitch is made possible by the additional strength afforded by the convexing of the plate. It is permissible under this rule to increase the spacing of the staybolts to $p_1$ in the formula, whereas the required cross-sectional area of the staybolts should be based on $p$.

Case No. 307.—Is it permissible to so locate the supporting lugs on horizontal return tubular boilers where more than four lugs are required, and, under paragraph 323 of the Code, must be set in pairs, that those in each pair come close together, or must the horizontal distance between the center lines of rivets attaching the adjacent lugs to the shell be at least equal to the vertical spacing of rivets that is required for lug attachments in paragraph 323, as shown in Fig. 1?

There is no requirement in the Code specifying the distance apart of the lugs forming pairs as required by the last sentence of paragraph 323. It is the opinion of the Committee, however, that in locating lugs in pairs on the shells of horizontal return tubular boilers, it will be in conformity with the spirit of the second sentence of paragraph 323 if the lugs of the pair are so spaced that the horizontal distance between the centers of the rivets which come nearest the adjacent edges of the lugs is at least 6 inches and not more than 12 inches.

Case No. 308.—Under what rules in the Boiler Code should the top head of a vertical submerged-tube type of firetube boiler, such as shown in Fig. 2, be calculated to determine whether or not it requires bracing?

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

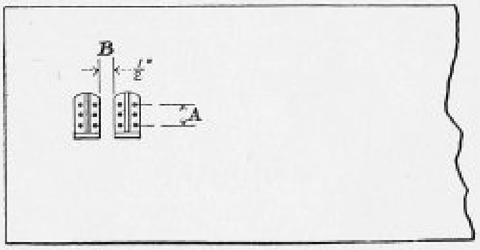



Fig. 1.—Spacing of Supporting Lugs in Pairs on Horizontal Return Tubular Boilers

Case No. 309.—Is it necessary to furnish test reports of the steel used in the tubes or flues of special type boilers which are formed of 18-inch lap-welded steel tubing, 15 feet long, where the wall thickness is ½ inch and the weld meets the requirements of paragraph 186?

It is the opinion of the Committee that the material used in the manufacture of lap-welded, low-carbon steel tubing should meet the stipulations prescribed in paragraphs 23 to 39 inclusive of the Code, which will make it necessary to furnish mill test reports of the material.

Case No. 311.—Is it necessary under paragraph 188 of the Boiler Code to use butt-strap joints in the construction of very small drums, say 10 or 12 inches in diameter, for pressures exceeding 100 pounds per square inch? Such construction does not appear to be practical for such small drums and neck pieces sometimes used to connect drums or shells.

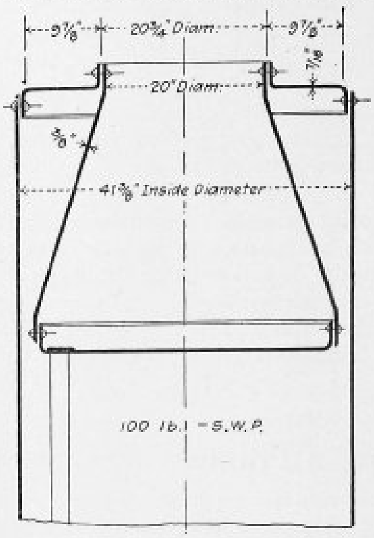



Fig. 2.—Design of Top Head of Vertical Submerged Tube Type of Firetube Boiler

Lap-riveted construction is prohibited by the Code Rules, but it is the opinion of the Committee that this should cause no hardships, as lap-welded or seamless pipe or tubes could be used, provided such tubes or pipes are constructed from material which in its initial form of plate or skelp conforms to one or the other of the specifications for open hearth steel given in the Boiler Code. No test would be required on the completed tube. (See Case No. 255.)

Case No. 312.—Is it necessary in the construction of small Star-type watertube boilers for steam heating which are to carry more than 15 pounds pressure at times to drill the inside and outside ends of staybolts? It is believed that it was the intent of the Committee to cover in this requirement the water legs at front and back ends which are considered as headers.

If the grate area is more than 15 square feet, the staybolts are less than 8 inches in length, and the pressure exceeds 15 pounds, it will be necessary to drill the staybolts in order to comply with the Code requirements.

## Conference Committee on Welding

The Boiler Code Committee of the American Society of Mechanical Engineers takes pleasure in announcing that the American Welding Society has appointed a committee to confer with the sub-committee of the Boiler Code Committee on welding. The above is the result of an invitation extended by the Council of the American Society of Mechanical Engineers at the request of the Boiler Code Committee. It is the desire of the Boiler Code Committee that the Committee of the American Welding Society shall co-operate with the sub-committee of the Boiler Code Committee in discussing the rules now in the Code and in proposing any revision or new rules that may be embodied in the Code at the next revision period.

## Safety in Boiler Rooms

Chains attached to quick-closing gage glass valves should be of such length that firemen must reach above their heads to pull them out. On one occasion a man was observed in the act of pulling the valve shut while talking to the fireman. He unconsciously had used the chain as a rest.

Impress upon firemen and water tenders that they must blow water columns when coming on duty. This old rule is too often disregarded in large plants.

Boiler cleaners and repairmen should be given strict orders that they must never enter a boiler without first telling the fireman in charge and seeing to it that blow-off valves and feed valves are shut tight.

When boilers are dropped for cleaning and repairs, both steam nozzle valves should be closed tight. Plug valves on feed water lines should also be closed, as firemen or water tenders have opened the feed valve on dead boilers by mistake.

Provide stationary steel ladders on both sides of all boilers, preferably one at the front and one at the back. Exit to the boiler house roof should also be provided.

Never permit ash handlers to crawl into ashpits. If the design used makes this necessary, change the design. Conveyors adapted to the layout usually save the first cost in the first year.

Boiler room basements in large plants should be provided with several avenues of escape in case a tube or a steam pipe should burst. The men should be taught to use all exits.

Stairways should be properly illuminated so as to prevent stumbling. Electric hand lanterns should be hung at suitable locations for use when the lights go out. Large sizes should be provided so that employees will not take them home.

Doors to furnaces should be provided with safety automatic latches. This should be applied to underfeed stoker doors, as men have been painfully burned while dumping fires. Neglecting to close damper in duct to overfeed element will cause this.—*Graphite.*

## Tensile Properties of Boiler Plate at Elevated Temperatures*

At the request of a committee of the Engineering Division, National Research Council, a study of the properties of boiler plate at various temperatures up to about 900 degrees F. has been instigated. This paper is a report of preliminary tests made on ½-inch, open-hearth boiler plate of marine and firebox grates of steel.

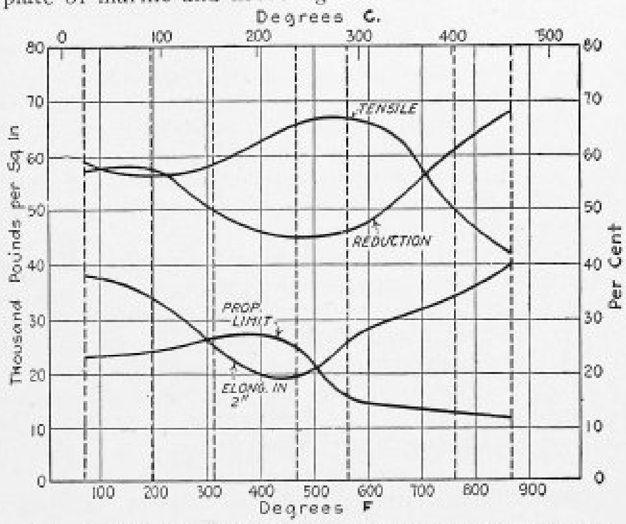



Fig. 2.—Results of Tests on Marine Boiler Plate at Various Temperatures

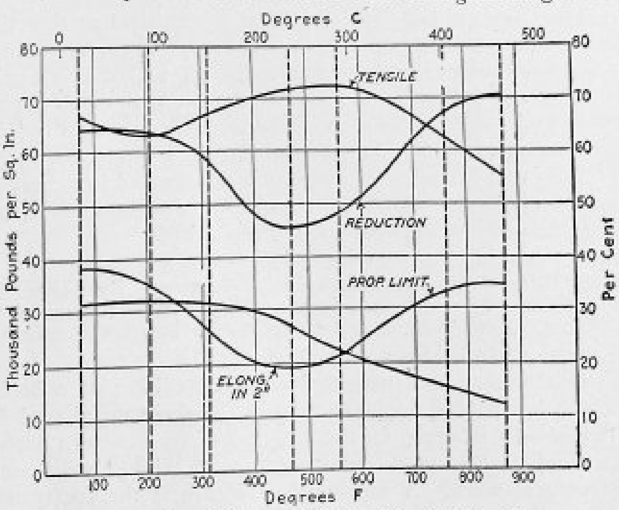



Fig. 1.—Results of Tests on Firebox Grade Boiler Plate at Various Temperatures

* Abstract of a paper by H. J. French, chief, Heat-Treatment Section, Division Metallurgy, United States Bureau of Standards, presented before the American Institute of Mining and Metallurgical Engineers and published in *Power.*

Special apparatus was designed to carry the extension measuring apparatus so that the indicating devices might be outside a tubular electric heater which surrounded the specimen while under test. The measured length of the specimen was 2 inches, and its temperature was measured by a thermocouple inserted in a small hole drilled in the fillet. The curves in Fig. 1 show the results of tests on firebox grade steel at temperatures from 70 degrees F. to 870 degrees F., and those in Fig. 2 show the results on marine grade steel under similar conditions. The curves are the average of three determinations at each of the points chosen. The values for the reduction of area were obtained from measurements of the minimum width and thickness of the fractured section and are not identical with values that would be obtained by the use of a planimeter, owing to a decided necking in both width and thickness in rectangular specimens.

The increase in temperature results in distinct changes in the properties, namely, (a) the tensile strength first decreases, reaching a minimum at about 200 degrees F., then increases to a maximum at about 500 degrees F., after which a final decrease occurs; (b) the percentage elongation in 2 inches decreases slowly to about 200 degrees F., then rapidly to a minimum at 470 degrees F., after which it increases; (c) the reduction in area closely follows the curve for elongation, but has its minimum at a slightly higher temperature; (d) the proportional limit increases slightly to a maximum at about 400 degrees F. for firebox steel and between 200 and 300 degrees F. for marine steel. It is noted that for firebox steel the increase is greater and the decrease takes place more sharply than for marine grade plate. The higher temperature for the maximum value of the proportional limit with firebox steel is credited to the greater mechanical work received by these examples.

## New Section of American Welding Society Formed

In order to bring the individuals interested in the practical phases of the autogenous welding process in closer touch with the developments in the trade, a Chicago section of the American Welding Society has been formed, with M. B. Osburn, assistant superintendent, Pullman Car Works, as chairman. O. T. Nelson, president of the General Boilers Company, is vice-president, and L. B. Mackenzie, publisher of the *Welding Engineer*, is secretary-treasurer.

Experimental and research work will constitute the principal activities of the society, although other matters of importance to the welding industry will engage its attention. Technical committees, recruited not only from the ranks of the society but from other scientific bodies as well, will analyze and report to the society upon the many and varied problems which are coming up in connection with the industry at all times.

A further work of importance to the welding industry is the training and certifying of operators.

Every manufacturer, engineer, plant manager, superintendent, foreman and welder is urged to co-operate with the members of the new Chicago section of the American Welding Society to the end that the use of autogenous welding may more rapidly assume the place that it is destined to hold in industry in the future.

## Standardization of Plain Limit Gages

A sectional committee of the American Engineering Standards Committee has just been organized to undertake the standardization of plain cylindrical gages for general engineering work, under the sponsorship of the American Society of Mechanical Engineers. The immediate occasion for undertaking the work was a request of the British Engineering Standards Association for cooperation on the subject. The committee held its organization meeting on June 11. It is understood that this committee will recommend to the American Engineering Standards Committee that the scope of the work should be broadened so as to cover all plain limit gages for general engineering work.

The present personnel of the committee is as follows:

E. C. Peck, chairman, general superintendent, Cleveland Twist Drill Company; L. D. Burlingame, vice-chairman, industrial superintendent, Brown & Sharpe Manufacturing Company; H. W. Bearce, secretary, gage department, Bureau of Standards, secretary, National Screw Thread Commission; P. W. Abbott, Lincoln Motor Company; John Bath, president, John Bath & Company, Inc.; Earle Buckingham, engineer of standards, Pratt & Whitney Company; Fred H. Colvin, associate editor, *American Machinist;* W. A. Gabriel, chief draftsman and designer, Elgin National Watch Company; F. O. Hoagland, vice-president and works manager, The Bilton Machine Tool Company; Edward H. Ingram, works manager, The Cleveland Drilling Machine Company; J. O. Johnson, office of chief of ordnance, War Department; A. W. Schoof, gage engineer, Greenfield Tap & Die Corporation; G. T. Trundle, consulting engineer, Engineers Building, Cleveland, Ohio; H. L. VanKeuren, The VanKeuren Company.

## Pipe Flanges and Fittings Standardized

The American Society of Mechanical Engineers has been requested by the American Engineering Standards Committee to assume sponsorship in the standardization of pipe flanges and fittings. In 1914 the society issued a report covering a schedule of pipe flanges and fittings for diameters from 1 to 100 inches for 125 pounds pressure, and also a schedule for extra heavy pipe, covering a range from 1 to 48 inches diameter and for 250 pounds pressure. In 1918 a supplementary report was published for working pressures of 50, 800, 1,200 and 3,000 pounds.

While the work has not been active during the last year, it is now proposed that it be continued, the society being formally recognized as sponsor, under the rules of the American Engineering Standards Committee.

## NEW BOOKS

APPLIED SCIENCE FOR METAL WORKERS. By W. H. Dooley. Size, 5¼ by 7½ inches. Pages, 479. Illustrations, 207. New York, 1919: The Ronald Press Company. Price, $2.

This book covers the general principles of science as applied to industry in general and to the metal working trades in particular. Among the subjects dealt with are the properties of matter, various systems of weights and measures, mechanical principles of machines, leverage, pulley action and various other subjects that may be classed under elementary physics.

In a section devoted to chemical subjects may be mentioned the chemistry of common industrial substances, physico-chemical processes, properties of acids, alkalies and salts.

The subjects of magnetism and electricity, its generation and transmission, are discussed in a more or less elementary manner, so that they may be readily understood.

Practical work is given on the use of hand tools, pattern making, machine shop practice and the like.

SHOP PRACTICE FOR HOME MECHANICS. By Raymond Francis Yates. Size, 5¾ by 8½ inches. Pages, 320. Illustrations, 306. New York, 1920: Norman W. Henley Publishing Company. Price, $3.

This is a volume intended primarily for the amateur mechanic or for an apprentice wishing to master the principles of machine work in the shops. The subject matter is arranged progressively so that the beginner may start with the elements of mechanics, which should be thoroughly understood before attempting to study the actual operation of machines. Chapters following this section treat of simple shop operations and the use of small tools.

The lathe is covered in detail, as this is the most important tool in the shop. Such operations as grinding, hardening and tempering steel, pattern making, soldering and the like are included, so that the beginner may be familiar with all branches of machine shop work. The final chapter contains such information and data as can advantageously be used in general shop routine.

VOCATIONAL ARITHMETIC. By Clarence E. Paddock and Edward E. Holton. Size, 5 by 7¼ inches. Pages, 232. Illustrations, 83. New York, 1920: D. Appleton & Company. Price, $2 net.

This book supplies the need for a practical arithmetic for apprentices and the men in the shops. There are many excellent books on elementary mathematics, but this work is designed primarily for the mechanic, and combines a clear and simple exposition of theory with practical applications of it to every day shop work.

The usual branches of arithmetic are treated in a simple way and a large number of practical problems serve to demonstrate the application of the methods.

TIN, SHEET-IRON AND COPPER-PLATE WORKER. By LeRoy J. Blinn. Size, 5 by 7¾ inches. Pages, 334. Illustrations, 207. New York, 1920: Henry Carey Baird & Company, Inc. Price, $3.

This volume is a new and enlarged edition of a book which has proved useful to men in the sheet metal trades. It has been enlarged by the addition of new pattern problems which deal more particularly with triangulation and structural work. A noteworthy feature is the treatment of metallic alloys and solders. The more important seams and joints used in plate work and the various ways of making them are illustrated and described. Especially interesting to boiler makers is the section devoted to pattern layouts and developments.

# The Boiler Maker

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## CONTENTS



Has it ever occurred to the ordinary trade association man the influence he has in shaping the economic and industrial conditions of the country? Here, for instance, is a little gathering of tradesmen, possibly fifteen or twenty, and before them is an economic and industrial problem. It concerns only them, and they proceed to its solution along the lines of least resistance or to the greatest immediate benefit to themselves. Pressure from some outside influence may be brought to bear. Perhaps this body of men are deciding the wage question of their employees. An increase is demanded, with possibly shorter hours.

The problem affects only one trade, and the immediate community and some workmen, so why bother greatly to decide the question on its merits, or as it affects the public at large, especially if some effort, or possible loss of business, is necessary? The demand for what these men produce is rather insistent, likewise the pressure to get the matter settled as quickly as possible. And so it is usually settled as it affects these fifteen or twenty firms, or any other number, as the case may be.

Now suppose this little gathering of industrial units is multiplied ten thousand times by such gatherings all over the country. When this is considered it will be seen that the economic and industrial policy of the nation is being shaped, not by the big gatherings, but by the great number of small ones. The number quoted above is not an exaggeration by any means. How many small industrial units there are organized in the United States has probably never been ascertained, but it undoubtedly runs into the thousands.

With this thought in view, is it not well for each industrial unit to thoroughly consider how it passes on its influence when these industrial and economic problems confront it for decision? Is it not well to bear in mind that the industrial policy of the nation is, after all, being shaped by the great numbers of small units rather than the few large industrial gatherings?

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The New York State Industrial Commission, Department of Labor, has recently issued the Industrial Code, governing the construction, installation, inspection and maintenance of steam boilers as amended to July 1, 1920. Copies of the code have been sent to boiler manufacturers throughout the country, but any individuals interested in the boiler requirements of New York state may obtain copies from the Department of Labor at Albany.

One important fact brought out in the announcement of the amended rules is that boilers which are not built according to New York state standards, or that do not meet specifications equivalent to the code, cannot be used in the state at pressures greater than 15 pounds per square inch. The 15-pound limit is designated, for boilers intended to operate above this pressure are subjected to an internal and external inspection at least once a year. The stress laid on this point of having manufacturers outside of the state of New York who are building boilers for service in the state comply with the code affords an opportunity to emphasize the ever-growing necessity of having uniform boiler requirements in all states.

Another feature of the regulations is the standard of inspection which must be maintained by the insurance company or state whose duty it is to certify boilers which are to be used in New York. Inspectors are obliged to pass written examinations equivalent to those which New York state inspectors must pass in order to obtain a certificate of competency.

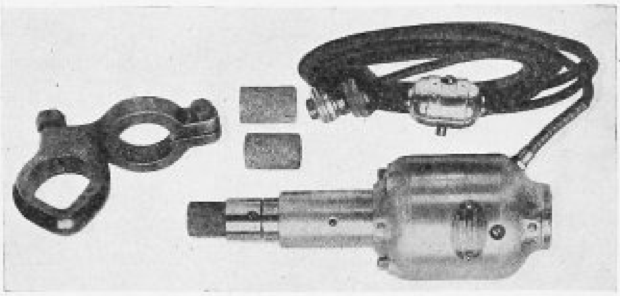
New York has apparently recognized the importance not only of standardizing the regulations for the construction and maintenance of boilers, but also the necessity of uniformity in the qualifications of the inspectors themselves, both in training and practical experience.

# Engineering Specialties for Boiler Making

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

### Truing Machine in the Form of a Grinding Wheel

A precision grinding wheel truing machine has recently been developed by the Precision Truing Machine & Tool



Precision Truing Machine

Company, Cincinnati, Ohio. The machine can be applied to any make and style of grinder, and it is operated by either alternating or direct current at 110 or 220 volts. Attaching brackets are supplied with each machine, but special brackets for unusual applications can also be obtained.

Three general-purpose abradant nibs are also furnished with each machine, and nibs for special purposes can be supplied to meet requirements. The general-purpose nibs are 1 inch in diameter by 1½ inches long, and it is claimed that one of these will keep an average grinding wheel in proper condition for 100 hours continuous operation. The machine has ball bearings throughout with adjustments for taking up wear.

### Reaming and Countersinking Machine

A reaming and countersinking machine having a capacity of 125 ⅞-inch diameter holes per hour through ⅝-inch metal has been produced by the Lakeside Bridge & Steel Company, North Milwaukee, Wis. The device, known as the Labride reaming and countersinking machine, consists of a movable trolley mounted on a 16-foot beam constructed of structural shapes, which in turn is supported on cast-iron wall brackets. The length of the beam can be adjusted to meet any required condition. When used as a radial drill, special advantages are claimed for the machine, as it takes up little space and, when not in use, can be swung back against the wall.

The drill is rigid and may be readily moved from end to end of the arm. The feed lever is counterweighted and can be adjusted to allow moving the spindle vertically without difficulty. The drill consists of a cast frame upon which a motor of ample size is mounted. Either alternating or direct current motors may be used. The current is collected from inclosed wires which are installed on the side of the channel beam. The gears are connected directly to the motor, and the main spindle drive bevel gears run in an oil bath. Three speed ranges are obtained by means of gear changes and are for the main spindle approximately 80, 115 and 170 revolutions per minute.

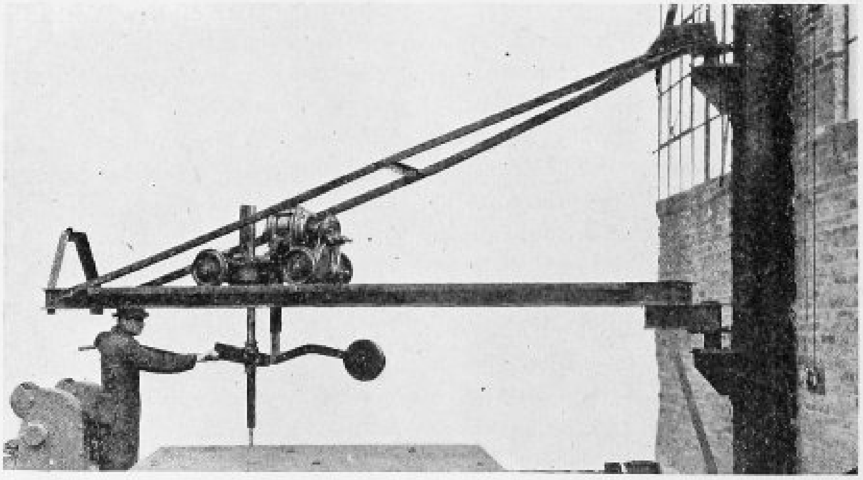
The main spindle bearings are bronze bushed, while all others are lined with babbit metal. The gears are all cast steel, while the pinions are forged. All gears outside of the main frames are guarded to prevent workmen from coming in contact with moving parts. Connecting wires are guarded by metal covers.

### Turret Toolpost

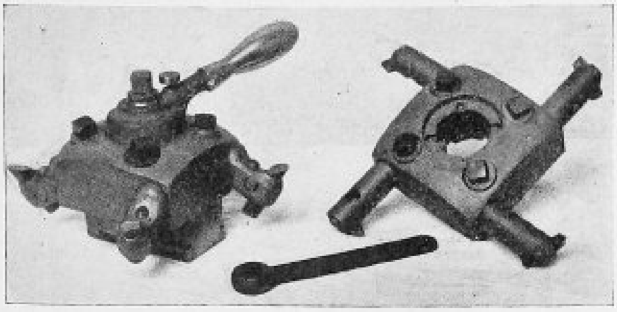
The Lovejoy Tool Company, Inc., Springfield, Vt., has recently developed a turret toolpost which is shown in the accompanying illustration. The positively locked cutter principle is used on tool holders, which are held in this turret toolpost, and the turning and facing cutters are adjustable for height as they become worn. The overhang of the tool has been reduced to a minimum. By a movement of the binding lever the operator can release and accurately index the turret to the next tool position, where it will be securely clamped in place by the completion of the single movement. The turret rings are approximately 4⅜ inches square made of hardened steel and are interchangeable on any base. This feature permits the use of additional rings carrying a variety of tool combinations for various jobs without disturbing the individual cutter adjustment, as well as a quick method of changing tools from outside to inside work.

The boring bars are 1 inch in diameter and free from projections, and will cut to the bottom of a hole which is only slightly larger than the bar itself. Special boring bars ¾ inch in diameter with bushings can be supplied if desired. The turning tools have a shank diameter of 1 inch and are furnished with 9/32-inch high-speed steel cutters.

This toolpost is



Reaming and Countersinking Machine Having a 16-Foot Capacity designed to interchange with any regular engine lathe toolpost without requiring a special fitting to the lathe.



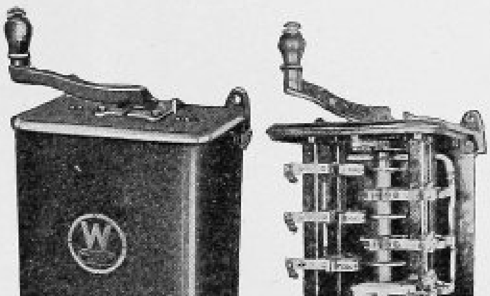
Turret Tool Post for Engine Lathe

## Drum Contactor Controllers

A new type of manually operated drum controller for direct current motors has been produced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This controller, known as the type "S" drum controller, employs practically the same principle of operation as the magnetic type controller.

During the last year, controllers of this type have been tested in operation in practically every industry. It is claimed that these service tests have indicated the superiority of the controller over the drum and face plate type formerly used. They may be used for starting and regulating the speed of shunt, series and compound-wound, direct current motors by adjusting the resistance in series and parallel with the motor armature. They may be applied to cranes, hoists, crushers, bridges, roll and transfer tables, punches, and practically all other machines on which magnetic contactor controllers have been used.

This type of controller is supplied both with and without dynamic braking. Controllers for use with crane hoists regulate the speed of the motor while lowering by



Drum Controller for Direct-Current Motors

dynamic or regenerative braking. They are so designed that if there is not sufficient weight on the hook or cage to revolve the motor and drums the motor will assist in lowering. The speed of the motor is always under the accurate control of the operator both when hoisting and lowering, regardless of the load. Cranes equipped with these controllers can have high safe lowering speeds, if the particular motor used is capable of standing such an operation.

## BUSINESS NOTES

The Mono Corporation of America announces the removal of its main office from Buffalo, N. Y., to 25 West Broadway, New York City, where a complete line of the automatic continuously recording gas analyzing instruments manufactured by this corporation will be displayed.

New offices have been opened by the American Rolling Mill Company, of Middletown, Ohio, in the Hibernia Bank building, New Orleans, La., to cover Southern states, including the state of Texas, excepting El Paso. This office will be in charge of P. C. Lynd, who has represented the American company at Atlanta, Ga., for several years past.

Pratt & Lambert, Inc., Buffalo, N. Y., has begun the erection of a building at its Buffalo plant to house the advertising, printing and finishing departments. The new structure will be four stories high, 100 feet by 55 feet, of reinforced concrete, face-brick veneered and set off by white stone trim. The work is expected to be finished by January, 1921.

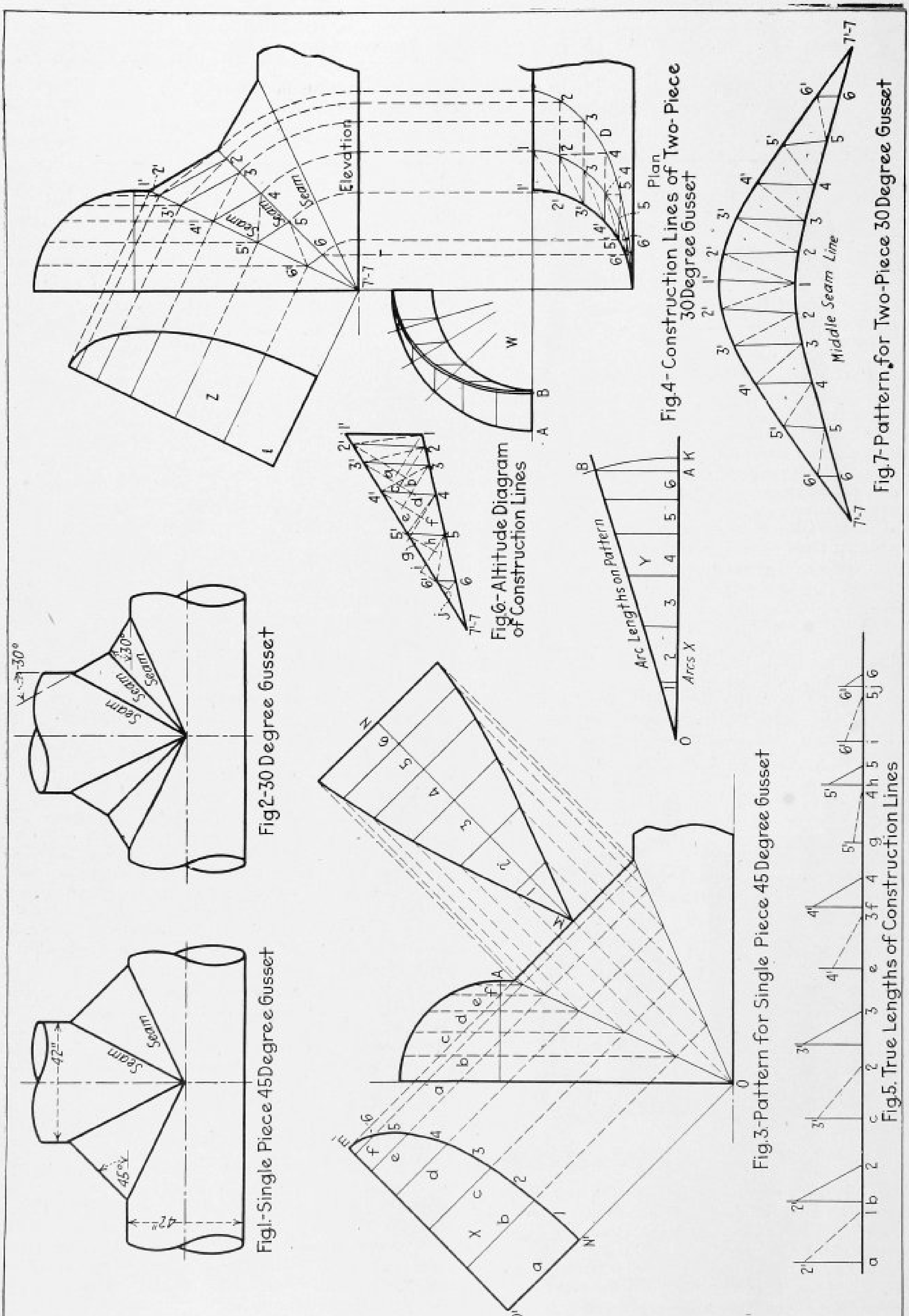
The Pennsylvania Pump and Compressor Company, of Easton, Pa., announce the opening of additional sales offices in the following cities: Buffalo, N. Y., J. B. Laird, manager; Cleveland, Ohio, L. J. Wakefield, manager; St. Louis, Mo., Corby Supply Company; Minneapolis, Minn., L. E. Pollard Company, and Omaha, Neb., L. E. Pollard Company.

H. A. Noble, vice-president of the Pittsburgh Spring & Steel Company, Pittsburgh, Pa., has been elected president to succeed D. C. Noble, deceased. S. F. Krauth, secretary and assistant treasurer, has been elected vice-president and treasurer, with headquarters at Pittsburgh. J. N. Brownrigg, eastern sales agent at New York, has been elected vice-president and eastern representative at New York, and M. F. Ryan, western sales agent at Chicago, has been elected vice-president and western representative, with headquarters at Chicago.

Robert M. Gates has been appointed managing engineer in charge of the Philadelphia, Pa., district of the Lakewood Engineering Company, Cleveland, Ohio, with offices at 1034 Widener building, Philadelphia. Mr. Gates is a graduate of Purdue University. He has been active in oranizing the Material Handling Section of the American Society of Mechanical Engineers, and is acting as chairman of that section during its period of organization. He has devoted the past twelve years to the design, application and engineering surveys of mechanical means of conserving labor in the construction, industrial and transportation fields.

The Uehling Instrument Company, 71 Broadway, New York City, manufacturer of fuel economy equipment, announces that it is now represented in the New England States by the Smith Engineering and Supply Company, 89 State street, Boston, manufacturers' agents and engineers specializing in power plant equipment. S. W. Smith, president of the latter company, was until recently associated with the Uehling Instrument Company, with headquarters in the New York office.

The American Steel Treaters' Society of Chicago, Ill., has combined with the Steel Treating Research Society of Detroit, Mich., to hold a convention in the Commercial Museum, Philadelphia, Pa., September 14-18 inclusive, 1920. About one hundred manufacturers have made arrangements for exhibiting at the convention and many more are expected to participate. These concerns include the largest manufacturers in the country of high speed steels, special alloy steels, carbon steels, metals and alloys, and other products used in connection with heat treating.




Method of Developing Patterns for Gusset Plates on Tee Connections

# 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.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Patterns for "Tee" Connections

Q.—Kindly show me the methods for laying out patterns for the gussets on the "Tee" connections in Figs. 1 and 2. One of these is a single-piece gusset of 45 degrees, and the other is a two-piece one having angles at 30 degrees. L. C.

A.—The pattern for the single-piece gusset having a 45-degree slope can be laid out in a very simple manner. See Fig. 3 for the method of originating the construction lines and the application of these construction lines to the stretchout for the pattern. It is necessary to use only one quadrant of the drawing. First divide the 90-degree arc forming the end view of the "Tee" into equal divisions, 6 being used in this case. From the division points draw vertical lines until they intersect the edge line *OA* of the gusset. Through these intersecting points draw lines square across the centerline *OM* of the gusset.

The next thing to do is to get the true lengths of the arcs formed by the division marks on the centerline *OM*. The method of getting the true lengths of these arcs is shown at *X*. Extend the division lines so as to duplicate *OM* at *O'M'*. Then on the division points of *O'M'* lay off distances equal to the verticals *a*, *b*, *c*, *d*, *e* and *f* taken from the end view of the "Tee." Through these points draw the curve *M'N'* and the intercepted arcs between the parallel lines will be the true lengths that must be laid off on the stretchout *MN* for the pattern.

In case thick plate is used, a correction should be made on these arc lengths before they are placed on the stretchout. The method of making this correction so as to allow for the thick plate is shown at *Y*. First lay off the lengths of the arcs on a horizontal line. Then at the end of the line lay off an additional length *AK* equal to one-fourth the thickness of the plate multiplied by 7. The thickness of the plate multiplied by 7 allows for the circumference, but as the pattern is laid off for a quadrant, it is necessary to take one-fourth of the product. Using the extreme length of the layout arcs as a radius, describe an arc of a length that will cut the vertical line through the point *A*. Then draw the sloping line *OB*, and the intercepted spaces on this line will be the lengths to lay off on the stretchout *MN*. The outline of the pattern will be found by drawing verticals through the points on the stretchout *MN*, and a series of parallel lines from the intersecting points on the edge line *OA* of the gusset. Draw a curve through the intersecting points so as to form the edge line of the pattern.

#### PATTERNS FOR TWO-PIECE GUSSET

In order to lay out the pattern for the two-piece gusset with a slope of 30 degrees, several drawings must be made so as to develop the necessary construction lines. In Fig. 4 the construction lines are shown as required in the quadrant. The end view of the "Tee" must be divided into equal arcs, 6 being used in this case, and vertical lines are drawn through the division points to the edge line 1'-7' of the gusset. The true lengths of the arcs on the edge line must be laid out as shown at *Z*. The method of getting these true lengths is the same as explained in connection with the line *OM* at *X*. Also, it is necessary to allow for the thickness of the metal in case thick plate is used, and this could be done the same way as shown at *Y* in connection with Fig. 3.

The centerline, 7'-1, of the gusset, which is also to be one of the seams, must be projected in the plan view, and the true lengths of the arcs determined. This centerline has the form of an ellipse in the plan view. In order to get the true lengths of the divisions it is necessary to revolve the centerline in the elevation until it is horizontal, and the true form of the ellipse is shown at *D* in the plan.

One method of drawing an ellipse which applies in this case is shown at *W*. Draw the circles *A* and *B* representing the boundaries and divide the circles into an equal number of spaces. Then from the division points on the outer circle draw horizontal lines, and from the division points on the inner circle draw vertical lines. The intersecting points will locate the curve of the ellipse.

In the plan view, solid horizontal lines are drawn through the equal divisions, 1', 2', 3', 4', 5' and 6', of the "Tee" and the points are located on the ellipse. These points are projected to the centerline, 7'-1 of the gusset in the elevation. It is next necessary to join the division points on the edge line, 1'-7', to the division points on the centerline, 1-7. These joining lines are to be used as construction lines when laying out the pattern. In order to avoid confusion, one set of the joining lines is made of solid lines and one set is made of broken lines.

The true lengths of these solid and broken lines must be found after the manner shown in Fig. 5. Draw a vertical line, *a*-2', equal to the height of the point on the edge line above the point on the centerline. Then on the horizontal line of Fig. 5 lay off a distance, *a*-1, equal to the horizontal projection of the given line in the plan view. Finally the sloping line will be the true length which is to be used as a radius when laying out the pattern. The method of getting the altitude of the points is shown in Fig. 6, so as not to use so many construction lines on Fig. 4. For example, the point 2' in Fig. 6 has an altitude of 2'*a* above the point 1. This altitude 2'*a* is laid off in Fig. 5. Likewise, the point 3' has an altitude of 3'*d* above the point 3, and so on until Fig. 5 is completed.

The pattern is shown in Fig. 7. First draw the line 1-1' in its true length taken from Fig. 4. At point 1 use a radius equal to the length of the arc 1-2 on the centerline, which is taken from 1-2 on the true ellipse *D* in the plan view. Also from the point 1' use a radius equal to the length of the arc 1-2' taken from *Z*. From point 1 use a radius 1-2' taken from the true length of the broken line found in Fig. 5.

By following out a series of constructions of this kind the points locating the curve for the edges of the pattern will be determined.

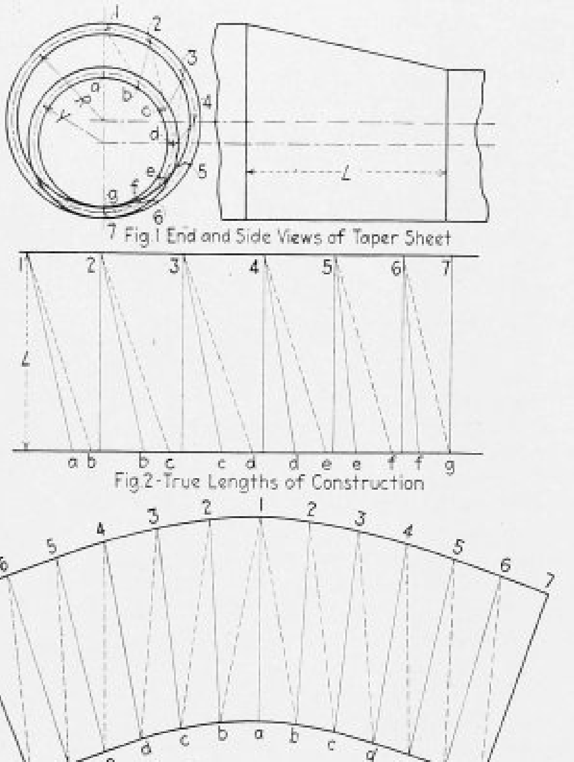
## Pattern for Taper Sheet with Straight Bottom

Q.—In the June issue of THE BOILER MAKER you give the development of a slope sheet for a boiler. I would be pleased if you could give the layout for one now in use generally called in our locomotive shop a taper course, straight on the bottom and with a sloping top. I have never seen the one you show in use today, but all boilers built in our shops have the style described. O. V.

A.—First draw accurate end and side views of the taper sheet, Fig. 1. Make these views as large as possible, full size being desirable. Divide the semicircles of the end view into any number of equal parts and draw solid lines between similar division points. Also draw dotted lines so as to connect the points and form triangles as shown in the illustration. The purpose of using two kinds of construction lines is to avoid confusion when making the layout.

It will be noted that the division points are laid off on the neutral circles, as all measurements must be made from the neutral lines when laying out heavy sheet metals.

The next thing to do is to find the true lengths of all the construction lines that have been drawn on the end view. The method of doing this is shown in Fig. 2. First




Layout for Taper Sheet

draw a vertical line *L* equal in length to the horizontal distance between the ends of the taper. Then from the foot of this line lay off horizontal distances equal to the lengths of the construction lines taken from the end view. The diagonals will be the true lengths of these lines.

The pattern is laid off by using the lengths of the arcs taken from the end view and the true lengths of the construction lines as radii and locating a series of points through which the edge lines of the pattern are drawn.

The pattern in Fig. 3 is started on a centerline equal to the length *L* of the taper sheet at the bottom. This method makes the joint come at the top, but the same layout could be used and the joint actually made at the bottom or at any other location desired. In starting the pattern after drawing the centerline, describe an arc from each end of the line with a radius equal in length to the arcs taken from the end view. Also from one end of the line describe arcs, using a radius equal to the true length of the first dotted construction line. The intersection of the arcs gives the first point on the pattern.

## Rivets and Tube Ends

Q.—Would you kindly answer the following questions: (1) Which of the two rivets shown is the most serviceable for general purposes, a snap rivet put in by hand as shown at *a*, or a raised countersunk rivet driven into the hole by hand and a ring put around it with a snap, as shown at *b*? (2) Which tube is the most serviceable, a tube in which the end is expanded and beaded, as at *c*, or a tube in which the end is expanded and then thickened or staved up, as shown at *d*? These tubes are superheater flue tubes, being 4 inches in diameter, and are in the firebox of a locomotive, having a copper tube plate. W. T. M.

A.—(1) The expression "general purposes," as used in your inquiry, is very indefinite. However, the rivet

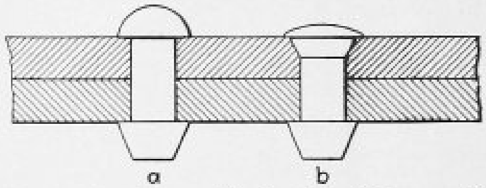



Fig. 1.—Snap Rivet. Fig. 2.—Raised Countersunk Rivet

shown at *a* is in common use because it is cheaper to use than the one shown at *b*. The form of rivet used should conform to the requirements of the job. Countersinking is practiced where the button rivet heads would be in the way and where the fire would attack the projecting heads.

For general purposes, the best plan is to use the simple standard form of rivets that does not require any special machine work on the holes, and which will make a tight joint.

(2) The A. S. M. E. rules for tube ends are as follows: A firetube boiler shall have both ends of the tubes substantially rolled and beaded, or rolled and welded in the firebox or combustion chamber end.

The ends of all tubes, suspension tubes and nipples shall be flared not less than 1/8 inch over the diameter of the tube hole on all watertube boilers and superheaters, or they may be flared not less than 1/8 inch, rolled and beaded, or flared, rolled and welded.

The ends of all tubes, suspension tubes and nipples of watertube boilers and superheaters shall project through the tube sheets or headers not less than 1/4 inch nor more than 1/2 inch before flaring.

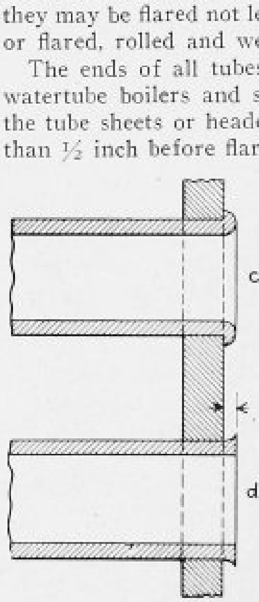



Fig. 3.—Beaded and Staved Tube Ends

According to these rules the beaded or welded tube end should stand the fire better than the projecting thickened end. As the thickened ends are probably the cheaper form to install, careful observations should be made and data kept of the service of both forms. Then a rational decision can be made as to which form is the better one for your engines.

The chief officers of the Industrial Relations Association of America for the coming year elected by the board of directors at their annual reorganization meeting held recently at Atlantic City are: President, J. M. Larkin, assistant to the president of the Bethlehem Steel Company; vice-president, Mark M. Jones, Thomas A. Edison Industries,

### Flue Gas Analysis

Q.—Owing to the smoke abatement law, I am interested in the question of flue gas analysis and the elimination of smoke, etc. Will you please inform me what has been done in the matter? J. I. K.

A.—There has been a great deal of practical work done on the elimination of smoke. You will find many articles on this subject in the power plant engineering magazines on file in your public library. It would be well for you to secure an outfit for making flue gas analyses, and thereby gain some practical knowledge of the use of this important apparatus. Write to the Hays School of Combustion, 1412 South Michigan avenue, Chicago, Ill., for trade literature on the subject. Also it might be well for you to make inquiry of the Smoke Prevention Department of the City of Chicago, as this department has done an immense amount of work on the improving of combustion in power plants.

### Buckling of Shell and Head in a Return Tubular Boiler

Q.—A certain boiler which was of the horizontal return tubular type was buckled along the fire sheet and the front head was somewhat drawn in. The through rods below the tubes had been tightened up and I laid the condition to the rods being tightened. Would the tightening of the rods cause the distress, or was it because of overheating? No oil or much sediment was found.

If the tightened rods caused the buckling, please explain what action takes place to cause this. W. S.

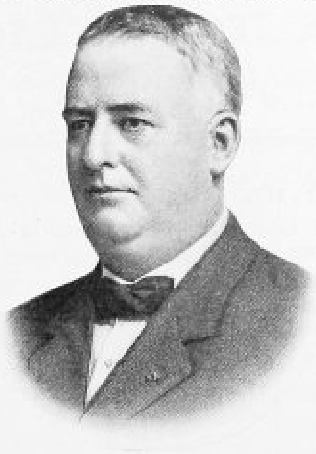
A.—It is evident from your description of this case that the buckling of the plate was due to too great a tension on the end-to-end stays and to overheating of the plate. A very thin coating of oil or scale on the plate leads to overheating. The shell in buckling probably pulled the head in. End-to-end stays should not be drawn up too tight, as in such cases the stays will carry an excess load, leading either to buckling of the plate around the stays or broken stays.

## Obituary

Benjamin F. Sarver, foreman of the Ft. Wayne shops of the Pennsylvania system, died July 23, 1920, at a Chicago hospital after a brave fight for life. He was buried from his home at Ft. Wayne, Ind. He had long been afflicted with a complication of physical disorders that previously imperilled his life, but to the gratification of his many friends he made a remarkable recovery.

Mr. Sarver was born at Allegheny, Pa., February 21, 1866. He entered the service of the Pennsylvania Railroad in February, 1881, as a car cleaner in the Allegheny yards, and in 1882 became a boiler maker's apprentice in the shops at the same place. In recognition of his managing and engineering ability, developed in studious devotion of his chosen calling, he ultimately became foreman of the shops at Crestline, Ohio, and in December, 1899, was transferred to the position at Ft. Wayne, which he held to the time of his death, thus serving the interests which commanded his best efforts and loyal attachment for more than 39 years. In all this time he has been regarded by the company and his immediate superiors as one of the most reliable and capable men engaged in the capacity of foreman. He won and firmly held the warmest friendship and esteem of all the shopmen and the officials.

In the 21 years he lived at Ft. Wayne, Mr. Sarver was actively identified with public affairs in that city and made an enviable record as a city official, being for a number of years chairman of the board of public safety, rendering important and greatly valued service. He was one of the earliest members of the present Master Boiler Makers' Association and a member for six years of its executive board, in which capacity he did much to advance its welfare. At the annual convention in Minneapolis last May he was elected for a third consecutive term of three years, which his associates and fellow members keenly regret he was not permitted to complete.



B. F. Sarver

Mr. Sarver was in all respects one whom it was a real pleasure to know and with whom it was an assurance of benefit to associate. His vision was broad, his manner always kindly and considerate, his friendship dependable and his grasp of questions requiring action never failing in intelligent treatment and sound judgment. He will be sadly missed in every circle in which he moved and the widow and two sons by whom he is survived have the deep sympathy of all who knew him in the great loss they have sustained.

## Marine Boiler Management and Construction

REVIEWED BY C. H. PEABODY, DR. ENG.

MARINE BOILER MANAGEMENT AND CONSTRUCTION. Fifth edition. By C. E. Stromeyer, M. I. C. E. Size, 5½ by 8½ inches. Pages, 437. Illustrations, 466. New York, 1919: Longmans, Green & Company. Price, $5.

This is the fifth edition of a well-known work on boilers as used at sea; the first edition was published in 1893 and the book might be considered a classic were it not so very much alive in this present edition.

The most notable feature in which it differs from the fourth edition is the final chapter, giving the findings of the British Marine Engineering and Design Committee, in anticipation of the adoption of their report by the various authorities that appointed the committee. It is needless to say that the rules and methods recommended by the committee are eminently practical and useful; this chapter alone makes the book a distinct advance. The book also gives the most recent Lloyd's rules and British Board of Trade rules for boilers.

The book opens with directions for boiler management, especially for Scotch boilers, and has chapters on properties of steam, on corrosion, on fuels and combustion and on heat transmission. These are proper for any book on boilers, whether for land or sea service. It is to be noted that the tables for steam are taken from Regnault and Rankine; but for boilers almost any steam tables are sufficient.

The discussion of strength of boiler materials is very much to the purpose because of the peculiarities of service; the chapter on mechanics may perhaps be justified on the same basis. If there is any criticism of the chapters on construction and design, it may be directed to an exclusive consideration of the Scotch boiler, which is indeed the standard for merchant practice, but is now threatened by the watertube boiler. In the chapter on steam pipes the most recent methods of construction by electric and acetylene welding are considered, as well as the older standard methods.

# 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 Study in Drills

Drilling generally forms an essential operation in all construction work. Knowing how to drill accurately and properly is an essential part of the training which a good mechanic must have.

In the following paragraphs will be found a short but practical treatise on the subject of drilling, intended for those who may be "short" on general machine shop practice.

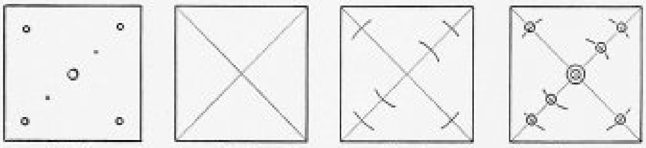


Fig. 1 Fig. 2 Fig. 3 Fig. 4

Operations in Drilling Brass Plate

Unless the holes are to be drilled promiscuously, measuring and marking constitute the first operation in drilling any object. As a means of illustrating, we will assume that we have a brass plate 3 inches square and ¼-inch thick, to be drilled with holes of various sizes. With the exception of the method of sharpening the drills, the drilling of a piece of brass is no different than the drilling of any other metal.

### Tools Needed

The tools necessary for marking are a rule, a pair of dividers, a center punch and a scribe. The scribe, which is merely a sharp-pointed piece of steel used to scratch marks on metallic surfaces, can be made from an old round file ground to shape on an emery wheel. A center punch can also be made in the same way. The rule is a steel one of the machinists' type, and the dividers need not be larger than four inches.

The brass plate is to be drilled as shown in Fig. 1. The first operation will be that of finding the exact center, and this can easily be done by scratching two lines, as shown in Fig. 2. (Do not scratch the lines too deeply, as they will have to be papered off when the drilling is done.) At the point where the lines intersect, make a small indentation with the center punch, as this is the exact center, and all future measurements will be made from this. We will now measure for the holes in the corners. As they are 1½ inches from the center, we will open our dividers to 1½ inches, and with one point in the center scratch a small arc in each corner of the plate, so it crosses the line we first drew. This is shown in Fig. 3. With the dividers open to ¾ inch, and the point in the center, mark two arcs as shown for the two small holes, which are to be ¾ inch from the center. At each point where the arcs intersect the two original, make a small indentation with the center punch.

With the dividers open ⅜ inch, scratch a circle in the center of the plate, and within this circle draw another one, about half the size of the first. Also scratch a small circle at each corner and for the two small holes just off the center. These circles are to aid us in drilling, and their use will be described later.

Before the actual drilling of the brass plate, it will be well to devote a few lines to the twist drill and how to use and sharpen it for different classes of work.

### Grinding the Drill

First, let it be known to every amateur mechanic that it is absolutely impossible to drill accurately unless the drill has been sharpened properly and with mechanical exactness. In order to sharpen a drill in the proper way, an elementary understanding of its working principles is essential.

Fig. 4 shows an ordinary twist drill, together with the names of its various parts. It will be noted that there is a pronounced clearance between the cutting edge *A* and the back edge *B*. Both cutting edges of a drill should be at exactly the same angle, and the clearances on each side should also be as nearly equal as it is possible to make them. In sharpening a drill, the angle of the lip clearance must be left to the judgment of the mechanic, and care should be taken that it is not too great, as this will cause the drill to bite too greedily. Equally defective is a drill without enough clearance between the cutting edge and the back edge, as it will heat excessively and also cause the flute edges to wear rapidly, thereby throwing the drill out of caliber. To those who are not experienced in grinding drills, the writer would suggest studying the clearances on new drills of various sizes. This will be found very helpful. In grinding the small drills (Nos. 60 to 80), care need not be taken in rounding off the clearance, as a flat clearance will suffice. Small drills should be ground on wheels of fine grit.

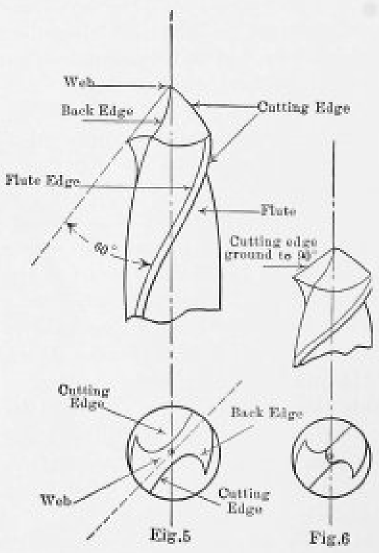



Fig. 5.—Proper Method of Grinding Drills

If the clearances on either side of a drill are not equal, it is impossible to drill accurately, as the drill will have a tendency to resolve eccentrically, owing to unequal pressure. A hole considerably larger than the gage of the drill will thus be produced.

### Sharpening a Drill for Special Uses

When a drill is to be used for drilling brass or cast iron, it should not be sharpened in the ordinary manner. The lip of the drill should be ground off as shown in Fig. 5. Aside from the advantage of cutting faster, this method of sharpening prevents the drill from worming as it breaks through the end of the bore.

Assuming that the drills are accurately and properly sharpened for the drilling of brass, we will now describe the procedure of boring the holes in the brass plate.

### Boring the Brass Plate

The large center hole is drilled first. It would be very bad practice to start drilling this hole with a ½-inch drill, as the web of such a drill is so broad that it is difficult to accurately center it. The only way to overcome this disadvantage is to start the hole with a drill of smaller gage. In this case a ⅛-inch drill will do nicely. It is at this point that the circles scratched on the plate come into use. Place the ⅛-inch drill in the chuck, start the press and bring the spindle down until the drill touches the center dot. Permit the drill to go just far enough to drill the dot off, then raise the spindle, and, by means of the small circle scratched on the plate, see if the tiny indentation made is exactly in the center, using the circle as a guide. If it is properly centered, drill just a little further (do not permit the point of the drill to go very far below the surface) and follow out the same operation on each corner. When the ½-inch hole in the center is drilled, go cautiously until the drill is centered accurately, and do not bore right through the plate without raising the spindle several times to see that the drill is in the exact center.

Amateur mechanics who have tried to drill a transverse hole in a piece of round stock know what a difficult matter it is to do this accurately. It can easily be accomplished, however, by the use of a V-block; and as these can be purchased for a few cents, the mechanic is urged to procure one. If the mechanic desires to make one, he can do so on the shaper, cutting the sides of the grooves exactly 45 degrees.

### Drilling Speeds

The rate of feed and speed for small bench drills should vary with the diameter of the drill and the hardness of the metal being drilled. As a general rule, small drills should be run at high speed and larger ones at lower speed. An easy method of obtaining the approximate speed is by dividing 80, 110 and 180 by the diameter of the drill, which gives the number of revolutions per minute for steel, cast iron and brass, respectively. In drilling wrought iron or steel, the drill should be flooded with oil or cutting compound (soap and water make a good substitute). Brass, copper and cast iron should be drilled dry.

If about to drill brass, don't fail to sharpen the drill, for this particular metal will grind off the cutting lips so they will have no angle or rake. On a power-driven press, and by means of a jig, the writer has drilled as many as twenty ⅜-inch holes in one minute through a brass strip having a thickness of 5/16 inch. This high rate of production can only be obtained when the drill is sharpened properly.

When grinding a drill, be careful not to burn it by holding it on the wheel too long without dipping it in a convenient receptacle of cold water. Burning a drill means heating until it loses its temper.

Waynesboro, Va. F. H. Sweet.

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The Mesta Machine Company, Pittsburgh, Pa., has opened an office in the Singer building, New York, from which point all its foreign business will be handled. The New York office will also be the sales office for the New York and Eastern states territory. M. M. Moore, the export sales manager, who has just returned from a several months' European trip, will be in charge.

## Dressing the Burr from Drilled Holes

The writer's advocacy of position drilling and its manifest advantages must by now be quite well known to the readers of The Boiler Maker. Repetition may become wearisome, but to overcome prejudice and to compel notice a certain amount of it is neither stale nor unprofitable, and is indeed essential.

All good boiler specifications insist first upon position drilling and provide that after the contacting plates have been holed in place they are then to be taken apart and the burrs dressed off before riveting. The need is obvious, but on more than one occasion a practical boiler maker has questioned the need for taking the plates apart after they have been assembled to dress the burrs. It is thought that part of this reluctance is due to the absence of some simple means of removing the burr, the additional work involved in re-assembly being easily understood. It is also desirable that the outer edges of rivet holes should be slightly countersunk, otherwise the head and shank of the rivet at either end will be a sharp square junction, a type of construction rather fatal in all metallic connections.

Apart from the labor and trouble involved in reassembly, any simple means to dress the burrs themselves is worth notice, and when the device is simplicity itself and can be made from available material at small trouble, and is guaranteed to be rapid in action, then its publicity should be widespread.

Although not by any means new, for it has been in use for at least a score of years, the device is not in universal application and perhaps the resentment at the need for dressing or its want of practice may have a bearing on the subject.

A common round file about ¾ inch in diameter has one end drawn down flat and cranked; it is ground on the sides to give a cutting edge at the shoulders, while the other end of the file is turned up into a handle. The business end is hardened and the tool is then ready for use.

The burr itself is displaced metal thrown up as a vertical wall round the hole, and the insertion and rotation of the cranked flat end peels the burr at a single revolution of the tool, coming away as a veritable shaving with the smallest effort on the part of the user. It is true machining without the need for power, pneumatic or electric, and is done on the job with the least skill at a fast rate. It leaves a small radius to reinforce the rivet head.

The speed with which the device can operate is not the least of its many charms, and it is available to all at a less cost than any shop device possessing equal merit.

Having become the perpetual advocate for position drilling in these pages, a missionary effort which I have reason to believe is bearing fruit and making converts, there is a peculiar satisfaction to me in bringing this device to notice.

Don't be prejudiced; try it, and if not pleased say so; if it gives the satisfaction, which it is sure to do, recommend it. There will be some satisfaction in taking the plates adrift to dress the burrs, and my advocacy of position drilling in the interests of safety and good workmanship will also be served.

London, England. A. L. Haas, A. M. I. M. E.

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Julius Janes, formerly president of the Standard Steel Castings Company, of Cleveland, has recently concluded an arrangement with the Farrell-Cheek Steel Foundry Company, of Sandusky, Ohio, by which he will be the sales representative of this organization in Cleveland and Cuyahoga County.

## Improper Practices in Flue Setting

In my experience with the construction and repair of locomotives I have found that the setting of flues does not receive the attention that it should, especially when a locomotive is receiving *general* repairs. As the flues in most cases are installed in the boiler just before the job is finished, and the time allowed to get the locomotive out of the shop by a certain date is growing limited, defective flue setting usually results. While the job is being rushed to completion the copper ferrules are allowed to extend past the sheet at the fire side when they should have been chipped off; the copper ferrules are expanded too much, the swaged ends of flues not properly cleaned, which prevents the making of a perfect joint between the ferrule and the flue. Finally, to complete the inferior job of flue installation quickly, beads are turned down with the flaring tool too far, thereby promoting crystallization of the metal as well as cutting into the flue, where it is forced against the edge of the hole.

It is my opinion that a flaring or belling tool should not be used on a flue that requires the bead to be calked tight against the sheet. For example, the flues in the firebox end of a locomotive are exposed to the fire and should not be beaded over with a hammer, but should be upset and calked properly with the beading tool.

For nine years I was employed on a railroad where the method of turning over the beads with a beading tool was the standard practice, and in all that time I failed to see a bead missing from a single flue in any of their locomotives. A good grade of material was always used, but I attribute their real success to careful flue setting and to the small number of operations in which the work was accomplished. If a single operation can be eliminated, it is undoubtedly true that the life of the flue is greatly prolonged.

What seems to me to be an extensive and inferior practice in connection with flue work occurs when flues are being reset in an old flue sheet for the second or third time. From the continuous working of flues the flue holes become enlarged and when the flues are removed the holes will be found 1/64 inch to 3/32 inch greater in diameter. In preparing the sheet for the installation of new flues, the flue setter will determine the particular size copper ferrule that will fit the greatest number of holes and place his order with the stores department accordingly. When he installs these ferrules some of them are, of course, too small, so he places them on a mandrel and expands them by hammering to a size that will fit the flue hole. What should be done, of course, is to find a ferrule that will exactly fit each hole. When a copper ferrule is forcibly expanded to a size for which it was not originally intended its serviceability has been destroyed even before it leaves the shop.

The next difficulty occurs with such distorted ferrules when the flues are fitted. The flue end has to be expanded sometimes as much as 5/64 inch, and in such cases the life of the flue is decreased about 50 percent. When asked for an explanation of this practice of misfitting ferrules, some men cannot understand the fact that it is an inefficient and wasteful method of procedure. In some other cases I have found that the stores departments do not maintain a supply of ferrule sizes to fill the shop needs.

The danger of this practice may be easily determined by measuring the inside diameter of the flues in a locomotive and keeping a record of those that have been stretched to fit the flue hole. The flues so treated will be the first ones in any set to start leaking.

It certainly does make a difference whether they are stretched or not in the life of the flue. The men having charge of this matter in the shops should be sure that the stores department maintains an ample supply of ferrules of the correct sizes.

There is no doubt in my mind that the majority of boiler makers and flue setters understand the proper method of setting flues, but it is after all up to the boiler foreman to see that the proper method is carried out.

## PERSONALS

Louis A. Delaney, formerly mechanical engineer with F. X. Hooper Company, Glenarm, Md., is now manager of the American Sheet Metal Corporation, of Philadelphia, Pa.

Harry de Lapotterie has resigned his position with the Townsend Company, of New Brighton, Pa., to become industrial engineer of the Falls River Company, of Kent, Ohio.

G. Bronson Philhower, Jr., is now with the Reading Iron Company, Reading, Pa., in its railroad sales department. Mr. Philhower has had extensive training in related fields—the technical publishing business in New York, automobile and tool steel sales work, and, during the war, the mechanical division of the Navy, Mr. Philhower being attached to the aviation and submarine chaser divisions. His sales experience has been supplemented by an intensive course of training in the various plants of the Reading Iron Company, whose apprentice course Mr. Philhower entered in February, 1920. After having worked in various capacities and gained a detailed knowledge of the manufacture of wrought iron pipe, Mr. Philhower was appointed salesman, with headquarters at the Reading Iron Company's New York office, 99 John street.

G. Bronson Philhower, Jr.

William D. Cecil has severed his connection as resident material inspector with the Baltimore & Ohio Railroad and is now connected with the Magnus Metal Company, of St. Louis, Mo.

W. Woodward Williams, vice-president of the Reading Iron Company, Reading, Pa., has resigned from that concern to become assistant to the president of the Pittsburgh Gage & Supply Company, Pittsburgh, Pa.

Captain George B. Malone, who formerly served with the United States Army Engineers and later was general manager of the K-G Welding & Cutting Company, 556 West Thirty-fourth street, New York, has recently been placed in charge of its Philadelphia (Pa.) office at 929 Chestnut street.

A. B. Way, until recently secretary and general manager of The Bridgeport Chain Company, has become affiliated with The Chain Products Company, of Cleveland, Ohio, in the capacity of district sales manager for New England, with headquarters at the company's New York office, 150-152 Chambers street.

## TRADE PUBLICATIONS

RIVETS.—A book containing useful information on rivets, especially intended to be of service to purchasing agents, engineers, draftsmen, shop foremen and others interested in the use of rivets, has been issued by the S. Severance Manufacturing Company, Glassport, Pa.

CONVERT-A-CAPS.—A pamphlet giving details of a new electrical connection plug cap has been issued by the Benjamin Electric Manufacturing Company, Chicago, Ill. Portable electrical appliances equipped with the new cap may be operated from almost any base board or wall receptacle of the slotted variety now in use. The base of the cap is adjustable and may be turned with the fingers to fit Edison base sockets having parallel slots, "T" slots or double "T" slots and tandem receptacles.

ELECTRIC DRILLS.—The Independent Pneumatic Tool Company, 600 West Jackson Boulevard, Chicago, is distributing a circular descriptive of Thor universal electric drills. A feature of this line is the size "00" portable electric drill with pistol grip handle, which is a useful tool under a wide variety of conditions, including such work as drilling, reaming, boring in wood, screw driving, etc. Other tools in this line are adapted for grinding as well as drilling and all are driven from ordinary lamp socket connections.

INSULATING MATERIALS.—Recent interesting and valuable bulletins by the General Electric Company, Schenectady, N. Y., include Nos. 48704A and 48715, dealing respectively with insulating compounds and insulating fabrics. A wide variety of materials for both purposes are illustrated and described, in addition to which are illustrations of the facilities and methods for producing and applying these materials in the various processes of manufacture carried out by this company. Other bulletins are No. 49400 on the Hewlett link insulator and No. 41311 on synchronous condensers.

SPRAGUELETS.—A catalogue describing conduit bodies produced by the Sprague Electric Works, New York, has just been issued. The principal features of this line of conduits are the knockouts and couplings which permit the assembly of conduit combinations that have not been possible with old tube bodies. The Spraguelet bodies are in three types and the couplings are designed for ½-inch and ¾-inch conduits, and are made to fit the one size knockout standard to all size bodies. Plates and covers for branch, deep and shallow body Spraguelets are listed and the entire line fully described.

CARBON DIOXIDE EQUIPMENT.—The Uehling Instrument Company, 71 Broadway, New York, has just issued bulletin No. 111 describing Style "U" Uehling carbon dioxide equipment. This is a new design built in single and multiple forms, the latter serving any number of steam boilers simultaneously, up to a total of six. The purpose of this equipment is to save fuel by burning it with the proper air supply. Neglect of this factor is costing power plant owners heavily. Among the notable features of the new machine are speedy action, resulting from a new form of aspirator, absence of chemical solutions, greater simplicity and the unique plan of providing an auxiliary boiler front $CO_2$ indicator, which guides the fireman, while the $CO_2$ recorder installed in the chief engineer's office or superintendent's office makes a continuous record showing all changes in boiler adjustments that are conducive to either waste or economy.

## ASSOCIATIONS

**Boiler Makers' Supply Men's Association**

President—Frank J. O'Brien, Globe Seamless Steel Tubes Co., Milwaukee, Wis.

Vice-President—William B. Wilson, Flannery Bolt Co., Pittsburgh, Pa.

Secretary—George Slate, THE BOILER MAKER, 6 East 39th Street, N. Y.

Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

**International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America**

Louis Weyand, Acting International President, suite 315 Wyandotte Building, Kansas City, Kans.

Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte Building, Kansas City, Kans.

James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte Building, Kansas City, Kans.

William Atkinson, Acting Assistant President, suite 315 Wyandotte Building, Kansas City, Kans.

International Vice-Presidents—Joe Reed, 1123 East Madison Street, Portland, Oregon; Thomas Nolan, 700 Court Street, Portsmouth, Va.; Joseph Flynn, 111 South Park Avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth Street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon Avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth Street, Columbus, Ohio.

**American Boiler Manufacturers' Association**

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.

Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

**Master Boiler Makers' Association**

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.

First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.

Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton Avenue, St. Louis, Mo.

Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.

Fourth Vice-President—Frank Gray, G. F. B. M., C. & A. R. R., 705 West Mulberry Street, Bloomington, Ill.

Fifth Vice-President—Thomas F. Powers, System G. F., Boiler Dept., C. & N. W. R. R., 1129 S. Clarence Avenue, Oak Park, Ill.

Secretary—Harry D. Vought, 95 Liberty Street, New York City.

Treasurer—W. H. Laughridge, G. F. B. M., Hocking Valley Railroad, 537 Linwood Avenue, Columbus, Ohio.

Executive Board—John F. Raps, gen. B. I., C. R. R., 4041 Ellis Avenue, Chicago, Ill., chairman.

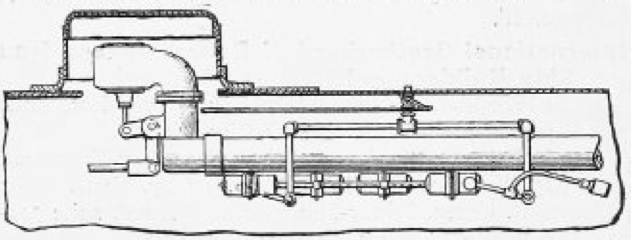
## Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,304,385. BOILER SKIMMER. NORBERT SCHREIBER, OF LINCOLN, ILLINOIS, ASSIGNOR TO AMERICAN STEAM BOILER CLEANER COMPANY, OF SAN ANTONIO, TEXAS, A CORPORATION OF TEXAS.

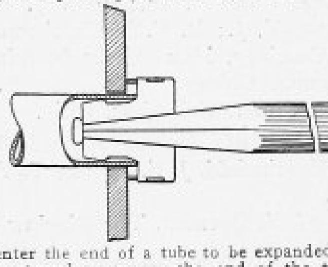
*Claim* 1.—A device of the class specified comprising a stationary



frame provided with a horizontally arranged pipe having its opposite ends provided with laterally extending horizontal cross pipes, a movable frame consisting of a pair of pipes extending longitudinally of said horizontally arranged pipe and provided with skimming apertures and floats and connections between said frames, consisting of pipe members extending between the opposite ends of said skimming pipes and the ends of said cross pipes and pivotally connected with the same. Fourteen claims.

1,306,982. TUBE EXPANDER. EMMET WALSH, OF SAN ANTONIO, TEXAS.

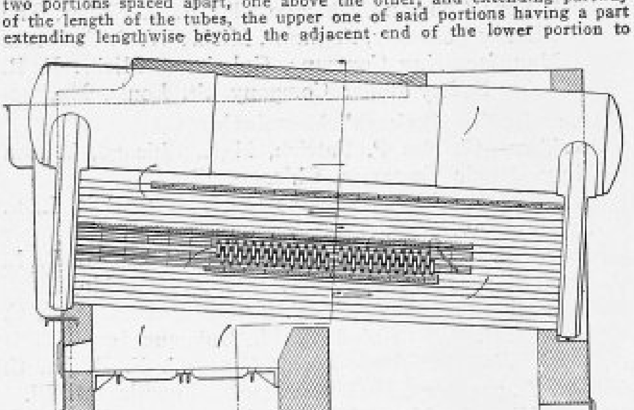
*Claim* 1.—In a tube expander, the combination with a tapered pin, of a plurality of expanding segments grouped around said pin and having



portions to enter the end of a tube to be expanded, and portions extending radially outward to engage the end of the tube, and means to be arranged between said radially extending portions and a tube sheet to which the tube is to be set, for determining the width of the bead to be formed on the tube, said segments being capable of being moved radially while said spacing means remains stationary. Three claims.

1,304,480. SUPERHEATER CONSTRUCTION FOR BOILERS. JOHN H. HINMAN, OF PHŒNIXVILLE, PENNSYLVANIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO HEINE SAFETY BOILER COMPANY, OF PHŒNIXVILLE, PENNSYLVANIA.

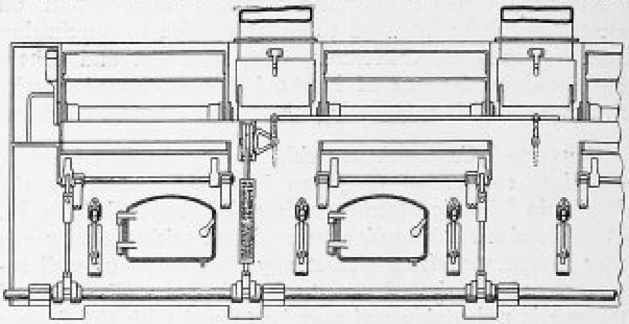
*Claim* 1.—A boiler including a casing, two headers, a plurality of superimposed rows of tubes connecting said headers within the casing, a baffle interposed between certain of the rows of tubes, said baffle having two portions spaced apart, one above the other, and extending partway of the length of the tubes, the upper one of said portions having a part extending lengthwise beyond the adjacent end of the lower portion to



prevent the products of combustion from passing directly from the firebox of the casing to the uppermost of said tubes, said portions of the baffle extending transversely from one side wall of the casing toward the opposite side wall of the casing and stopping short thereof, said baffle also having an upright portion extending lengthwise of the tubes and between said first and second portions, said third mentioned portion being spaced between said side walls of the casing, another baffle portion bridging the space between said upright portion and said opposite side wall of the casing, and a superheater extending inwardly from said first mentioned side wall and between said first two portions of the baffle, substantially as described. Five claims.

1,318,579. FURNACE CONSTRUCTION. WILLIAM McCLAVE, OF SCRANTON, PENNSYLVANIA, ASSIGNOR TO McCLAVE-BROOKS COMPANY, OF SCRANTON, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

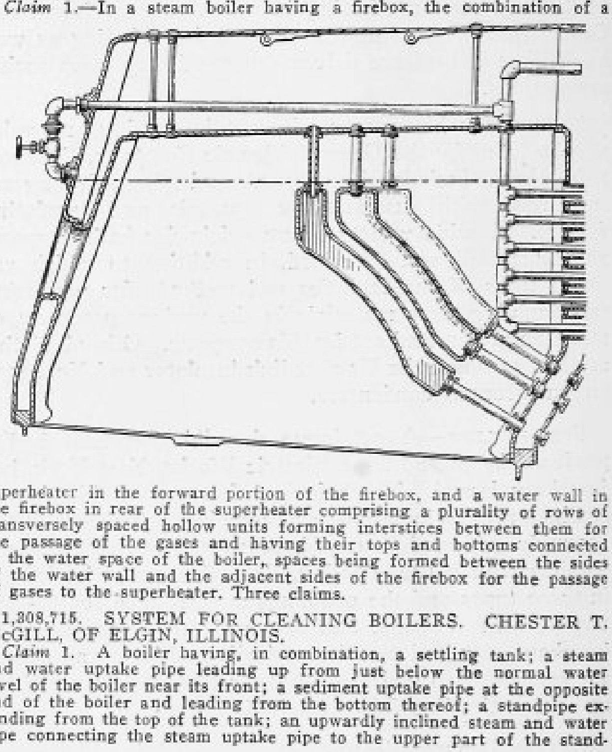
*Claim* 1.—A furnace construction comprising the combustion chamber,



the grate supported within the combustion chamber, a substantially inclosed fuel receiving channel within the furnace extending transversely substantially clear across and in front of the fuel receiving end of the grate, said channel having a transversely extending opening in its front and rear walls substantially coextensive with the latter, means for feeding fuel into said channel, and means for distributing the fuel transversely therein, said distributing means and the openings in the walls of the channel being located in different horizontal planes, whereby access may be had to the interior of the combustion chamber through the openings in the channel walls throughout the entire length of said channel. Twenty-two claims.

1,306,613. STEAM BOILER. JAMES S. NICHOLS, OF ATLANTA, GEORGIA.

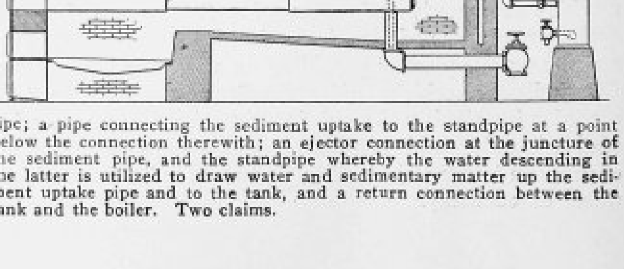
*Claim* 1.—In a steam boiler having a firebox, the combination of a



superheater in the forward portion of the firebox, and a water wall in the firebox in rear of the superheater comprising a plurality of rows of transversely spaced hollow units forming interstices between them for the passage of the gases and having their tops and bottoms connected to the water space of the boiler, spaces being formed between the sides of the water wall and the adjacent sides of the firebox for the passage of gases to the superheater. Three claims.

1,308,715. SYSTEM FOR CLEANING BOILERS. CHESTER T. McGILL, OF ELGIN, ILLINOIS.

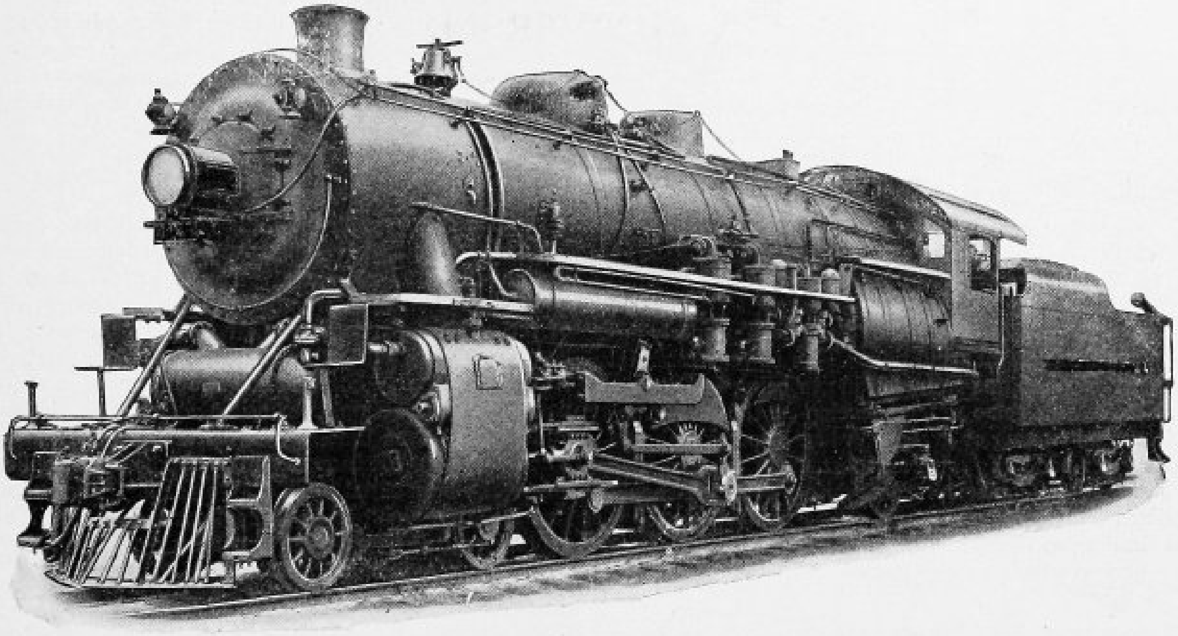
*Claim* 1. A boiler having, in combination, a settling tank; a steam and water uptake pipe leading up from just below the normal water level of the boiler near its front; a sediment uptake pipe at the opposite end of the boiler and leading from the bottom thereof; a standpipe extending from the top of the tank; an upwardly inclined steam and water pipe connecting the steam uptake pipe to the upper part of the stand-



pipe; a pipe connecting the sediment uptake to the standpipe at a point below the connection therewith; an ejector connection at the juncture of the sediment pipe, and the standpipe whereby the water descending in the latter is utilized to draw water and sedimentary matter up the sediment uptake pipe and to the tank, and a return connection between the tank and the boiler. Two claims.

# THE BOILER MAKER

OCTOBER, 1920



# Carrying Out Running Repairs on Locomotive Boilers*

*With improved appliances many difficulties have been overcome in the maintenance and repair of locomotives and the operating expense has been reduced to a minimum. The designs and construction of locomotives have also been vastly improved, and the best engineering minds in the country are constantly engaged in still further advancement. It seems, however, that in some of the more elemental requirements of the service there is need of a greater degree of earnestness in boiler maintenance.*

It has been frequently pointed out that scale formation in the boiler, which is inevitable, if permitted to assume any measurable degree of thickness, is perhaps the greatest obstacle to advancement in the problem of fuel economy. The estimates furnished by experts as to the effects of certain thicknesses of scale in boilers are very conflicting, depending, as they do, on the degree of hardness of the scale or heat-resisting qualities. All agree, however, that the effect is by far greater than the degree of attention that is given to its remedy.

As to the efforts made by the leading railroads in recent years on the matter of boiler washing, it may be stated briefly that 9,760 locomotives made less than 500 miles between wash-outs, while 11,283 engines made less than 1,000 miles; 8,312 engines made over 1,000 miles and less than 1,500 miles, and 20,472 engines made over 1,500 miles. The passenger locomotives make on an average 30 percent greater mileage between washouts than freight engines. The average number of washout plugs in modern locomotives is 32. Washing out with hot water costs 35 percent less than with cold water. Roads using water-softening plants report over 100 percent gain in mileage as compared with untreated water. The average cost of washing out with cold water is $4.50, and with hot water about $3.00. The incrusting matter in boiler waters consists almost entirely of carbonates of lime and magnesia and sulphates of lime and magnesia. The carbonates require treatment with hydrated lime, and the sulphates require soda ash.

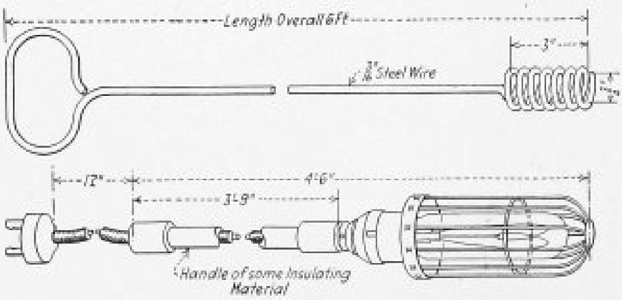
While these data are of real value, as showing a condensed reflex of the general practice in recent years, there are little data regarding the actual time occupied in the operation, but, on the contrary, there is abundant evidence of a pressing desire to make the operation as cheap as possible, as if the lessened cost were the sole object to be aimed at instead of an absolute degree of thoroughness. Those who have had opportunities of observing the condition of boilers that have been some time in service cannot have failed to observe that, while a large area of the boiler surfaces as well as the flues is comparatively free from any accumulated scale, other parts, particularly certain kinds and forms of crown sheets may have been allowed to become considerably incrusted, showing that the operation has not received the attention that it demands from those having the work in charge.

### Shop Organization

A word or two may be said in regard to shop organization and its bearing upon boiler maintenance before we take up the matter of boiler cleaning or washing, as a great deal depends on the proper handling of the routine

* From *Railway and Locomotive Engineering.*

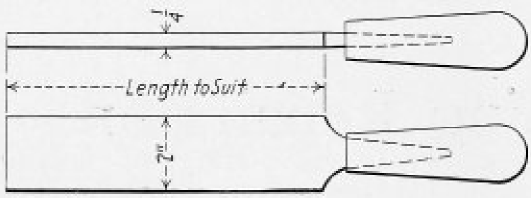
work in running repairs. After the locomotive has been turned out of the shop, and before being placed in active service, the roundhouse inspectors should make a thorough inspection of the front end appliances, ash pan and




Boiler Inspection Torch and Electric Light

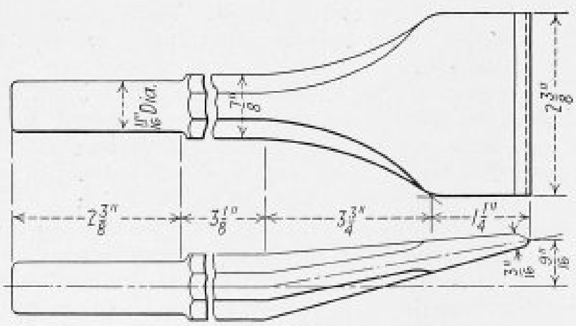
grates, in order to ascertain if they have been properly applied and are in perfect condition. This is very essential in order to avoid engine failures, due to being improperly drafted or having some defect develop in the newly applied front end rigging or grates. A like inspection should be made after each trip, and a report made on a regular form showing the condition. Any defect reported should be repaired immediately.

The cleaning of flues is a very important factor in locomotive performance, as stopped-up flues will cause an




Tool for Scraping Shell

engine to steam poorly. Whenever an engineer reports steam pipes leaking, the engine not steaming, the flues should be examined to make sure that they are clean, as almost invariably the conditions referred to are due to stopped-up flues. The proper method of cleaning flues is with the auger and compressed air. Flues should be thoroughly blown out with air at the termination of each trip.



Tool for Scaling Shell

When flues are stopped up they should be bored out with an auger of sufficient length to reach from end to end and then blown out thoroughly with air. Special attention should be given to flues in superheated locomotives. In locomotives with brick arches the bottom flues should be maintained in clean condition, and no locomotive should be allowed to go into service with any flues stopped up. This work should be done before the boiler makers enter the firebox, in order that they may check the work to see that it has been properly performed.

The brick arch, which has gained such a prominent part in the economical operation of the locomotive, should receive a great deal of care and consideration. By doing so the trouble experienced by leaky flues is very materially decreased and their life greatly increased. Care should be taken to see that the brick arch is properly cleaned after each trip and is maintained in perfect condition, and the engine should not be allowed to go into service with holes in the arch or with part of the arch missing, as trouble is likely to be experienced either with the flues leaking or a poor steaming engine.

### Use of the Expander

If flues show cinder-pit leaks they should be calked by hand with standard beading tools. Flues blowing or leaking enough to allow water to run down the sheet should be expanded with a straight sectional expander; the use of the roller expander is not advisable. The leaks should be stopped with the sectional expander while the boiler is still comparatively hot, and a section of flues in the lower part of the sheet should be beaded with a light air hammer and the standard beading tool after the boiler is empty. The flues should be inspected after the boiler is refilled and any leaks eliminated. This is especially important, because the inequalities in temperature occasioned by the cooling and washing have a tendency to break the joint of the flues in the flue sheet.

### Washing Out the Boiler

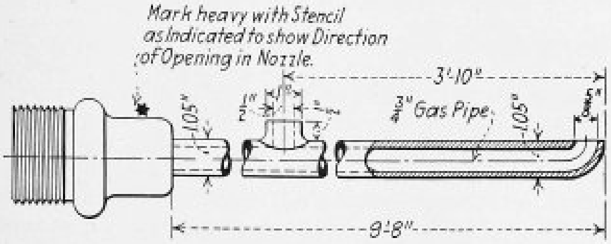
Coming to the washing of the boiler, the subject is so extensive and the methods used may be conducive to good or bad results that a few concise rules should be established as the proper method of preparing and washing the boiler. General rules stating that locomotive boilers are required to be washed out as often as may be necessary to keep them clean and free of scale and sediment are hardly sufficiently explicit, as individual judgments differ in this as is all other subjects. Observations gathered from various sources have shown that it is good practice for boilers to be thoroughly cooled before being washed, excepting where improved hot water washing systems have been installed.

In most division points where there is no specially perfected appliance in use, the injector is very serviceable in helping to cool the boiler. If there is sufficient steam pressure to work the injector, it should be kept in operation until the steam pressure will no longer operate the injector. Then connect the water hose to the feed pipe and fill the boiler, allowing the remaining steam pressure to blow through the syphon cock or some other outlet at the top of the boiler. The blow-off cock may then be opened, and the water in the boiler allowed to escape, but not faster than it is forced through the cheek, so as to keep the boiler completely filled until the temperature of the steel in the firebox is reduced to about ninety degrees. All blow-off cocks may then be opened and the boiler emptied as speedily as possible.

All washout plugs should then be removed, including the arch tube plugs, and the washing of the boiler should begin with the crown sheet, starting on the sides and washing through the holes in the back head. The door ring may then follow in the process, succeeded by a careful and thorough washing of the arch tubes, and it should be remembered that the pneumatic or other cleaner should be used every time that the boiler is washed out. The washing may then be continued through the plug holes in the barrel of the boiler immediately ahead of the firebox, using a bent nozzle in order to thoroughly wash down the flues.

The same appliance and method should be continued at the front of the barrel. In washing the belly of the boiler, it is good practice to begin at the front end, using a bent nozzle and washing the scale toward the firebox.

In washing the legs of the boiler through plug holes in the side and corner of the firebox, a straight nozzle should be used in corner holes and a bent nozzle through side




Crown Sheet Washing Nozzle

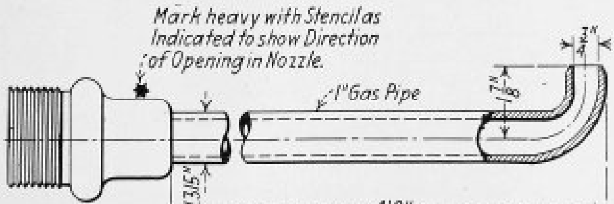
holes, revolving them in order to thoroughly clean the side sheets. Rods should be used to dislodge any accumulation of matter that water pressure fails to remove.

When the operation is finished, the boiler should be thoroughly inspected through the plug holes before any plugs are replaced. This inspection should be made by the foreman boiler maker or special inspector, just as any other piece of work is examined by other than the workman himself. In returning the plugs to position, it is good practice to apply a coating of graphite and oil made to the consistency of a paste. It will be found that if this practice is adopted, the plugs may be removed more readily in the future. The water pressure should not be less than 100 pounds.

It must be remembered by those in charge that when orders are issued to boiler washers to slight the washing of any boiler in order to get the locomotive ready for a certain run, they are storing up trouble for the future. Although it might not be in evidence at that time, the day of reckoning is sure to come. Blowing-out can be resorted to in some instances to save washouts, with either incrusting or alkaline water, but care must be taken to see that the fire is in proper condition—that is, clean and bright.

### Improper Use of Injector

The prevention of engine failures due to leaky flues does not rest entirely with the roundhouse boiler makers, regardless of the fact that they are compelled to assume the responsibility in most instances. One may take a locomotive with practically a new set of flues, and by the im-

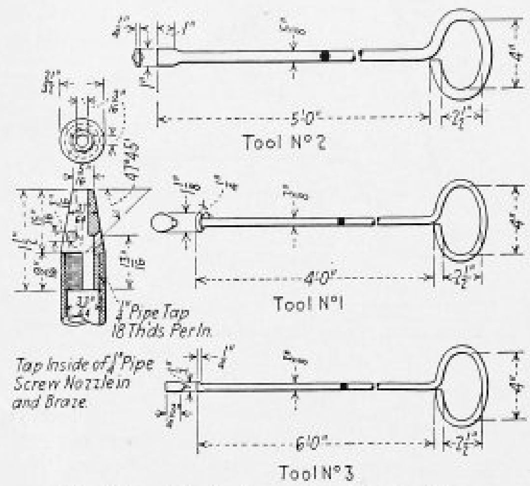



Dove Sheet Washing Nozzle

proper use of the injector cause most of the flues to leak. This can be demonstrated by getting into the firebox after the fire has been drawn and the locomotive placed in the roundhouse with a perfectly dry set of flues, then start either the right or left injector and watch the results caused by the change in temperature of the water around the flues. The engineer and fireman should carefully examine the firebox sheets and flues as soon as they take charge of the locomotive, reporting any leaks or defects to the round house foreman.

If the flues are all open, in good condition and there is no mud on the flue sheet, there is absolutely no reason for a failure due to flues leaking, yet there are cases where tonnage is reduced or trains set out, and on making an inspection of the flues they are found to be in good condition, but loose in the sheet, which is sufficient evidence of the improper use of the injector.

After the cause and effect of the inequalities of temperature in the boiler are thoroughly understood by the engine men and hostlers, it should not be difficult for them to fully appreciate the damage done to the flues and firebox sheets by the injection of water at a temperature of about 200 degrees lower than the water in the boiler. It is a common practice to fill the boiler at the terminal while the blower is on and the fire door standing open, in order to eliminate the black smoke. Whenever it becomes necessary to fill the boilers while standing at stations or on sidings, a bright fire should be maintained, using the blower and applying fresh coal if necessary. The fire door should be closed while the injector is working. It is not desirable to put a large amount of water in the boiler at one time, unless it is necessary in order to protect the crown sheet. Enginemen should endeavor to leave their




Tools for Cleaning Large Superheater Tubes

locomotives at the cinder pit with a full boiler of water and a good fire, in order that the hostlers will not be required to fill the boiler just previous to blowing off. Care should be exercised by the hostlers in blowing off, and in no instance should the boiler be blown off when the fire is dirty. Too much water should not be blown out at one time; in no case should the water be reduced over one gage. Hostlers should see that there is plenty of water in the boiler to allow for re-firing before knocking the fire, as it is very poor policy to put water into the boiler while cleaning. Care should also be taken to see that the fire is clean and in good condition in locomotives that it is necessary to herd on account of short lay-over or shortage of roundhouse room.

The successful maintenance of the locomotive boiler in service is summed up in just one word, "co-operation"—first, by the foreman and mechanics turning out a perfectly tight boiler from the locomotive works or the company shop; second, the careful inspection and work of the roundhouse organization in keeping the boiler tight and free from mud and scale; third, in the careful handling by the enginemen. The best care and workmanship will be of no avail, however, if the boiler does not receive intelligent treatment while in service. If at all possible to allow time, no limit should be placed on the washing out period required.

# Correct Application of Water Level Indicators in Locomotive Boilers[*]

BY A. G. PACK[†]

To further determine the approximate outline and proportions of the water conditions existing at the back boiler head, while the locomotive is being operated with heavy throttle, or when steam is being rapidly generated and simultaneously escaping from the boiler, tests were made with appliances shown by Fig. 6, covering a distance of 808 miles, in bad water districts, on approximately level track and while handling regular tonnage.

The locomotive on which these tests were made was of

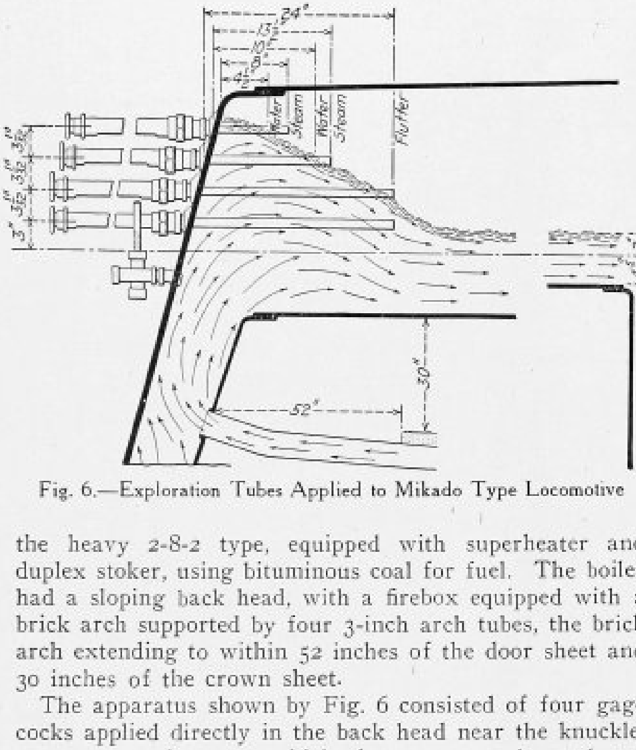



Fig. 6.—Exploration Tubes Applied to Mikado Type Locomotive

the heavy 2-8-2 type, equipped with superheater and duplex stoker, using bituminous coal for fuel. The boiler had a sloping back head, with a firebox equipped with a brick arch supported by four 3-inch arch tubes, the brick arch extending to within 52 inches of the door sheet and 30 inches of the crown sheet.

The apparatus shown by Fig. 6 consisted of four gage cocks applied directly in the back head near the knuckle, one water column to which three gage cocks and one water glass were attached, one water glass with a 9-inch reading, standard application, with both top and bottom cocks entering the boiler back head direct, one water glass applied for experimental purposes with the bottom cock entering the boiler head direct and with one top connection entering the boiler head on the back knuckle and one entering 13 inches ahead of the back knuckle, and four exploration tubes or sliding gage cocks.

These exploration tubes or sliding gage cocks entering the back head parallel to the horizontal axis of the boiler through suitable stuffing boxes, with a vertical pitch of 3½ inches, giving a total vertical reading of 10½ inches, with a horizontal adjustment of 24 inches. Graduations were marked on these tubes so that accurate readings could be taken and recorded. The lowest one of these tubes entered the boiler head on a level with No. 2 gage cock. The lowest reading of all water glasses and gage cocks was 4⅝ inches above the highest point of the crown sheet.

It will be noted from this figure that while tube No. 1 was submerged, tube No. 2 showed a flutter of steam and water at an adjustment of 24 inches; tube No. 3 showed water at an adjustment of 10 inches and steam at 13½ inches; tube No. 4 showed water at an adjustment of 4½ inches and steam at 8 inches. These readings were taken while the experimental water glass and water glass attached to the water column registered 2 inches of water, and the gage cocks attached to the water column showed one gage, while the four gage cocks applied in the back head registered full.

The water in the territory where these tests were made is very light and foams badly when compound is not used. About 110 readings were taken with these tubes or sliding gage cocks and other appurtenances used to register the water level. It is impossible to outline this flow of water accurately, as it changes with the operating conditions and the condition of the water in the boiler, but it is believed that this serves to illustrate the general condition which prevails to a greater or less extent in all locomotive boilers, especially those equipped with brick arch and arch tubes, while the locomotive is working heavy throttle or steam is rapidly escaping from the boiler.

It was found that approximately the same conditions were disclosed as those developed in other tests, except that the outline of water reached a higher elevation and greater proportions at the back head than those illustrated by Fig. 5, which is, no doubt, due to the extremely good water used for locomotive purposes in the district where the previous tests were made.

The readings of the water column and experimental water glass, shown by Fig. 6, could not be varied when changing from one connection to the other, as was the case in other tests, which we believe was due to the increased steam space in the back end of this boiler; and

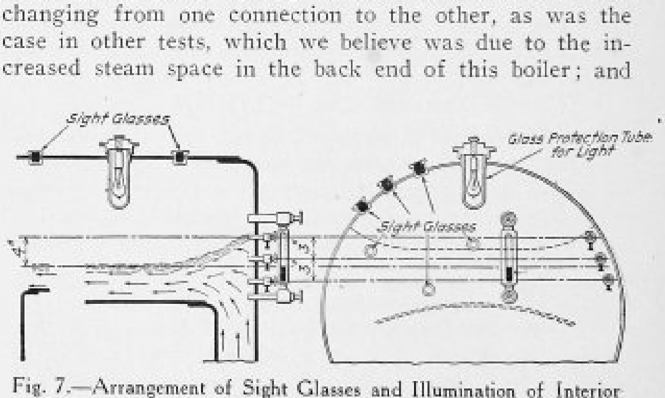



Fig. 7.—Arrangement of Sight Glasses and Illumination of Interior of Boiler

while the roll of water up the back head reached at times an approximate height of 12 to 13 inches above the general water level in the boiler, it did not apparently reach the top connection to these appliances in the back head knuckle.

### Effect of Foaming

When foaming very badly, there was slight agitation in the experimental glass when connected in the back knuckle, and occasional bubbles in the glass, but not sufficient to attract serious attention. This agitation was entirely absent when the top connection was made ahead of the back knuckle. With 1 inch of water, or less, the water in the standard glass registered practically the same height

* Continued from September Boiler Maker.

† Chief of Bureau of Locomotive Inspection, Interstate Commerce Commission.

as the other two glasses. With 2 to 2½ inches of water in the glass, when water was foaming, the water in the standard glass rose 2 to 3 inches higher, and there was much agitation and many bubbles in it, while the column glass and the experimental glass connected ahead showed no agitation whatever. With 3 inches or more of water in the standard glass and the water foaming badly, the standard glass would fill, and it was impossible to tell the actual height of water in the boiler by that device, without closing the throttle, while the experimental glass and the glass attached to the column continued to register 3 or more inches of water, and the top gage cock, attached to the column, would indicate dry steam when opened in the usual way, and the four gage cocks applied directly in the boiler would register full water.

### OBSERVATIONS MADE WITH LIGHT IN BOILER

Tests were made on a comparatively small locomotive, used in switching service, equipped with a wagon-top, radial-stayed boiler, having a narrow OG firebox and vertical back head, the diameter of the largest course being 59 inches. The special feature which should be borne in mind is that no arch or arch tubes were used in this boiler and that the back head was vertical.

The water-indicating devices consisted of three gage cocks spaced 3 inches apart and applied directly in the right knuckle of the back boiler head, with a vertical reading of 6 inches, and one reflex water glass with a clear reading of 7 inches, and with top and bottom connections entering the boiler head direct on the vertical part 5 inches to the right of the centerline. The lowest reading of the gage cocks and water glass was 3 inches above the highest part of the crown sheet.

So that the action of the water could be observed, a glass tube was inserted in the top of the wrapper sheet, which permitted the use of an electric light inside the boiler, which clearly illuminated the steam space over the crown sheet. Five bull's-eye sight glasses were applied over the back end of crown sheet, two over the front of the crown sheet and three in the vertical back head, so that the action of the water in this part of the boiler could be seen while under steam pressure. The arrangement of these appliances is illustrated by Fig. 7.

Both main rods were disconnected, cross heads blocked at the end of the stroke and valve stems disconnected and so placed that steam was discharged through the exhaust nozzle and stack, creating a forced draft on the fire, representing as nearly operating conditions as possible.

### OBSERVATIONS

When the throttle was closed and no steam escaping from the boiler, the surface of the water was approximately level, with a distinct circulation noted from back to front and from the sides toward the center of the crown sheet. When the safety valves lifted, the water rose with a fountain effect, around the edges of the firebox, from 1 to 2 inches, and the circulation was materially increased.

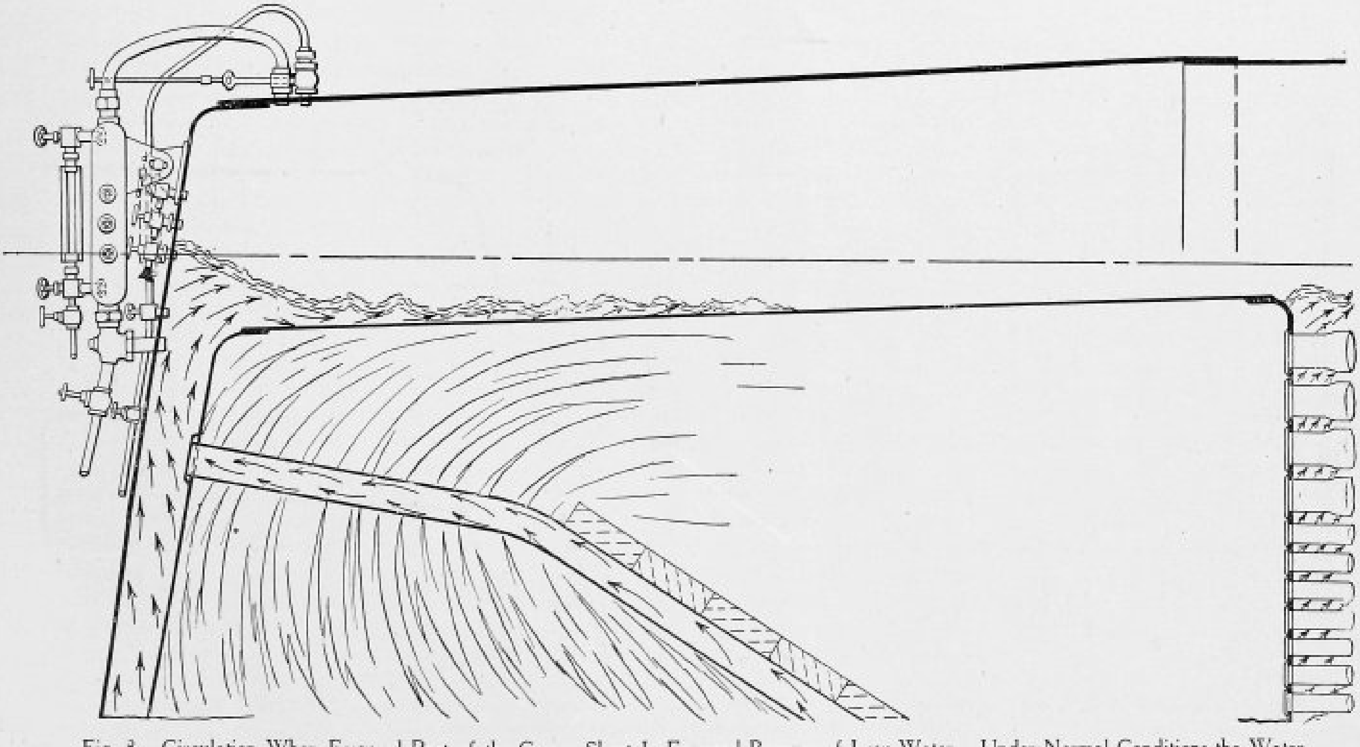


Fig. 8.—Circulation When Forward Part of the Crown Sheet Is Exposed Because of Low Water. Under Normal Conditions the Water Level Is Indicated by the Dotted Line

When the throttle was opened and steam was being generated and escaping from the boiler in greater volume, the level of water throughout the boiler was seen to rise 1 to 1½ inches, which rise was registered by the water glass, and a marked flow of water, with fountain effect, was observed rising around the firebox at the back head and wrapper sheets, reaching a height above that over the remaining portion of the crown sheet of approximately 2 to 4 inches, in proportion to the amount of steam being generated and simultaneously escaping from the boiler.

The important feature to be noted is that this height of water, as seen at the back head, was approximately 4 inches at its maximum, and was registered by the gage cocks, while at the same time it could be seen that the water glass was registering the level further ahead over the crown sheet.

Among the interesting features observed were the size of the steam bubbles, which were approximately ¼ to ⅜ inch in diameter, and the rapidity with which they were seen to rise to the surface and explode. The size and number of these steam bubbles, which were seen rapidly rising next to the back head, explain one of the physical reasons for the increased height of water around the crown sheet and the rapid circulation attained.

These observations establish beyond question that when steam is being generated and escaping there is an upward movement of water at the back head of the locomotive boiler which carries it above that further ahead over the crown sheet, and that the gage cocks, when applied directly in the boiler, register this rise of water and do not indicate the level further ahead, while the water glass registers the level of water further ahead and not the fountain of water at the back head.

Since a difference of 4 inches was observed between the height of water at the back head and that further ahead in this boiler, which had a vertical back head and an OG type firebox and was not equipped with a brick arch or arch tubes, there can be little question but that in the modern locomotive boiler, which has a sloping back head and is equipped with a brick arch and arch tubes, greatly accelerating the movement of water in this part of the boiler, due to the rapid circulation through the arch tubes and the deflection of heat against the door sheet and back end of crown sheet by the brick arch, this difference between the height of the water at the back head and further ahead over the crown sheet must be materially increased.

Fig. 8 illustrates the circulation of water in the boiler. The feed water which enters near the front end is much lower in temperature than that in the boiler, which, due to its density and weight, naturally lowers and moves toward the firebox sheets where the greatest evaporation takes place. As the water is heated it rises, due to its decreased weight, influenced by the steam bubbles rising to the surface where they explode. This circulation causes a movement of water from front to back in the lower portion of the boiler, and upward around the firebox, and from back to front in the upper portion. This circulation unquestionably takes place with sufficient rapidity to carry the water in the boiler around the firebox sheets above the general water level, due to the limited space in the water legs, where the greatest amount of heat is applied.

### Increase in Water Volume

It is recognized that the volume of water in the boiler increases in proportion to the amount of steam being generated and in the same ratio that the steam bubbles below the surface are formed and expanded, the volume of which depends to a very considerable extent upon the purity of the water in the boiler and its ability to readily release the steam being generated, consequently increasing the height of water in the same proportion, which height is registered by the water glass.

Since it has been established that gage cocks screwed directly in the boiler do not correctly indicate the general water level, the question arises as to what would be a proper appliance. After a careful investigation and tests, it is believed that Fig. 9 illustrates a water column that will afford the safest and most practicable method yet disclosed for accurately indicating the general water level in the boiler under all conditions of service.

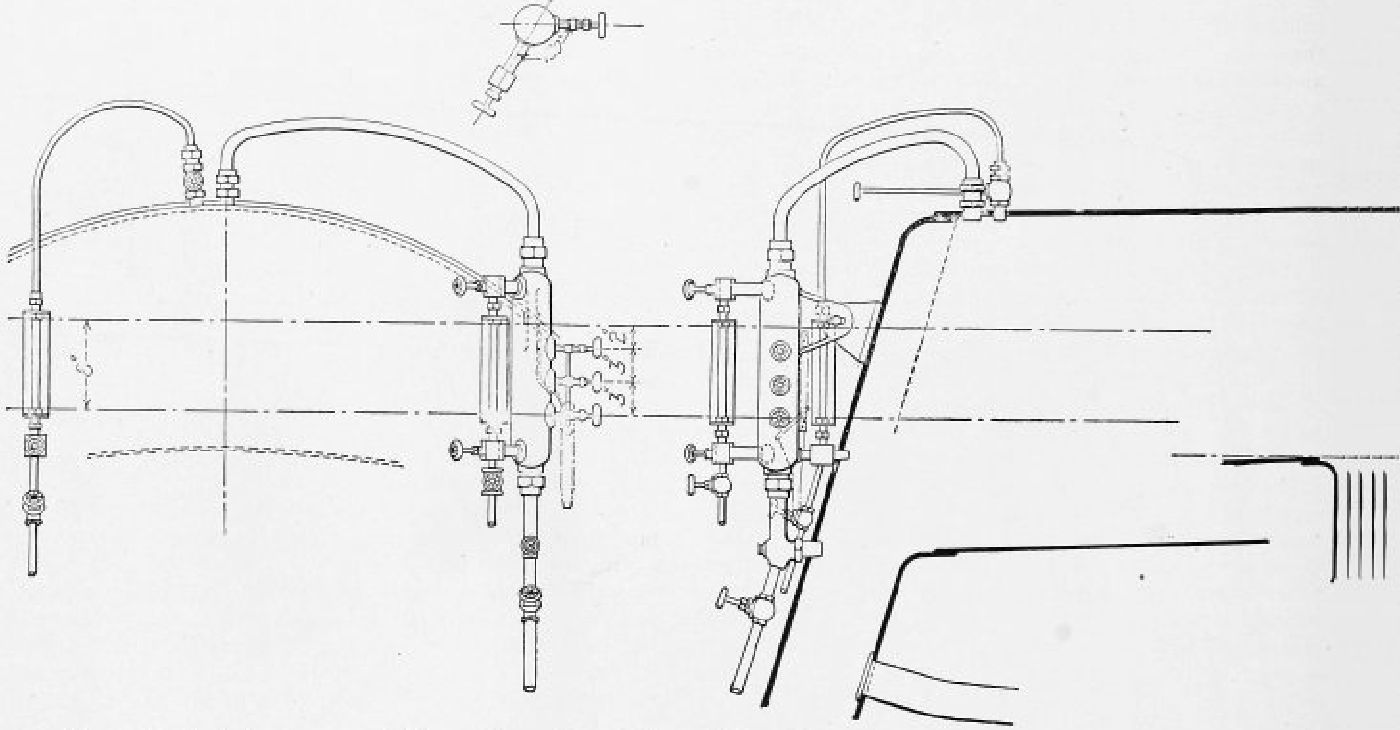


Fig. 9.—Standard Arrangement of Water Column, Gage Cocks and Gage Glasses as Adopted by the Mechanical Standards Committee of the United States Railroad Administration

This arrangement has been recommended by the locomotive inspection bureau and was adopted as recommended practice by the committee on standards of the United States Railroad Administration at its February, 1920, meeting. To this water column three gage cocks and one water glass are shown attached, one water glass applied in the usual manner on the left side of boiler head for the purpose of forming a double check of the height of water over the crown sheet and to broaden the view from different parts of the cab.

In constructing and applying the water column, the ratio of openings between the top and bottom connections, as indicated by Fig. 9 should be retained, and the bottom connection screwed into the boiler far enough to pass all obstructions which may be immediately above them. It was illustrated in the fifth series of tests that when the bottom connection to the column entered the boiler head one inch past flush, and directly under a "T" iron, it caused the water to rise one inch in the column glass, but when extended past the "T" iron, the readings in all glasses corresponded.

The larger connection to the top of the column, and restricted openings in the gage cocks, which should be not more than ¼ inch in diameter, are suggested for the purpose of preventing the water from being raised when the gage cock is opened wide, the object being to compensate for the lowering pressure in the column through the larger top connection, the area of the smallest opening of which should be not less than 1½-inch copper pipe, or preferably larger.

### Results of Recent Tests

Very recent tests indicate that to avoid the possibility of inaccurate readings due to raising the water in the column when the gage cocks are opened excessively wide, the inside diameter of the column may be made 3½ inches and that of the top connection 2 inches. Experiments with a column and steam pipe of these dimensions and the ¾-inch opening in the connection to the boiler at the bottom showed that the water in the column glass could not be raised by opening the gage cock to exceed ¼ inch, regardless of the amount or the length of time the gage cocks were open.

It is recommended that the bottom water glass cock and bottom connection to the water column enter the boiler horizontally, and that the water column and water glasses should stand vertical.

Steam pipe connections to water columns and water glasses should be made as short as possible, so as to obtain a supply of dry steam at all times, and so arranged as to thoroughly drain and be free from short bends or any possibility of sags or traps. It has been definitely established that where traps or sags that will retain the water of condensation are permitted in the top connection to water glasses or water columns, the reading of the water is materially affected, causing a higher level to be indicated.

It should be borne in mind that when water glasses are in proper condition to correctly register the water in the boiler, the water is never at rest while under pressure, and that when the water becomes slow or sluggish of movement or in agitation, it indicates an improper condition that should be immediately corrected. Such conditions are usually caused by restriction in the openings in the fixtures, sags or traps in the steam pipe connection, or the top connection made so as to allow water to enter, and sometimes by bottom connection being improperly located so as to cause steam bubbles to enter.

The water-indicating appliances are among the most important devices on the locomotive, from the viewpoint of safety as well as economy; therefore, every effort should be made to see that they are so constructed, applied and maintained as to properly perform their function under all conditions of service, and so that the enginemen operating the locomotive may have the widest and easiest possible view from their usual and proper positions in the cab.

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The total output of soft coal during the week of September 25 is estimated at 11,817,000 net tons, according to the weekly bulletin of the Geological Survey. This figure represents the largest production in any week since last January. The rate per working day was 1,969,000 tons. Production during the first 228 working days of this year has been 392,747,000 net tons, about 13½ million tons less than that for 1917.

## Mechanical Torch Cutting*

Boiler making requires much skilled hand work with percussive tools, and the hammer is one of the boiler maker's principal instruments of torture. The pneumatic hammer, therefore, is regarded as one of the greatest labor-saving devices ever introduced to the boiler shop, because it performs by power the same work done ordinarily by hand. But great a labor-saver as is the pneumatic hammer, it is not in a class comparable with the mechanically operated cutting torch when used for flange trimming operations. The pneumatic hammer does its work in the same manner as the hand tool, but the cutting torch burns or consumes the metal in its path and removes excess flange metal at a rate with which no pneumatic hammer can compete.

For instance, the head of a Scotch type marine boiler 15 feet diameter presents from 47 to 48 feet of irregular flange measuring 1 inch thick, more or less, which must be cut down to uniform height and calking angle. The only way for the operator with the pneumatic hammer to do the job is to chip off the excess metal. The greater the irregularity of flanging the more work to be done. Such a job may require two chipping experts to work about 16 hours each, or 32 man-hours labor to finish. The same job can be done with the mechanically operated cutting torch by one man in 45 minutes actual cutting time!

It makes no difference whether the flange is regular and a minimum amount of metal is to be removed or whether it is very irregular and a large amount of excess metal has to be cut away; the cutting time of the torch remains the same. What other tool introduced to the boiler shop has made so great a reduction in labor cost and time as this?

This torch is ably seconded by another type also for cutting, as a factor in modern boiler making. This machine used for trimming plates to straight and curved lines, for beveling edges and for cutting openings, is a productive prodigy. For instance, an egg-shaped opening having a periphery of 10 feet and curved sides generated by radii of three different lengths may be cut in ¾-inch plate in from 8 to 10 minutes. Jobs of this sort are everyday operations in shops building large marine boilers. No foreman boiler maker can afford to ignore the great saving made possible in labor cost by these mechanically operated cutting torches.

When this torch is used to cut arcs or circles on comparatively small plates it is necessary to provide a track plate. This may be simply a 12-gage steel plate, say 20 inches square, having the corners clipped and an opening 12 or 15 inches diameter cut in the center. The rim furnishes the track for circular cutting and the opening permits the torch to reach the plate that is to be cut beneath.

In general, the oxy-acetylene torch in a repair shop can be made useful for many purposes other than welding. It furnishes the means of instantly applying heat of any intensity precisely where wanted. If, for example, a short piece of copper tubing is to be annealed, the torch may be used effectively, or if a hardened steel piece requires local softening it saves fussing with a gas furnace. Local case hardening with cyanide may be done without overheating.

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According to the official figures shown in the Monthly Summary of Foreign Commerce of the United States, the exports of steam locomotives for this year are going to break all records. The exports in July, 1920, numbered 134 valued at $4,742,306 as compared with 17 valued at $322,775 in July, 1919. In the first seven months of 1920 locomotives valued at $32,549,343 were exported.

* From *Autogenous Welding*.

# How to Design and Lay Out a Boiler—XXV

## Designing the Columns in Boiler Suspension Systems —Details of Masonry and Fire Brick Construction

BY WILLIAM C. STROTT*

The average boiler shop is frequently called upon to design cast-iron columns which are generally used in supporting heavy pipe lines and tanks. The proposed formula of the New York building laws covering cast-iron columns gives very satisfactory results and is here presented:

$$S_c = 9{,}000 - 40 \frac{l}{r},$$

(Note.—Maximum value allowed for $l/r$ in this formula is 70.)

in which the terms $S_c$, $l$ and $r$ have the same significance as in the American Bridge Company formula for steel columns.

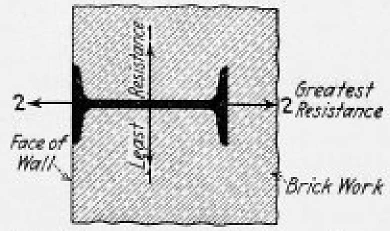



Fig. 101.—Column Bonded Into Masonry

### General Instructions Relating to the Design of Boiler Suspension Systems

The values employed by the author in determining the size of the column sections for this boiler may be regarded by many boiler manufacturers as too high—very much too high. In fact, it will be found that the majority of installations of boilers of this size (72 × 18 × 150 pounds) do not have supporting columns exceeding 9 inches or 10 inches in depth. Considering the gross cross-sectional area of 9-inch "I" beams at 21 pounds per foot, which is 6.31 square inches, it is true that for an allowable axial load of 4,450 pounds per square inch determined by the American Bridge Company formula for one particular ratio $\frac{l}{r}$, the total allowable compressive stress on such a column would be (6.31 × 4,450 pounds), or 28,000 pounds. Although the value is almost three times the actual load on the column, the least radius of gyration of the 9-inch "I" beam section is only 0.9 inch, whence the ratio of slenderness would be $\frac{132}{0.9}$, or 145.5. It follows that this value would not be permitted under any building code specifications with relation to main supporting members, but, unhappily, steam boilers are not erected in accordance with the building codes governing the locality in which they are installed. This does not refer to large and important installations where the entire construction program is placed in the hands of competent engineers, but rather to the thousands of small isolated power plants where the question usually is not how well can the plant be built, but for how little expense.

Such flimsy "gallows-frames" cannot be erected as a unit from which the boiler may be directly suspended before the brick walls are commenced. The supporting columns being merely set on cast-iron base plates with no anchorage to the foundation whatever must be prevented from toppling over by means of wood lean-to's braced against the ground or adjacent building walls, etc. The boilers themselves must be jacked into place and wooden cribbing placed beneath them until the boiler walls have been bricked up to their full height. By bonding the columns into the masonry as shown in Fig. 101, the brick walls of course naturally form an efficient bracing to the columns in the direction of their least resistance, which, as we know, is at right angles to axis 2-2.

Figured on this assumption, that the boiler walls form a support against lateral deflection of the columns, it is a positive fact that even the smallest standard "I" beam manufactured would more than safely carry the total actual load on the column.

Proof:

Beam section = 3-inch "I" at 5.5 pounds per foot.
Greatest radius of gyration (axis 1 — 1) = 1.23.
Height of column = 132 inches.
Ratio of slenderness = 108 (approximately).
Area of section = 1.63 square inches.

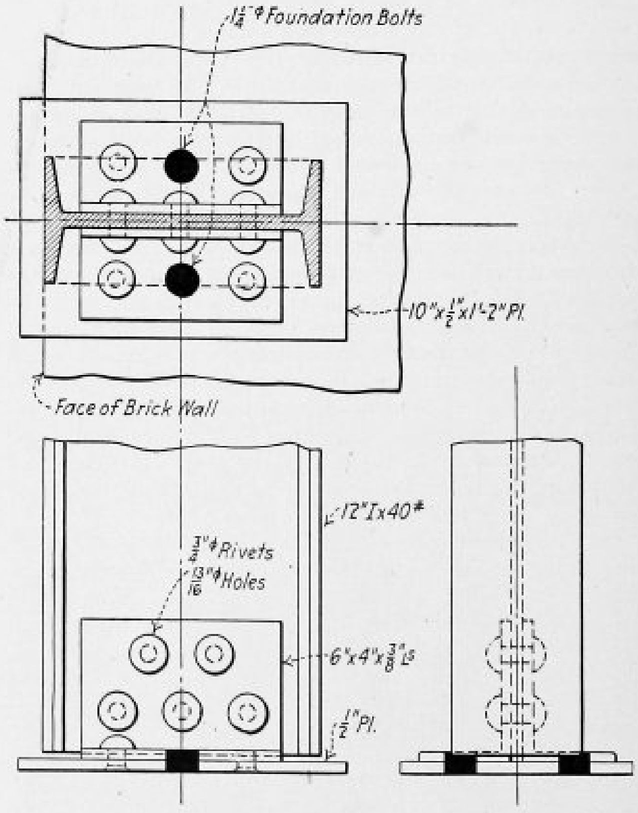



Fig. 102.—Column Anchorage

By American Bridge Company formula for steel columns:

$$S_c = 19{,}000 - \left(100 \times \frac{l}{r}\right),$$

* Engineering Department of The Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

whence the allowable unit compressive stress on the column is found to be:

$S_c = 19{,}000 - (100 \times 108)$, or 8,200 pounds per square inch.

Then the total allowable load on the column would be:

$$1.63 \times 8{,}200 \text{ pounds} = 13{,}350 \text{ pounds.}$$

It is hoped that the reader will grasp the point which the author is attempting to drive home, for although no

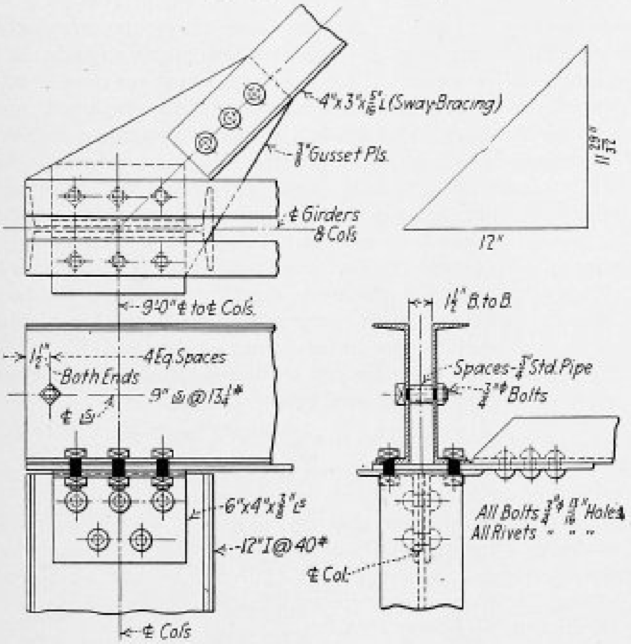



Fig. 103.—Construction at Upper End of Columns

boiler builder would attempt to use 3-inch "I" beam columns for this purpose, they would serve the purpose just as well as 9-inch "I" beams, for the reason that since the latter gives too high a value for $\frac{l}{r}$, they cannot stand without support from the side walls of the setting. Such a suspension is worse than none at all, because it defeats the very purpose for which it is intended, viz., to support the boiler independent of the brick-work entirely. If it does not meet that requirement it actually stands as a menace to those who at some future time may be called upon to remove a large part of the setting for alterations or repairs. It would be very likely, then, that the workmen might remove that portion of the masonry around the columns, believing the steel work fully efficient, with the result that the system would overturn with fatal results.

### DESIGN OF COLUMN BASE

The bases of all columns should be designed similarly to that illustrated in Fig. 102 and anchored to the foundation as shown.

It should be noticed that the bottoms of the columns do not bear directly on the base plates. For very important and heavy construction, as in the case of main building columns subjected to heavy loads, the bottoms are accurately milled to give a true bearing on the plates. This practice reduces the shear in the rivets at the connecting angles to a minimum and permits of a lighter base plate. But for ordinary work the expense of milling the ends of the columns is dispensed with and the base so designed that the rivets transmit the full load to the base plate. On pages 244 and 245 of "Carnegie" will be found tables giving the shearing and bearing value of rivets for varying thicknesses of plate and rivet diameter.

The base plate should have sufficient bearing surface so that the pressure on the foundation does not exceed 250 pounds per square inch. For our case the required area of base plate will be:

$$\frac{10{,}000}{250} = 40 \text{ square inches.}$$

The actual size of the base is usually fixed by the depth of the column and spread of the toe angles. Note that the base plate shown in Fig. 102 would be good for a total bearing pressure of:

$$10 \times 14 \times 250 = 35{,}000 \text{ pounds,}$$

which value is more than ample for the actual load imposed.

### DESIGN AT TOP OF COLUMNS

At their upper end, where the columns connect with the cross-beams or girders, a similar connection is used, since the load at each point is, of course, the same. To prevent the vertical columns from swaying, due to any lateral movement of the boiler or in case the latter should be hung slightly to one side, diagonal or "sway bracing," as it is termed, should be provided. Fig. 103 illustrates an excellent method of designing the connections at the top of the columns, and Fig. 104 illustrates diagrammatically how the sway bracing is connected between columns.

When designing such a system it should be made certain that the diagonals will not foul pipe connections in the top of the boiler shell, particularly the main steam and safety valve nozzles. A boiler suspension system, when designed in accordance with ideas set forth in the last three illustrations, will form an independent steel structure requiring no support from any external source whatsoever. The framework is erected complete on the foundation, after which the boiler or boilers are placed in position under the girders. They are then raised to their proper elevation by any means that may be available, viz., screw-jacks or by a hoisting engine. The suspension bolts

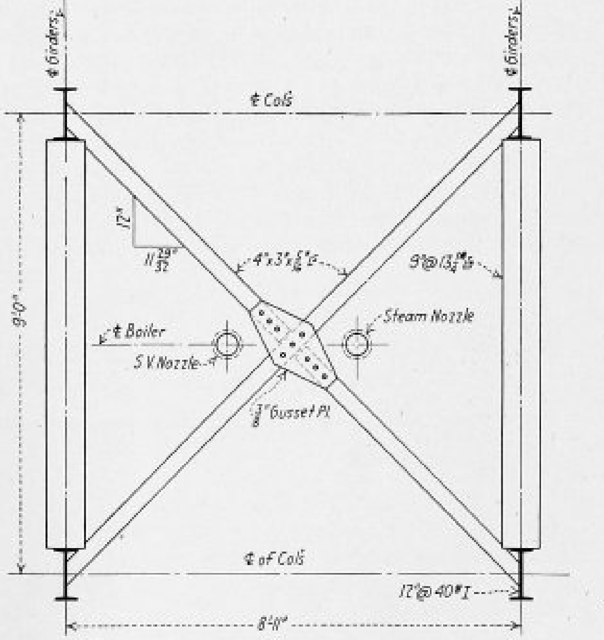



Fig. 104.—Erection Diagram of Steel Work of Boiler Suspension System for 72-Inch by 18-Foot Horizontal Return Tubular Boilers

are next inserted, after which the temporary support to the boilers is removed and the latter allowed to hang in their final position from the steel work.

The back setting may then be commenced and carried to completion without hindrance from any cribbing or external support, such as is ordinarily employed to carry the boiler and brace the steel work until the side walls are erected.

### Thickness of Brick Walls

The thickness of the side walls for a horizontal return tubular boiler setting should never be less than 17 inches at any point. The center walls, which separate the furnace of a battery of two or more boilers, usually have a minimum thickness of 22 inches.

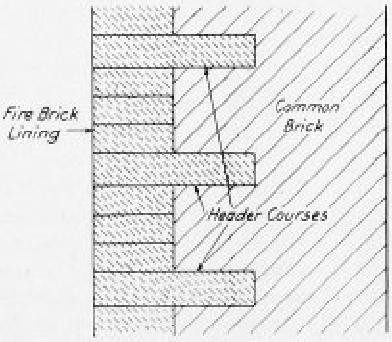



Fig. 105.—Header Courses in Furnace Lining

### Fire-Brick Lining

In the furnace proper, commencing at least 6 inches below the grate-line, and extending as far up as the center line of the boiler shell, a firebrick lining 4½ inches thick is provided. This lining is to be first quality fire-brick and must be carried to a point not less than 12 inches beyond the rear face of the bridge wall. The balance of the setting is of course lined in the same way, but may be of second quality fire-brick because the gas temperature beyond the furnace is considerably reduced, and the brick lining is consequently not subjected to as severe a destructive action as is the furnace proper.

### "Laying Up" the Fire-Brick

Unlike common clay brick, fire-brick is not "layed-up" with cemented joints for the reason that Portland Cement mortar cannot withstand the high temperatures present in the furnace. Even a bonding mixture made of fire-clay is not successful because it has little, if any, adhesive properties. The only recourse is to thoroughly bond the fire-brick lining into the outer, or common brick wall. This is accomplished by making every fourth course of fire-brick a "header," which simply consists in laying the bricks lengthwise with relation to the thickness of the wall as clearly shown in the illustration, Fig. 105. It is clearly evident that these header courses also serve as ledges or "shelves" upon which the upper course of brick

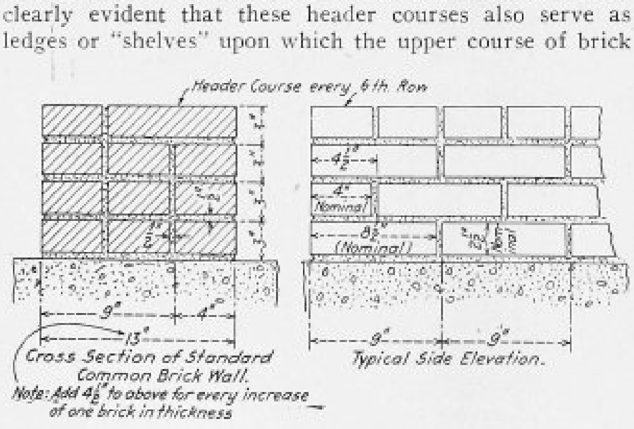



Fig. 106.—Brick Masonry Construction

rests. These ledges are of course effective as supports for the brick-work above whenever it is necessary to tear out portions of a fire-brick lining, in the case of alterations or repairs to the furnace or setting.

So as to make the fire-bricks fit snugly against each other, and to close up any pores or openings between the faces of adjacent bricks, they are dipped in a thin fire-clay mixture almost of the consistency of water and each brick is carefully "rubbed" into place, to remove any excess mixture.

It should be quite plain, that for the reason no efficient "mortar" can be had for laying fire-brick, the idea is necessarily to build up the fire-brick lining as compactly as possible and also to secure a firm anchorage in the outer wall by means of the header courses previously referred to. Were fire-brick mortar to be employed for making the joints in a fire-brick wall in a manner similar to ordinary brick masonry construction it would result in a joint from ⅜ to ½ inch thick. Since the joints contain a large proportion of water it is quite evident that as soon as the water has been evaporated the joints would finally consist of nothing but dry fire-clay—literally of no more effectiveness than so much dry sand. After the brick had been subjected to a high temperature for a comparatively short time, the fire-clay in the joints would burn out, with the result that the fire-brick lining would settle and eventually drop out altogether.

### Laying Up the Common Brick

Because standard red brick is 8½ inches long, 4 inches wide and 2½ inches thick it is the mistaken idea of a great many draftsmen that the thickness of a brick-wall is alway an exact multiple of the number of bricks the wall is thick. Then again we find drawings of boiler settings wherein the brick walls are specified as 12, 15, 18, etc., in thickness.

It is hoped that the following illustration, Fig. 106, will serve to clear up this matter for those boiler draftsmen who are not familiar with brick masonry construction. In connection with the accompanying illustrations, it should be noted that the dimensions, both vertically and horizontally, are given from edge to edge of adjacent bricks and include one joint. It may readily be seen how the usual variations in the dimensions of the brick may be compensated for in making the joints. All that the mason needs to do when laying-up successive courses is to see that the upper surface of the top brick is exactly the specified amount from the top of the brick beneath it. The same process is of course carried out when measuring both the thickness and also the length of a brick wall.

*(To be continued.)*

## Lubrication of Pneumatic Tools*

The name pneumatic tools applies to that class of portable, self-contained motor tools operated by compressed air. Pneumatic tools are sturdy little machines and will stand a lot of abuse. It is well that they will, however, for it is doubtful if any machines are handled more carelessly or roughly than these. The lack of proper attention, no doubt, is largely due to the fact that the rugged exterior appearance conveys a false impression of the intricate mechanism beneath. A study of the accompanying illustrations will reveal that pneumatic tools contain a number of more or less delicate parts.

### Necessity for Proper Care

In order to obtain a full measure of service from pneumatic tools and eliminate the necessity for repairs, it is of paramount importance that they be handled carefully and also kept clean and well lubricated with a high-grade lubricant. The working parts of pneumatic tools are accurately and closely fitted. If their lubrication is neg-

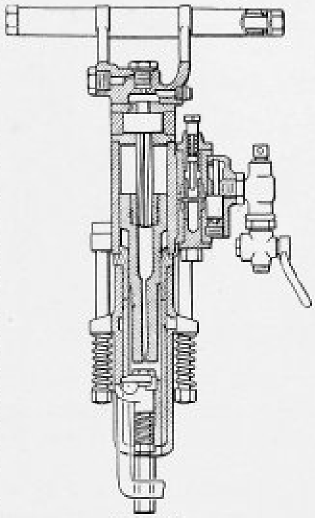
* Reprint from *Lubrication*.

lected these fine pieces of machinery wear rapidly and in a short time refuse to work.

There are a number of factors which make the lubrication of pneumatic tools difficult. The air passing through the tools expands and absorbs heat from its surroundings. Unless the air is preheated or the tool is operating in a very warm atmosphere, the expansion temperature may run very low. There is always a tendency for lubricants to congeal in the presence of cold, and unless they are manufactured for low-temperature conditions they may become sticky or stringy and greatly impede the operation of the machine.

### Prevention of Leakage

In addition to the moisture carried into pneumatic tools by the air, some tools, notably water drills, are exposed to water leakage. As a result, conditions in the cylinders are somewhat similar to those met with in the cylinders of pumps.

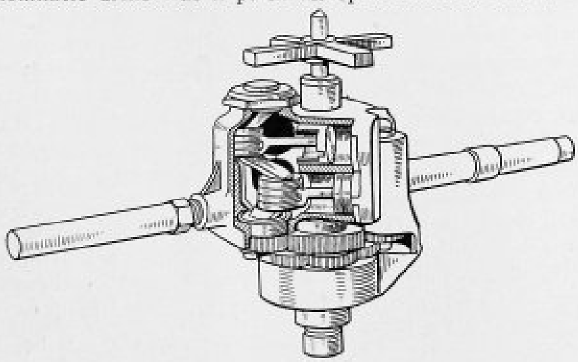


Jack Hammer

There is bound to be some little dust contained in the air carried into the cylinders of pneumatic tools. Further, the moisture in the air tends to corrode the transmission pipes and storage tanks, with the result that some small particles of rust are carried along by the air. Particles of rubber from the air hose and gaskets may find their way with the other foreign matter into the air passages and cylinders and greatly interfere with the free operation of the tool. Dust, rust or rubber cannot be classed as lubricants and should be kept out of the tool by means of a fine wire strainer inserted in the inlet pipe.

### Impurities in Lubricants

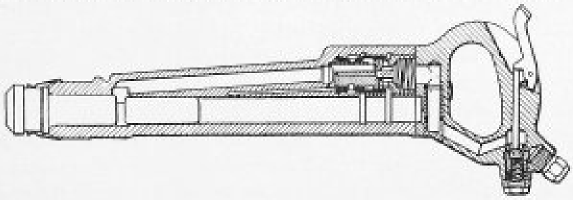
Not all foreign matter which gets into the cylinders and valves of pneumatic tools is carried in with the air. Unless care is exercised, a great deal may be fed in with the lubricant. We have known cases where the lubricant for pneumatic drills was kept in an open can near the drills.



Rotary Drill

A great deal of dust and grit naturally fell into the can, with the result that the drills were being "lubricated" with an abrasive compound.

In selecting lubricants for pneumatic tools, judgment should always be used, as there are some tools, or portions of them, that require a light oil, while others work most successfully with grease. The lubricant most suitable for any particular pneumatic tool will vary with the type of tool, the nature of the work, the condition of the air and the state of the atmosphere. Generally speaking, the heavier tools require the heaviest lubricants, slow-



Riveting Hammer

moving tools requiring a heavier lubricant than those operating at high speed. Heavy lubricants are necessary for use on tools using preheated air or those exposed to high temperatures.

### Lubricating High Speed Tools

Tools of the trunk-piston and rotary types are commonly lubricated with a light grease, while the high speed, hammer types, such as riveting hammers, under average conditions of operation, are most successfully lubricated with a light oil of about 100-150 seconds viscosity Saybolt at 100 degrees F. Tools such as reciprocating drills are provided with grease chambers, which are filled by means of a grease gun and from which the grease slowly exudes into the cylinders. One charge of grease, if suitable, should last several weeks. The gears, crankshafts and pistons of rotary tools all operate in a bath of grease, new applications of which are necessary only after long periods of time. The high speed tools are lubricated with oil by means of a squirt can. As there is a tendency on the part of the exhausting air to carry a light oil out with it, tools of this kind should receive a few drops of oil every hour or so.

Oils used upon pneumatic tools should have a low cold test, and greases to be successful must be manufactured from low cold test oils. In addition, pneumatic tool lubricants should possess enough body to prevent metal contact and friction, but if they are too heavy for the mechanical conditions they tend to impede the action of the tools.

The operating efficiency of pneumatic tools will be greatly enhanced if they are frequently cleaned. The smaller tools may be cleaned by submerging them in a bath of benzine or gasoline for a few hours and then blowing them out under pressure. This dislodges any accumulations which may have built up in the tool. After a tool has been cleaned, the working parts always should be lubricated thoroughly with the proper lubricant before the tool is put to work again.

Such small quantities of lubricants are used in pneumatic tools, and the shut-downs and depreciation resulting from the use of an unsuitable lubricant may cause such a large loss of money that a small difference of price between the best lubricant and a poor one should never be considered in purchasing an air tool lubricant.

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Four hundred members of the American Society of Mechanical Engineers have organized themselves into a professional section on materials handling which will provide primarily a common channel of intercourse between all the technical and industrial organizations connected with the handling and distribution of materials and products. This section will aim to be a bureau of information by having special meetings on particular subjects, meetings jointly with other sections, other organizations or associations, and by taking part in all local and national problems relating to the purpose of this section.

# Scarfing Machine Adapted to Boiler and Railroad Work

A machine designed during the war in England for scarfing plates for all manner of structural work has been introduced into this country by Alfred Herbert, Limited, of New York. It was originally intended for work in the shipyards for machining scarfs on ship plates, stern and stem post scarfs, angles and rudder posts, engine beds in position and also roller paths. In machine shops it has been used for machining keyways of large diameters in shafts of all descriptions such as propeller shaft keyways up to 3 feet 6 inches in length and also for watertight door facings. In the boiler shop it is now being used for machining scarfs on the end plates of marine boilers, for machining bridges and also, by using a former, for machining the strap joints. There are many other applications

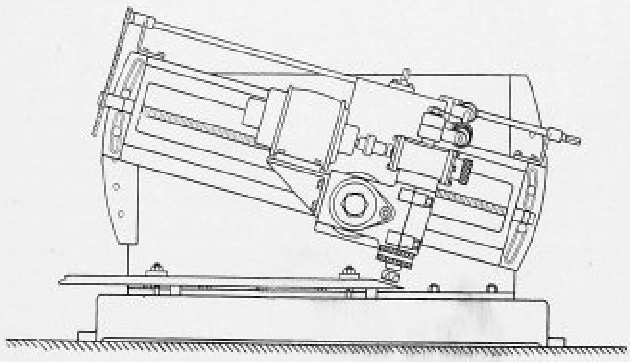

Fig. 1.—Front View of Scarfing Machine with Bevel Fixed for Operation on Flat Plate

in this connection to which the machine may be put. Its uses in the railroad shop might also be mentioned, where as a portable tool for machining the guides for axle boxes and locomotives and steel truck frames it is quite useful.

### Description of Machine

The base of this machine is arranged to form a bed 64 inches long and 47 inches wide, which has T slots for bolting work to. On this face is mounted a back member 31 inches high which has two faces both machined and arranged with a center spigot on which a slide revolves; provision being made for bolt'ng the ma'n slide rest carrying the milling head. This slide rest can be bolted either to the back or front so that if the work is too large to go underneath the m'lling head when in its normal

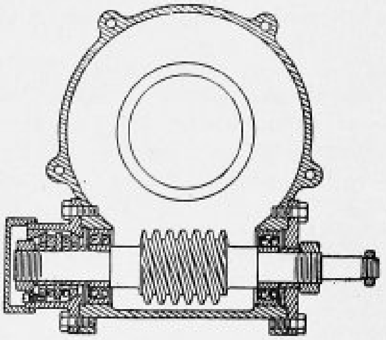

Fig. 3.—Section Plan of Wormbox

position the milling head and slide rest may be placed on the back so that larger work can be machined. This slide rest is rotatable from the center, 14 degrees up or down and graduated so that it can be swivelled to any angle that may be required or it may be worked at zero.

On the main slide is fitted a heavy cross slide which has a longitudinal movement of 42 inches and so fitted that the milling head can be bolted in a low or a high position. The vertical movement is 12 inches. When in

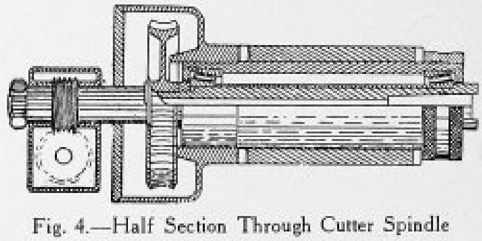

Fig. 4.—Half Section Through Cutter Spindle

a low position a piece of work can be machined down on the bed and when in a high position shafts up to 23 inches diameter can be put underneath the cutter. If, however,

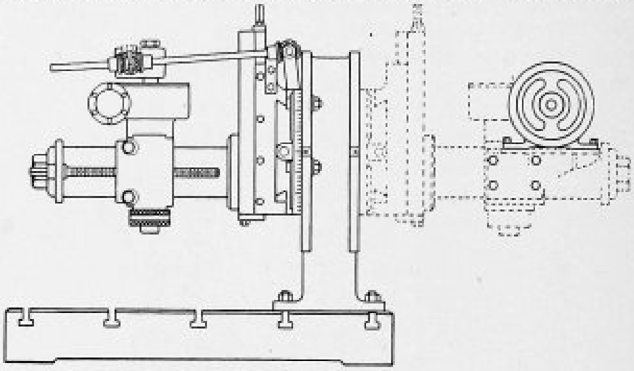

Fig. 2.—Side View of Machine Showing Adaptation of Slide Rest to Either Side or Back

it is required to have a higher movement than this, packing slips may be placed under the back member.

### Milling Attachment

On the compound slide rest is fitted a Barnes No. 5 milling attachment which has a column 6 inches in diameter and 20 inches long, which gives a 12 inch movement. On this is mounted a slide bracket moved up and down by a central screw which carries on one side a milling quill with a worm drive and on the other side a bracket for a 2-horsepower motor. This motor is preferably arranged to run at 1,700 revolutions per m'nute, the reduction of the worm being 16 to 1.

The worm is of hardened steel fitted on one side with Skefko radial bearings, on the other side with double thrust Skefko bearings as shown in Fig. 3. The worm is of bronze and both worm and worm wheel are packed with grease. The whole of the worm box and quill, carrying the milling cutter, can be reversed, and so instead of working on the right hand side can be used on the left. The motor is arranged accordingly.

On the main shaft of the milling spindle is arranged a worm box which gives a drive through a nest of bevels to the shaft, and back to an automatic feed on the slide rest. By means of a clutch arrangement this can be made to travel either way.

### Automatic Feed Mechanism

The automatic feed is arranged to come between the top of the slide rest and the back, and can be swung to full angle without catching the slide or bracket, and can be used independently of either the base or back, if required, thus enabling the milling head and slide to be used as a portable machine.

*(Continued on page 307.)*

# A Limiting Formula for Long Through Stays

**Discussion of Method of Determining the Proper Sizes of Through Stays in Boilers—Chart Developed to Simplify Calculations**

BY JOHN S. WATTS

A danger point not generally appreciated in calculating the strength of long through stays in boilers is the additional stress induced in the body of the stay by reason of its own weight.

The writer knows of a case of a portable locomotive type boiler in which the combined stress, due to the steam pressure, and the weight of the stays was so great that they elongated under the load, so much so that when the boiler was being moved to a new location these stays were so loose they rattled.

To show how great this strain may be, we will take an example and work out the total combined stress on the through stays in a boiler 20 feet long and carrying 100 pounds pressure with 9/16-inch heads.

### Assumptions Necessary in Calculations

At 8,000 pounds stress a 1⅝-inch diameter stay with a pitch of 12⅞ inches is required.

Assuming the stay as a beam supported at both ends and loaded with its own weight, we have the formula:

$$W = \frac{8 \times f \times z}{l},$$

in which:

$W$ = load = weight of stay = in this case 140 pounds.
$f$ = stress in pounds per square inch.

$$z = \text{modulus of section} = \frac{\pi}{32} d^3 = 0.0982 \times 1\tfrac{5}{8}^3.$$

$l$ = length in inches between supports = 240 inches.

I am taking the formula for beams supported at each end, and not for beams fixed, as, although the stays may be said to be fixed at the ends, it is doubtful if the thickness of the plates in the heads is sufficient to make the support absolutely rigid, as it must be if we are to take 12 as the constant in the above formula instead of 8.

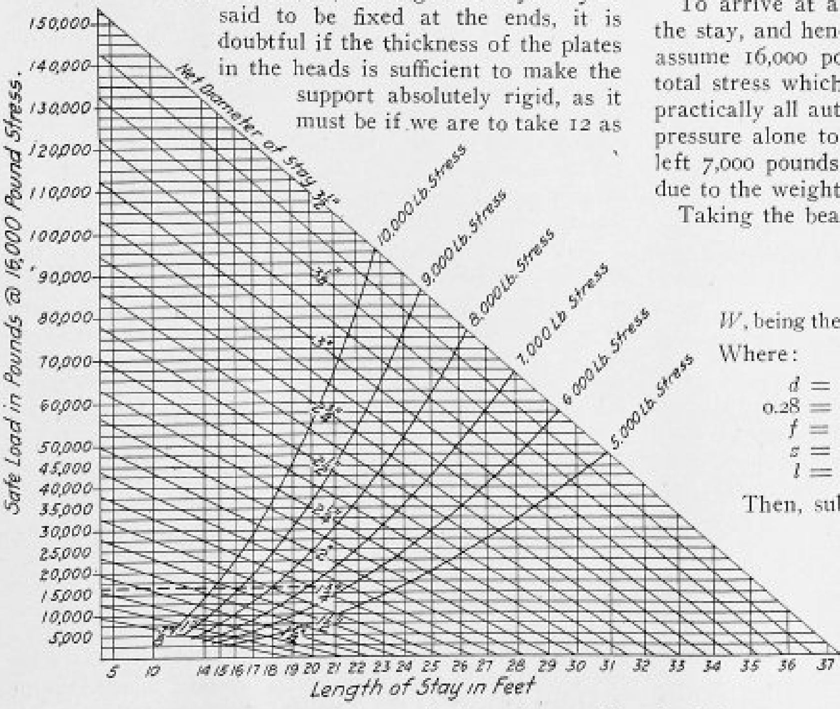


Diagram Showing Relation Between Load on Stays and Length of Stays

Working out the values to determine the stress, we have:

$$W = \frac{8 \times f \times z}{l}.$$

Therefore:

$$f = \frac{W \times l}{8 \times z}$$

$$= \frac{240 \times 140}{8 \times 0.4213}$$

$$= 10{,}000 \text{ pounds per square inch.}$$

This 10,000 pounds stress added to the 8,000 pounds stress per square inch, due to the steam pressure on the head, makes a total combined stress of 18,000 pounds per square inch, which is too high and will in a short period of time cause permanent deformation.

### Stress Partially Carried by Plate

It may be contended that at least a part of the stress due to the steam pressure is taken by the plate, but actual experiment shows that an unstayed plate deflects as soon as the least pressure is put upon it. This is confirmed by an account of an experiment in Kent's Pocketbook, where it is noted that a head 26¼ inches in diameter and ⅜ inch thick deflected 1/32 inch under a pressure of only 10 pounds per square inch.

It is safe to say that the stays being fitted so as not to allow any deflection in the plate must of necessity carry the full load.

To arrive at a formula which will limit the length of the stay, and hence the total stress to a safe figure, let us assume 16,000 pounds per square inch as the maximum total stress which should be allowed on the stay; and, as practically all authorities limit the stress due to the steam pressure alone to 9,000 pounds per square inch, we have left 7,000 pounds per square inch to withstand the stress due to the weight of the stay.

Taking the beam formula:

$$W = \frac{8 \times f \times z}{l}.$$

$W$, being the weight of the stay, $= d^2 \times 0.7854 \times l \times 0.28$.

Where:

$d$ = diameter of stay in inches.
$0.28$ = weight of steel per cubic inch.
$f$ = 7,000 as determined above.
$z$ = for circular sections = $0.0982 \times d^3$.
$l$ = length in inches.

Then, substituting, we have:

$$d^2 \times 0.7854 \times 0.28 \times l = \frac{8 \times 7{,}000 \times 0.0982 \times d^3}{l}.$$

Therefore:

$$d^2 \times 0.7854 \times 0.28 \times l^2 = 8 \times 7{,}000 \times 0.0982 \times d^3.$$

Therefore:

$$0.7854 \times 0.28 \times l^2 = 8 \times 7{,}000 \times 0.0982 \times d.$$

### Resulting Computations for Length of Stays

Therefore:

$$l^2 = \frac{8 \times 7{,}000 \times 0.0982 \times d}{0.7854 \times 0.28}$$
$$= 25{,}000 \times d.$$

Therefore:

$$l = \sqrt{25{,}000 \times d.}$$
$$= 158 \times \sqrt{d.}$$

That is, the maximum length of the stay in the example used above should be:

$$158 \times \sqrt{d} = 158 \times \sqrt{1\tfrac{5}{8}} = 201 \text{ inches} = 16 \text{ feet } 9 \text{ inches.}$$

Or, the length having to be 20 feet 0 inches, the diameter should be increased to:

$$d = \frac{l^2}{25{,}000}$$
$$= \frac{240^2}{25{,}000}$$
$$= 2.3 \text{ inches.}$$

### Allowing for Bending Strain

Increasing the diameter to take care of the bending strain of course reduces the tensile stress due to the steam pressure, thus leaving a larger proportion of the total stress allowed of 16,000 pounds available for the bending stress.

So it follows that by calculating again for a size smaller than 2.3 inches we could reduce the diameter required to take care of the total strain, below that found by the formula $d = \frac{l^2}{25{,}000}$, and still not exceed the 16,000 pounds total stress per square inch.

As the smallest diameter that will carry both loads at a stress not to exceed 16,000 pounds can only be determined by a series of trial calculations, which is a slow and tedious operation, I have drawn up the chart which accompanies this article and which will solve the problem at the first attempt.

### Use of the Chart

To use the chart, follow along the horizontal line for the load, due to the steam pressure only, to the curved line marked for the stress allowed by the authority under whose jurisdiction the boiler is being built.

If this intersection is past the vertical line for the length of the stay in question, the diameter of the stay is read from the nearest diagonal line above the intersection. If otherwise, we continue along the horizontal line to the vertical line for the length of the stay and read there the diameter of the stay from the diagonal line, at or above the intersection.

For example, taking the stay calculated for above, we have as the load due to the steam pressure:

$$12\tfrac{7}{8}^2 \times 100 = 16{,}576 \text{ pounds.}$$

A dotted line is drawn on the chart at the height which represents this 16,576 pounds, and, continuing along this horizontal line, we find that a 1⅝-inch stay would just carry the load at 8,000 pounds stress; but is only good for 18 feet in length.

As the stay in question is 20 feet long, we continue along the horizontal line until it intersects the vertical line marked 20 feet, where we find the size of stay required to be a little over 1¾ inches diameter and will have to be made 1⅞ inches diameter.

The curved lines indicate by their intersections with the diagonal lines the load that each diameter of stay will carry at the given stress, as calculated in the usual way; that is, disregarding the stress due to the weight of the stay. These same curved lines also indicate the lengths at which the total combined stress becomes greater than 16,000 pounds per square inch. It need scarcely be said that this chart will also be useful for any case where a long circular bar is used for a tension member in a horizontal position.

### Method of Constructing Chart

The chart is constructed by setting up the vertical line at the left and starting the diagonal lines from points laid off to scale at heights measured from the base, equal to the squares of the diameters—this because the strength of a stay varies as the square of its diameter. Then calculate the load that the largest size stay will carry at the 16,000-pound stress and divide up the vertical line by horizontal lines to indicate this amount at the point for the largest diameter. The points for each diameter will be obviously at the height representing its strength at 16,000 pounds per square inch.

The stress in the stay due to the bending strain varies as the square of the length, which in turn varies as the diameter. The horizontal line is, therefore, laid off to scale equal to the diameter of the largest stay and points located on this line at distances from the vertical line equal to each of the other diameters to the same scale.

The diagonal lines are now drawn, joining the points on the vertical line to those on the horizontal line, each being marked for its proper diameter.

Calculating the length at which the 3½-inch (the largest) stay will just support its own weight with a stress of 16,000 pounds per square inch, the length of the horizontal line may be now taken to represent this length squared.

We can next divide up the horizontal line to indicate divisions of one foot in length, scaled off from the vertical line as zero, at distances equal to the squares of the lengths, to the same scale as the total length.

It may be seen that the diagonal lines will each intersect the base line at the length at which each diameter will be subjected to a stress of 16,000 pounds per square inch, in carrying its own weight, and also that the height to the intersection of any length line, and any diagonal line will represent the available tensile strength left in the bar at 16,000 pounds total stress after allowing for the stress caused by the weight of the bar itself.

The curved lines are obtained by simply dividing up each diagonal line into 16 parts and drawing a curve through the 5th, 6th, 7th, 8th, 9th and 10th division points.

As the total height of each diagonal at the vertical line at the left indicates the strength of the bar at 16,000 pounds stress, it is obvious that the height of the diagonal lines at the above points will represent the strength of the bar at 5,000, 6,000, 7,000, 8,000, 9,000 and 10,000 pounds stress per square inch respectively, disregarding the strain due to the bending moment.

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As a means of providing for the present shortage of skilled labor in France, a law has been promulgated providing for the creation of technical classes for youths under the age of eighteen employed in works and factories. Employers themselves have the right to establish classes for their hands, but where this is not done the classes must be instituted by the chambers of commerce or by professional groups with funds provided partly by the state. Employers are being urged by the state to provide the instruction as part of the technical training of their hands.

## Examination Questions for Inspectors

The following answers to the examination questions which appeared on page 218 of the July BOILER MAKER have been submitted by one of our readers. We shall be glad to receive further answers to the same questions as well as additional information on exminations that have been given in connection with boiler work.

Q. If the boiler has a tendency to foam, what precautions should be taken?

A. First the boiler should be thoroughly cleaned out; next, the feed water should be treated before it is allowed to go into the boiler; at least it should be filtered. While the boiler is foaming, check the draft of the fire, if possible and convenient, shut the stop valve, and allow the water to settle down for a few minutes before starting operations again. When starting up, do so slowly at first. The water glass and column should be blown out frequently to ascertain the level of the water in the boiler. Blowing off the bottom cock and refilling with fresh water in the boiler may also help. It is a case of *coaxing* and *humoring* the boiler along until the cause is discovered and removed. Generally, foaming is caused by dirty water, and in some instances it may be caused by using a boiler that is actually too small to furnish the required steam, without forcing the boiler more than a reasonable amount.

Q. If there is an overflow of water in the boiler, what effect would the blowing of the pop valve have?

A. The probable effect would be for the water to rise, due to the sudden release of the pressure through the safety valve, and the large amount of latent energy in the body of water itself.

Q. How many pounds of coal will be burned per square foot of grate area per hour?

A. It may be anything from 10 to 40 pounds, according to the rate of combustion required in any given case. In ordinary cases the rate is from 10 to 15 pounds per square foot. In extraordinary cases it may be from 15 to 40 pounds, where economy does not count, but where the demand for power is great.

Q. How many square feet of grate area will be required to burn 1 ton of soft or bituminous coal per hour?

A. One ton of coal contains either 2,000 or 2,400 pounds (according to which figure is taken in any case, or in any location). If the rate of combustion is, say, 12 pounds per square foot per hour, then $2,000 \div 12 = 166$ square feet of grate to burn one ton in one hour. If the rate is higher than 12 pounds, then a smaller grate will do.

Answers to the remaining questions will be published in later issues of THE BOILER MAKER.

## Essential Information for Boiler Shop Apprentices

BY GEORGE L. PRICE

The safe working pressure for a boiler can only be determined by computing for each section of the boiler separately. To find the allowable pressure in the boiler shell, we shall assume certain data which will assure simple solutions for typical boilers.

### CALCULATING THE SAFE WORKING PRESSURE FOR TYPICAL BOILER

Find the safe working pressure of a boiler shell 60 inches inside diameter, of ½-inch plate, having a tensile strength of 60,000 pounds per square inch, a riveted joint efficiency of 80 percent and a factor of safety of 5.

A simple formula has been worked out in which the factors given above are used to obtain the working pressure. This takes the form:

$$\frac{\text{Tensile Strength} \times \text{Efficiency} \times \text{twice the Plate Thicknesses}}{\text{Inside Diameter of Boiler} \times \text{Factor of Safety}} = \text{Allowable Working Pressure.}$$

More commonly this formula is written:

$$(1) \qquad \frac{TS \times E \times 2T}{D \times F} = P.$$

Substituting the values given above, in this formula we have:

$$\frac{60{,}000 \times 80 \times 2 \times 0.5}{60 \times 5} = 160 \text{ pounds per square inch,}$$

which is the allowable working pressure on the boiler.

### COMPUTATIONS FOR TWO COURSE BOILER

$TS$ = tensile strength of plate in pounds.
$T$ = thickness of plate in inches.
$F$ = factor of safety.
$D$ = inside diameter of boiler.
$E$ = efficiency of longitudinal seam.
$F$ = working pressure.

The boiler shell in the example above is constructed of ½-inch plate having a tensile strength of 60,000 pounds per square inch, a factor of safety of 5 and an inside diameter of 60 inches. In this case we will assume a longitudinal seam efficiency of 85 percent. In addition, a second course having an inside diameter of 72 inches, a plate thickness of ⅝ inch and a longitudinal seam efficiency of 80 percent will also be assumed. For this boiler the allowable working pressure would be found from the above formula by substituting the values in the case of each course in the formula (1).

For the 60-inch course the safe working pressure will be:

$$\frac{60{,}000 \times 85 \times 2 \times 0.5}{60 \times 5} = 170 \text{ pounds per square inch.}$$

For the 72-inch course the safe working pressure will be:

$$\frac{60{,}000 \times 80 \times 2 \times 0.625}{72 \times 5} = 166 \text{ pounds per square inch.}$$

### EXPLANATION

The allowable working pressure of the 60-inch course in the second case has been found by calculation to be 170 pounds and that of the 72-inch course to be 166 pounds. The latter value must be used as the working pressure for the boiler because, with the pressure that could be used in the first course, the factor of safety of the boiler would be reduced.

Further data of value to beginners will appear in later issues of the journal.

## Oxy-Acetylene in the Boiler Shop

Few industries offer so many applications of oxwelding in proportion to the number of operations involved in the manufacture, maintenance and ultimate disposition of a product as the boiler business. Oxwelding may be applied in various operations from the time the sheets are brought into the shop until the finished boiler is tested; it may also be applied at intervals throughout the life of the boiler, for running repairs that can be best made by oxwelding; and the worn-out boiler is finally reduced to sizes for junk by use of the cutting blowpipe.

When the sheets are brought into the layerout they are often cut once to render them easier to handle. Such parts as dome saddles, washout holes and cleanout holes in the front ends of boilers are easily cut to precise measure by using a simple one-wheel attachment for radial work. The sheets leave the layerout for the shears and punches where mistakes are nearly always made. A hole punched in a wrong place is welded and the sheet saved; an edge or angle damaged by shears is reclaimed.

Boiler steel is of high tensile strength, but flanges do crack despite the utmost care both in flanging and in fitting up or assembling. Here again vital defects are easily corrected with the welding blowpipe. In fitting up, the dome must be driven down into the saddle, the mud ring into the water space, and the old-fashioned heater bar, formerly used to help in fitting these heavy parts, is now being superseded to a certain extent by the welding flame, which, by applying a maximum of heat to a small area, permits the parts to fit easily and properly. This proper fit-up is absolutely necessary if rivets are to perform their service adequately, for the holes must be fair and the flanges true.

The staybolts are cut off to exact length for driving after they are inserted, and if, as it occasionally occurs, the staybolt hole is made too large in tapping, instead of using an oversize bolt the hole is welded and another of standard size drilled and tapped.

After the shell of a boiler is assembled the firebox is applied. Here again the welding blowpipe has proved its usefulness, for the sheets may be welded together as well as the door hole.

In boiler repairs one of the most profitable applications for a welding blowpipe is the reclamation of fire flues and tubes. These are reclaimed very satisfactorily by cutting off the defective ends and welding on new short lengths.

Patches in the firebox sheets offer the welder an opportunity to demonstrate his skill to great advantage. Many railroads now use the oxy-acetylene process for welding sheets and patches in fireboxes, because of the great ductility of the weld. This is a feature of utmost importance in this work.

Calking edges in riveted fireboxes deteriorate so that either new sheets must be applied at considerable expense or the edges reclaimed by welding, which costs very little.

Another application in the boiler industry is probably the best known. It is the cutting into suitable sizes the old and worn-out boiler, so that scrap may be turned back into the steel furnace from whence it originally came.

## Annual Meeting of American Society of Mechanical Engineers

The 1920 annual meeting of The American Society of Mechanical Engineers will be held in the Engineering Societies Building, 29 West 39th street, New York City, from December 7 through December 10. Sessions will be held on the subjects of Appraisals and Valuation and the Application of Engineering to Woodworking. The newly founded Professional Sections on Management, Power, Fuels, Machine Shop, Railroad and Textiles will also conduct sessions to consider the vital problems in their field. In addition, a number of valuable papers will be presented at General Sessions. A memorial session for Dr. Brashear is planned as a fitting tribute to his life and work.

The executive committee of the Metropolitan Section of the Society has decided to hold a series of joint meetings throughout the year with the New York Section of The American Institute of Electrical Engineers. In general the subjects selected for these meetings will come under the following classifications: Marine Engineering, Engineering Education, Industrial Installations, Power Generation, Steam Railroad Electrification, and Industrial Relations. It is intended to hold the first meeting in October.

## National Conference of Boiler Inspectors

Under the signature of Charles E. Gorton, chairman, administrative council of the American Uniform Boiler Law Society, 253 Broadway, New York, a letter has been sent out asking for contributions to be used in defraying the expense of getting the "National Board" representatives together in conference at a centrally located point.

The National Board was organized for the purpose of promoting uniform boiler laws throughout the jurisdiction of the members of the organization, for the interchange of opinions, rulings and the approval of specific designs, appurtenances and devices used in connection with boilers, and uniform examination of boiler inspectors, with the object of maintaining uniformity throughout such jurisdiction. The membership is restricted to inspectors or other officials charged with the enforcement of rules and regulations covering boilers and pressure vessels in the states and municipalities which have adopted the American Society of Mechanical Engineers' Boiler Code.

The expense of getting this conference together is estimated at approximately $2,500. The questions that will be taken up by the conference, viz., uniform interpretations, uniform stamping of boilers and uniform examination of inspectors, etc., are questions that the boiler and allied industries are vitally interested in, and, when properly handled, will mean a big saving to these industries.

It is desirous to call this conference at as early a date as possible.

## Steam and Electric Locomotives to Be Compared

The relative advantages of modern steam and electric locomotives are to be described in four papers to be presented before a joint meeting of the New York Section of the American Institute of Electrical Engineers, the Metropolitan Section of the American Society of Mechanical Engineers and the Railroad Section of the A. S. M. E., to be held October 22, in the Engineering Societies Building, 29 West 39th street, New York.

The papers on steam locomotives will be presented by W. R. Muhlfeld, vice-president, Railway & Industrial Engineers, Inc., and W. E. Woodard, vice-president, Lima Locomotive Works.

The papers on electric locomotives will be presented by A. H. Armstrong, chairman, electrification committee, General Electric Company, and F. H. Shepard, director of heavy traction, Westinghouse Electric & Manufacturing Company.

The following men have agreed to take part in the discussion: W. L. Bean, mechanical assistant, New York, New Haven & Hartford; A. W. Gibbs, chief mechanical engineer, Pennsylvania system; F. H. Hardin, chief engineer motive power and rolling stock, New York Central; F. W. Kiesel, Jr., mechanical engineer, Pennsylvania system; C. H. Quinn, chief electrical engineer, Norfolk & Western; A. L. Ralston, mechanical superintendent, New York, New Haven & Hartford; and R. Beeuwkes, electrical engineer, Chicago, Milwaukee & St. Paul.

The meeting will be conducted by a joint committee of the three society sections, will be opened by Frank J. Sprague, Sprague Safety and Signal Corporation, and George Gibbs, chief engineer electric traction of the Long Island, will close the discussion.

# The Boiler Maker

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WE GUARANTEE that of this issue 4,800 copies were printed; that of these 4,800 copies 4,206 were mailed to regular paid subscribers, 16 were provided for counter and newscompany sales, 96 were mailed to advertisers, 66 were mailed to employees and correspondents, and 416 were provided for new subscriptions, samples, copies lost in the mail and office use; that the total copies printed this year to date were 52,300, an average of 5,230 copies a month.

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


## CONTENTS



Owing to the shortage of paper, the annual index of The Boiler Maker, which formerly was published as a part of the December issue, will hereafter be published separately at the end of the year. As the annual index will be useful only to those subscribers who have kept a complete file of the magazine for the year, only a sufficient number of copies will be printed to fill the orders received for it at this office on or before December 1. A copy of the index will be mailed without cost to each subscriber whose order is received on or before that date.

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We have to announce to our readers at this time an increase in the subscription price of The Boiler Maker. Hereafter the subscription rate throughout the United States, Canada and Mexico will be $3. The rate to subscribers in other countries will be $5, and the price of a single copy 35 cents.

Publishers, like everyone else in the business world, have been faced with tremendous increases in the cost of materials. For example, the cost of engravings used as illustrations in our editorial pages has gone up 265 percent. Other items have increased as much as 125 percent. In this connection it should be remembered that postage on second class matter was materially increased on July 1, 1920, and that it will be increased *again* on July 1, 1921. We could go into greater detail regarding these matters, but we feel that our readers appreciate the conditions, which are world-wide in scope.

We are planning bigger and better things for The Boiler Maker and we are confident that we will continue to have your support in the future as we have had it in the past. Our aim is to make the magazine of the greatest possible value to its readers and we expect not only to keep all our present readers with us, but to go on steadily adding to our subscribers.

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In the proper maintenance and care of locomotives and, for our purposes, of locomotive boilers, which, incidentally, are rather essential parts of the machine, there are many factors to be considered. Certain of these are discussed in the leading article in this issue of The Boiler Maker under the head of running repairs on locomotive boilers.

As this article points out, boiler washing is probably the most important item to be dealt with, while the cleaning of flues and stopping flue leaks are vitally essential to the efficient operation of the engines on the road. The suggestions made for carrying out the details of the work are with the idea of emphasizing the seriousness of the fundamental requirements of boiler maintenance. Superintendents and shop foremen understand the necessity of observing the greatest care in carrying out operating repairs, but unless the men who are actually doing the work appreciate their responsibilities, small errors are bound to occur which may not be discovered until serious damage happens to the engine after it has left the shop.

In another direction possible improvements in the economical and efficient maintenance of locomotives may be found in standardizing repair parts, especially those which have to be replaced often. The advisability of this standardization is apparent when, because of a slight difference in the size of a part from the original, the locomotive may be held up in the shop unnecessarily. Any plan that reduces the labor of making a part fit or makes its installation almost automatic is worthy of investigation. Interchangeable parts may be turned out on a production basis and the cost, as well as the time element, in this way reduced.

Responsible workmanship combined with such improvements as result from standardization will aid materially in keeping locomotives on the road.

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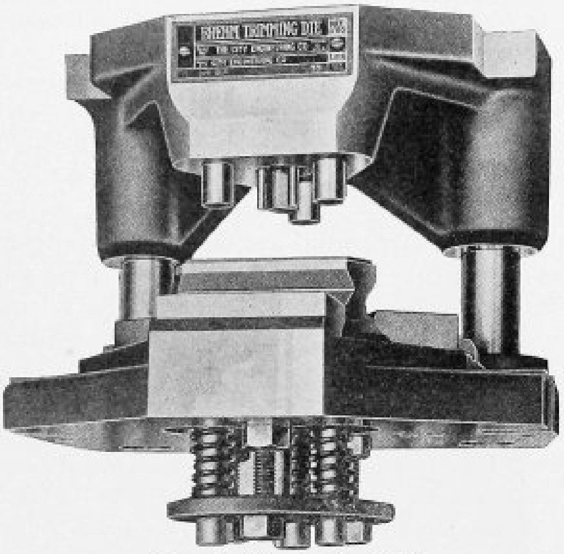
The fall meeting of the American Boiler Manufacturers' Association will be held at the Hotel Astor, New York City, October 18.

# Engineering Specialties for Boiler Making

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

### Construction and Operation of the Brehm Trimming Die

One of the new tools recently introduced to the market by the City Engineering Company of Dayton, Ohio, is the Brehm Trimming Die. This die, as the name infers, is for trimming various shaped shells or cups drawn from sheet metal by the punch press, but it can also be used for certain forming operations. In the trimming operation the shape of the shell does not interfere with the operation of the die; blanks drawn into round, square or irregular shapes can be trimmed equally well.




Trimming Die for Steel Shells

The die block is triangular in shape having cams cut on its side faces similar to the one shown, except that they are so placed as to operate in rotation. The shell to be trimmed is placed in the die and as the punch slide descends the punch enters the blank. Three studs mounted on the punch holder, which are slightly longer than the punch, come in contact with the die block and force it down on the springs. As seen in the cut, this downward movement of the die block will cause the cam on this piece and the cam on the permanent female cam to operate, forcing the die in a lateral direction, which, in connection with the punch, causes the cutting operation. After the first cam has operated, the cam on the second face operates, in a similar manner, and then, in rotation, the third set of cams.

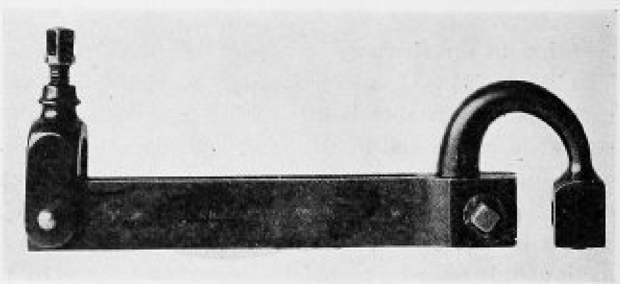
To sharpen the die, one of the permanent or female cams is removed allowing the die block to be lifted out. After removing the surface plate the die can be ground on an ordinary surface grinder. The screw which supports the shell during the trimming operation can be lowered to compensate for the grinding. Throughout the life of the die the grinding does not affect the timing of the cams. The punch is ground in the same manner as the blanking punch and a slight amount less than the pressure studs—this variation allowing a clearance between the punch and die when in operation. The grinding of either punch or die does not change its shape enough to affect the shell to be trimmed.

When operating the die the pieces to be trimmed are merely dropped into the hole in the die block. There are no stop pins, clamps or nests or other attachments to retard the speed of the operation. If the press is inclinable and equipped with compressed air which can be used to eject the shells, it is claimed that a high speed of production can be obtained.

Owing to the shear movement the dies have a long productive life. The minimum grinding space allowed is one-half inch. Dies built for shells of one inch or under have oil-hardened die blocks with carbonized female cams. All larger sizes have die blocks of carbonized steel with tool steel inserted bushings which do the cutting. All cam faces on the female cams and the die blocks are ground to their proper dimensions.

### Combination Tool Holder

The combination tool holder recently developed by Maurice H. Derringer, 3133 North Eighth street, Philadelphia, Pa., is shown in the accompanying illustration. This holder is intended for medium sized work and will hold cutters made from either square or round stock. The holder is made of steel with all parts properly hardened and drawn. The cutters, made from square stock to 5/16 inch, can be used for turning, boring and internal threading and can be held in one side of the tool holder. By turning the yoke to the opposite side of the holder a 45-degree slot is presented which will take round stock from 1/8 to 5/16 inch in diameter. This side of the holder is useful for cutters employed in boring or internal threading of small and large holes. The holder is adapted also for other kinds of work such as holding an indicator or scriber when setting up work for various machining operations. The yoke which is attached to the body of the tool holder is fastened with a taper pin and can be removed in a few seconds. The yoke has a 5/16-inch screw and



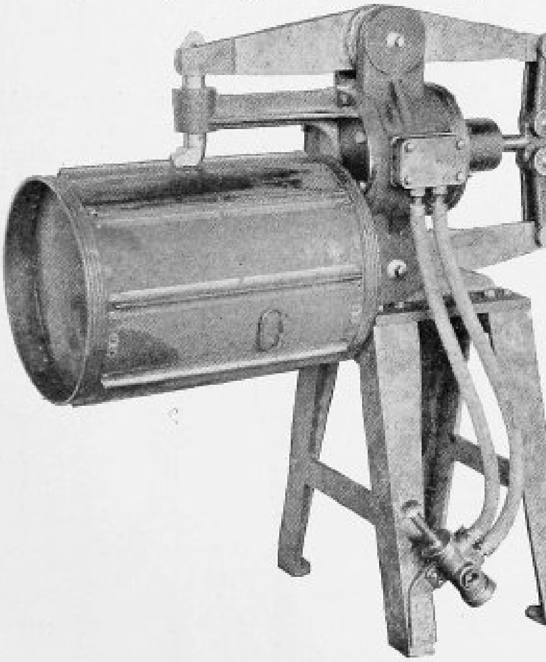
Tool Holder for Medium-Sized Work

when the holder is placed in the toolpost of a lathe a double grip is obtained on the tool, the screws in the hook and the toolpost both gripping it so that it cannot spring.

The main feature of the Derringer combination tool holder is a spring tool holder in the form of a gooseneck which is brought into use by taking out the taper pin that holds the yoke in place and removing the yoke. The gooseneck is then attached with a taper bolt and nut which, when tightened prevents the gooseneck from moving. The spring tool is broached to receive a 5/16-inch tool bit and will be found useful for cutting threads. This tool is also used for planer and shaper work as well as for turning operations in the lathe.

### Ash Can Riveter

The Baird Pneumatic Tool Company, Kansas City, recently developed a pneumatic riveting machine for the Dover Stamping & Manufacturing Company of Cambridge, Mass., which is specially adapted for ash can and small tank construction. The machine has a four-way foot valve, thereby leaving the hands of the operator free



Rivet Adapted to Small Tank Work

to place the material being riveted while the stroke is made. Special dies have been constructed for this device so that if reinforced ribs are built into the can or tank the dies bridge these ribs. Two rivets can be headed over at a single stroke.

Special dies are available which can be inserted in the projecting arms for any particular form of tubular riveting. Although the machine is placed on a metal base this can be detached and the tool bolted on a work bench if desired.

It is claimed that by this method of riveting the rivets are virtually welded into the metal surrounding them inasmuch as a pressure of 35 tons is exerted on the dies. Improvements are claimed over the hammer method of riveting in that there is no chance for a rivet to turn and tear the light metal of the container nor are there any loosely-driven rivets wtih this machine. The total weight, including the stand, is 740 pounds and 100 pounds air pressure is used for is operation.

### Pneumatic Backing-Out Punch

The Scully Steel & Iron Company, Chicago, Ill., has announced the production of a new backing-out punch for rivet work. The main feature of this tool is the pneumatic shank for long-stroke hammers.

Although no new principle is involved in the operation of this punch, it is probably the first time that such a device has been furnished commercially and this fact will be of interest to boiler shops.

It is claimed that with this punch one man can back out a greater number of rivets than two gangs using the old hand punch and sledge hammer method. In shops where the device has been adopted each riveting gang is furnished with one or more punches and, if a rivet is improperly driven, or has to be cut out for some other reason, the men simply slip in the punch in place of the usual rivet sets.

## BUSINESS NOTES

The American Locomotive Company is making plans for the erection of an addition to its machine shop at Chester, Pa., at a cost of $40,000.

Preparations are being made at St. Louis, Mo., for the first annual railway exhibition, which will be held during the week of October 25 under the auspices of the Railroad Y. M. C. A. and the St. Louis Railway Club at the Railroad Y. M. C. A. building.

The Norton Company, Worcester, Mass., has opened a branch office for its grinding machine division in room 304 Penway Building, 241 North Pennsylvania avenue, Indianapolis, Ind., under the direction of Walter F. Rogers, district representative. The establishment of this branch office will in no way affect the distribution of Norton grinding wheels. These will be handled as in the past by the Vonnegut Hardware Company.

The East St. Louis Locomotive & Car Company, capitalized at about $5,000,000, will establish a railroad car and locomotive building and repair plant at East St. Louis, Ill. The plant, it is stated, is ultimately to employ 3,000 men. R. W. Crawford, formerly head of a car building plant at Streator, Ill., is president of the company. Options have been obtained on three sites, according to J. N. Fining, secretary of the East St. Louis Chamber of Commerce, and it is planned to begin work at once on several buildings. The plant, with buildings and tracks, is expected to cover 150 acres and to have an output of 75 to 120 freight cars per day. The company expects to be in a position to begin repair work this winter.

At the annual meeting of the Canadian Locomotive Company, Limited, Kingston, Ontario, on September 16, the board of directors was increased by two new members, William Harty, Jr., and William Casey having been elected to the board. The other members of the board were reelected. J. H. Bickett, formerly secretary and treasurer, is now treasurer and has been succeeded as secretary by William Harty, Jr. William Casey, who was formerly general manager, has been appointed a vice-president. The other executive officers were re-elected.

Dwight P. Robinson & Company, Inc. (with which Westinghouse, Church, Kerr & Company, Inc., was recently consolidated), engineers and constructors of New York, has established a new branch office in the Home Savings and Loan Building, Youngstown, Ohio, in charge of C. I. Crippen. The company recently moved its Cleveland office from the Leader News Building to the Citizens Building, and H. P. Clawson, who was for several years a member of the Chicago staff, has been transferred to Cleveland to take charge of this office. The company now maintains branch offices in Pittsburgh, Youngstown, Cleveland, Chicago, Dallas and Los Angeles, and Sao Paulo, Brazil.

# 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.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Laying Up Boilers

Q.—Would you kindly advise me the best way to have a stationary boiler stand in the summer time when not in use, i. e., filled or not filled with water or any other method of storage? H. W.

A.—There are two common methods known as the *wet* and *dry* method. By the *wet* method the boiler is first cleaned out. Remove all scale and dirt, then replace the hand-hole and man-hole plates and screw up any plugs. Then fill the boiler with clean water. The boiler must be free from all leaks, as otherwise the water will seep through, air taking its place, causing corrosion or oxidization of the metal. The principle of this method is that the water excludes the air, preventing corrosion and oxidization of the plate.

The *dry* method consists in drying thoroughly the inside of the boiler by means of a wood fire built in the firebox or furnace. It is necessary occasionally to build wood fires during the period that the boiler is laid up. The scale need not be removed, as it will act when dry as a protection against corrosion. The outside should be given a good coat of boiler paint.

Another way is to clean the boiler. It is then thoroughly dried, painted and stored in a dry place.

### Welding Patches

Q.—In the March and April issues of THE BOILER MAKER the articles on the welding of patches, etc., were very interesting. We have several types of patches to weld in our shops and would like to have information on the best method of doing the work. In the cases shown by the accompanying illustrations is it necessary to preheat the sheets? Where should the patches be bolted, as in the case of mudleg patches, while they are being welded; or should they be left loose to take care of expansion? C. K.

A.—In the use of the electric arc with the metal electrode it is not essential to pre-heat the metal before or during the operation of welding. The joint to be made, however, must be thoroughly free from grease, dirt and scale. Welding wire of a soft grade of steel or iron is recommended. There are several grades of welding wires on the market, viz., Armco, Roebling, etc. It is important to use welding wire of the proper diameter and also the correct amperage for the plate thickness. For plates of the following thickness, use the welding rod diameters and amperages indicated:

TABLE OF WELDING ROD SIZES FOR GIVEN PLATE THICKNESSES

| Plate Thickness, Inches | Diameter of Metal Electrode, Inches | Amperes |
|---|---|---|
| 1/16 | 1/16 | 30 |
| 1/8 | 1/8 | 50 |
| 1/4 | 1/8 or 3/16 | 100 |
| 3/8 | 3/16 or 1/4 | 125 |
| 1/2 | 1/4 | 140 |
| 5/8 | 1/4 | 150 |
| 3/4 | 1/4 | 160 |
| 1 | 1/4 | 160 |

In Figs. 2*a* and 2*b* the sheets are shown to be cracked between stays and small cracks in the stay heads. To weld sections 8 inches and under, the plate should be chipped out to a V having an angle of 90 degrees between the sloping sides, this work to be done with the chipping hammer. The cracked sections in the stay heads should also be chipped out. The welding should be started from the bottom of the crack if the section lies in a vertical position, working upward, applying the arc at the bottom of the V so as to fuse thoroughly the metal of the plate and electrode.

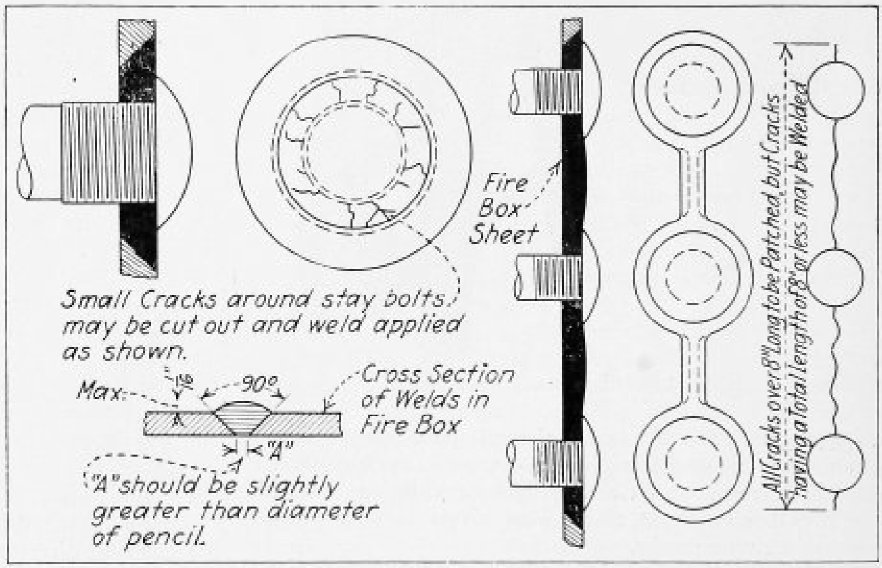
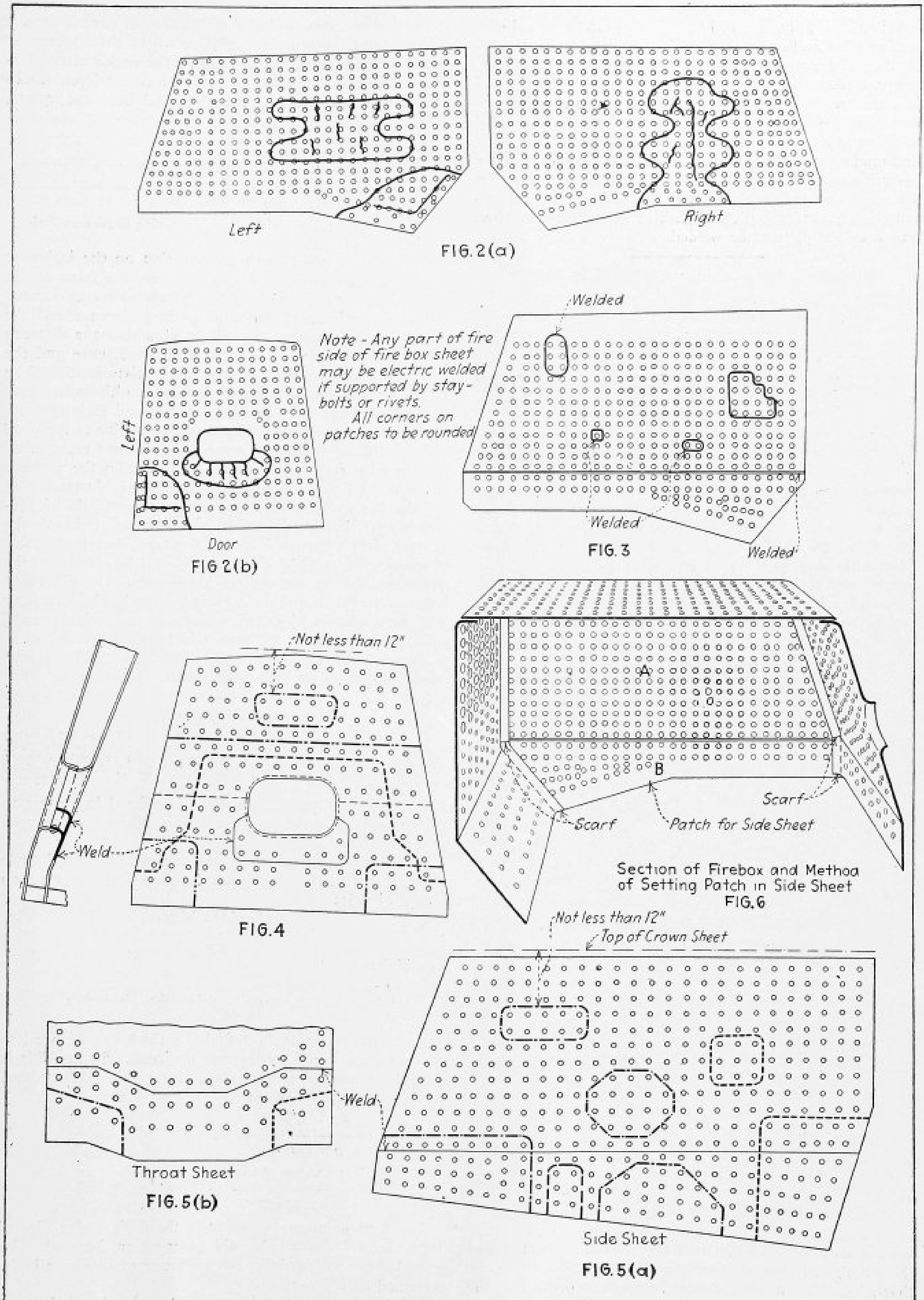



Fig. 1.—Details of Welding Around Staybolts Where Sheet Has Cracked

In the case of larger welds, as in patches and also when stays are to be installed, care must be taken of the stresses due to expansion and contraction of the plate which arises, due to the heating of the plate and its subsequent cooling. These stresses cannot be entirely taken care of unless by pre-heating; however, the following method gives good results: On patches as in Figs. 3, 4 and 5, the patch plates should be slightly dished. Allow a small clearance between the wrapper sheets and patches, tack the patch in position and perform part of the welding on one side for a short distance and then on the opposite sides. Applying the heat about the patches in this manner reduces the expansion stresses in the metals. The stays are to be applied after the welding of the joints.




Various Methods of Welding Repairs in Locomotive Boilers

When long joints are to be made, as in the renewal of a section of a firebox, care must be taken to prevent overlapping of the plate and patch.

Fig. 6 illustrates a weld now often made. The plate *A* is a section of the old firebox, and *B* a patch or plate section to be welded in place. The corners of *B* are scarfed to fit snugly between the tube and side sheet, door sheet and mud ring. At the connection of the flue sheet end a ¼-inch clearance is made between the plate edges, and at the other end the patch sheet is dropped so that the distance is equal to about one-eighth of an inch in each foot length of the plate to be welded.

## Allowance for Curvature of Thick Plates

Q.—In reading the article "Development of Slope Sheet" on page 180 of the June number of THE BOILER MAKER, I have not been able to understand the reason for the addition of 7 times the plate thickness in Fig. 3. Suppose the large and small diameters are 60 inches and 48 inches respectively, I would be inclined to add 3 1/7 times the thickness of ½ inch, or 1 9/16 inches, to be exact, then add the lap and allowance for beveling. This, of course, would be the same as figuring on the neutral axis of the plate, taking the diameters as 60½ inches and 48½ inches respectively. The method given in the article provides 1 15/16 inches more metal, but this, of course, would not be enough for the lap.
D. F. McL.

A.—The allowance for curvature depends upon the diameter of the curve and the thickness of the plate. The allowance can be calculated, but it often happens that some changes are necessary in order to provide for the irregularities in the thickness of the plate and in the bending operation. The inside diameter of the cylinder is stated and the thickness of the plate is given, and these figures are used as the basis of the calculations. The inside circumference is supposed to shorten and the outside is stretched in the rolling operation. The line midway between the inside and outside is supposed to be the same length after the plate is rolled as before, and therefore this is called the neutral axis.

If the calculation is made on the neutral diameter, then the theoretical results should apply in practice. However,

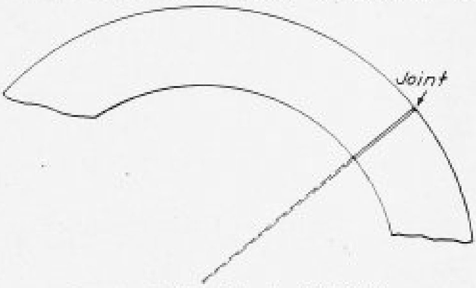



Fig. 1.—Perfect Joint in Thick Plates

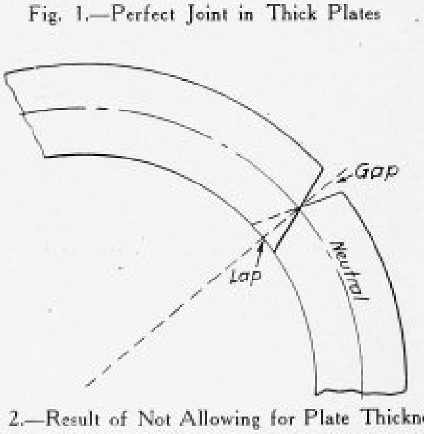



Fig. 2.—Result of Not Allowing for Plate Thickness

with thick plates there is such a great difference between the length of the inside circumference and the outside one that a special allowance should be made in order that the two edges of the plate will roll together. The desired condition is shown in Fig. 1, where the two edges match perfectly, and the joint would be finished with cover plates.

In Fig. 2 is shown the condition where the edges meet at the neutral point, but overlap at the inside circumference and fail to meet at the outside circumference. In this instance the ends of the plate had been cut square,

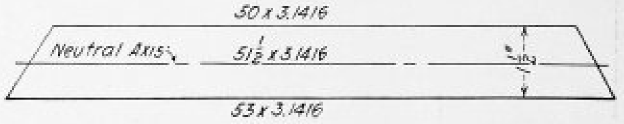



Fig. 3.—Laying Out Thick Plates According to Neutral Axis

and there was not enough compression on the inside or enough stretch outside. Fig. 3 indicates the form of the plate when cut according to the calculated length for the inside circumference, the neutral circumference and the outside circumference. It will be seen that the distance between the lengths of the inside circumference and the outside one is twice the thickness of the plate multiplied by 3.1416, or it is the thickness of the plate multiplied by 6.28. Instead of using this fractional value and making some allowance for the irregularity that may be due to the plate and the rolling operation, some plate workers recommend the use of a factor of 7. This was done in the problem mentioned on page 180 of the June BOILER MAKER.

Take the problem of a 50-inch cylinder made of 1½-inch plate. The inside circumference is $50 \times 3.1416$, the neutral circumference is $51\frac{1}{2} \times 3.1416$, and the outside circumference is $53 \times 3.1416$. It should be noted that the plate must be cut for the outside length. The difference between the inside and the outside lengths is $3 \times 3.1416$, or $2 \times$ the thickness $\times 3.1416$, which equals the thickness $\times$ 6.28. It is recommended that a factor of 7 be used so as to insure that the outside circumference will be long enough to reach all the requirements.

## Dished Head Calculations

Q.—I would like to find out how to design a dished head for a carbon catcher of 10 feet diameter and working pressure of 100 pounds. This head will have a double or triple riveted lap joint as specified by the American Society of Mechanical Engineers' Code. A sketch is inclosed herewith.
T. R. B.

A.—The following information is offered in answer to your question on the design of a dished head to carry a pressure of 100 pounds per square inch.

The American Society of Mechanical Engineers' Code gives this rule for the allowable working pressure on bumped heads:

$$P = \frac{(t - \frac{1}{8})\ 2 \times 55{,}000}{5.5 \times L},$$

in which:

$t$ = plate thickness.
$L$ = radius to which head is dished, in inches.
$P$ = pressure in pounds per square inch.

From this formula first find the thickness of head to carry a pressure of 100 pounds per square inch. This is done by transposing and substituting the values given. In this example we haxe:

$$t = \frac{5.5 \times L \times P}{2 \times 55{,}000} + \tfrac{1}{8}.$$

$$t = \frac{5.5 \times 120 \times 100}{2 \times 55{,}000} + \tfrac{1}{8} = 0.725 \text{ inch.}$$

The next point to determine is the design of a riveted joint that will carry safely the pressure on the head. For a double riveted lap joint the efficiency of the joint is determined as follows:

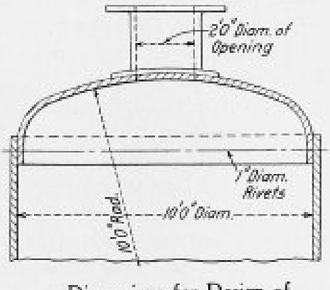
Using 1-inch rivets (driven size) make the pitch equal to three times the diameter of the rivet hole. $3 \times 1 = 3$

inches pitch. The back pitch is equal to at least twice the diameter of the rivets. Make the calculations as for a double riveted, lap joint, longitudinal seam. The effective efficiency of the net section of plate is equal to the pitch minus the diameter of the driven rivet, or $\frac{3 - 1}{3} = 66\frac{2}{3}$ percent.

The tensile strength of the solid plate section $= 3 \times 0.725 \times 55{,}000 = 119{,}625$ pounds.

The area of a 1-inch rivet $= 0.7854$ square inch.

In the net section of the joint there are two rivets in single shear. The shearing strength of steel rivets equals 44,000 pounds per square inch. Strength of two rivets $= 44{,}000 \times 0.7854 \times 2 = 69{,}115.2$ pounds.



Dimensions for Design of Dished Head

The effective efficiency of rivets as compared with the solid plate section $= 69{,}115.2 \div 119{,}625 = 57.7$ percent, showing the rivets to be the weakest part. The pressure allowed on the girth seam by the formula:

$$P = \frac{2 \times T \times t}{R \times f} \times E,$$

in which:

$T$ = tensile strength of plate.
$R$ = radius of shell inches.
$t$ = thickness of plate.
$f$ = factor of safety.
$E$ = lowest efficiency of joint.

Using the values found, allowing 55,000 pounds for the tensile strength of the plate, we have:

$$P = \frac{2 \times 55{,}000 \times 0.725}{60 \times 5} \times 0.577 = 153.4 \text{ pounds.}$$

showing that the joint will safely carry 100 pounds per square inch required. You will note that the decimal 0.725 plate thickness of head is used in the calculations; if lighter plate is used in the shell, substitute its thickness in the formula.

## Drill Sizes for Pipe and Bolts

Q.—Can you tell me where to procure the charts of tapping drills for both pipe and bolt threads—that is, the sizes of drills for different sized taps? A. H. W.

A.—Kent's Engineering Hand-book or any other standard work of this kind contains the data you seek. Also the catalogues issued by tap and die manufacturers give tables on sizes of drills and taps for different kinds of bolt and pipe work:

TAP DRILL SIZES—UNITED STATES STANDARD

| Size Tap, Inches | Threads per Inch | Drill Size, Inch Decimals | Commercial Size, Inches |
|---|---|---|---|
| 1/4 | 20 | .201 | No. 7 |
| 5/16 | 18 | .257 | F |
| 3/8 | 16 | .316 | O |
| 7/16 | 14 | .368 | U |
| 1/2 | 13 | .422 | 27/64 |
| 1/2 | 12 | .422 | 27/64 |
| 9/16 | 12 | .484 | 31/64 |
| 5/8 | 11 | .5313 | 17/32 |
| 11/16 | 11 | .594 | 19/32 |
| 3/4 | 10 | .656 | 21/32 |
| 13/16 | 10 | .7188 | 23/32 |
| 7/8 | 9 | .7656 | 49/64 |
| 15/16 | 9 | .828 | 53/64 |
| 1 | 8 | .875 | 7/8 |
| 1 1/16 | 8 | .9375 | 1 5/16 |
| 1 1/8 | 7 | .984 | 63/64 |
| 1 3/16 | 7 | 1.0625 | 1 1/16 |
| 1 1/4 | 7 | 1.109 | 1 7/64 |
| 1 5/16 | 7 | 1.1875 | 1 3/16 |
| 1 3/8 | 6 | 1.218 | 1 7/32 |
| 1 1/2 | 6 | 1.3438 | 1 11/32 |
| 1 5/8 | 5 1/2 | 1.453 | 1 29/64 |
| 1 3/4 | 5 | 1.5625 | 1 9/16 |
| 1 7/8 | 5 | 1.6875 | 1 11/16 |
| 2 | 4 1/2 | 1.781 | 1 25/32 |

DRILL SIZES FOR PIPE TAPS

| Size Tap, Inches | Briggs Standard Thread | Briggs Standard Drill | Whitworth Standard Thread | Whitworth Standard Drill |
|---|---|---|---|---|
| 1/8 | 27 | 21/64 | 28 | 5/16 |
| 1/4 | 18 | 27/64 | 19 | 27/64 |
| 3/8 | 18 | 9/16 | 19 | 9/16 |
| 1/2 | 14 | 11/16 | 14 | 11/16 |
| 5/8 | .... | ..... | 14 | 25/32 |
| 3/4 | 14 | 29/32 | 14 | 29/32 |
| 7/8 | .... | ..... | 14 | 1 1/16 |
| 1 | 11 1/2 | 1 1/8 | 11 | 1 1/8 |
| 1 1/4 | 11 1/2 | 1 15/32 | 11 | 1 15/32 |
| 1 1/2 | 11 1/2 | 1 23/32 | 11 | 1 23/32 |
| 1 3/4 | .... | ..... | 11 | 1 15/16 |
| 2 | 11 1/2 | 2 3/16 | 11 | 2 5/32 |
| 2 1/4 | .... | ..... | 11 | 2 13/32 |
| 2 1/2 | 8 | 2 9/16 | 11 | 2 25/32 |
| 2 3/4 | .... | ..... | 11 | 3 1/32 |
| 3 | 8 | 3 3/16 | 11 | 3 9/32 |
| 3 1/4 | .... | ..... | 11 | 3 1/2 |
| 3 1/2 | 8 | 3 11/16 | 11 | 3 3/4 |
| 3 3/4 | .... | ..... | 11 | 4 |
| 4 | 8 | 4 3/16 | 11 | 4 1/4 |
| 4 1/2 | 8 | 4 11/16 | 11 | 4 3/4 |
| 5 | 8 | 5 1/4 | 11 | 5 1/4 |
| 5 1/2 | .... | ..... | 11 | 5 3/4 |
| 6 | 8 | 6 5/16 | 11 | 6 1/4 |

## Scarfing Machine in Boiler Work

*(Continued from page 296.)*

The feed has been arranged so that the standard traverse of the slide rest will be 3/8 inch per minute. Cutters of various sizes up to 4 inches can be used. The machine is equipped with an arbor for taking 1 1/4-inch cutters. Cutters can be used having No. 4 Morse taper shanks with flats for driving from the jaws. The base, back and slide rest are of cast iron well machined and fitted; the rest of the machine is of malleable steel. It will be noted that the quill is fitted with roller bearings of ample proportions for any stress that may be required.

The scarfing of flat plates will serve to indicate the operation of the machine. The machine is arranged as in Fig. 1, having the necessary bevel fixed. The cutter is just brought in touch with the plate. The bevel required will then be obtained at a single cut. If more speed is required the feed can be done by hand until the cutter gets well in the depth and then the automatic traverse put on. For this purpose a cutter of 3 1/2 inches diameter is used. For cutting a scarf of the opposite angle all that is necessary is to swing the slide to the opposite degree required and so instead of making a right hand cut, the same cutter will produce a left hand scarf.

# 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 Ancient Boiler Specification

The following specification of a locomotive boiler for an engine built for the Grand Junction Railway about 1840 is worth comparison with the locomotive boiler of to-day. Its interest is not altogether in its antiquity, although we are too ready to assume that our predecessors lacked mechanical ingenuity. Indeed, the main features of the modern locomotive—the inevitable arrangement, for example, of its components—were nearly all included in Stephenson's "Rocket."

At the same time the older generation did lack modern appliances together with the benefits of modern workmanship and productive means and the working pressures used did not demand the refinements now essential.

### Specifications for Locomotive

The locomotive was a six-wheel passenger engine with 13-inch cylinders, 18-inch stroke, having 5-foot driving wheels with the leading and foot plate ditto 3-feet 6-inches.

"*Boiler* to be cylindrical 8 feet 6 inches long, including tube plates; 3 feet 6 inches diameter outside, and made of the best Lowmoor plates, ⅜-inch thick, laid lengthways of the boiler, and well riveted together; fixed to fire and smokeboxes with extra strong angle irons, 2½ inches wide, and a single row of rivets for the upper half, and 3 inches wide for the lower, with a double row of rivets. Six longitudinal iron stays to pass through boiler, connecting tube plates at chimney with firebox. These stays 1 inch in diameter at the firebox to be attached to a strong piece of angle iron, riveted to the firebox plate, and at the chimney end to be tapped and screwed into the tube plate, and made secure with lock nuts. The tube plate at chimney end must also be made of the best Lowmoor iron ⅝ inch thick, and provided with a mud hole and door in place of two tubes in the bottom row.

"Outside firebox also of the best Lowmoor plates ⅜ inch thick; a wrought iron dome 20 inches inside diameter, with a circular top to be placed on it; this dome is to be bolted with ¾-inch bolts, 3 inches asunder, to be wrought iron or brass ring riveted to the boiler with ⅝-inch rivets; the upper surface of which ring, as also the flanche at bottom of dome, to be turned perfectly true, and ground together so as only to require a little red lead to make a steam tight joint. An oval fire door 12 inches by 10 inches, with chain attached. The angles of firebox at the bottom, to be round with a radius of 3 inches and an oval mud hole to be placed at each corner, with a joint made inside. The bottom of the firebox, when the engine is in working order, must be 20 inches from the rail. Ashpan to be made of the best Staffordshire iron plate, 5/16-inch thick, with close back; the bottom of pan to be made of iron bars 1½ inches by ⅝ inch, this pan to be hung to firebox with four hinges and to fit close at both sides and end with a jump joint, and to be provided with a door under the foot plate, for the purpose of raking out ashes.

"*Inside Firebox.*—To be made of the best copper plate 7/16 inch thick, except the tube plate, which must be 3.4 inches. The roof to be well stiffened with six wrought iron stays, arched, and resting on the upright plates. The water space between inner and outer boxes at bottom, to be fitted up with strong double angle iron also at fire door, with a wrought iron ring 2½ inches wide and 3 inches deep, this ring to be faced on both sides. The outer and inner boxes to be stayed together with the best iron stays ⅞ inch diameter, and 4 inches apart from center to center; these stays to be tapped and screwed into both plates, and well riveted at each end.

"*Smoke Box.*—Also made of best Lowmoor iron ⅜ inch thick, except the plate to which the cylinders are attached, which must be ½ inch thick; the length of it to be 2 feet 1½ inches inside dimensions. Chimney to be 13 inches diameter outside, and 13 feet high from the rails to the top of wire cap, and made of a single plate ⅛-inch thick, the seam plate being inside.

"*Tubes.*—109 in number; 2 inch diameter outside, and No. 14 wire gage; to be made of the Cheadle or Basley Company's best sheet brass, with cap joints, and soldered inside. The tubes to be placed ⅞ inch apart, to have ⅜-inch cap at each plate, and properly fastened with steel ferrules; the ferrules at smokebox end to be wider at the box than those at the firebox.

* * * * * * *

"The outside framing of the engine itself was of ash 8 inches by 2⅞ inches, plated with 5/16-inch iron plates, wrought iron wheels, brass slide valves and 15-inch leather buffers stuffed with horsehair. Inside framing of iron was placed between the wheels and the cranks.

"The pressure on the boiler is not stated but two Salter's spring safety valves are specified, one on top of the dome, the other on the boiler barrel, each to be 3 inches in diameter; the only indication as to range of pressure is that the levers are to be so proportioned that 40 or 50 indicated on the balance will be 40 pounds or 50 pounds per square inch on the valve."

The specification is too long to quote in its entirety, but the foregoing will be of interest to boiler makers, the omissions from the specification are quite as noticeable as the inclusions, and together with a drawing not now in existence formed the basis of a valid contract.

Attention is worth while to the fact that the boiler plates were to be lengthways of the boiler. Evidently at this date, the fact that a circumferential seam was exactly twice as strong as a longitudinal seam had not been discovered. It is curious that iron stays with a copper firebox were specified. The want of judgment here is marked. Steel ferrules in brass tubes also call for notice. Another curiosity is the use of the word flanche for flange.

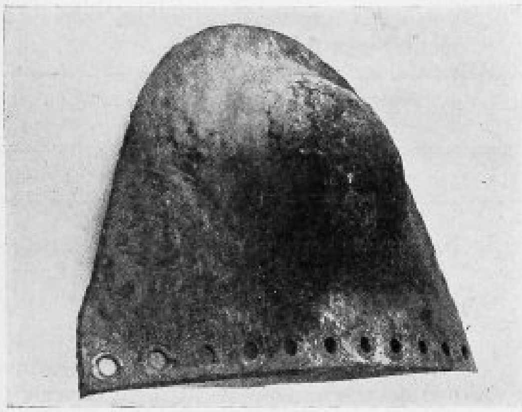
One further quotation is perhaps worth while, under the head of general remarks occurs the sentence, "All steam joints are to be faced and ground so as to require no sheet lead."

London, England. A. L. Haas.

## Mud-Burned Horizontal Return Tubular Boiler

An interesting example of the effect of a mud burn on a boiler recently came to the writer's attention. The illustration indicates the condition of a portion of the bottom of a 54-inch boiler of the horizontal return tubular type.

A few weeks ago the owner of this boiler asked me to inspect it, stating that a spot on the bottom was slightly bulged and leaking. After looking it over, I remarked to him that it certainly was slightly bulged to the extent of a



Bulge in Boiler Sheet Resulting from Mud Burn

4½-inch drop in a 14-inch circle and leaking badly. He then wanted to know if the bulge could not be heated and driven back into position and a bolt with gum washers applied to stop the leak.

I asked him how long since the handhole plates had been removed and the boiler cleaned? He thought it was about ten or eleven months, but could not understand how mud or scale could possibly accumulate considering that one gage of water was blown off twice each day. The state of Pennsylvania, under whose jurisdiction this boiler came, has laws which are supposed to govern the care and maintenance of boilers. There are also inspectors supposed to see that these laws are respected and carried out, but it is quite evident from this case that a few of them are not on the job.

I would like to hear from the readers of THE BOILER MAKER whether any similar cases have come to their attention.

Galeton, Pa. G. M. R.

## Cause of Water Hammer

Although the effects of water hammer are very well known to all engineers, the exact nature of the phenomenon has never been clearly defined. It is caused by an accumulation of condensed steam in pipes or fittings. Should steam be suddenly admitted to a pipe partly filled with cold water, the latter will be set in violent motion and travel the length of the pipe in the form of waves and will gain sufficient velocity to rupture any valve, blank flange or other obstruction in its path.

In opening valves to the line, care should be taken to open them very carefully and gradually, in which case there will be slight vibration and noise. If valves are opened suddenly, however, an explosion is almost sure to follow. The velocity of the incoming steam will determine the extent of the rupture.

Olean, N. Y. CHARLES W. CARTER, JR.

## Watertube Boiler Questions

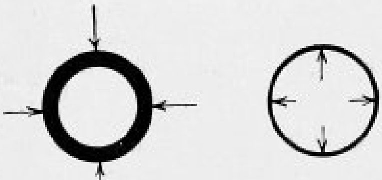
The questions are often asked: Why is the watertube boiler coming into such prominence? Why is it more efficient than the firetube boiler? Why does it cost less? The simplest answer I know is in the little sketch accompanying this letter, and which covers practically every question in this connection.

The pressure on the firetube of a boiler of this type is on the "outside," as indicated, tending to collapse the tube. On the other hand, the pressure on the watertube is "inside" and tends to burst the tube. Now, any child who has ever blown through a dandelion stem knows that it is a simple matter to collapse the stem by suction, but to burst the stem by compressing air into it with the lips and lungs is almost impossible. The boiler tube problem is practically the same; a given mild steel tube can withstand much more pressure from the "inside" than from the "outside."

Hence, to withstand given pressures the tubes in a watertube boiler are made considerably thinner than in firetube boilers, as the sketch indicates. I may have exaggerated the thickness in the sketch, but I did it in order to bring out the point clearly. It is now plain why a firetube boiler costs more because it weighs more per horsepower. The cost of a boiler is about proportional to its weight. Firetube boilers, remember, contain about as many tubes as do watertube boilers. And as to efficiency, doesn't it seem reasonable that a thin shell will transmit heat more efficiently than will a thick shell?

The firetube boiler was the first really successful boiler on the market and had a long start over the watertube boiler. The watertube presented more problems. There are so many joints and seams and chances for steam to leak in watertube boilers that our ancestors couldn't combat the problem with their knowledge of metals. They were compelled to use castings a great deal, and castings are always troublesome. It was a casting, you will remember, that caused the Quebec bridge span to plunge into the river. Likewise, castings have been, and still are, the cause of many boiler explosions.

Today, however, most of the prominent watertube boilers are made of ductile metal throughout. Even the headers in many makes of watertube boilers are of forged or wrought steel construction. True, the firetube boiler has advantages over the watertube in many respects. Where water is bad and contains much sediment, the watertube boiler may become choked or covered with scaly matter. In small sizes the firetube boiler generally costs less because it is easier to make and easier to install. In the opinion of the writer there will always be a market for both types of boilers—firetube and watertube—but the firetube boiler will never really "come back."



Relative Thickness of Tubes Used in Firetube and Watertube Boilers

Brooklyn, N. Y. W. F. SCHAPHORST.

## Methods Used in Computing Boiler Patches

On page 193 of the July issue of THE BOILER MAKER, in an article entitled "Diagonal and Horseshoe Boiler Patches," R. J. Furr gives the shearing strength of rivets as 43,000 pounds. At the top of page 194 the shearing strength is given as 42,000 pounds. The shearing strength of rivets as used in the American Society Mechanical Engineers' Code is 44,000 pounds per square inch, and this value is generally accepted. The various shearing values for rivets in the article would seem to be misleading and might cause misunderstandings of the methods of computation.

It is also noted at the top of page 194 in the same article, that the patch material should have a tensile strength of 55,000 pounds per square inch. In my experience I have found it advantageous to use firebox steel for patches exposed directly to the heat of the furnace, especially when difficulty is experienced in keeping the patch seams tight. Mr. Furr would have done well to have stated specifically what grade of steel would be used in patches, because the tensile strength of firebox steel frequently runs below 55,000 pounds per square inch.

It is generally conceded that a given seam has a certain strength regardless of its position in a boiler. It is also a fact that the girth seams of a boiler are subjected to only one-half the stress applied to the longitudinal seams and, therefore, need be only one-half as strong. It appears that Mr. Furr has confused these facts, because in several places in his article he states that an inclined or diagonal seam has a greater efficiency by reason of its position. He apparently intended to say that a diagonal seam is subjected to stresses less than those imposed upon a longitudinal seam.

To illustrate his method of determining the efficiency of patch seams, a single riveted seam is assumed having an efficiency of 57 percent, forming an angle of 45 degrees with the girth seam, and having an inclined side 42 inches in length and a width of 30 inches. From this an efficiency of 79 percent is found for the patch by dividing 42 by 30 and multiplying the result by the assumed efficiency 57 percent. In the next paragraph a different formula is given for the solution of practically the same problem, and it is found that a seam inclined at an angle of 45 degrees is 126.5 percent stronger than a similar longitudinal seam. In the next sentence Mr. Furr attempts to correct this by stating that this formula indicates that a diagonal seam at a 45 degree angle will resist a bursting strain 26.5 percent greater than a similar seam in a longitudinal position. This being true, it is fair to increase the efficiency of the seam used to illustrate the first problem, which is 57 percent by 26.5 percent, which gives the result of 73.5 percent. Obviously, this discussion of the efficiency of patch seams is erroneous and misleading.

I will be pleased to have this letter published in the columns of THE BOILER MAKER and will be interested in any discussion which may result from it.

Newark, N. J. J. WELDON MELROY.

## Welding Copper by the Oxy-Acetylene Process

It has been stated that among other metals, copper could be successfully welded by the oxy-acetylene process, rolled naval brass being the favorite filling material. Some have even predicted that with intelligent operation the welding of copper may some day almost completely supplant the coppersmiths' art of brazing. The fact is, however, that copper welded with rolled naval brass as filling material is not welded at all, but *brazed*, and badly brazed at that, as the brittle brass filling does not allow any extensive working of the metal.

At present the welding of copper is not practical, copper being so great a conductor of heat that the piece to be welded would have to be kept on a forge or other suitable apparatus for preheating at a temperature of approximately 1,100 degrees F. while the welding was going on, the process therefore being very costly.

It is of absolutely no use to attempt the extensive welding of copper unless a filling material of at least 95 percent copper content can be used. Properly preheated and kept hot and properly welded, the seam will stand some working; but up to the present time no filling material has been found which will permit the seam to be worked the same as the rest of the material. However, the oxy-acetylene process is very useful to the coppersmith, as many small flanges, branches, bosses and seams can be *brazed* economically in this manner.

Bridgeport, Conn. ARTHUR J. ROSEN,
Coppersmith, The Lake Torpedo Boat Company.

## PERSONALS

Fred J. Passino, formerly assistant district manager of the New York territory of the Independent Pneumatic Tool Company, Chicago, Ill., has recently been appointed district manager at Pittsburgh, Pa.

L. R. Day has succeeded W. E. Allison as representative in the railroad department of the Western Electric Company at Milwaukee, Wis. E. B. Dennison has been appointed manager of the new branch office at Nashville, Tenn.

Carl J. Schmidlapp and Allan A. Ryan have been elected members of the board of the Chicago Pneumatic Tool Company, New York. Mr. Schmidlapp takes the place of A. F. Cassidy and Mr. Ryan fills a vacancy that had existed in the board for some time.

Laird W. Hendricks, superintendent of shops of the New York, New Haven & Hartford, with headquarters at New Haven, Conn., has been appointed mechanical superintendent of the Bangor & Aroostook, with headquarters at Derby, Me., succeeding H. Shoemaker, resigned, effective September 17.

F. F. Fitzpatrick, president of the Railway Steel-Spring Company, New York, has received the decoration of Officer of the Crown of Italy. This order was founded in 1868 by King Victor Emmanuel II and is given as a reward for signal merit to military officers and others who have performed distinguished service in Italy.

Mervin E. Lyle, formerly assistant to the president, Columbia Graphophone Company, and for a number of years manager of their Bridgeport factories, is now associated with Willard C. Brinton, consulting engineer, of New York, and has been appointed assistant to the president of the Terminal Engineering Company, Inc., of which Mr. Brinton is president.

S. J. Lupton, chief boiler inspector of the Canadian National Railways, with headquarters at Winnipeg, Man., has had his jurisdiction extended to include the lines of the Grand Trunk Pacific Railway, effective September 1.

The Reading Iron Company, Reading, Pa., announces the appointments of H. D. Elvidge and Agnew T. Dice, Jr., to higher positions in their organization. Mr. Elvidge, formerly assistant to the advertising manager, has been appointed assistant advertising manager. He has also held the position as assistant to the advertising manager of the Traylor Engineering & Manufacturing Company, of Allentown, Pa., from which position he resigned to join the Reading Iron Company. Mr. Dice, who is railroad sales manager of the company, was recently placed in charge of the cut nail business of the Reading Iron Company, thus sharing in the sale and distribution of their products. He is a graduate of Princeton University and has spent six years in the service of the Philadelphia and Reading Railway Company.

## TRADE PUBLICATIONS

Steam Hoists.—The Lidgerwood Manufacturing Company, 96 Liberty street, New York City, has issued a catalogue describing steam hoisting engines for contractors' uses. Specifications and details of construction are given for engines to be used for derricks, pile drivers, coal hoisting, dredge work and the like.

Locomotive Shops.—Dwight P. Robinson & Company, New York, consolidated with Westinghouse, Church, Kerr & Company, has issued a folder containing thirteen photographs of the Baltimore & Ohio locomotive shops at Glenwood, Pa., and Cumberland, Md., which were built by Westinghouse, Church, Kerr & Company.

Reading Wrought Iron Pipes.—This new catalogue of the Reading Iron Company, Reading, Pa., contains a brief history of the iron industry from the time the metal was first discovered down to the present. In addition to this, a complete description accompanied by illustrations is given of the modern processes as carried out by the Reading Iron Company.

Data Book for Engineers.—The Locomotive Superheater Company, 30 Church street, New York City, has issued a convenient pocket size data book for the use of practical operating engineers. The uses of superheated steam in boilers is discussed in the introductory pages of the book and the remainder of it contains tables and general information taken from authoritative sources that might be at all useful in the operation of a power plant.

Industrial Uses of Superheated Steam.—This is a reprinted pamphlet by the Power Specialty Company, 111 Broadway, New York. The original paper was read before the American Society of Heating and Ventilating Engineers. In it the various uses of superheated steam are stated and illustrated, and there are also a number of calculations of heat transfer and steam saving accomplished by it. The paper is of particular value to boiler operators.

Prudential Steel Buildings.—The Blaw-Knox Company, Pittsburgh, Pa., has issued a 32-page catalogue illustrating and describing the line of portable steel buildings manufactured by that company. There are photographs and short accounts of the use of these buildings for a number of different purposes, including labor camps, field offices, watchmen's shanties, industrial buildings, etc. The latter part of the catalogue is devoted to general plans for the various standard structures.

Stationary Boilers.—An interesting and well illustrated catalogue entitled Boiler Logic, has been issued by the Heine Safety Boiler Company, St. Louis, Mo. It contains a large amount of valuable information regarding boiler design, such as proper mixture of the gases, heat transmission by radiation, by convection and by transmission through the tubes to the water. Practical methods of baffling watertube boilers are described, with emphasis laid on flexibility of design, prevention of leakage, active and inactive surfaces, and ease of cleaning. Illustrations and descriptions are given of Heine boilers arranged for hand firing with bituminous or anthracite coal. Various kinds of stokers, including chain grate, side feed and underfeed stokers, are described. The catalogue illustrates different arrangements for burning fuels, including oil, shavings, bagasse and gas. Several pages are devoted to the overloading of boilers and a chart shows the relation between boiler load and excess of flue gas temperature over steam temperature. The last pages of the catalogue consider the design, construction and methods of shipping of Heine boilers.

## ASSOCIATIONS

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Secretary—George Slate, The Boiler Maker, 6 East 39th Street, N. Y.

Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

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Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte Building, Kansas City, Kans.

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Executive Board—John F. Raps, gen. B. I., C. R. R., 4041 Ellis Avenue, Chicago, Ill., chairman.

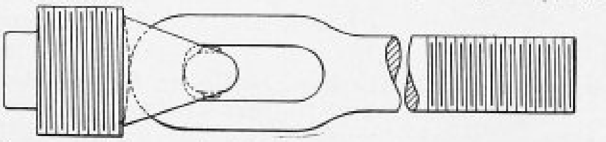
## Selected Boiler Patents

Compiled by
GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,308,185. STAYBOLT. ROBERT J. McKAY, OF PITTSBURGH, PENNSYLVANIA.

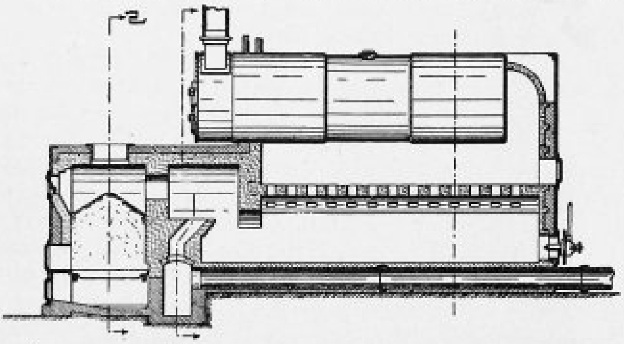
*Claim* 1.—A staybolt comprising a shank having a loop, an eye-head



having an eye-loop engaging the loop of said shank, said eye-head comprising an eye-loop portion formed with a longitudinally divided tail-piece and a cap inclosing said tail-piece. Four claims.

1,318,690. FURNACE. FREDERICK PEITER, OF BROOKLYN, NEW YORK.

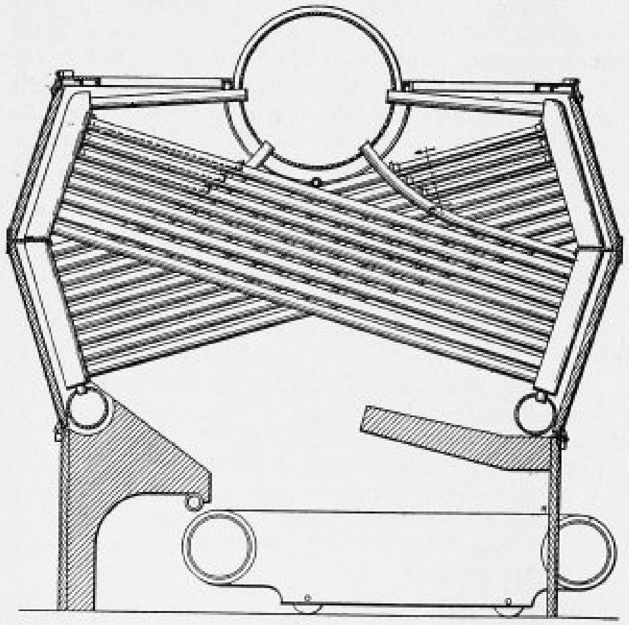
*Claim* 1.—In a device of the kind described, a gas generator chamber, a combustion chamber communicating with said generator chamber to



receive a generated gas from the latter, means for supplying auxiliary air to said combustion chamber for mixture with said gas, a muffle chamber into which the burning gas is discharged from said combustion chamber, a perforated muffle wall covering said muffle chamber, and a chamber above said muffle wall in which is located the ultimate object to be heated. Fifteen claims.

1,334,937. BAFFLE PLATE FOR BOILERS. THOMAS H. BURTON, OF CHICAGO, ILLINOIS, ASSIGNOR TO DE PERE-BURTON COMPANY, OF MILWAUKEE, WISCONSIN, A CORPORATION OF WISCONSIN.

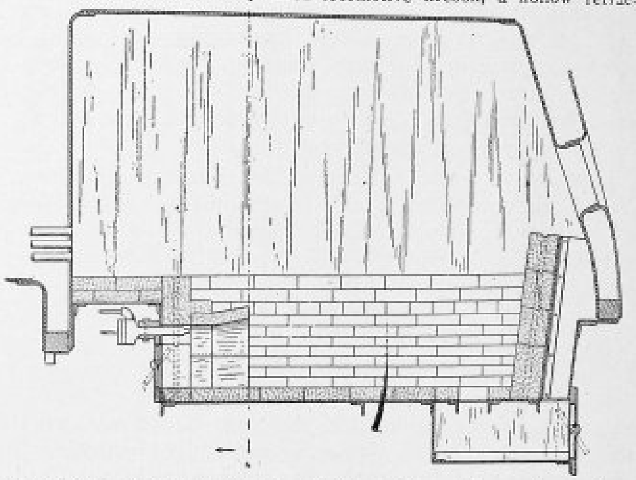
*Claim.*—A baffle structure for watertube boilers comprising a plate of angle iron with the ridge of the angle iron uppermost; separately formed



pedestals provided with angular saddles conforming to the under side of the plate; and lugs carried by the pedestals and disposed adjacent the saddles above and spaced apart therefrom a distance conforming to the thickness of the angle iron, the ends of the plate being received between said saddles and said lugs, in combination with a watertube boiler between and upon adjacent tubes, of which said pedestals are supported, said plate in conjunction with such adjacent tubes forming a baffle. One claim.

1,333,868. REFRACTORY BRICK CONSTRUCTION FOR LOCOMOTIVE BOILER FURNACES. JESSE C. MARTIN, JR., OF SAN FRANCISCO, CALIFORNIA.

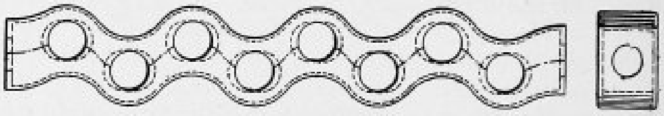
*Claim* 1.—In a refractory lined locomotive firebox, a hollow refrac-



tory brick, constructed of unit members positioned by and extending rearwardly of the refractory front wall thereof and held in place therein by the bottom refractory floor of the firebox whereby an air passage is provided through the brick into the firebox combustion chamber. Eight claims.

1,337,590. HEADER FOR TUBULAR BOILERS. JOHN J. CAIN, OF BAYONNE, N. J.

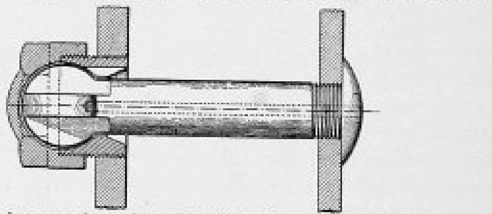
*Claim* 1.—A header for tubular boilers, composed of two trough-like vessels with thickened side and end walls and placed together with



tory brick, constructed of unit members positioned by and extending connected at intervals throughout their lengths by a welding process, and having holes through the welded sides at the spaces between the welded intervals. Four claims.

1,304,890. STAYBOLT FOR BOILERS. HARRY A. LACERDA, OF SCHENECTADY, NEW YORK, ASSIGNOR TO R. B. G. HAUGHTON, OF PITTSBURGH, PENNSYLVANIA.

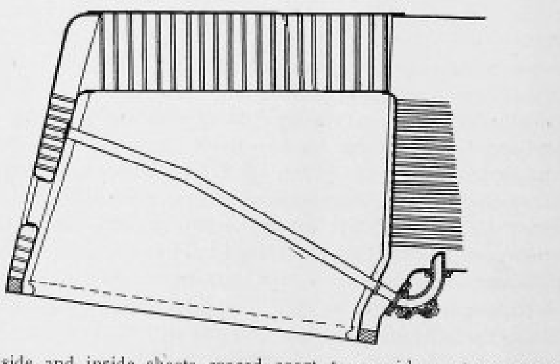
*Claim* 1. The combination with a locomotive boiler having a firebox,



bolt and a socket member, the said bolt and socket member having a ball and socket joint connection, and one of said members having a circulating passage for water or steam to keep the ball and socket joint free of extraneous matter and in clean, active condition, said socket member having a removable cap, and said cap having an end portion forming a wrench seat. One claim.

1,308,102. LOCOMOTIVE FIREBOX CONSTRUCTION. LE GRAND PARISH, OF NEW YORK, N. Y.

*Claim* 1.—A locomotive firebox construction comprising in combina-



tion outside and inside sheets spaced apart to provide a steam space and water legs, a circulation tube connecting front and rear water legs and having its forward and extending through both sheets of the front water leg, and a circulation extension member establishing communication with the boiler, having a flange adapted to be secured to the outside sheet over the end of said tube and a flange for attachment to the boiler sheet. Four claims.

THE BOILER MAKER

NOVEMBER, 1920

# Penstock Built by Duluth Boiler Works

### Contracts Handled by Boiler Shop in the Great Lakes District Include Both Pipe and Boiler Construction

At the present time the Duluth Boiler Works, Duluth, Minn., is completing the fabrication at their plant and the erection in the field of a new penstock for the Great Northern Power Company. The penstock is to be used in connection with a 13,500-horsepower motor generator set which is now being installed at Fond du Lac, Minn.

The importance of the work may be judged from the fact that the pipe line is 8 feet in diameter and approximately 536 feet long, involving a weight of materials of approximately 800,000 pounds. The plates in the penstock range in thickness from 1 inch at the lower section of the pipe to 9/16 inch at the upper end.

Some of the rivets used in the largest section of the pipe are 1¼ inches in diameter by 6 inches long and weigh nearly 3 pounds apiece.

#### Construction of Pipe

The pipe is of butt-jointed construction with double covering butt straps, quadruple riveted. Before being put into operation the sections of the pipe have been tested under a hydrostatic pressure of 240 pounds per square inch and for a working pressure at the pivot valve of 160 pounds per square inch.

#### Fabrication in the Shop

The penstock is made up in sections in the shop in lengths of 26 feet. These sections are then transported to Fond du Lac and hauled from the Northern Pacific right away to the top of the grade on a special industrial track which was constructed by the Duluth Boiler Works. Incidentally, the grade is about 41 percent. The pipe is then lowered into the trench section by section, where it is connected, riveted and afterwards thoroughly sand blasted and coated both inside and outside by a special covering made for this purpose.

Several of the sections as built in the shop weigh 28 tons each. From the accompanying illustration the difficulties which have been encountered and overcome may be readily understood.

After being given the specifications by the Great Northern Power Company, the engineering, detailing, fabricating, handling of the pipe and the erection in the field were entirely in the hands of the Duluth organization.

Penstock Installed at Fond du Lac (Minn.) Power Station

The undertaking is quite similar to one in 1914 when a similar penstock was built and installed for the Great Northern Power Company. Five units of this type are now in operation which make available a total of 67,500 horsepower in water power units.

At the same time that the work for the Great Northern Company has been in progress, the Duluth Boiler Works has been manufacturing 4,000 additional feet of penstock pipe for a large western power project. This pipe is similar in every respect to that described above.

#### Additional Work of the Company

Together with the work on pipe fabrication, the company is completing orders covering six hundred 10-foot by 30-foot horizontal oil storage tanks for prominent oil companies, as well as the complete installation of four 300-horsepower watertube boilers, including superheaters, soot blowing equipment and stokers. This power plant, aggregating an amount considerably over $1,000,000, is very complete and it is of special interest from the fact that it is being erected to serve the municipal and heating system of Hibben, Minn., although the town is small having only 15,000 inhabitants.

The complete installation of a 600-horsepower horizontal tubular boiler equipment is being made for one of the large grain elevator companies in Duluth.

The last of the sixty internally fired Scotch boilers which were being constructed for ships built at Lake yards by this company are now nearly completed. These boilers are of 14 feet 6 inches diameter by 12 feet in length. The shell plates are of 1 7/16-inch thickness with double butt strap joints. Each boiler has three Morison corrugated furnaces, three hundred and sixty 2¾-inch tubes, of which one hundred and thirty are stay tubes. Hydraulic riveting machines have been used throughout the work. Each boiler is built for a working pressure of 190 pounds and tested at 285 pounds hydrostatic pressure.

# Reducing Locomotive Repair Costs*

BY S. W. MULLINIX†

*Reducing the cost of repairing and maintaining locomotives has been open for discussion ever since railroads have been in existence, and probably will remain so. It is one of the most important questions which confronts the mechanical department today, and one which can only be solved by careful study, efficient handling, plus good, hard, honest labor.*

Never before has labor in all its branches required the efficient handling that it does today, and in view of the enormous increase in the cost of labor, we must find some method of increasing the production of each and every employee, regardless of his position, for example:

Make use of all labor devices which we now have available, such as electric and oxy-acetylene welders, high speed tools, drills and cutters, air tools, electric trucks, cranes and hoists. Create wherever possible new labor-saving devices or better methods of doing the work. Purchase where possible modern machines to replace obsolete machinery found in a great many railroad shops today. While a great many modern machines and tools have been installed, we have not kept pace with other manufacturing industries in the way of purchasing tools and equipment to handle repairs on the present locomotives. Establish and maintain rigid standards on as many parts as possible so that they may be manufactured in quantities on machines especially adapted for the purpose. This alone will save many dollars in labor in small shops and roundhouses which are forced to furnish parts which they have not the facilities to make, and which might just as well have been manufactured in larger shops or, better still, in a separate manufacturing plant.

### Rearranging and Regrouping Machines

The rearranging and regrouping of machines to eliminate the handling of material from one part of the shop to another often produces great savings. I recall one case of this in the repairing the flues. From the time the flue was started on the first machine, after it had been rattled until it was completed, safe end applied, cut to length, tested and annealed, it traveled just sixty feet, with no back hauls whatever.

### Cleaning and Stripping Engines

Engines and tanks should be thoroughly cleaned, all coal and cinders removed, front ends washed out before the engine is placed in the shop. Cleaning vats should be located as near as possible to where engines are being stripped; all parts removed should be cleaned before being sent to the various parts of the shop to be repaired. All parts removed should have the engine number stenciled or tagged on them so they may be replaced correctly. Many small pieces find their way to the scrap dock on account of not being properly marked.

Do no more stripping than is absolutely necessary. I believe we should be as careful in stripping an engine as we are in assembling it, for every piece removed must be replaced, and I sometimes think we go too far in dismantling engines. We will take down parts that were renewed or put in 100 percent condition in some roundhouse only a few days before the engine was sent to the shop. Sometimes in order to get a few more miles out of the engine, after the locomotive is authorized for general repairs, steam pipe joints are ground and pipes reset.

Engines should be carefully inspected before being placed in the shop, and also while being stripped, and parts such as pedestal binders, where found loose on frame fit, should be marked the amount necessary to close before being removed and should be repaired before being sent back to the engine.

### Work Reports

Engines sent in from outside points should be accompanied by a work report made out by the person having direct charge of the engine, as he knows the good and bad points of the engine under his charge and is more competent to make out an intelligent report and one that would be of some use to the people repairing the engine.

Locomotive candidates for the shop should be examined as far in advance of shopping as possible, to determine the repair part requirements, so that the store department will have plenty of time to meet the demand by placing orders for castings and other material not on hand. This examination should be supplemented by a more minute check while the locomotive is being stripped, at which time parts are more accessible. Certain care should be exercised to prevent the diverting to other uses of material intended for locomotives in the shop.

Tool room and portable tools should be located in convenient places with respect to points where the work is being performed to avoid unnecessary errands of mechanics and helpers.

### Routing and Scheduling

In all shops larger than the so-called one-man shop, there should be some method of routing engines and work through the shop, or a schedule system which will enable all departments to know just what work is to be finished first and when it is expected. It also enables the man in charge to tell just what departments are holding back the output, as the output of most all shops is controlled by one department, and any steps that will tend to build up this weak department will increase the output. It is very essential that our forces be equalized, and no matter what system you have, whether it is a simple or elaborate one, it will be no use unless it is followed up and followed up religiously.

### Supervisory Forces

One of the most important factors in increasing the efficiency of shops and roundhouses is the shop organization or supervisory forces. It is up to these men to make a careful study of their own particular class of work and department. They should be thoroughly familiar with locomotives and the tasks they have to perform and the conditions under which they have to perform them.

I believe a gang or boiler shop foreman should have at least some roundhouse experience, as only by actual experience do we realize what the roundhouse people have to contend with, and to know the things which give the most trouble. A machine shop foreman should have some erecting shop experience; he should also be familiar with the so-called standard practice cards used in a great many shops to describe the manner of doing different classes of work. These foremen should be examined by their

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* Abstracts from a paper read at the April 19 meeting of the Western Railway Club.

† Superintendent, C., R. I. & P. R. R. shops.

superiors from time to time to make sure that they are familiar with all standard practices.

The staff meetings held once a month or oftener, if possible, are very good if conducted with the spirit of making all feel that they are officers of the company and bringing them to realize the importance of doing their duties as such, endeavoring at all times to reduce the cost of labor by increasing the efficiency. We must increase our production without increasing the physical exertions on the part of the men.

### Visiting Shops

A great deal is accomplished by going to other shops to make observations and study the progressive features, whether they be large or small. We often run across kinks that are good and productive of reducing locomotive cost.

We do send foremen occasionally to other shops and they never fail to return without bringing something that is an improvement over what we have. My experience has been when visiting shops the officers in charge have always been glad to impart any information asked for, and also seem to take pride in showing their practice. If we feel that our methods are better than theirs, we should say so. We often get many good kinks from the traveling or supply men, as they have the advantage of seeing how work is being done in a great many shops, especially those who had been connected with the mechanical department, being more familiar with shop practice.

### Punching Material

Material represents approximately 40 percent of the cost of repairing and maintaining locomotives, a large percent of which is purchased either in the rough or finished state, and, owing to the high cost of labor and the absence of modern and special production machines in many railroad shops, there are many articles which can be purchased, finished, cheaper than they can be manufactured on our railroads. There are also many articles and tools sent from the purchasing to the mechanical department to be tested out to see how they compare with home-made articles and tools, as well as to compare with similar articles from other manufacturers. These tests should be given careful consideration, as they very often decide a standard for an entire system, and sometimes what is considered a successful article or tool in one shop is complained of by another. For this reason when an article is being tested it should be gone into thoroughly, having competent men pass on it.

During the war period the locomotive cost has also been greatly affected, due to shortages, which made it necessary to substitute all classes of material.

The mechanical department is to blame to some extent for this condition, due to the changing of patterns and specifications which no doubt are paying propositions, but tend to discourage the store people from carrying any large amount of stock. The mechanical department is also responsible for the great number of parts which the store is compelled to carry.

We must check over our material and equipment, eliminating where possible, and we must bear this in mind at all times, not go over them once and then sit back and imagine that the job has been completed. It never will be as long as we operate railroads.

Another very expensive practice is the robbing of material from one engine for another. We not only pay for removing and replacing the part removed, and the chances are that it will cost more to apply the piece removed than it would cost to apply a new one. If each one of these items were traced down you will find that if some one, whoever he may be, had been on the job it would not have been necessary.

Material where carried in stock by the store should not be ordered before it is to be applied, especially small finished parts, as they will be thrown around and either broken or lost, necessitating ordering another piece, which will double the cost. Shop people should be familiar with the cost of different items of material which they use, as it is surprising to many good railroad men to know just what many small items really do cost, and probably they would think twice before expressing the following sentiment: "Oh, throw it away and put on a new one."

### Manufacturing Locomotive Parts

The use of forging machines in our blacksmith shop certainly has worked wonders in the way of producing forgings which require very little or no finish, such as small side rods, eccentric rods, motion work, spring hangers and yokes, large hex nuts and other like material. Many large shops today are equipped with modern and up-to-date forging machines, which, with the proper dies, are a great help in reducing costs, as many of the parts now made require very little finish, where formerly they were finished all over. I believe the blacksmiths take a great deal more pride today in doing their work so as to eliminate finish. For example, in the main and side rods, center sections are forged to size, requiring no finish except where the rods are channeled. Guide blocks should also be forged requiring no finish except where they fit on the cylinder head and one face for the guides and yoke. Guides should also be forged so as to eliminate as much finish as possible. Parts such as piston rods and valve stems should be cut to the proper length. Wedge bolts should be forged and ends squared, so all that is necessary for completion is to thread them in a bolt cutter. These were formerly made from bar stock on turret machines. Eccentric blade forks, ends and jaws for other motion work should be made allowing finish only where they fit onto the links; outside contours may be ground off. Eccentric blades for the outside valve gears should be forged allowing finish only on the sides on the back end and for the link fit on the front end. Large hex nuts, as well as castle nuts, should be forged and holes punched, allowing very little finish. There are many other items where finishing can be reduced, or eliminated if we only look for them, as the less number of operation necessary to produce a finished part the less the cost will be. Dies for this work are very expensive and should be taken care of, and they will pay for themselves many times over.

### Reclaiming of Material

We have made wonderful progress in the last few years in the way of reclaiming material, although it will not be so noticeable in the next few years and the results will be as good, if not better, as we are making a more careful study of the things which might be reclaimed and other places where we can use material which has been reclaimed. We are also making many special machines such as rattlers for cleaning nuts and other small material, cutting shears and machines for straightening iron, special cutters for cutting gaskets and washers from old leather and rubber. The electric and acetylene welders have also worked wonders in the way of reclaiming. Most of this material is reclaimed after reaching the scrap dock and is handled in most cases by a special reclamation department.

There is also another side to the reclaiming question, one which is not so often heard. This is the reclaiming of material such as broken parts on locomotives without removing them or by removing, reclaiming and replacing on the same engine they were removed from. In most cases this is done either with the electric or acetylene welders. There is very often a close margin between the cost of reclaiming some certain piece and purchasing and applying a new one. In these cases we should apply the new piece, as we too often in figuring the amount which we save try to make the figures look as attractive as possible or to make a good showing without taking into consideration the life or wearing qualities o fthe piece we reclaim against that of a new one. We must guard against letting our enthusiasm get the best of our good judgment in the things which we reclaim. I will venture to say that there are many parts being reclaimed today at a loss in dollars and cents in the long run, and it is the long run or the cost per mile that tells the tale—both in material and labor.

The practice of welding small broken cast iron parts which in the first place do not require much finish is not worth the chances you take in getting a good weld. In many cases a new part will be just as cheap and much better.

As I look back through the years that I have been employed by various railroads I can plainly note the progress made day by day and year by year, made possible both by more modern machines and tools and by improving the methods of doing work. Still our progress has not kept pace with the modern locomotives, which are not only much larger but equipped with modern appliances such as mechanical stokers, superheaters, feed water heaters, brick arches and power reverse, all of which adds to the cost of maintenance. There is no comparison between the cost of repairing engines today and a few years ago. The average cost of repairing engines has increased year by year, but let us hope that by our united efforts we may make it possible by more efficient methods and practices to stop the upward trend of this cost, as this is necessary before we can reduce it.

## Essential Information for Boiler Shop Apprentices

BY GEORGE L. PRICE

What are the tensile strength and the elastic limit of boiler plate?

The tensile strength of a plate is its ultimate strength in pounds per square inch and the elastic limit is the limiting strength in pounds per square inch which may be applied without a permanent elongation taking place in the metal. This limit is approximately one-half the tensile strength, and when the applied load equals or exceeds this point the metal will not resume its original dimensions after the load is removed.

### Use of a Safety Factor

What is the factor of safety for boiler work?

The factor of safety is the ratio between the working pressure and the pressure at which the boiler will burst.

Should staybolts have a greater factor of safety than the boiler shell? If so, why?

Because staybolts are threaded, cracks develop more easily than in solid plate. A comparison might be made between a threaded bolt and an iron rod that has been nicked in a vise with a chisel, which, if it is bent back and forth, will break where it has been nicked. Staybolts are subjected to both a direct pull and a vibratory stress, so that their factor of safety should exceed by many percent the factor of safety of the boiler shell.

The greatest angle at which a brace should be inclined must not exceed 20 degrees, if it is to give a maximum support.

### Pop Safety Valves Required on Locomotive Boilers

Why are pop safety valves used in locomotive boilers?

These valves are used due to the fact that locomotive boilers are subjected to such treatment that ball and lever valves, if installed, would soon get out of order. Pop safety valves have not the objectionable features of the other type and are used on most boilers.

### Patching the Firebox Sheet

What is the proper way to apply a patch to the inner side sheet of a locomotive boiler firebox?

When applying a patch to the inner side sheets with rivets or patch bolts, staybolts in the rivet line of the patch should never be included. Staybolts must not be used to secure a patch to the sheets, as they have their own load to take care of.

When arch plug holes in the door sheet or flue sheet are to be plugged, side rods should be used in the interests of safety. In fact, all plugs larger than 1¼ inches in diameter should be tied in with side rods.

### Applying the Hammer Test to Staybolts

Can fractured staybolts be discovered by the hammer test?

It may be possible to do this, but the writer has never found it so. The proper method of locating fractured staybolts is by an internal inspection, in which case a mark at the point of fracture may easily be detected by experienced inspectors.

What load is carried by a staybolt?

The load is equal to the area supported at the staybolt multiplied by the steam pressure per square inch. In the case of staybolts spaced 4 inches between centers in a boiler carrying 150 pounds per square inch steam pressure, the load on each staybolt will be $4 \times 4 \times 150 = 2{,}400$ pounds.

### Practical Example of Area to be Stayed

Allowing 6,000 pounds stress per square inch for a staybolt, what area may be supported when the least diameter of the bolt in question is ⅞ inch and the working pressure on the boiler is 200 pounds per square inch?

The area of the staybolt must first be determined:

$$\text{Area} = \frac{\pi^* \times \text{Diameter}^2}{4}.$$

$$A = \frac{\pi D^2}{4} = \frac{3.1416 \times 0.875^2}{4} = 0.6013 \text{ square inches.}$$

Multiply the area of the staybolt by its allowable working stress per square inch and divide the product by the working pressure per square inch. This gives:

$$\frac{0.6013 \times 600}{200} = 18.03 \text{ square inches.}$$

Staybolts are threaded twelve threads to the inch in order to make them steamtight and to improve their holding power over what would be obtained with the standard threads.

Is the area of a threaded stay calculated from its outside diameter?

No. When a staybolt is threaded its entire length the area is calculated from the original thread.

### Allowable Stress on Staybolts

What force will a staybolt having an allowable working

* $\pi$ is a constant value = 3.1416.

stress of 6,000 pounds per square inch resist if it is chamfered at the center to ¾-inch diameter while the diameter at the root of the thread is ⅞ inch and that of the telltale hole is 3/16 inch?

First, the area at the root of the threads must be determined and from this must be deducted the area of the 3/16-inch hole. The two areas may be solved by substituting the diameters given in the formula of the example above. This will be:

$$\frac{\pi \times 0.875^2}{4} - \frac{\pi \times 0.1875^2}{4} = 0.601 - 0.028 = 0.573 \text{ square inches}$$

The area for the staybolt at its ¾-inch diameter will be 0.442 square inches. The area at the ¾-inch diameter is therefore less than the area at the root of the threads minus the area of the telltale hole, so that the load to be allowed must be computed from the ¾-inch diameter area.

Area × working stress = the load to be allowed on each staybolt. Substituting the above values, this becomes 0.442 × 6,000 = 2,650 pounds.

## The Back Pressure Gage*

Notwithstanding the fact that the effect of excessive back pressure on the operation of locomotives is well known, it has been given little attention in practical locomotive operation. The primary object of adjustments of draft appliances is, of course, to improve the steaming of the locomotive, and so long as steam enough can be generated to do the work, little attention is paid to the effect of the adjustments on the steam economy of the engine proper. Back pressures as high as 20 pounds and 25 pounds are not infrequently attained in every-day service, and seldom are disclosed so long as the locomotive maintains schedules or handles its tonnage. It is true that there is a growing dissatisfaction with the status of our knowledge of the locomotive front end, but it has not yet reached the point where the railroads are willing to take the measures necessary to place front end design on a scientific instead of a rule-of-thumb basis. As a means of disclosing just how bad conditions are, the use of the back pressure gage mentioned in the report of the committee on draft appliances at the recent meeting of the Traveling Engineers' Association in Chicago is worthy of general application. The device mentioned is nothing more than a pressure gage in the cab, connected by suitable branch pipes to the exhaust cavities of the cylinders. Ultimately the greatest return from the use of this device undoubtedly would be the sentiment its disclosures would create in favor of a scientific investigation of the whole problem of locomotive drafting. But it would also be of immediate value in comparing draft conditions on various locomotives of the same class; it would show why some locomotives are unable to maintain schedules well within the capacity of others of like design.

* *Railway Mechanical Engineer.*

## English Type Electric Riveting Machine

Electric power is available in nearly every up-to-date boiler shop, and the electric riveting machine has become almost of equal importance to the hydraulic and pneumatic riveting machine in British shops. Most of the large shops have both these forms of power available, but the distributing mains are not carried entirely throughout the plants, so that there is an opportunity to apply electric power to riveting both in such cases and in smaller shops where pressure water or air pressure systems are not installed.

The electric riveting machine constructed by the Mada Engineering Company, Limited, of Liverpool, England, illustrated in Figs. 1 to 6, gives an idea of the development along this line in England. The machine known as the "Remca" consists of a bow frame with the operating mechanism carried on one arm. The machine may be used vertically or horizontally as desired, it being possible to fasten a stand to the base or the side as shown in Figs. 1 and 3. The operating mechanism consists of a long stroke solenoid so arranged that full advantage is taken of the increasing gain in power which is obtained as the magnet approaches the end of its stroke, when the final heavy pressure is required to form the rivet head.

### Operating Details

Details of the operation of the machine will readily be understood from Fig. 4. The rocking lever *A* pivoted to

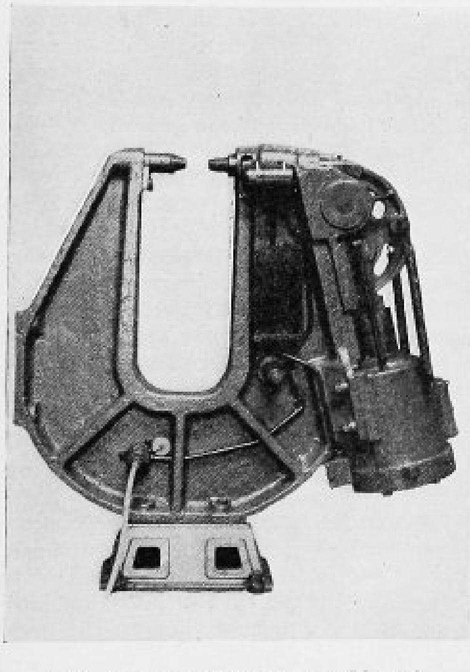


Fig. 1.—Riveter Arranged for Vertical Work

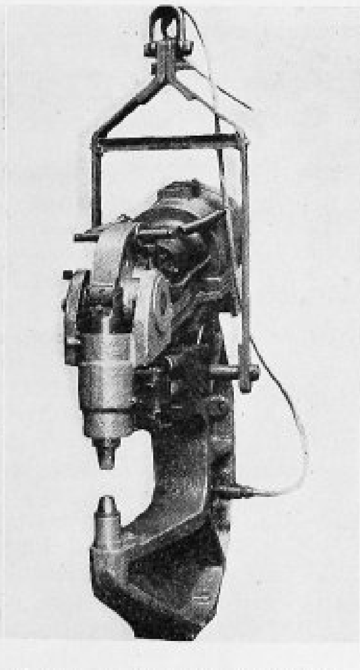


Fig. 2.—Riveter Slung from Crane for Portable Work

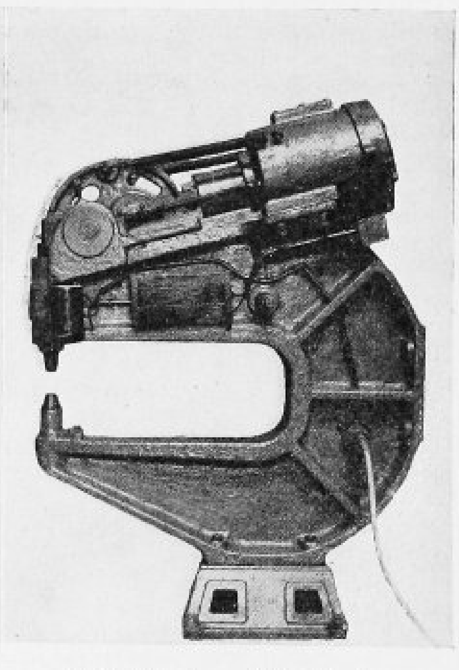


Fig. 3.—Position of Machine for Horizontal Work

the frame is attached by a pin joint to the head of the riveting ram. As the lever is rocked, the arm is lifted or depressed. The roller *B*, carried between the side plates *D*, which are secured to the end of the solenoid core, operates the lever. This roller *B* works on an inclined extension of the lever *A*, and it is evident that as the solenoid is drawn inward by the coil, the lever *A* is rocked over

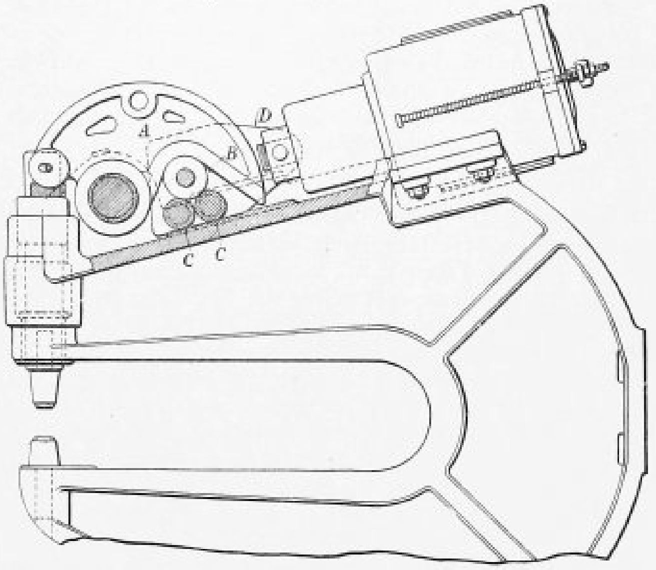



Fig. 4.—Sectional View of Riveter Showing Operating Details of the Machine

and the riveting ram forced down. The side plates *D* carry two other rollers *CC* on which the roller *B* works, the whole arrangement forming a roller bearing construction.

Both the solenoid core and the rocking lever are actuated by springs which return them to position after the power stroke.

In Fig. 5 the electrical connections of the riveter which are quite simple are shown. In Fig. 6 a cross-section of the flexible cable is given. A ground wire is incorporated in this cable so that the frame of the machine may be ground if desired.

The tool is operated by alternately closing and opening a switch, and more than one point may be arranged for by fitting separate switches. When the rivet is headed, the pressure may be maintained while it partially cools by leaving the switch closed. Trials of this machine have indicated that a ⅝-inch rivet may be headed with 16 amperes at 230 volts, the time from closing the switch to opening it being 3 seconds. The riveters are built in sizes to handle rivets from ¼-inch to 1¼-inch diameter and with various depths of gap.

## Organization of American Welding Bureau

A plan for the reorganization of the American Bureau of Welding is now being proposed by Professor C. A. Adams, director of the Bureau.

This plan is briefly that the Bureau be organized as the general welding research advisory committee of the American Welding Society, and also of the Engineering Division of the National Research Council. The members of this committee or Bureau would be made up of representatives appointed by all interested societies and organizations and a certain number of members at large chosen for their special ability and interest in welding matters. The dominant representation, however, would be from the American Welding Society, as it is the society most interested.

The new scheme of organization has been heartily endorsed by a number of the older members. A tentative programme of activities for the Bureau has been drawn up by C. A. Adams, H. Lemp, S. W. Miller, C. A. McCune, H. L. Whittemore and W. Sparagen, and is given below:

1. Standardize welding procedure, in so far as possible, for each process and for each application of the process

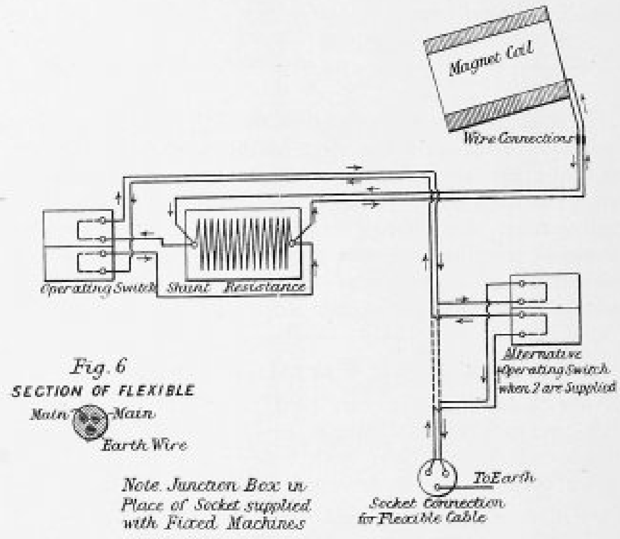



Fig. 5.—Wiring Diagram Indicating Simplicity of Electrical Connections

in order that users may have the best available instruction for the work.

2. Compilation of data as to strength, ductility, etc., of welds made by the various methods; also such data as will enable the user to estimate cost of welding by the various methods. These data should be so arranged in tables and curves as to be most expressively and conveniently useful for the various conditions and types of work met in practice. It should also be accompanied by such information and references as to the various tests recorded as will enable the reader to judge intelligently of the value of the resulting data.

3. Develop a standard training course by obtaining from the railroads training schools and other sources copies of methods of welding instructions, and from them and other experience make up a set of instructions, giving proper credit for the ideas and methods selected. This course shall also include inspection training.

4. Collection of impartial information and data, based on tests of welding apparatus, including such data as efficiencies, pounds of metal deposited per hour and per kilowatt hour under specified conditions, power factor of alternating current apparatus, cubic feet of gas per hour and per pound of metal deposited, data on apparatus and material needed for other processes of welding such as thermit, spot electro-percussive, automatic arc, etc.

5. Compilation of impartial information on welding materials such as fluxes, gases, electrodes and welding rods. (Note.—Certain research work will have to be carried out in this connection.)

6. Standardize methods of inspection and testing of welds.

7. Make sets of sample fractured welded test specimens of specified materials made by standard procedure which will be furnished to those interested upon payment of a proper fee. (Note.—The Bureau of Standards standard sample of steels has been of immense value to the steel industry.)

8. Revise and standardize welding nomenclature.

# The Immediate Future of the Boiler Manufacturing Industry

BY L. W. ALWYN-SCHMIDT*

*The most important question before the boiler manufacturers at present is that of the future possibilities of the industry. The author of the following article points out that the problem will solve itself, for new industrial developments in this country will create a greater demand here and trade expansion in foreign fields will provide a ready market for our surplus power units abroad.*

When our economists and business men were talking about the readjustment period during the war, this was done always in a manner as if readjustment meant a continuous action that could be regulated at will and not a multitude of economic processes, each acting from a different point and distributed all over the world. In consequence, reconstruction took in our minds the shape of a sinister process that would need the application of special forces all under our own control, instead of being merely a natural development that had to take its course. The result of this faulty angle of observation was that we have been inclined to interfere by artificial means with the operation of natural laws, adding in this manner to the entanglement instead of facilitating its solution. Problems have been created where there were none.

One of these problems has been that of credit inflation. We have accepted the rise in commodity values as something aside from the rest of the readjustment period, while it is in reality only a comparatively insignificant part of it. We are now inclined to view the drop in prices as a new disease, while it is nothing else but the outward expression of the recurring health of the economic body of the world and our own domestic market.

> The coming winter will not be an easy one for American industry. Not that there is actual trouble ahead, but the process of readjustment which has been affecting industrial production during the last two years has now come to an end and the economic life of the nation has taken a definite turn in the direction of lower prices. This will mean a considerable shifting of economic forces in the factories, which in turn must have an effect upon the supply of all industrial equipment, including that of boilers and power supplies in general.
> —*L. W. Alwyn-Schmidt.*

### Interdependence of Prices

True, if the price of cotton goods should decline today independently from the prices of all other goods, this certainly would be a very serious blow to the cotton industry. But it must be well understood that an independent drop in the cost of any article is an economic impossibility. Sudden rises or drops in the cost of any article will happen, but statistical research will soon show that the average price remains always in conformity with the price levels governing the whole market. American industry has nothing to fear in any sporadic and independent reduction in the price of any article, but must expect a slow reduction in the price of all. Or, to speak in money values, the dollar that today will buy only 50 cents worth of goods at the pre-war standard will be worth 75 cents in the future, or even more.

The prices of shoes, of eggs, of cloth—all will decline evenly. It is a matter of indifference to the maker of shoes whether he receives $7 for a pair of shoes or $4, so long as $4 will buy in the future just as many eggs as will $7 at the present moment. In turn, it is just as immaterial to the farmer whether he receives $4 or $7 for his eggs, as long as he can get a pair of shoes for the same number of eggs. This is the point that the manufacturer must keep clearly in mind when approaching the problem of price adjustment which now faces him.

### Decline of Production Costs

Raw materials, the cost of equipment and even overhead expenses will decline uniformly with the general price and cost situation. Only one factor will finally undergo a severe change; this is the cost of labor. Let us not close our eyes to the fact that labor has gained for itself a new position in the world's affairs. The quicker we realize this fact, the earlier shall we be able to deal with it in a sensible manner. The man behind the lathe has improved his economic position during the war and has climbed up a few steps of the ladder that leads to social happiness and enjoyment of life. In the future the percentage of labor cost upon the price of manufactured products will be higher than in the past. Where labor retained 20 percent from the value of the output at cost price it will in future retain 25 or even 30 percent.

If we have once assimilated this truth it will be easier for us to deal with its effect upon cost. This 10 percent added to the cost of production will either have to be unloaded upon the consumer, which also means the producer where he becomes a consumer, or preferably must be neutralized by savings in the cost of production. Such savings should, of course, be applied first to the spot where the price increase has occurred, which is labor. As the pay rate of the individual workman cannot be reduced, it will become necessary to reduce the number of men who are required on any given job. This will reduce the cost of the article and also will set free labor for other employment, adding to the productive capacity of the American industry.

### Boiler Industry Aids in Reducing Cost of Production

The problem of neutralizing the effect of labor and bringing down the cost of production to a normal level is a matter for the engineer. The solution will undoubtedly be in further replacements of human labor by machines.

The importance of this for the boiler industry is evident. One cannot expect to increase the machine power of industry without adding also to the power equipment. The question is, how much of the newly required power capacity will really flow to steam generated power equipment and how much will be generated by other means? There is no denying the fact that steam power generation has not quite kept step in recent years with the demands of

* New York Economic Service Bureau.

the minor industries. The individual steam power plant is severely attacked by the electrical and internal combustion motor, and reforms will have to be undertaken if the field is to be completely recovered. It is generally realized that steam power has many advantages as a power generator which are not found in other known forms of power generation. This is especially the case where no water power can be had. The fact that we have in our possession still an enormous steam power equipment is another reason why no rapid change from one form of power generation to another can be expected. The boiler, therefore, remains a very important feature of all power generation, and every increase in the power supply of the country must inevitably bring a correspond'ng demand for boilers. We need not, therefore, fear any severe depression in the boiler industry as long as there is a chance for an increase in power consumption.

### Problem of the Central Station

But a new problem arises which requires the urgent attention of all those interested in the well being of the boiler industry. The war has shown that our present system of fuel management is wrong in principle, although no really serviceable suggestion has been made to change it. The burning of coal by individual consumers; the transportation of coal to a great number of points of consumption; the difficulties in handling coal over long distances, and many other defects have become very pronounced during and since the war. The electrical industry has been very ready to take up the cry for improvements and has to offer electrical power to individual plants formerly utilizing steam. The argument of the electrical industry is strong and is exceedingly dangerous to the steam power industry, especially the boiler industry, which finds the greatest number of customers in the sale of individual boiler equipments. In England the beginning has already been made by erecting large super power stations which will distribute electrical energy over wide districts, eliminating practically the steam boiler. The same thing has been attempted in Germany.

### Change in Firing Steam Power Equipment May Become Necessary

Of course, boilers are required for operating central stations, but the outlook would be rather bad if the boiler industry were obliged to exist on the construction and repair of the comparatively few boilers required for this purpose.

The oil burning vessel has shown already one way by which the present firing methods can be improved and the load upon coal distribution be relieved. English engineers have now come forward with another proposal, which also is supported by continental European power engineers, namely, to replace coal firing under the boilers with gas firing. It is argued for this project that it is not revolutionary in character, leaving the power equipment practically where it is and the industries building steam power equipment practically unimpaired. The firms constructing coal firing appliances may just as well turn to the building of gas fired installations.

Europe regards this change not only with the eye of the engineer, but also with that of the economist. Europe has no money to waste, so it is not ready to discard steam power in favor of electrical power where steam power is installed. It has a very great argument in favor of a change of firing, however, and this is the growing shortage of the supply of coal, coupled with the increasing demand for its by-products. As long as food can be made from coal, and dyes and medicines, to mention only a few of the products, it cannot be a matter of indifference that a great quantity of coal is burned without having first obtained the by-product. A movement is on foot that can lead to no other conclusion than the complete prohibition of burning coal wastefully, wherever it can be prevented.

This does not mean that the boiler industry will have to take sides in the dispute over the selection of the firing system. The only interest is that steam power generation in its present form be continued. This will be the case if the firing problem is solved in a manner suitable to our new economic conditions.

Incidentally, the question arises whether it is not time for the boiler industry in the United States to aid in the expansion of steam power generation in other industrial fields. The demand for boiler equipment in the United States has not reached its highest point by far, and many years will pass before the peak is reached. The demand for industrial products is growing rapidly all over the world, and while this process goes on there must be a demand for boiler equipment somewhere in the world.

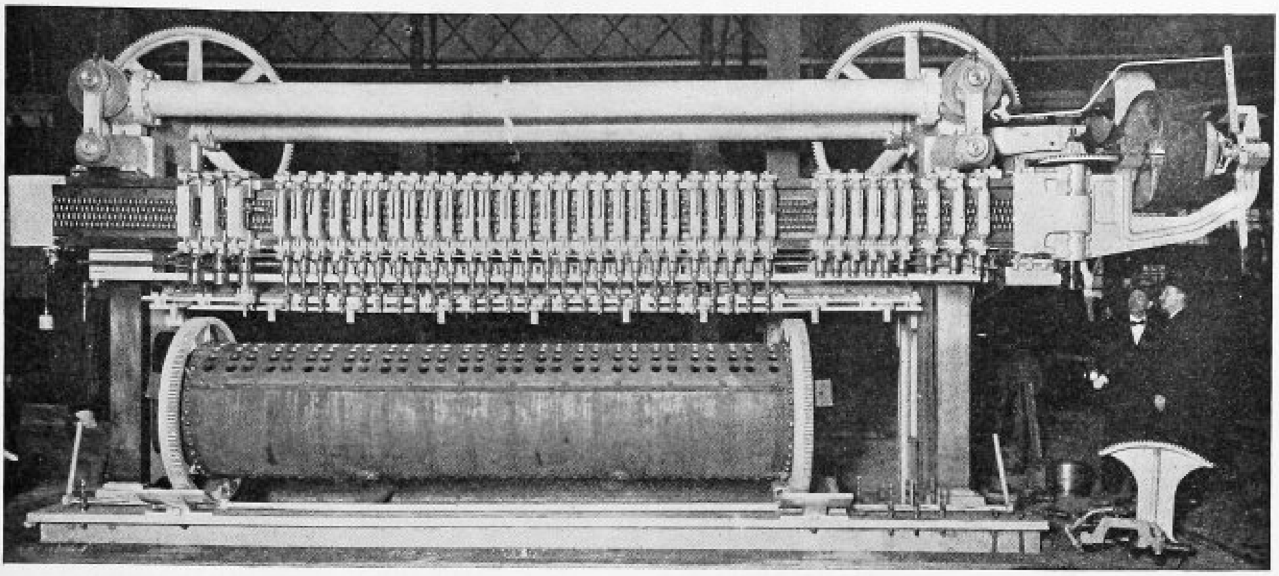
Take, for instance, South America. Wherever one looks, whenever one opens a South American paper, one finds reports of the foundation of new factories, of artisan shops turned into industrial enterprises and of increases in the demand for industrial equipment. Our machine tool industry is finding a considerable demand in South America. The English machine tool manufacturers also look to South America for a large and growing market. No machine tool can work unless there is the power to move it.

The plantation industry comes forward with quite an enormous demand for boilers. Sugar making cannot be done without the aid of steam. Of the great number of boilers supplied during the last year by the American boiler industry to Cuba, a large percentage has gone into sugar factories. This growth of the plantation industry provides, all through South America, an important market for boiler equipment, that will grow from year to year. Here also the firing problem has turned up.

The sugar factories prefer to burn bagasse under their boilers and the firing arrangement must be constructed accordingly. Farm and plantation refuse generally makes a very good fuel, and steam generation cannot expect to prosper in South America unless our manufacturers are willing to aid in the introduction of firing systems other than coal. This may necessitate changes in the construction of the boilers, but the point is not that our industry should avoid inconvenience but that it should gain for itself a large and continuous market all over the world.

What applies to South America applies just as well to South Africa, to British India, to Eastern Asia and Australia. These countries are not so poor of coal as South America. On the other hand, the conservation of national resources is more highly developed in Australia, for instance, than in practically any other country of the world. In New Zealand a large programme for the exploitation and conservation of national natural resources has been worked out and is being slowly carried into effect. Such a programme will not permit the existence of wasteful methods, and it is practically certain that no coal will be burned in a short time in New Zealand unless care has been taken to save some or all of the by-products. This is a very important point for the boiler industry of the world to keep in mind. It is just as clear that only that country will get the business which has made the widest advance in the conservation of coal and the manufacture of equipment suitable for this purpose.

The immediate outlook is good abroad and at home. What the American boiler industry needs at the present time is to keep its eyes open for changes in the economic situation. If the firing principles undergo an alteration, the boiler industry must take early notice of this fact.



Machine 20 Feet Between Housings, Weighing 25 Tons, Designed for Drilling a Row of Holes Simultaneously Through Boiler or Other Heavy Plate

# A Multiple Spindle Drilling Machine

BY G. L. BOHANNON*

*The quantity production demand for boilers during the war led to the development of a multiple drill which permits placing the boiler industry more nearly on a manufacturing basis than has been possible in the past. The following article gives a short description of the machine and some of the work accomplished by it.*

The necessity of utilizing the man power available in various industries in the most efficient manner for the past two or three years made necessary the development of labor-saving machines of many kinds. In the boiler industry, in structural steel work and in the shipyards, the time-wasting process of drilling single holes in plates or punching small holes and reaming them to size pointed out the need for a machine that would eliminate the inefficiency of these methods. Such a machine was invented by Aaron Hill, of Los Angeles, Cal., and is now built by the Thomas Spacing Machine Company, Pittsburgh, Pa.

Six of these machines have been in successful operation for some time; two at the boiler works of the Badenhausen Company at Cornwells, Pa., one at the Erie City Iron Works at Erie, Pa., one at the D. Connelly Boiler Company, Cleveland, Ohio, and one at the Heine Safety Boiler Company at Phoenixville, Pa., and St. Louis, Mo.

### Description of Machine

The capacity of this drill is unlimited, the spindles are chain-driven, and by virtue of the almost direct application of power require a comparatively small horsepower consumption for the operation, thus enabling great latitude in the number of drills driven. The flexibility and strength of the chain drive also makes a machine that is adaptable not only for heavy duty, but for gang drilling on any type of work. The cycle of operation in the actual drilling is completely automatic. The spacing of the spindles is universal, above a minimum which on the heavy duty type is 2¾-inch centers.

The main feature of this machine is the chain drive, which gives a direct pull on the spindles and is found to eliminate power losses or chatter.

The spindle sprockets engaging the chain are staggered, which distributes the load over the several chains provided; and the web of the drill carriage forms a lubricated runway for these roller chains and serves to prevent the chain from slipping off the sprockets.

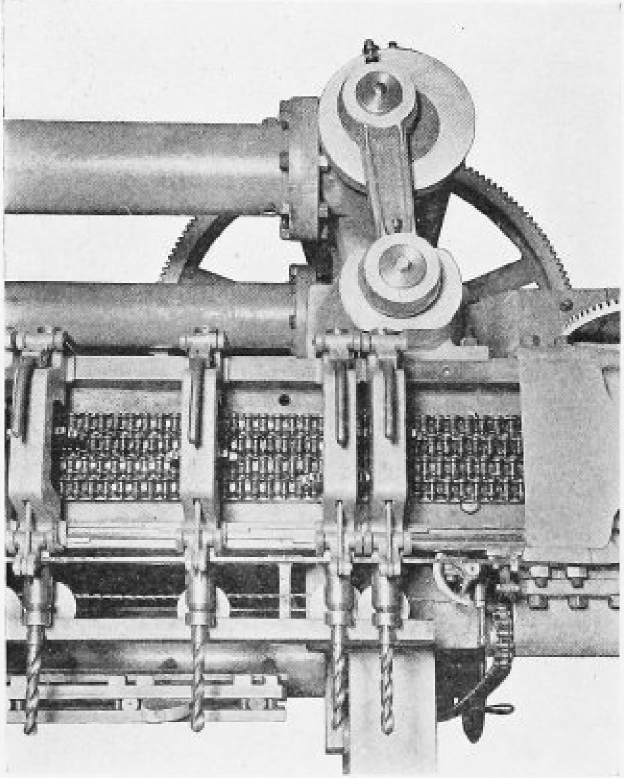
Other features of this machine that are worthy of note are that it feeds down the drills automatically; it also clamps the work in place exerting over twenty tons pressure, which is sufficient to straighten any ordinary sweep or buckles in plates; it lubricates the drills individually and stops the lubricant when the machine is not in operation; it stops automatically when drilling is done, releases the clamps automatically and is ready for the next cycle of operation.

### Unit Construction of Drill Heads

The drill heads are built as independent detachable units. Each unit consists of a small bridge casting which straddles the chainway and is machined at each end to slide easily along the carriage rails. At the top and just above the spindle socket are hinged clamps operated by levers linked to the adjusting handle for moving the spindle to the desired spacing. Placing the spindle to the correct centers is facilitated by means of a steel tape stretched across in front of the spindles. The units weigh from forty-five to sixty-five pounds and can be easily handled. The entire lot of spindles may be set in ten minutes' time.

The usual practice in drilling calls for higher speed and slower feed the smaller the diameter of the drill. This feature is automatically taken care of without changing the feed or speed of the machine proper, but by variations in the design of the various size units. A unit designed for a number 3 socket taking drills up to 1¼ inches is equipped with a 10-toothed sprocket turning up to about 160 revolutions per minute with an average feed of 0.004 inch, while the unit for the number 5 socket holding a

* Eastern representative of the Thomas Spacing Machine Company, Pittsburgh, Pa.



Mechanism in Starting Position with Disk Crank Just Past Dead Center

3½-inch cutter is equipped with a 20-toothed sprocket turning 80 revolutions per minute and feeding at an average of 0.008 inch per revolution.

The feed is controlled by the rotation of the large spur gears which are mounted on shafts, on the front end of which are disk cranks. The adjustment of the drills to the starting position is accomplished by hand, as it requires very little time. In the starting position the disk cranks hold the carriage just past the upper dead center, so that the initial drill feed is a minimum, in the first stages approaching the maximum of 0.005 inch per revolution passing through the body of the work and automatically diminishing to about 0.003 inch at the break through. This variable feed safeguards the machine against shocks and minimizes losses from breaking drills by "hogging" or the break through.

### Adjustment of Feed

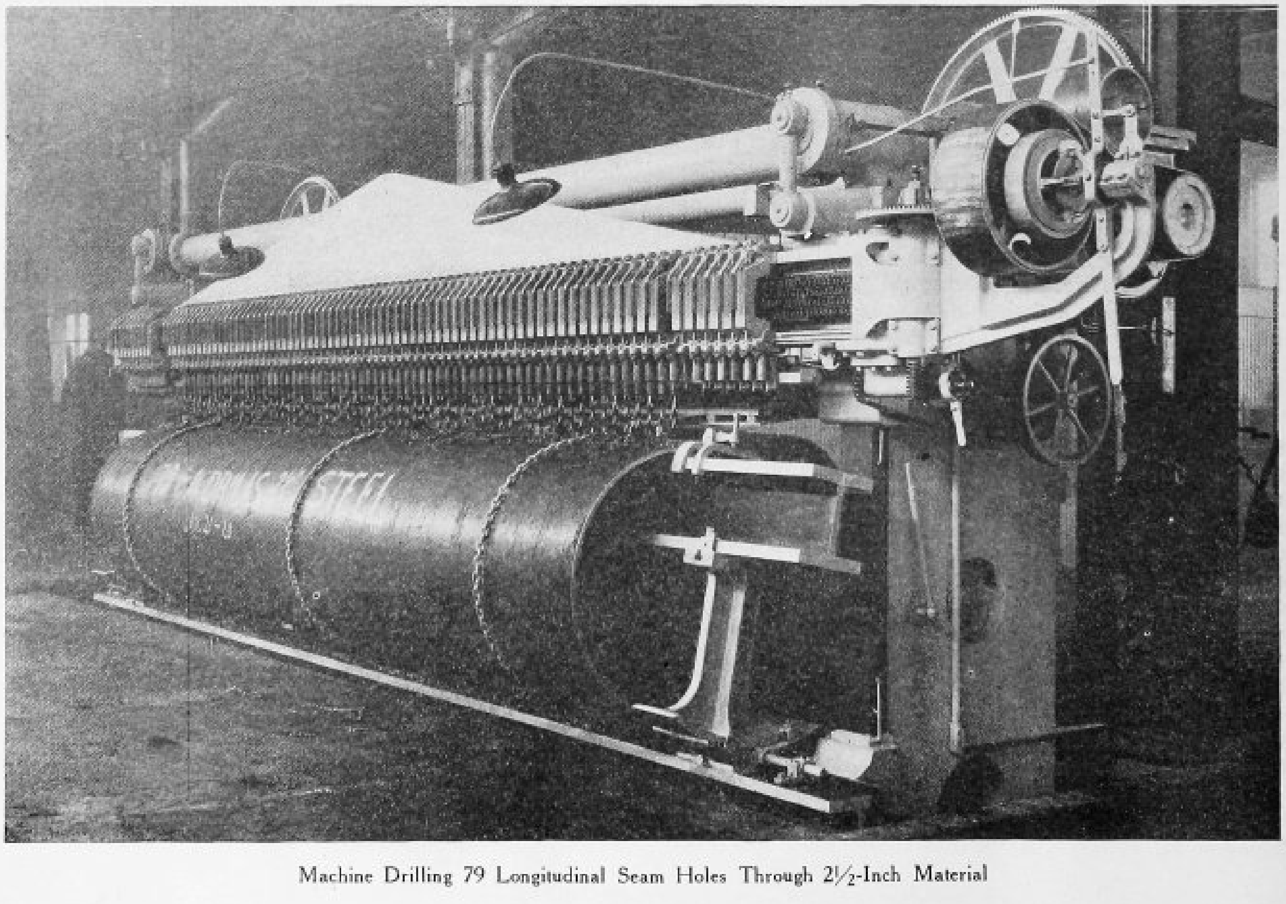
The machine is adjusted to feed slightly beyond the break through before reaching the lower dead center, and upon passing this point 600-pound counterweights on the two large spur gears simultaneously pass through in the top point of equilibrium and throw out of balance, whirling the spur gears through an arc of 180 degrees and raising the drill beam back approximately to starting position.

During the return position a small cam on the hub of the large gear at the driving end operates a lever to throw the clutch out and break the motor circuit, bringing the entire machine to a standstill.

Various tables for different classes of work such as channel, "I" and "H" beams, as well as for plates of practically any length and width may be fitted to the machine. The 80-spindle equipment illustrated has a 20-foot span, an overall height of 14 feet and a weight assembled of 56,000 pounds.

### Drilling Tests

In the various tests conducted on the drills is recorded one in which forty-four 1 1/16-inch diameter holes were drilled through ⅞-inch plate and ½-inch inner and outer butt straps, with a total of 11 horsepower required for the work.



Machine Drilling 79 Longitudinal Seam Holes Through 2½-Inch Material

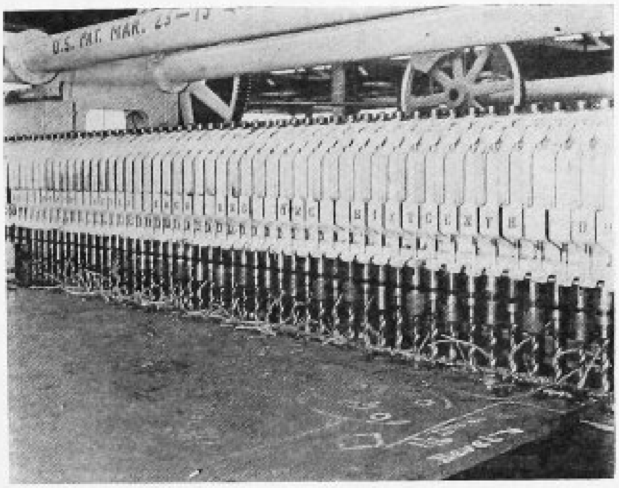
On a chart record of two tests conducted on 2-inch plate a maximum of 47 horsepower was required to drill fifty 1 1/16-inch holes, the time taken for this work being 4 minutes 41 seconds. The second test required less power and less time to drill the same number of holes in 2-inch plate, the maximum horsepower in this case being 44.2 and the time 4 minutes 21 seconds.

### Application to Boiler Work

In drilling the drums of boilers the inner butt strap is placed upon the beam of the machine and held in position by special gage bolts. The beam, having geared wheels on each end, is then run inside of the drum shell, which is already rolled up without holes in it. Special slings are used to lift the beam onto cradles, after which the outer butt strap is placed in position. Automatic clamps, with which the machine is fitted, hold the straps and drum down upon the beam with a pressure of over 20 tons. When the drills are properly set and placed according to the method previously described, the drill runs one complete row of holes longitudinally and then is automatically released. In actual running tests, 30 drills have been set at various spacings in 5 minutes.

### Circumferential Feed

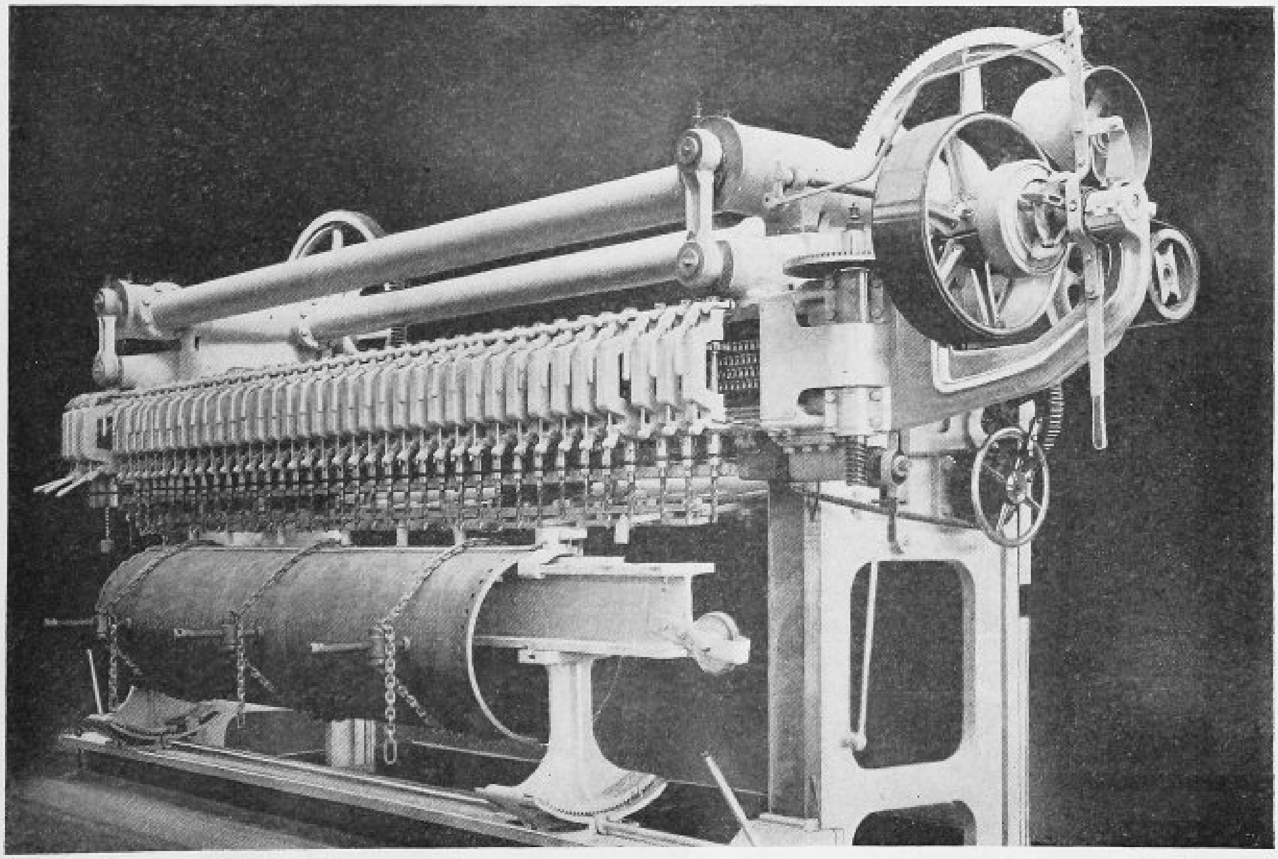
The cradle of the machine is geared so that it can be moved circumferentially to bring the next pitch in line for drilling another row of holes. The hand clamps shown in the detail of the drill holders make possible the removal of any spindle that is not required for certain drilling operations. Tube holes 3¼ inches in diameter may be drilled with large size spindles, 32 or more being accommodated at once, so that the labor-saving facilities of the machine cover a variety of drilling operations usually necessary in boiler work.




Detail of Drill Units Working on Flat Plate

Just at this time when production costs must be cut to a minimum to meet the new level of prices, machines designed to accomplish a saving in time and labor are important in every industry. The day for doing multiple drilling operations by means of hand tools or on individual drill presses has gone by in modern shops, and work of this kind can be speeded up by utilizing equipment available.

Although, conditions are such now that plants are making no attempt to increase their facilities, the existing period of industrial depression will be ended within a few months, and a new era of business prosperity will begin, in which machines are bound to play an even more important part than they have in the past.



Control and Feed Mechanisms of Multiple Drill Are Clearly Shown in This View of the Machine

# How to Design and Lay Out a Boiler—XXVI

**Further Details of Setting Boilers—Construction of Combustion Chambers—Reinforcing the Side Walls in Cases Where Special Foundations are Needed**

BY WILLIAM C. STROTT*

The loss of heat from boiler furnaces due to radiation through the brick walls is enormous, and is a matter to which considerable thought has been accorded. Various expedients have been resorted to with more or less success, with a view towards reducing this heat-loss to a minimum.

One method, and probably the most successful for an ordinary brick-set boiler, is that of providing a "dead" air space in the center of the brick-walls as shown in Fig. 107.

The principle upon which this construction is based is that dead air (i. e. non-circulating) is the most perfect non-conductor of both heat and cold that is known. It is due to this theory that our modern fireless cookers and the well known thermos bottle were produced. It has also been proved that any heat insulating material containing a maximum number of dead air cells is far more effective than a material which is more dense or compact. Therein lies the efficiency of magnesia wool and asbestos fiber when used to cover steam pipes and exposed boiler surfaces against heat loss by radiation.

An air space in a brick boiler wall if not properly constructed so as to be a dead air space in every sense of the word is, however, worse than useless. If cracks or openings in the outer or inner walls are not properly closed, then air circulation will result, and the final effect is as though the outer wall were omitted altogether, in so far as its ultimate usefulness is concerned.

Fig. 107 also illustrates the usual method of flaring out the side wall directly over the grates so as to allow the hot gas to strike every portion of the boiler heating surface, up to the center line of the shell. This construction is of course employed only where the grate, or furnace is made equal to the diameter of the boiler, which is, however, the usual practice.

### The Bridge Wall

The bridge wall, see Fig. 108, serves essentially as a support for the rear end of the grates, and also as a back wall for the ash pit. The top of the bridge wall is carried well above the surface of the grates to prevent the fuel from being thrown into the combustion chamber. The front face of the wall is beveled off at an angle of about 50 degrees to 60 degrees, which deflects the flame and hot gases uniformly along the boiler heating surface. The distance from the bottom of the boiler shell to the top of the bridge wall should be such that the area of the opening will be about one-seventh to one-ninth of the grate area.

### The Combustion Chamber

The portion of the setting back of the bridge wall is termed the combustion chamber. It is in this chamber that the products of combustion should thoroughly intermingle and mix with the proper amount of oxygen for complete combustion before the gases pass through the boiler tubes. Fig. 109 illustrates a typical section through the combustion chamber of a horizontal return tubular boiler setting.

It will be noticed that, unlike the section through the furnace, Fig. 107, the inner face of the side walls at the combustion chamber are not battered, but are made perpendicular. This simplifies the construction and also greatly increases the volume of the combustion chamber, which is desirable for reasons previously referred to. Instead of carrying the floor of the combustion chamber on a line with the floor of the setting, as was illustrated in both Figs. 108 and 109, it is the practice of some engineers to commence the floor of this chamber flush with the top of the bridge wall, as indicated by light dotted lines in Fig. 108, and slope the floor down to the bottom of the rear boiler wall. The space underneath this floor is filled with tamped earth or cinders. With this construction it is assumed that the hot gases are kept in better contact with the boiler shell than where this space is left open. It is, however, the opinion of many that more complete combustion of the gases takes place in an open chamber such as Fig. 109 than where the space is more or less restricted.

### The Rear Combustion Chamber

The space between the rear face of the boiler and the inner face of the rear brick wall is termed the rear combustion chamber. A cross-section taken through this part of the setting would be identical with that of Fig. 109, in so far as the side walls and floor of the chamber are con-

* Engineering Department of The Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

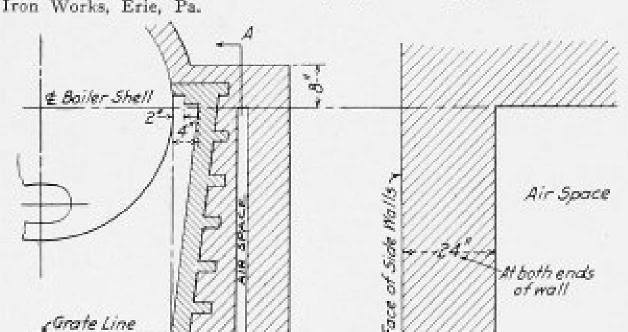



Fig. 107.—Dead Air Space Provided in the Center of the Brick Walls of the Boiler Setting

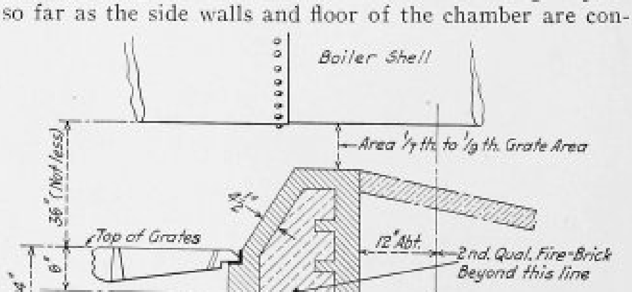



Fig. 108.—Usual Construction of Bridge Wall

cerned. But the rear combustion chamber is equipped with a "roof," the inner side of which is carried to a point 2 inches above the top of the upper row of tubes.

The gases at this point of the setting are at a comparatively high temperature, and, since the normal safe water

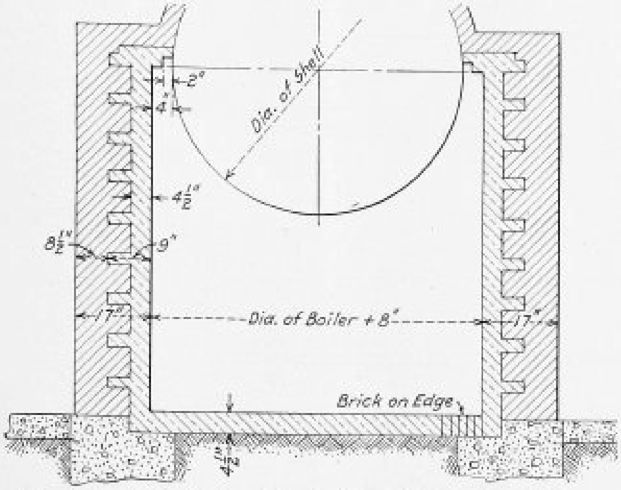



Fig. 109.—Typical Cross Section Through Horizontal Return Tubular Boiler Setting Back of Bridge Wall

level in a boiler of this type is maintained at about 2 inches above the upper row of tubes, it should be clear that were the hot gases permitted to strike above that point, the rear head of the boiler would become overheated due to the absence of water on its opposite side to conduct the heat away from the metal. An excellent illustration of the usual construction of the rear combustion chamber was given in Fig. 78, published in the May installment of this series of articles. There are three different methods of roof or arch construction for the rear combustion chamber, viz., the flat, as was shown in Fig. 78; the Hartford, which is very similar to the latter, except that it arches from side wall to side wall, and the "Lucke" rear arch, illustrated in Fig. 110.

This type is the most effective of any, as in the first place it offers no resistance to the easy flow of the gases into the boiler flues, and, furthermore, there is practically no metal exposed to the products of combustion. Sketch "A," Fig. 110, illustrates a cross-section through each unit, which simply consists of a lining of 9-inch standard straight fire brick. In case of repairs to an arch of this kind it is not necessary to tear down the entire arch, but merely to replace any sections that may have failed.

Figs. 111 (a) and (b) illustrate the flat arch and the Hartford rear arch bars.

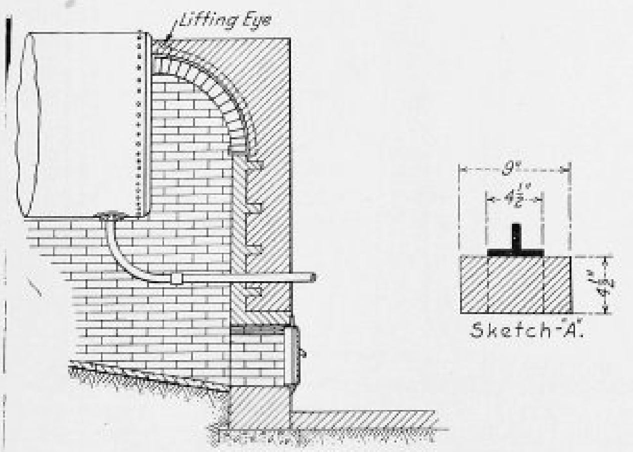



Fig. 110.—Application of Lucke Rear Arch Bars

There are two distinct types of front wall construction for horizontal return tubular boilers, viz., the full-front and the half-front. In Fig. 112 are illustrated sectional views of the full-front style of setting. Owing to its "flush" finish, this is also very frequently designated as a flush-front setting.

### FRONT WALL CONSTRUCTION

In the half, or extended front setting, the front of the setting is not flush, but the boiler shell is extended to form the smokebox. What we wish to consider here mainly is the construction of the arch over the fire doors, and this applies to both full and half front settings.

The front arch probably gives more frequent trouble than any other portion of the fire brick work, which is very largely due, however, to careless construction in the majority of cases. These front arches, and, in fact, any others with which the general run of boiler settings are equipped, are usually built up of standard straight fire-brick, whereas "arch" brick is absolutely necessary. In Fig. 113 is shown an enlarged portion of a brick arch as incorrectly built with straight brick.

For the reason that the bricks are not radial, their lower edges may be brought into fairly close contact, but at the top large spaces are the result which must be "slushed in" with fire-clay and broken brick. It is clearly evident that such an arch cannot last very long, owing to the joints existing in the arch.

From what has been stated in previous paragraphs, it

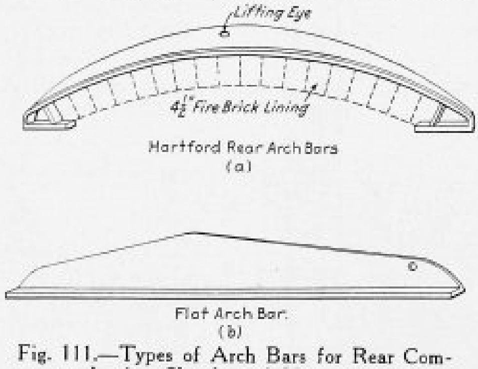



Fig. 111.—Types of Arch Bars for Rear Combustion Chamber of Horizontal Return Tubular Boiler

should be apparent that a fire-brick lining fails first at the joints. Fire-clay joints cannot stand up or remain tight due to the great difference in expansion and contraction between the brick and fire-clay. The failure of the joints throws concentrated pressure on the bricks, which crack, spall off and fall out.

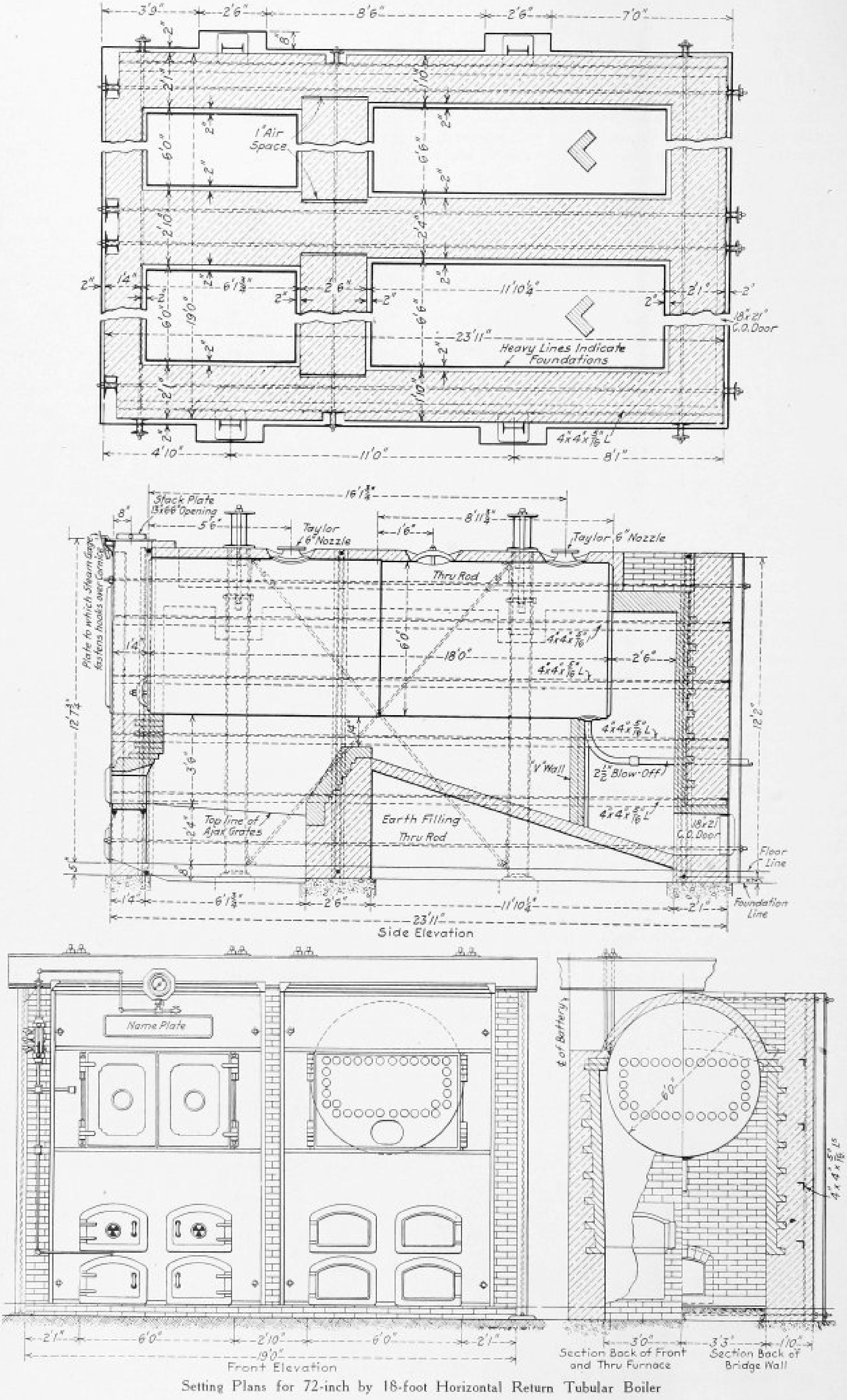
A fire-brick arch should always be constructed of arch bricks which are radial. When laid side by side without joints they form a solid arch. Of course, every arch brick will not suit all lengths or rises of arches, but the sizes have been standardized by fire-brick manufacturers for practically every variation met with in usual practice. The standard dimensions of such brick are given in handbooks distributed by the manufacturers of fire-clay products.*

### MOLDED FIRE DOOR ARCHES

For both ease in erection and durability, there is probably nothing to compare with the solid molded fire-door arches and jambs that are now on the market. Fig. 114 illustrates one such product.

Due consideration must also be given here to the various forms of plastic fire brick which have proven so successful in the past.† They are said to be a composite of

* Habison-Walker Refractories Company, Farmers Bank Building, Pittsburgh, Pa.
† Betson Plastic Fire-Brick Company, Inc., Rome, N. Y.



Setting Plans for 72-inch by 18-foot Horizontal Return Tubular Boiler high grade refractory materials mixed so as to eliminate the objectional expansive and contractive properties.

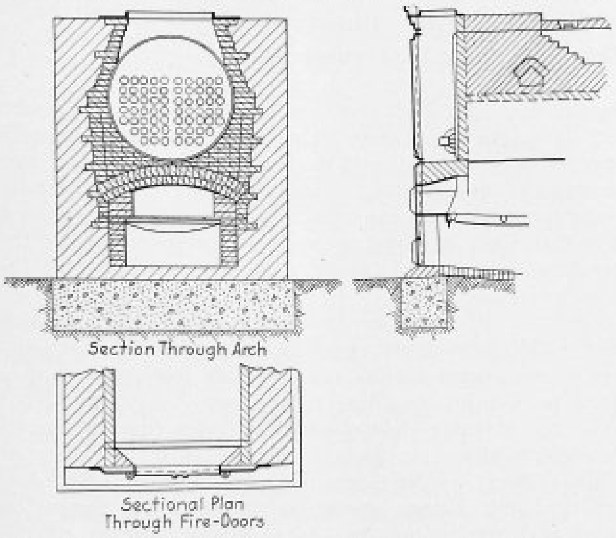



Fig. 112.—Full or Flush Front Construction for Horizontal Return Tubular Boiler Setting

Plastic fire brick is obtained in barrels in stiff, plastic condition, which is molded directly into place in the setting. With it may be formed a seamless, monolithic furnace lining, including walls, door arches, rear arches and bridge walls.

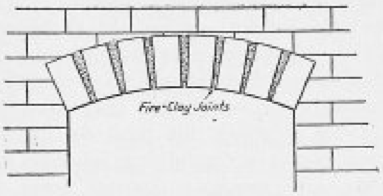



Fig. 113.—Use of Straight Brick Causes Faulty Arch Construction

Under extremely high temperature, however, the very best furnace door arch will eventually burn down. A water-cooled arch has been placed on the market in recent years whose economy and utility are becoming more and more appreciated. The application of this device to a horizontal return tubular boiler is clearly illustrated in Fig. 115*

It consists essentially of a set of welded steel boxes connected by a series of tubes through which water is circulated. The device is simply nothing more nor less than a water-cooled lining for the furnace door arch and is installed as such. Its purpose, as may be readily inferred, is to conduct the heat away from the brick work. The cooling water passing continuously through the coils of pipe evidently becomes heated to very nearly the boiling point, and this water is, of course, pumped into the boiler as feed water, as clearly indicated in the illustration. It therefore serves a dual purpose, and the ultimate efficiency of this apparatus cannot be overestimated.

### Buck Stays

In a previous chapter the subject of expansion of steel due to increase in temperature was very thoroughly treated. Brick also expands when its temperature is raised, and the coefficient of expansion for fire brick is about the same as that for steel.

In any boiler setting we find at least three lateral arches, viz., fire door arch, bridge wall, and the arch forming the roof of the rear combustion chamber. It should be quite plain that these lateral arches expand on reaching the high temperature of the furnace, which causes them to thrust with great force against the side walls of the settings. Consequently, if the side walls are not reinforced in some way to resist this pressure, bulges in the brick walls will occur.

Such reinforcement is accomplished by means of buckstays and tie rods, consisting of a pair of steel beams

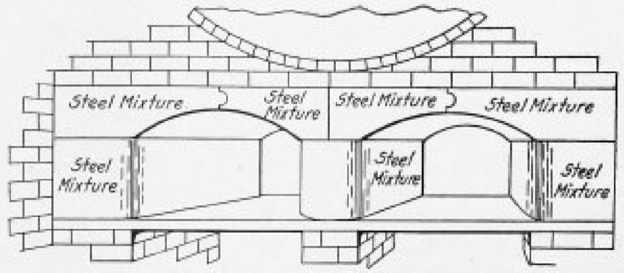



Fig. 114.—Solid Mould Fire Door and Arch‡

bound to the outside of the brick walls and directly opposite to the arch being supported. A detail of the lower ends of these buckstays as best applied to a boiler setting is given in Fig. 116. It is poor practice to carry the bottom of the buckstays only as far as the top of the foundation. This means that the bottom tie rod takes anchorage in the brick wall. It is the brick wall we must support, hence the buckstays should be carried down into the foundation and take anchorage there. In metallurgical furnace design the buckstays are embedded into the concrete foundation and the tie rods are omitted entirely at this point. There is no method at hand for determining the actual size of buckstays and tie rods required for a given boiler setting, but they should not be less than 6-inch channels in any case, while for very large watertube boiler installations the buckstays frequently consist of a pair of steel rails securely bolted together.

### Foundations for Boiler Settings

An ordinary steam boiler foundation is quite simple in design and easily laid by unskilled labor. Foundations

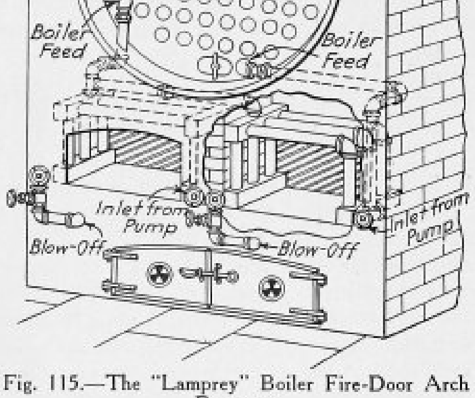



Fig. 115.—The "Lamprey" Boiler Fire-Door Arch Protector

frequently consist of stone masonry, but the most modern, and at the same time most economical, construction is that of concrete, either plain or reinforced, as conditions may

(Concluded on page 342.)

* Courtesy of the McLeod & Henry Company, Troy, N. Y.

‡ The Lamprey Company, Westfield, Mass.

# Fall Meeting of Boiler Manufacturers

**Review of Conditions in Boiler Manufacturing Industry Indicates That Normal Production May Soon Be Expected**

The first special meeting of the American Boiler Manufacturers Association since the annual convention in June was held at the Hotel Astor, New York City, October 18. About twenty members representing companies in all sections of the country were present, so that existing conditions in the industry and the prospects for the future were well outlined. The apprenticeship question, the problem of labor turnover, contract forms, group insurance and the reports of standing committees occupied the morning and afternoon sessions.

In a short review of trade conditions, A. D. Schofield, president of the association, declared that it was impossible to visualize the future, but that the industry must be prepared for a steady normal production after the presidential campaign and other uncertain factors had been adjusted.

In the South, in which section most of the business for the boiler companies is provided by the power requirements of the cotton mills, the slump in this latter industry has brought a corresponding falling off in the demand for boilers. The long expected general deflation in prices has commenced, brought about by various economic factors governing the supply and demand of commodities. Slow delivery of coal by the railroads in this section has caused frequent shut-downs of plants and lessened production. The boiler making industry as well as others should go on record as approving plans for financing and properly maintaining the railroads in order to provide adequate transportation for industries of the country.

The matter of the excess profits tax as it exists today, which is crushing out the life of American business, should be in some way more equably adjusted under the new administration.

Since the June convention, strikes have been less prevalent in the country, and nothing of special importance has occurred that requires attention other than a dropping off of orders. All members should be prepared for the slump in trade and do everything in their power for increasing shop efficiency.

### Report of Membership Committee

No notable change has occurred in the membership since the annual convention, only two companies having applied for admission, while one company has resigned its membership.

### Report of the Committee Acting with the Boiler Code Committee of the American Society of Mechanical Engineers

As E. R. Fish, chairman of the Code Committee, was absent, the general report of the work of the committee was read by the secretary and amplified by E. C. Fisher. The Boiler Code Committee of the American Society of Mechanical Engineers meets regularly once a month in order to interpret sections of the code which may be questioned by interested individuals. Decisions reached at these meetings are published in the *Mechanical Engineer*, the official organ of the American Society of Mechanical Engineers. (These interpretations are also published in complete form in The Boiler Maker as soon as released by the Boiler Code Committee.)

The National Board of Boiler and Pressure Vessel Inspectors is beginning to function, and it has been proposed that the chief inspectors of the various states governed by the A. S. M. E. Boiler Code meet at least once a year for the purpose of standardizing the enforcement of boiler inspection regulations and the requirements for inspectors throughout the country. This organization has the complete support of the Uniform Boiler Law Society, since it aids materially in carrying into practice and enforcing the work of this society after a state has once adopted the standard code.

Both Mr. Fish and Mr. Fisher attended a recent meeting of the Ohio inspectors, at which it was decided that Ohio would not accept boilers from outside states unless they have been built according to the required standards of Ohio and properly supervised while under construction by inspectors who were declared competent by the state of Ohio. Objections have been raised by the Ohio Board to certain boiler fittings, particularly nozzles and flanges on horizontal return tubular boilers which are not of the proper size. It was decided that these fittings should be sufficiently large to take care of the intermediate size safety valves shown in Table 15 of the A. S. M. E. Boiler Code.

Plans are now being completed for the inspectors of the various states to hold a meeting in New York in December, and the support of individual members of the American Boiler Manufacturers' Association as well as of the association as a body should be extended to the organization of inspectors in order that there may be no difficulty in defraying expenses for this meeting. The Uniform Boiler Law Society is supplying funds to make this meeting possible, and requests support from the American Boiler Manufacturers' Association.

The association voted the sum of $500 to be used for this purpose.

### Report of Related Industries Committee

At a meeting of the Related Industries Committee the matter of co-operation with other industries was discussed and it was the sense of the meeting that inasmuch as the committee cannot commit the association to any definite action it should in this, its first report, endeavor to set forth a definite programme for future action and to receive suggestions from the membership of the association as to what specific matters should be taken up with allied industries.

A study of a list of trade organizations has brought out the fact that the only existing associations with which the American Boiler Manufacturers' Association can at this time make contact are the following: Stoker Manufacturers' Association, New England Association of Boiler Manufacturers, and possibly the American Iron & Steel Institute; this latter because it has much to do with the formation of policies of all steel manufacturers.

There are no organizations of superheater, economizer, powdered fuel equipment, fuel oil furnace equipment, feed water purifiers, or stack and breeching manufacturers, and it is questionable if there are a sufficient number of manufacturers in these industries to warrant their forming associations. In these fields it therefore seems proper to suggest that this committee discuss matters of mutual interest with such manufacturers direct.

The Stoker Manufacturers' Association has appointed a committee to meet with this committee of the American Boiler Manufacturers' Association to discuss any matters of mutual interest.

This committee has written to the New England Association of Boiler Manufacturers and to the Stoker Manufacturers' Association to learn if there are any ways in which these associations feel that the American Boiler Manufacturers' Association can co-operate with them or any action which this association can take which in their opinions will be helpful both to them and to us.

It has been suggested that inasmuch as there are no associations of manufacturers of superheaters, economizers, powdered fuel equipment, fuel oil equipment, feed water purifiers, etc., it would be of advantage to this association and to them if manufacturers of such apparatus would join this association as associate members. If this suggestion meets with the approval of the association the Membership Committee should take this matter in hand.

It has also been suggested that the association give statistics of boiler sales to the Stoker Manufacturers' Association, receiving in return a statement of stoker sales. This committee will endeavor to arrange for this exchange of information if the association so directs.

One of the most troublesome features of the boiler industry in this day of special requirements and settings is where the work of the boiler manufacturer starts and leaves off, not only as it affects our own work but also as it affects our contracts with our customers and their other contractors; also as it affects prices for construction which neither we nor those who are furnishing apparatus which connects up to ours have included in our prices. The result is that the purchaser rarely pays for such connecting links; the stoker or superheater manufacturer rarely pays for them, and the cost, therefore, falls upon the boiler manufacturer. It does not seem proper that we as an association should endeavor to agree with other associations as to where we stop and they begin, because the construction followed by different companies varies greatly. It may be that discussion on this point would be beneficial. It has seemed to your committee, however, that it may be helpful for it to point out what junction points should be watched and guarded against. With this in mind your committee has drawn up, and attaches thereto, a list of such junction points in connection with the installation of (a) stokers, (b) superheaters, and (c) we also attach memorandum received from one of the prominent superheater manufacturers, detailing information required by superheater manufacturers. It is felt that these may be helpful in determining whether an agreement should or may be reached with the manufacturers of such equipment.

### Information with Reference to Mechanical Stokers to Be Furnished by Boiler Manufacturers

Name of contractor:
Type of stoker: Width: Depth:
Extension furnace, if any, to be furnished by:
Length: Height:
Fire brick arches, if any, by:
Fire brick furnace lining, if any, by:
Location of bridge wall:
Panel between upper boiler front and stoker front, if required, by:
Height from floor line to bottom of upper boiler front:
Boiler to be raised over standard setting height.
Front boiler wall to be supported by:

What portion, if any, of stoker driving mechanism to be attached to boiler supports, and how will attachment be made?

What special lower boiler fronts, if any, to be furnished by the boiler manufacturer?

Are any clean-out or inspection doors to be furnished in addition to standard, or any deductions to be made?

Is any special baffle arrangement required? If so, by whom will it be furnished?

What guarantees, if any, have been made by stoker manufacturer which are in any way connected with boiler performance?

From whom are prints showing stoker arrangement to be obtained, and to whom is the boiler manufacturer to look to straighten out points of difference between himself and the stoker manufacturer?

### Information Required Relative to Superheaters to Be Furnished by Boiler Manufacturers

Name of contractor:
Steam pressure at boiler outlet:
Degree of superheat at boiler rating:
Location of superheater:

Is it necessary to enlarge the chamber of the boiler in which the superheater is to be installed? If so, in what manner?

What superheater weight, if any, is the boiler to carry, and at what points are hangers, straps, etc., to be used?

What are the loads at each point of attachment?

Are any clean-out or inspection doors to be furnished in addition to standard boiler doors, or are any doors to be omitted?

Is any special baffle arrangement, casing, insulating material, cover plate, etc., required? If so, by whom will it be furnished?

What guarantees, if any, have been made by superheater manufacturer with reference to moisture in saturated steam, temperatures in superheater chamber, etc?

From whom are prints showing superheater arrangement to be obtained, and to whom is the boiler manufacturer to look to straighten out points of difference in design between himself and the superheater manufacturer?

### Suggestions on the Subject of Superheaters

The design and location of superheaters in stationary boilers are essentially so closely related to the boilers and settings that the relation between the superheater manufacturer and the boiler manufacturer implies the closest co-operation. In most instances the boiler design is definitely decided upon before the superheater design is started, and the superheater manufacturer should look to the boiler manufacturer for prints and dimensions essential in defining the space available for the superheater, as well as the size and location of the boiler nozzle. In some instances the co-operation of the boiler manufacturer is necessary, that minor modifications in the design of the boiler be made in order to obtain a more efficient or less expensive design of superheater.

Inasmuch as the design and size of the boiler are dependent on the fuel and method of stoking used, the boiler manufacturer will be fully informed as to these details, and the superheater manufacturer can obtain all the necessary information from him.

Other details, such as draft, baffling, method of setting, whether singly or in batteries, are important items on which the boiler manufacturer can furnish the superheater manufacturer information.

Briefly, the following notes will define the information ordinarily required by the superheater manufacturer, which can readily be supplied by the boiler manufacturer, and which is essential to the design of the superheater:

1. Number of boilers.
2. Make of boilers.
3. Type of boilers.
4. Class of boilers.
5. Rated horsepower.
6. Heating surface.
7. Steam pressure at which boilers will operate.
8. Percent of rating at which boilers will operate.
9. Kind of fuel to be used.
10. Type of stoker.
11. Single or battery setting.
12. Space each side of setting. (Alley-way).
13. Number of gas passes or details of baffling.
14. Inside width of furnace.

WATERTUBE BOILERS

15. Horizontal boilers—
    (a) Number of tubes wide.
    (b) Number of tubes high.
    (c) Distance between drums and tubes at front.
    (d) Number and diameter of steam drums.
    (e) Number and spacing of steam tubes.
    (f) Length of tubes if other than 18 feet.
16. Vertical boilers—
    (a) Number of tubes wide.
    (b) Number of tubes at first bank.
    (c) Number of gas passes.
    (d) Type of furnace.

FIRETUBE BOILERS

17. Horizontal return tubular boilers—
    (a) Number of tubes wide.
    (b) Length of shell.
    (c) Diameter of shell.
    (d) Distance between rear head and wall.
    (e) Width of combustion chamber.
18. Blue prints of boilers.

In order to define the point at which the superheater manufacturer's work should start and end, it may be briefly said that the superheater and attachments should include all parts that would not be required in connecting up the boiler for saturated steam operation, i. e., the supports for the superheater and attachments should be connected *directly* to the boiler or the setting, where possible, and, where not possible, means of supporting them on the boiler or brickwork structure should be furnished by the superheater manufacturer.

Further, should the location for the superheater involve the provision of supports for part of the boiler setting located above the superheater, these supports should be furnished by the superheater manufacturer. The following list indicates in a general way the material which the superheater manufacturer should furnish:

1. Connecting pipes between boiler nozzle and saturated header, with flanges, bolts and gaskets for attaching.
2. Headers complete, with inlet and outlet flanges.
3. Units together with parts necessary for attaching to header.
4. Castings and steel work necessary for the support of headers and units from the boiler structure or setting.
5. Openings and access doors where such openings and access doors, furnished by the boiler manufacturer for saturated boilers, cannot be used to obtain access to superheater units.
6. Accessories:
    (a) Safety valve.
    (b) Thermometer or pyrometer.

The suggestions mentioned in this outline are proposed to cover the conditions briefly and in general. Owing to the wide variation in the design of superheater and boiler, specific cases must be considered in the light of existing conditions.

### Horizontal Return Tubular Boilers in Heating System

The possibilities of the horizontal return tubular boiler in heating plants to compete with the cast iron low pressure heating boilers now in general use should be determined by the sales policy of individual companies. Since the cast iron boiler companies supply data on their installations to steam-fitters and plumbers, architects and constructors, if the horizontal return tubular boiler companies wish to enter the field, information should be supplied to the same prospective purchasers of heating units.

The proposal of Charles F. Koopman to organize a special association of those interested in horizontal return tubular heating boilers should not be a matter for the association to take up, but it was finally decided to send out a copy of Mr. Koopman's letter to all members of the association, asking for suggestions as to what action the association should take in the matter.

### Commercial Committee Report

No formal report of the commercial committee had been prepared, but W. C. Connelly, chairman of the committee, gave an outline of business conditions as experienced in the Middle West. The most important matter at present in connection with the work of this committee is the determination of the best means of standardizing contracts, in particular the non-cancellation clause. The discussion of this question was taken up later in the meeting by the members present.

### Apprenticeship Question

The results of the questionnaire sent out by H. N. Covell, secretary of the association, asking for information on the status of the apprenticeship situation, indicated that in the boiler making industry at the present time there is no general class of apprentices in existence. The problem is a rather serious one because the foremen of the future must be provided for, and practically the only way in which these men may be given a general training in all phases of their work is by a complete course of study in the shops. The rise of war industries first caused apprentices and young men who would have become apprentices to flock to positions with high pay. This condition has been further aggravated by the automobile industry and the system of piece work practised in many industries. Both causes made possible high pay even for untrained and unskilled men.

The situation is now so serious that it demands immediate attention by everyone connected with the industry. Since it will be impossible to induce young men to bind themselves under contract for three or four years while learning the trade, practically the only solution is to organize plant schools for putting men who are specially qualified for special study through an intensive course of training.

A report was submitted by H. N. Covell covering the answers to the heating and ventilating questionnaire which had been sent to the members.

Probably the most important of all matters discussed at the meeting was that of the advisability of each member submitting monthly sales reports. Very few of the eighty members of the association have been sending in these reports regularly, probably because of the failure to appreciate the value of such reports as indicating the trend of business. Unless the reports are inclusive and cover the entire country, they fail to be of any practical benefit. The secretary of the association particularly requests that this matter be given careful attention by every member company.

In continuation of the informal report of the commercial committee given earlier in the meeting, W. C. Connelly mentioned certain matters that would be taken up and submitted later in a formal report, including standard forms of specifications covering masonry work on boilers, the standard guarantee clause on labor and material of finished boilers, standard clause on payments and cancellations of contracts, and on adopting a standard size specification sheet. In the case of the latter it was determined that the ordinary size sheet used for letterheads is the best for specifications, since this size is most convenient for filing.

In a short discussion by the members on the cancellation of contracts, the opinion seemed to be quite general that it was not advisable to accept any cancellations of existing contracts, especially on work for which material had been ordered or fabrication commenced. Various means for holding contracts and being reimbursed for work done were suggested by different members.

H. S. Hastings, of the National Metal Trades Association of Chicago, gave a short talk on the work of this association and of its value in insuring production in shops which come under its organization.

### Labor Turnover

The matter of labor turnover in the boiler making industry as in practically every other industry in the country has been tremendous in the last two or three years, approaching 300 percent early in 1920. The cost of training men and then losing them has increased the overhead expenses of various plants to a startling degree, and steps are very necessary to end this loss. Fortunately, because of the readjustment of conditions and the curtailing of production in unessential commodities, this matter is gradually approaching a lower normal.

Closely connected with the matter of welfare of men in the shops is the effect that group insurance has in holding the men at their work. Opinions seemed to vary as to the value of insurance, but many of the companies that are using it have found it to be satisfactory.

Most companies manufacturing boilers have experienced a general falling off in new orders during the last month or two, and it may quite safely be stated that the Presidential campaign, as is usual every fourth year, has tended to bring this about. The fall months in any year are the slack months, so that no concern need be felt on this account. Most companies have orders on their books for work which will carry them four or five months at least, when the settling of conditions may be expected to create new demands for power equipment.

In order to keep production costs as low as possible and not in any way reduce the current rates of pay, it is necessary to utilize machine tools to good advantage and to increase the productive efficiency and skill of the men in the shops.

There is no particular need to be pessimistic about the future, for there will be plenty of work for the industry.

## Reducing Accidents

It is quite generally conceded that only 10 percent of the accidents in our industries are caused directly by machines, either through lack of guards, improper adjustment, failure of certain parts while the machines are in operation, or in other similar ways. The remaining 90 percent are caused by inattention, carelessness, lack of skill or judgment, or even the extraordinary expertness of the workmen. It will be seen therefore that the installation of mechanical guards and the proper adjustment and thorough inspection of all parts of machines will promote safety only to a limited extent. *Mental* guarding is the important thing—training the workmen in safe practices so carefully and thoroughly that they will be constantly on the alert to detect and avoid dangerous conditions and to correct chance-taking habits. This may best be done through effective safety organizations. Establishments having such organizations report reductions, varying from 20 percent to 75 percent, in their industrial accidents, accompanied by greater output, products of better quality, and smaller labor turnover.—*Travelers Standard.*

## Lathe Tools for Small Shops

The Ready Tool Company, Bridgeport, Conn., recently placed on the market a set of Red-E-Style lathe tools especially adapted for use in a small shop having only one or two lathes. The set contains a left-hand "off-set" turning tool with an off-set cutting off and threading tool, an inside boring bar with a holder, an inside threading bar provided with an extra cutter and a board on which the tools are mounted. All of the cutters are made of high speed steel except the threading cutters, which are made of tool steel properly hardened and drawn. The holders are designed for tools ½ inch by 1 inch.

## Welded Tank of Large Size

What is perhaps the largest welded tank ever built was recently completed by the Welded Products Company at Birmingham, Ala., for the Liquid Carbonic Company. The tank is 22 feet in diameter and stands 30 feet high. It was made of ¼-inch steel plates, joined at the seams by oxy-acetylene welding. The big tank has satisfactorily withstood the required tests and has been found to be gastight in all of the welded seams under an excess of working pressures.

The Welded Products Company uses oxy-acetylene with remarkable success in tank construction, and has for some time specialized in this field, having built many large tanks for gasoline storage and other uses in the South. The welded construction has proved thoroughly satisfactory and very much cheaper than riveted tanks of the same capacity.

Gas Tank 22 Feet in Diameter, 30 Feet High, Welded Throughout by Acetylene Process

This company has one of the best equipped welding plants in the country, having the latest improved Oxweld apparatus throughout. Linde oxygen is supplied to the blowpipes through a system of shop piping. The company is estimating now on the gas holders for the new plant of the Linde Air Products Company at New Orleans, and if awarded this contract there will shortly be a new "largest welded tank" to take its rank in the welding field, and, incidentally, to open up an entirely new outlook for the industry.

## Examination Questions for Inspectors*

Q.—What is (a) combustion, (b) evaporization, (c) heat?

A.—(a) Combustion is the process of consuming, oxidizing or burning the fuel.

(b) Evaporization is the converting of water into steam through the agency of heat.

(c) Heat is defined as motion; that is, motion or vibration of the molecules of the substance that is receiving the heat. Heat has no weight.

Q.—Would perfectly pure water be desirable for use in a steam boiler?

A.—Pure water is not exactly desirable for boiler feed, for it has a certain corrosive action on the metal.

Q.—What is the cause of scale forming in boilers, and what is the remedy?

A.—Scale is due to substances in the water that separate under the action of heat, and these substances precipitate and cling to the metal surfaces in the boiler, forming a coating. This coating, if only very light, is a preservative of the metal against corrosion, but if the coating gets thicker than that of ordinary paper, then it becomes a detriment, for it prevents the passage of heat to the water.

* Continuation of October article.

The remedy for scale is, first, prevention by treating the water before it goes into the boiler. If this cannot be done, then the scale formation may be minimized by the introduction of certain boiler compounds into the boiler with the water. Lastly remove the scale by mechanical means.

Q.—What is (a) steam, (b) saturated steam, (c) superheated steam, (d) dry steam?

A.—(a) Steam is a vapor or gas generated from water by the application of heat.

(b) Saturated steam is that which has a fixed corresponding temperature for each individual pressure, and likewise a fixed corresponding pressure for each individual temperature to which the steam may be raised. In brief, saturated steam is steam that is saturated with heat, containing all the heat that it can without changing its pressure and without adding superheat.

(c) Superheated steam is steam which is given additional heat, and therefore its temperature is higher than that due to its pressure only. Steam may be heated to any degree above the temperature corresponding to its pressure, without increasing the pressure.

(d) Dry steam is steam which contains no moisture. Saturated steam may be either dry or wet. Wet steam contains moisture due to condensation.

Q.—What is the function of a steam dome and why is it being eliminated?

A.—The presumed function of a steam dome is to secure dry steam, but, owing to structural defects and inherent weaknesses at the joints, and also owing to the introduction of internal dry pipes which serve the purpose as well, a dome is no longer considered essential, especially where high pressures are used.

Q.—What is a steam gage, injector, non-return valve, steam trap, steam loop, and what are their functions?

A.—A steam gage is an accessory for indicating the pressure of steam in the boiler.

An injector is virtually a combined feed water heater and feed pump for a steam boiler. It works on the principle of the momentum of a volume of steam at high velocity, overcoming the resistance against which the water must act to gain entrance to the boiler.

A non-return valve is one that permits of a flow only in one direction. The fluid passing through cannot return.

A steam trap is an apparatus that collects the water of condensation in any steam system, and disposes of the water without wastage of steam.

A steam loop is a device whereby the water of condensation is returned to the boiler by employing the force of gravity. It gives an overbalancing of pressure due to a gravity head, causing the water to enter the boiler against the pressure therein, which pressure is less by a few pounds than that in the base of the steam loop.

Q.—What is one of the prime causes of boiler explosions and how can this cause be prevented.

A.—One of the prime causes of boiler explosions is the development of cracks in the plates along the longitudinal joints. These cracks weaken the plates below the strength needed to hold the pressure. Explosions can be prevented by careful designing and building followed by frequent inspection, internally and externally, while in service. Prompt repairs should be made when any defects are discovered.

Q.—What is a water glass and where should it be located on a horizontal return tubular boiler?

A.—A water glass is for the purpose of showing the water level. No matter what the style of boiler, the water glass should be installed so that when the water just shows in the bottom of the glass the water level will be about 3 inches above the top row of tubes or the crown sheet, whichever the highest fire surface may be. Then, by carrying a half-glass of water, the operator will be assured that there is enough water for safety with some to spare. The water should never be allowed to get out of sight in the bottom of the glass.

## Checking Tools in Locomotive Shops*

BY J. B. HASTY

Employes entering the service are required to sign a card form in duplicate. The original is retained by the foreman and the duplicate by the employee. Six tool checks, a hammer, monkey wrench and three chisels are furnished and entered on his card, which he retains until he leaves the service. The main tool room is located in the center of the machine shop. There are also sub-tool rooms in the boiler shop and car shop. All new or repaired tools are distributed to the sub-tool rooms from the main tool room. All small hand tools are grouped in racks with the sizes stenciled on the racks; small hooks are provided to hang the checks. Checks must be presented for all tools in the tool room, except chisels and machine tools. A supply of these is kept in the tool room and exchanged as they require redressing.

When chisels become too short for further use as chisels they are made into center punches, drill drifts and other small tools. Machine tools are of standard sizes, and when 2-inch by 3-inch tools become too short for further use they are made into smaller sizes until they are worked down to ¼ inch by ¼ inch for Armstrong tool holders. Tools that require redressing are delivered to the smith shop each morning and returned to the tool room in the evening, ground and placed in racks for distribution. Pneumatic tools are returned to the tool room each evening for inspection and oiling. All tools must be turned in before quitting time on Saturday. A record is made of all checks left in the tool room over Sundays and the employees involved are taken to task for not obeying rules.

Shop goggles are kept in an inclosed case, checked out and sterilized as they are returned. If tools are lost broken or damaged by an employee he is required to get a clearance card properly signed by his foreman before his check is returned to him. An employee leaving the service is required to return the tool checks and tools recorded on his card to the tool room foreman, who checks them up, and if there is no shortage signs the orders for his time. In case of a shortage, explanation is demanded, and unless he can give a good reason for the shortage the cost of the missing tools is deducted from his pay.

## New York Section of Welding Society

The American Welding Society called a special meeting of its New York members on October 14, at the Engineering Societies building, for the purpose of forming a Metropolitan section of the society. About forty members were present at the meeting, which was presided over by Comfort A. Adams, past president of the society. Temporary officers were chosen and a nominating committee was appointed for the purpose of choosing permanent officers for the local section at its first regular meeting, which was held on October 25. Sections of the society have already been formed in Philadelphia, Chicago, Cleveland and Pittsburgh. The New York section will begin its career with 125 members who have been transferred from the parent organization to the local section.

* Paper read at annual convention of the American Railway Tool Foremen's Association held in Chicago, September, 1920.

# The Boiler Maker

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JOHN E. BURKE, *Business Manager*
6 East 39th Street and Woolworth Building, New York, N. Y.

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The thirteenth annual convention of the Master Boiler Makers' Association will be held at the Planters' Hotel, St. Louis, Mo., May 23 to 26, 1921. The secretary of the association has called the attention of the members to the fact that all committee reports must be sent to him before March 1, if they are to be presented at the convention in printed form. Further details of the meetings will be published later.

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During the past two years the labor turnover in all industries has been very great, approaching in many cases 300 percent in the early months of 1920. The curtailing of production in many lines, however, has brought about a marked decrease in the floating labor element. Increased efficiency of man power combined with machine power are both working to stabilize production.

The cost to the consumer of nearly every commodity has been made to bear the high overhead charges resulting from training men for special work and then losing them. However, this shifting has been lessened and men are now more interested in holding good jobs than in finding new ones. The direct result is an increase in both the quality and quantity of production and a corresponding drop in overhead expense.

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Questionnaires recently sent to members of the American Boiler Manufacturers' Association, brought to light the fact that there is no apprentice class in the boilermaking industry, and that there is little hope of ever again inducing young men to go through a long course of training in the trade.

Shop foremen and superintendents must have a general understanding of boiler construction from the laying out of the work to the final assembly. The specialization of labor does not permit a man to become proficient in all departments, but tends to make him an expert in carrying out a single operation.

A source of men trained for the positions of shop leaders must be provided at once. An intensive course of study carried on at the plant, covering a period of several months, intended for young men entering the industry, seems to be the best plan for creating an interest in boiler making and providing a competent body of men, thoroughly familiar with all phases of the work.

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The general review of business conditions given at the recent special meeting of the American Boiler Manufacturers' Association, seems to indicate that with the new administration acting as a stabilizer, production in every essential industry may be expected to reach a normal basis within a few months. When this level is determined definitely, new power equipment will have to be built so that the outlook for a steady demand for boilers is good.

One of the best possible measures for determining the trend of the market was proposed and adopted at the June convention of the association in the form of a monthly sales report to be submitted by each member company. These reports were to be circulated so that every one in the association could keep in touch with the demand for equipment and purchase raw material, accordingly. A number of companies have faithfully submitted their reports each month, but the majority have neglected to do so.

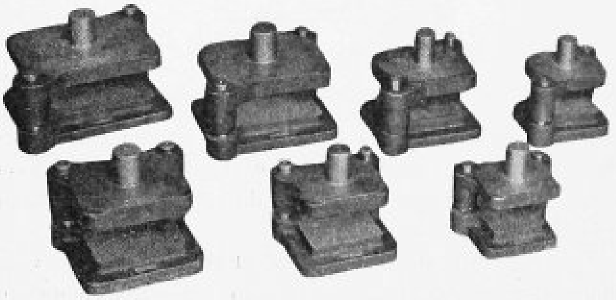
The entire value of this system lies in the fact that it covers the demand in all parts of the country, so, when it fails to be inclusive, there ceases to be any special object in its continuance. For this reason, the officers of the association request that every boiler manufacturing company submit a report of sales promptly at the end of each period.

# Engineering Specialties for Boiler Making

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

### Sub-Presses

The United States Tool Company, Newark, N. J., is manufacturing a line of sub-presses of standard design which are made in various sizes to meet the requirements

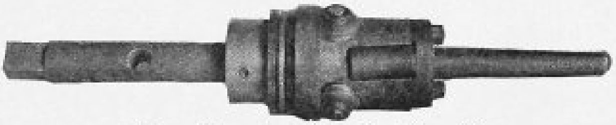


Standard Design Sub-Presses

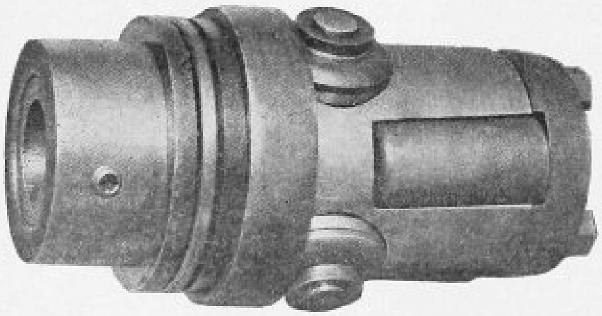
of different users. These presses are built with two, three and four pilots and one of their principal features is said to be the accurate alinement of the pilots. To any experienced mechanic the features of these tools will be apparent from the illustration without need of a more complete description.

### Self-Feed Boiler Tube Flaring Expander

The Kling self-feed boiler tube flaring expander produced by the S. and J. Tool Company, Philadelphia, Pa., is intended to expand a tube and flare the end in a single operation without adjustments.



Flaring Expander Assembled for Use



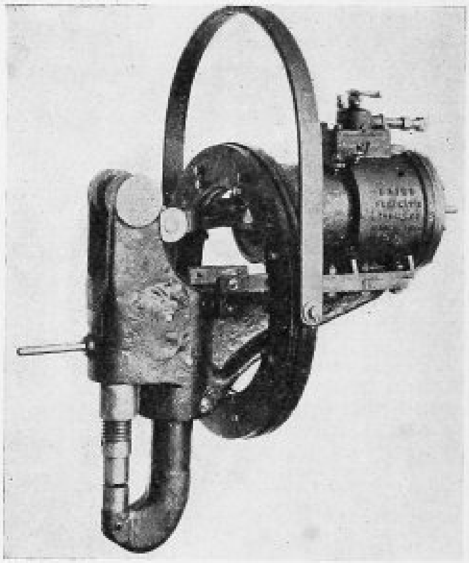
Detail of Expander

All moving parts work on ball bearings, thus reducing friction to a minimum. The mechanism is simple and light in weight varying from 10 to 15 pounds according to the size required. All parts are machined from solid bars of high grade tool steel carefully hardened and tempered. No castings are used.

The projection of the tube end into the boiler, due to the thrust of the expander is not increased as the tool is contained within the tube and no part is in contact with the tube sheet. The outside diameter of this expander is only slightly larger than the tube. It is claimed that the tool can expand tubes in any thickness of boiler plate as the necessary adjustments are provided.

### Pneumatic Riveter for Driving Flanges on Marine or Morison Corrugated Furnaces

The accompanying illustration is of a special stake riveter designed by the Baird Pneumatic Tool Company, Kansas City, Mo., to go between the closest flanges of either two or three furnace boilers. The machine has a reach of 5 inches, a gap of 12 inches, with a die adjustment of 3 inches to accommodate the varying lengths of rivets and thicknesses of plate. The adjustment screw is of the but-



Stake Riveter Adapted for Work on Boiler Furnaces

tressed thread type, providing a broad bearing surface during the delivery of tonnage. The air cylinders are tandem unit, being composed of two pistons arranged on a single piston rod. The delivery of power is at right angles to the set of the rivet. The toggles are of simple design, being composed of three pieces directly joined through the connecting rod to the piston rod. Under operation the connecting rod in transmitting the cylinder power to the toggles does not vary more than ½ inch out of a straight line drive.

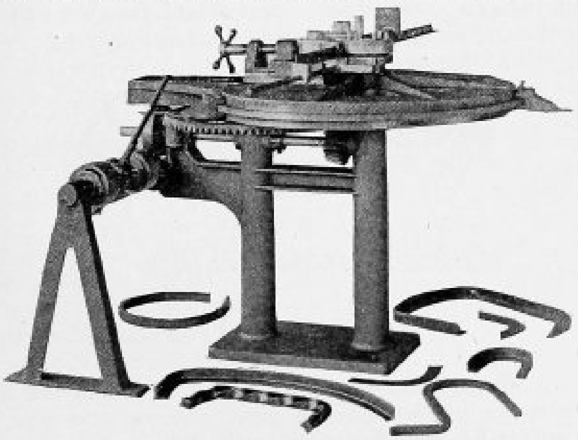
The machine is adapted to the setting of 1-inch steam-tight rivets and consumes four cubic feet of free air per drive of rivet. The equipment is hung from the gravity point, being equipped with a circular supporting frame securely fastened to the riveter stake. Around the circumference of this frame and in a grooved slot of good proportions and securely riding on ball bearings is a band fastened to the bail, thus providing the machine with a circular working movement or a swinging movement in the opposite direction.

The machine was primarily designed to facilitate the setting of rivets between the firebox flanges connecting the corrugated fireboxes to the outside backhead in Scotch marine boilers. The machine is a closely designed unit, being approximately 33 inches long by 40 inches high and weighing 750 pounds. In addition to its use as a marine boiler riveter, wide adaptation can be found in the fabrication of boiler and tube construction where the requirements call for operating equipment of extreme portability, together with the possibility of adjustment into any of the difficult positions confronted in boiler construction.

## Pipe and Angle Bender

The pipe bender shown in the accompanying illustration is made by the Wallace Supplies Manufacturing Company, Chicago, Ill. This machine is designed for bending pipe cold, and to a certain extent without the use of an inside follower or floating mandrel. For special forms, however, inside follower bars are employed. The standard equipment furnished with the machine consists of four forming heads which may be employed for bending different sizes of pipe as follows: 1-inch pipe to an angle of 90 degrees with a 6-inch radius; 1¼-inch machine pipe to an angle of 90 degrees or less with a 9-inch radius; 1½-inch iron pipe to an angle of 90 degrees or less with a 12-inch radius; 2-inch iron pipe to an angle of 90 degrees or less with a 14-inch radius.

When making a bend the pipe is secured to the form by



Specially Designed Pipe and Angle Bender

means of a strap. Both the outside follower and the form are grooved and the clearance between the pipe and the follower and form is such that saisfactory results are obtained. The outside follower bar operates between the tube and the roller so that the tube is well supported. This method prevents the forming of depressions in the pipe.

The roller bracket is adjustable and will take forms up to 50 inches in diameter. The machine is controlled by lever operating two friction clutches which permits the table to be rotated in either direction at the will of the operator. Adjustable stops are provided which can be set to automatically throw the clutch out of engagement so that the bending operation can be stopped at any desired point. For bending light gage tubing to a sharp radius without flattening or crimping, special forms with inside follower bars or floating mandrels are available which will permit tubing with 1/32-inch walls from 1 inch to 2 inches in diameter to be bent to small radii.

The approximate weight of this machine is 1,200 pounds. A machine of this type is also made with equipment suitable for bending angles, channels, tees, rounds, squares, twisted squares or special steel sections and flat bars on edge.

## Crane and Hoist Motors

For use on such apparatus as cranes and hoists where a heavy starting torque is required and service is maintained at varying speeds, the Westinghouse Electric & Manufacturing Company has recently developed the type H. K. direct-current, series-wound motor.

The motor is compact in construction and of light weight. It has a forged, open, hard-steel frame and solid, forged steel feet. Motors above 3 horsepower rating are equipped with commutating poles so that high momentary loads can be carried without series sparking, thus insuring long life of the commutators and brushes. Oil ring lubrication is used. Armature coils are form-wound, insulated and impregnated before being placed in position. A blower is located in the rotor to ventilate both the armature and the field windings. This allows a smaller diameter armature to be used, resulting in low flywheel effect. For this reason but little energy is required to start and stop the motor, cutting down wear on the bearings and brakes.

## BUSINESS NOTES

R. B. Bennett, formerly connected with the Standard Steel & Bearing Corporation, Plainville, Conn., has been appointed mechanical superintendent of the Canadian General Electric Company.

The American Engineering Company, of Philadelphia, has opened a new office in Cincinnati for the purpose of extending Taylor Stoker representation and service. M. M. Masson is in charge of this office at 207 Neave building.

The American Car & Foundry Company has awarded a contract to the Wimmer Construction Company, Victoria building, St. Louis, Mo., for the erection of a new one-story spring works in that city, 72 by 161 feet, to cost about $50,000.

The Cambria Steel Company is having plans prepared for the construction of a three-story sintering plant, 60 by 170 feet, at Johnstown, Pa., at an estimated cost of $300,000. A. S. McKee Company, 2422 Euclid avenue, Cleveland, Ohio, are the engineers.

The Frederick Engineering Company, of Frederick, Md., has opened a district office at Chicago, 1247 Marquette building, to place the company's automatic underfeed stoker and steam jet ash conveyor in this territory. Ralph W. Gillette will be the district sales manager.

The Bethlehem Steel Company, Bethlehem, Pa., has awarded a contract to The Austin Company, Cleveland, Ohio, for the construction of new machine and locomotive shops at Lebanon, Pa., 110 by 160 feet, to cost about $135,000, and to be supplemented by a power house. The equipment will include a 30-ton traveling crane and 200-ton hoist.

W. H. Sanford, for many years manager of the Buffalo, N. Y., plants of the American Car & Foundry Company, New York, has been appointed assistant vice-president in charge of sales in the Buffalo district. This is in connection with the company's plan of extension in that district. Prior to the formation of the American Car & Foundry Company, Mr. Sanford was employed by the Union Car Company, and when that company was absorbed he was appointed paymaster and cashier at the Depew plant. In 1902 he was appointed local auditor of the Buffalo district, followed by promotion to the position of resident representative. In 1912 he was made district manager in charge of the Depew and Buffalo plants.

# 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.*

*Address your communication to the Editor of the Question and Answer Department of* THE BOILER MAKER, *6 East 39th Street, New York City.*

### Method for Finding Length of Firebox Sheets

Q.—Will you kindly explain the proper method of finding the exact measurement on a flat plate, the *door end* of a *crown and side* of a firebox, measured from the center of the crown sheet to the bottom of the mudring, as shown in Fig. 1, in order that I may get the staybolt spacing correct. W. J.

A.—A practical and rapid method of finding the stretchout of the inside firebox wrapper sheet as shown in Fig. 1 is as follows:

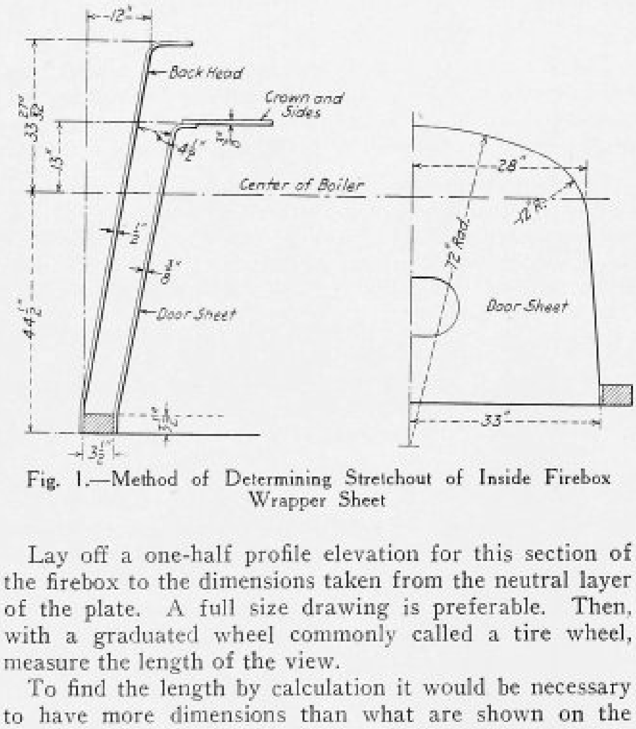



Fig. 1.—Method of Determining Stretchout of Inside Firebox Wrapper Sheet

Lay off a one-half profile elevation for this section of the firebox to the dimensions taken from the neutral layer of the plate. A full size drawing is preferable. Then, with a graduated wheel commonly called a tire wheel, measure the length of the view.

To find the length by calculation it would be necessary to have more dimensions than what are shown on the sketch.

### Delivery of Feed Water

Q.—The discharge pipe from the injector on a locomotive projects into the boiler 16 inches above the tube head. Does that cause the tubes to leak sooner than when the discharge pipe projects into the boiler below the tube head? E. S.

A.—The point where feed water enters the boiler varies for different types. The feed water should enter the boiler so that it does not come directly in contact with hot plates or tubes. The practice is to lead the water to the coolest part of the boiler. Cool water discharged on or near the hot plates or tubes causes heavy strains in the joints. Continued strains of this kind cause leaks due to the contracting of the plates and tubes cooled by the feed water. The practice followed by some engineers is to distribute the feed water over as large an area as possible. This may be done by drilling a large number of holes in the feed pipe so arranged that the entering feed water does not come directly in contact with the plates.

Feed water is often discharged level with the tubes in the top row through a perforated pipe that discharges the water downward between two tiers of tubes; or the water is sometimes injected in the form of a spray, above the water line.

### Spiral Riveted Pipe

Q.—Please explain how to lay out stock for a continuous spiral seam around a pipe as shown in Fig. 1. R. C. D.

A.—The pattern for the sheets that form the spiral riveted pipe have parallel edges. The sheet really consists of a ribbon which is rolled so as to take a circular form. In case the ends of the sections are to be square with the axis so that flanges can be used, then the pattern for the end of the sheets could be made according to the following diagram, Fig. 2.

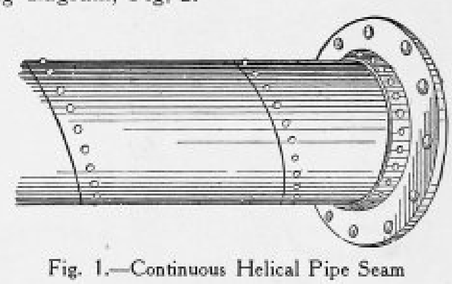


Fig. 1.—Continuous Helical Pipe Seam

Lay off on a straight line a distance equal to the circumference of the required pipe. At one end erect a perpendicular equal in length to the lead or the distance advanced along the pipe by the seam in one turn. Then

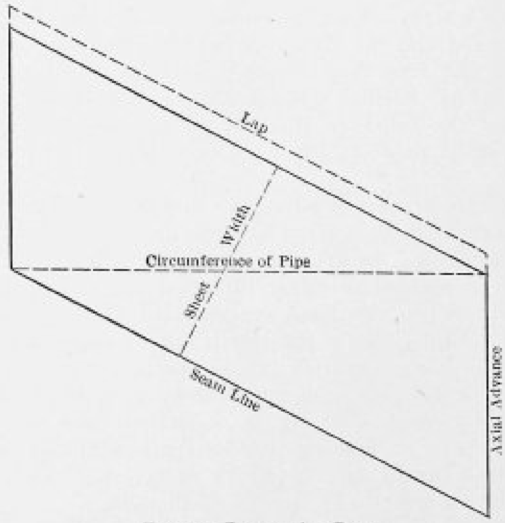



Fig. 2.—Pattern for Pipe

the diagonal line will be the joint line of the sheet. The slope of the joint line may be any desired amount. It will depend upon the width of the strips used to make the pipe and on the diameter of the pipe. By making models of stiff paper, using strips of different widths, you can easily roll these strips to conform to the required diameter ot the pipe and thus get the pattern for the end of the sheet.

## Stack Construction and the Hydrostatic Test

Q.—How would you lay out and build a smoke stack for a wood-burning locomotive?
What are the necessities for giving a boiler a hydrostatic test from start to finish, and are the bolts ever tested when under water pressure?
I hope you will answer these questions in the next issue, if possible. I have one of the smoke stacks to build and only have a print of one that was made in 1873, a little out of date nowadays. J. H.

A.—The sketch Fig. 1 shows a *diamond stack* used in conjunction with short smokeboxes. It is made up of two conical sections, *X* and *Y*, and a cylinder *Z*. The frustums *X* and *Y* are bolted together along line *C-D*, which is the flange of the cones. A wire netting is placed as shown in *X*, for the purpose of breaking up the live or red hot cinders carried up by the exhaust. The patterns for the frustums are shown at *M* and *N*. They are laid off by extending first the sides of the cone sections as at *A-C* and *C-B*. With these lines as radii, draw arcs from the points *C*, and with *A-o* as a radius, draw an arc from point *o*.

Make the lengths of these arcs equal to the circumference of their respective bases *C-D*, *l-o* and *a-p*. These arc lengths may be determined by drawing circles for these bases and dividing them into equal spaces. Then transfer their respective chord lengths to the patterns. Allow for laps to form rivet seams and flanged section along *o-l* and *C-D*.

Hydrostatic tests are made by filling the boiler with water, then pressure is applied to the water by a pump, which may be operated by hand or power. The general practice is to subject pressure vessels as steam boilers to 1½ times the pressure for which they are constructed. For example, if a boiler is designed to carry a working pressure of 200 pounds per square inch, the hydrostatic test is made at $200 \times 1\frac{1}{2} = 300$ pounds pressure.

The purpose of this test is to determine leaks, and the strength of the boiler to stand a prescribed pressure.

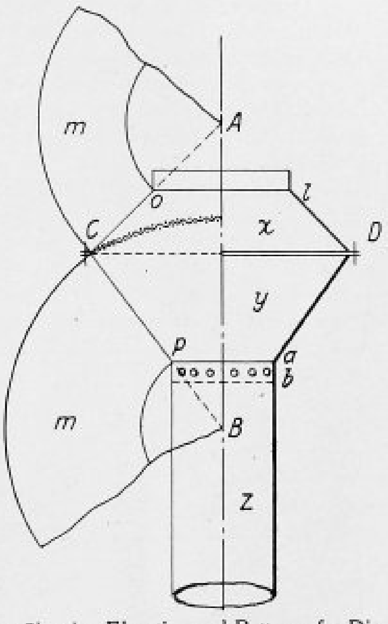


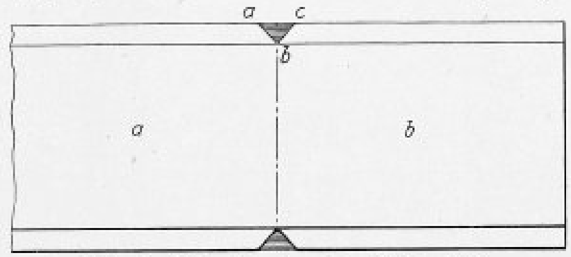

Fig. 1.—View Showing Elevation and Pattern of a Diamond Stack

When applying the test, first close all valves and tighten all clean-out plugs, etc. Allow some opening at the top of the boiler so that the air in the boiler may escape. When the boiler is filled with water, close the air vent valve or cock and apply the pump. When boilers are under steam pressure they should not be hammered or calked. Under water pressure it is claimed that there is danger of straining the plates beyond the elastic limit. There is additional danger of bringing this about by hammering bolts or stays and calking seams, rivets, etc., under this pressure.

## Welding Superheater Safe Ends

Q.—I will be very grateful for all the information I can get on welding safe ends on superheater tubes by means of the electric or acetylene welding process. I would like particularly to know how the ends are prepared for welding. J. E. T.

A.—The drawing Fig. 1 shows a sectional view of the tube *a* and the new tip *b*. The edges of both are first ground to a bevel as *a-b-c* and are butted together. This form can be used for either the electric or oxy-acetylene




Method of Beveling for Safe Ending Tube

method of welding. During the welding operation, tack the joint at several places to hold the tube and end in alinement. Do not allow the weld to extend through the tube and leave a rough edge. If this does happen, place the welded tube end over a mandrel or shaft and hammer the weld until it is smooth inside. Be careful not to break the weld, as hammering cold metal soon crystallizes it, thus destroying its strength. It is advisable to anneal the work first, which softens the metal, making it pliable and easily worked. If the electric method is used the current should be of the proper amperage.

For metal ⅛ inch in thickness use wire ⅛ inch in diameter and an amperage of 50. The metal electrode should be of the same quality steel as the tubes to insure a good, homogeneous weld.

The making of welded joints is an art in itself. It requires a good, steady hand, a thorough understanding of the nature of the materials used, methods of making joints, the use of the electrical apparatus or gas equipment employed, and, moreover, considerable practice in performing the welding operation. A weld can be easily destroyed by burning the metal or by simply piling the metal on without fusing properly the metal and metal electrode.

From the descriptive matter issued by manufacturers of electrical equipments and gas apparatus, additional data may be obtained.

## Pattern and Calculations for Large Dished Head

Q.—Kindly show me the proper way to lay out a dished head 9 feet in diameter in two parts. Is the radius of dish equal to the given diameter of the tank, or is there a rule for depth of dish? This head is made from two plates 5/16 inch thick with a seam in the center of the head (single riveted lap). I understand that the rivet line should have a camber. What is the method for obtaining this amount of camber so that the holes will match up after being dished? Hoping you will understand my question and be able to assist me in this problem. J. McM.

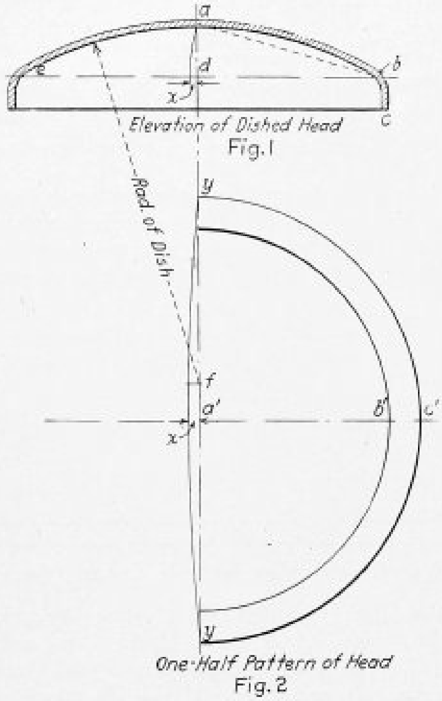
A.—The A. S. M. E. Code, paragraph 195, states as follows on convex heads:

"The thickness required in an unstayed dished head with the pressure of the concave side, when it is a segment of a sphere, shall be calculated by the following formula:

$$t = \frac{5.5 \times P \times L}{2 \times T.S.} + \frac{1}{8},$$

where:

$t$ = thickness of plate, inches.
$P$ = maximum allowable working pressure, pounds per square inch.
$T.S.$ = tensile strength, pounds per square inch.
$L$ = radius to which the head is dished, inches.




Layout of Dished Head

Where the radius is less than 80 percent of the diameter of the shell or drum to which the head is attached, the thickness shall be at least that found by the formula, by making $L$ equal to 80 percent of the diameter of the shell or drum."

It is common practice in pressure vessels to give the dish a radius equal to the diameter of the shell or drum.

Referring to Fig. 1, in which is shown a section of the dished head, the line $ab$ is a diagonal taken from points $a$ and $b$ on the neutral line or center of the plate. This line is the required radius for laying off one section of the head. A full view or a scale drawing can be made to determine this radius, or it may be found by calculation, finding the hypotenuse of a right angle triangle $d$-$a$-$b$ as follows:

$$ab = \sqrt{ad^2 + db^2}.$$

The depth of dish $a$-$d$ may be found by calculation also, and in this case, where the radius to which the head is dished is equal to the diameter of the head, proceed as follows: Find the length of $f$-$d$, Fig. 1, and subtract it from the radius of the dish, which will give $a$-$d$.

$$df = \sqrt{ef^2 - cd^2}.$$

If

$ef$ = 9 feet, or 108 inches,
$cd$ = 4½ feet, or 54 inches.

Then

$\sqrt{108^2 - 54^2} = 93\frac{1}{2}$ inches length of $df$,
$108 - 93\frac{1}{2} = 14\frac{1}{2}$ inches depth of dish $ad$.

The center-line in the pattern Fig. 2, as at $y$-$x$-$y$, may be laid off by setting off the distance $X$, Fig. 1, on the horizontal line, as in Fig. 2. With a thin strip of metal or wood, place it so that it passes through three points and draw the camber line. This line may be laid off by several geometrical methods, but the way explained is close enough for practical purposes.

The second section of the head can be laid off as explained, but remember that it must fit inside the first section. Scarf the ends where the flanges come together so as to make a snug fit between the shell and head.

## Simple Layout Problems for Beginners*

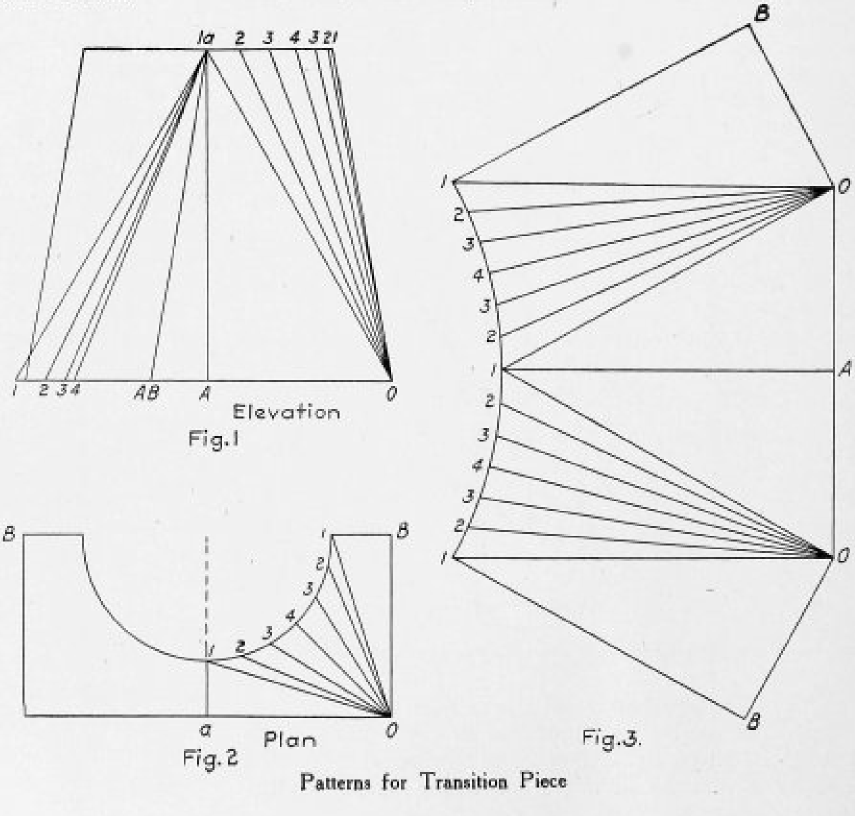
To develop and lay out the transition piece, a part of which is illustrated by Fig. 1, it is necessary to follow the steps given below:

First lay out the plan and elevation of the transition piece, and, as the four quarters of the plan are alike, only one-quarter need be used to indicate the process. In the two views the points 1-2-3-4 of the top section and points $A$-$O$-$B$ of the base are obtained first.

In order to find the true or full length of the lines, set up a right angle and locate the point $O$. Then at the base of the right angle set off the distance $A$-1-2-3-4 and join to point $O$. The connecting lines will be true lengths.

Now set off another right angle, Fig. 3, and locate the point 1 taken from the true length of the lines. Set off the point $O$ and join the lines $O$ and 1. Now take a pair of dividers and having them set with the radius 1-2, strike an arc of indefinite length from the point 1. Taking the true length of line 2, strike an arc from $O$ intersecting the arc already described and proceed until the point 1 is reached. Now with the distance $O$-$B$ of the plan strike an arc of indefinite length, and with the true length of the

* Further laying out problems of a similar character will be published in later issues of THE BOILER MAKER.




Patterns for Transition Piece

line *B* and 1 as a center strike an arc to intersect the arc already described and connect the lines, thus obtaining one-half of the pattern.

Olean, N. Y. Charles W. Carter, Jr.

## Inspection Incidents

In the latter part of the article "Mud-Burned Horizontal Return Tubular Boiler," published in the October issue of The Boiler Maker, the author states that he would like to hear from the readers of any similar cases which have come to their attention. I am therefore taking the liberty of submitting the following interesting case of an improperly maintained boiler which I found in a sawmill located in St. Lawrence County, New York State, about two years ago.

Under the law in force at that time in New York inspectors had no authority to examine boilers unless the owner employed help. Since then, however, the law has been amended and now subjects all classes of boilers to inspection whether help is employed or not. Incidentally, this is one of the best "safety first" laws that has been placed on the statute books so far as boilers are concerned.

When I called at the sawmill I inquired of the owner who inspected the boiler, and he answered that it was not subject to inspection, since he employed no one in the mill. He offered no objection to my looking over the boiler, however, so I opened up the fire door, and there directly over the fire was the largest bag on the barrel of a boiler I had ever seen. I informed the owner that his boiler was in a very dangerous condition, but he did not seem worried over it, and, as I later discovered, did not even bother to have the sheet repaired.

The writer of the previous letter stated that the state of Pennsylvania has laws governing the care and maintenance of boilers, but I cannot find any mention in the state requirements of how often a boiler must be washed or cleaned out. I believe that some provision should be made in every state that boilers be washed out at least once a month, as this is one of the greatest boiler accident preventatives. The general performance of boilers is also much better when they are washed frequently.

At one time while I was working in Pennsylvania I met an Allegheny county inspector who had been inspecting at the same plant as myself, and, as a matter of interest, we compared our reports. The two boilers installed in the plant were of the Babcock & Wilcox type, and I found that No. 1 boiler had several bulges on the tubes of the lower row. After my friend had looked over the boiler he asked me what I had found, and I told him that the bulged tubes should be replaced. He could not, however, seem to realize the necessity of doing this, for he declared that he had seen tubes in as bad condition last ten years. In spite of his opinion I informed the chief engineer that I would like to see that the tubes were renewed at once and the orders were carried out. It is a fact that there are inspectors who, through lack of training or knowledge of their work, let things like this through and thus fail to enforce the standards of the states in which they act.

While on another inspection trip I came across a horizontal tubular boiler in which the longitudinal seam was located just below the flange of the dome. There was a pressure on the boiler at the time, so I could not make an internal inspection, but I gave it a thorough external examination. There were signs of corrosion of the longitudinal joint at the base of the dome flange, so I took out my jack knife to dig away some of the scale and rust, and, to my surprise, I opened up a hole about two inches long through which the steam commenced to sputter.

When we come across conditions such as these we wonder why there are not more violent explosions, especially since plants are often operated by men who are entirely ignorant of the care and maintenance of boilers. As requirements now stand, after an inspector orders repairs to a boiler the work is never followed up until the following annual inspection. I would suggest that some provision be made whereby a follow-up inspection of a boiler would be compulsory within thirty days after the repairs were ordered.

Olean, N. Y. C. W. C.

## Obituary Notices

Elisha S. Williams, vice-president of the United States Rubber Company, died on October 8, 1920. Mr. Williams was born in Malden, Mass., in 1873, and was educated in the Malden public schools, taking a business course in the Malden High School. He then entered the employ of the Revere Rubber Company, and in the course of a few years became the New England manager, later the Chicago manager, treasurer and president.

On January 1, 1910, when the Revere Rubber Company was purchased by the United States Rubber Company, Mr. Williams was elected president of the Rubber Goods Manufacturing Company. Mr. Williams was largely instrumental in the consolidation of the tire business of the company's subsidiaries by forming the United States Tire Company in 1911, of which he was president until 1915, at which time he was elected vice-president of the United States Rubber Company, in charge of the mechanical goods business. He was also a director in the United States Rubber Company, a member of the Operating Council, and president of several subsidiary companies.

Robert E. Munro, chief inspector of the Baltimore Department of the Hartford Steam Boiler Inspection & Insurance Company, died on March 29, 1920, after a prolonged illness. He was born June 14, 1862, and was educated in Liverpool, England, being graduated from the Liverpool Institute in 1877. After serving his apprenticeship with Rollinson's Engineering Works, Liverpool, his early career was as engineer for various steamship lines, his last engagement being with the Red Star Line, on board the *Pennland*, one of the largest ocean liners of her time. In 1888 Mr. Munro settled in this country and accepted the position of chief engineer for a large oilcloth-manufacturing establishment, at Astoria, L. I., N. Y., remaining there until September, 1891, when he became an inspector in the Baltimore office of the Hartford Steam Boiler Inspection & Insurance Company. He was promoted to the position of chief inspector in 1893 and served in this capacity until his death. Mr. Munro became a member of the Society in 1916.

### Motor-Operated Switchboard Instruments

Various changes have been made by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., on type "M" switchboard and portable graphic instruments. The principal change in these instruments is in the pen-driving mechanism, which before this time has been driven by solenoids and damped by dash pots. Now the drive is by means of a small motor actuated by contacts in the main circuit. Damping is accomplished by means of permanent magnetics on an aluminum disk attached to the shaft of the pen-operating motor.

The external resistance is in a compact unit-form so that interconnections can be made to allow any instrument to operate on a control voltage of 110 volts direct current, or 25 and 60 cycles alternating current. A 220-volt, 25 or 60 cycle control resistor may be used.

# Letters from Practical Boiler Makers

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

## How to Draw an Ellipse

The focal point and string method of drawing an ellipse at one time described by N. G. Near in THE BOILER MAKER is mathematically accurate, but is virtually never used even on paper because of practical considerations.

In the writer's experience, even over the drawing board using pins and cotton for the purpose, the method has failed to give results to specified dimensions. An ellipse results all right from the process, but not the one with specified dimensions. The thread used has a bad habit of ravelling round the pin, or of climbing up its length, if of a domestic variety. Repeated trial is necessary to get the exact length of thread required. The stretch of the sewing thread spoils the results and the pencil slips at a criitcal moment. Rough and ready methods such as this lead to the abandonment of others which are perhaps more accurate and nearly as simple in the long run.

The following suggestions are tentative in character, but it is thought that along these lines a practical apparatus for drawing an ellipse can be constructed suitable for use in marking out shell plates.

First a word as to materials. Fine wire, if soft, will kink; if hard, it will not readily bend at the angle needed. Some form of flexible stranded wire might serve similar to that used in electrical instruments.

There is an existing material as nearly free from stretch as any flexible cord can be, and this is the fine cable used in connection with the steam engine indicator.

Also in connection with this well-known instrument are several varieties of cord shortening devices, which, being already in existence, can be applied to our proposed ellipsograph. There is no better method than to make the cord endless round the pins at the focal points and the indicator cord shortening device will serve to readily adjust the cord to any desired length.

The flexible member makes a closed loop and disposes of the necessity for any attachment to the focal pins. To overcome the clear impossibility of sticking pins in boiler plate:

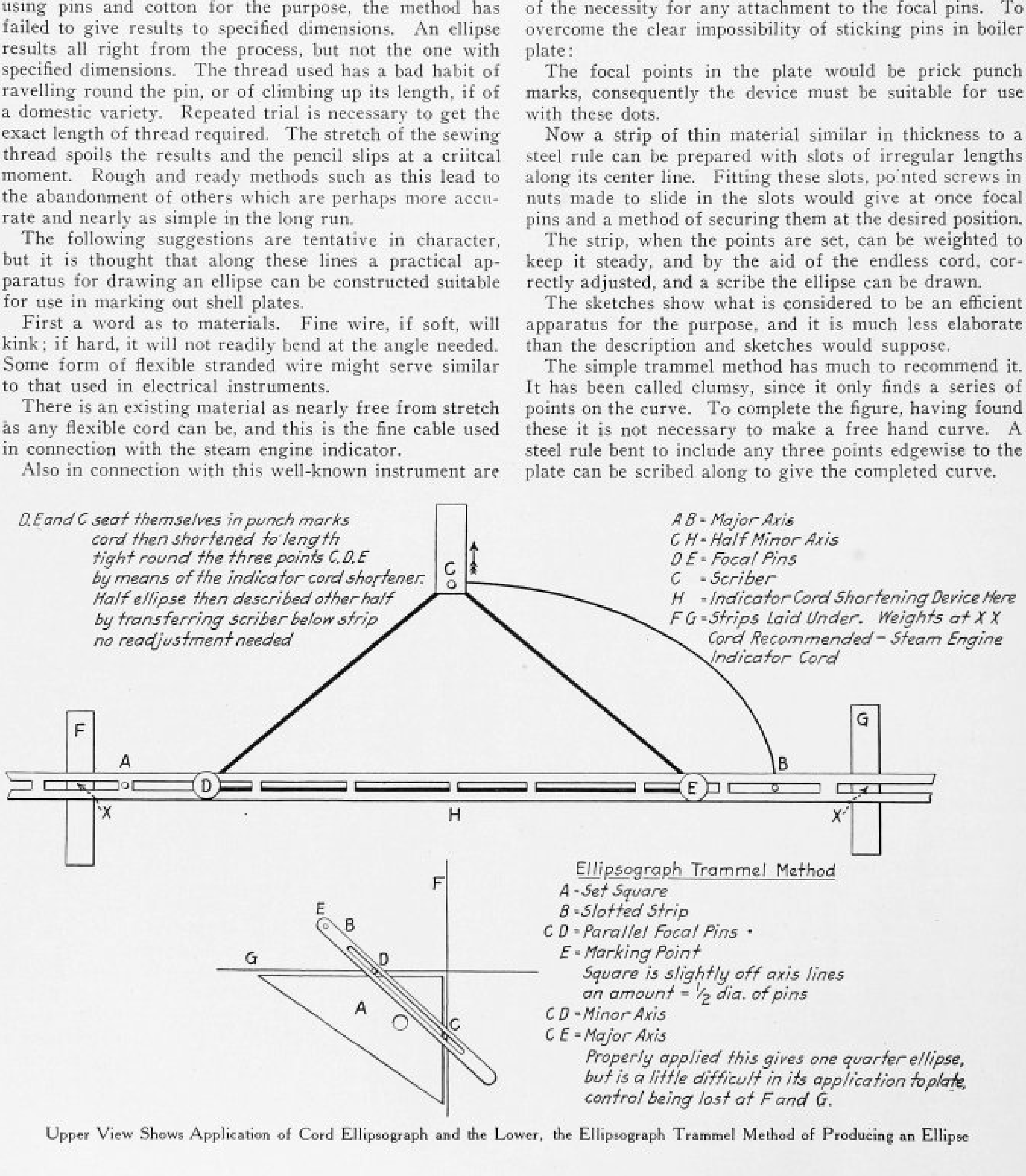
The focal points in the plate would be prick punch marks, consequently the device must be suitable for use with these dots.

Now a strip of thin material similar in thickness to a steel rule can be prepared with slots of irregular lengths along its center line. Fitting these slots, po'nted screws in nuts made to slide in the slots would give at once focal pins and a method of securing them at the desired position.

The strip, when the points are set, can be weighted to keep it steady, and by the aid of the endless cord, correctly adjusted, and a scribe the ellipse can be drawn.

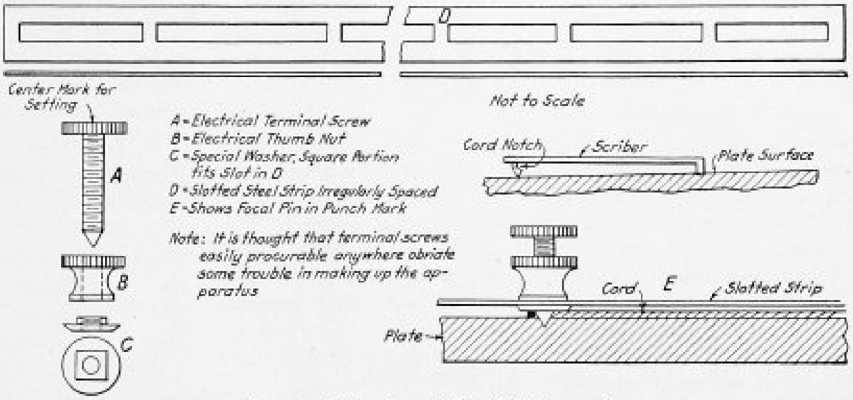
The sketches show what is considered to be an efficient apparatus for the purpose, and it is much less elaborate than the description and sketches would suppose.

The simple trammel method has much to recommend it. It has been called clumsy, since it only finds a series of points on the curve. To complete the figure, having found these it is not necessary to make a free hand curve. A steel rule bent to include any three points edgewise to the plate can be scribed along to give the completed curve.




Upper View Shows Application of Cord Ellipsograph and the Lower, the Ellipsograph Trammel Method of Producing an Ellipse

The draftsman uses a try square with the right angle coinciding with the intersection of the major and minor axes in each quarter in turn. A strip with adjustable pins, carrying a pencil point at its outer end, will draw a complete and perfect curve. The same method is applicable to shell plate. The sketch given shows the device and its application.




Structural Details of Cord Ellipsograph

The trammel method lends itself by reason of its straight line guidance to mechanical exploitation. It is the method used in all elliptical chucks, trepanning tools and compasses ever devised.

The antiquity of the trammel method is remote; it is possible that Euclid was acquainted with its possibilities.

An example of its ancient origin and use. The city of Pompeii was buried in A. D. 79, and exploration in the 19th century discovered many interesting things.

The writer has seen a museum case of mathematical drawing instruments made of bronze and badly corroded at South Kensington, London. Among them is an elliptical compass based on the trammel method. This instrument is equal in design to that employed by any modern draftsman.

London, England. A. L. Haas.

## Burning Air

The idea is still prevalent among many engineers and other persons who would save fuel that after one gets a fire started it is simply necessary to force as much air as possible through the fire and burn the air. I remember, some years ago, hearing a salesman talk to the women of a small town about saving fuel. He was boosting fuel oil to replace wood and coal in cooking stoves, and had his demonstrating apparatus so arranged that drops of oil would fall onto a hot plate supporting combustion. The drops of oil could be seen dropping, and they dropped very slowly. It seemed that very little oil was being consumed, and yet a nice hot fire was maintained. It looked very good, and his argument was, "You see, ladies, I am not burning much oil, but I am burning lots of air." The argument sounded good to me, also, and I believed the theory to be sound for several years until I heard a college professor explode it. The salesman sold many of his outfits to the ladies of the town.

It is true that fuel can be burned in two ways. It can be burned incompletely or completely. Carbon will unite with one portion of oxygen and form carbon monoxide or CO, or carbon will unite with two portions of oxygen and form $CO_2$. The trick in securing correct combustion is to use the proper amount of air—not too much and not too little.

Theoretically, burning one pound of carbon "completely" to $CO_2$, 2⅔ pounds of oxygen are required. The method of arriving at this theoretical amount is not difficult, and is as follows: The atomic weight of carbon is 12, and the atomic weight of oxygen is 16. Two portions of oxygen would, therefore, weigh 32. Dividing 32 by 12 we get 2⅔ as the number of pounds of oxygen required per pound of carbon for complete combustion.

Now, how much "air" is theoretically required for complete combustion? That is not difficult, either, as it is known that 23.2 percent of atmospheric air is oxygen and the remainder, or 76.8 percent, is nitrogen. Since the nitrogen is of no value in the combustion process, we simply divide the 2⅔ pounds by 23.2 percent and get 11.5 pounds of air per pound of carbon as the answer.

This 11.5 pounds of air per pound of carbon must not be confused with coal, because coal is never pure carbon. There are some coals so low in carbon, for instance, that much less air is required per pound of coal. Thus a poor quality of bituminous coal may require no more than 7 pounds of air, theoretically. The average anthracite coal requires about 10 pounds, and liquid fuel a bit over 14 pounds.

Practically, fuel requires more than the theoretical amount in the boiler furnace in order that all of the carbon will be completely burned. In boiler furnaces we have the mixing problem to contend with, which is necessarily imperfect at its best. So, in practice, 16 to 18 pounds of air are needed per pound of fuel. Few plants, however, are able to keep air usage down to these figures. Forty pounds per pound of fuel is a very common figure. Frequently it runs up to 60 and 70 pounds per pound of fuel.

Now, where the amount of air theoretically required is, say, 10 pounds, it is plain that if 60 pounds are permitted into the furnace per pound of fuel there is an excess of 50 pounds of air. The oxygen in these 50 pounds serves no purpose whatsoever, being as valueless as so much nitrogen. The carbon in the fuel can unite with only so much oxygen and no more, that amount coming out of the ten pounds of air theoretically required. The extra air forced through the fire or permitted to pass through, as the case may be, is, therefore, a cause of "loss" instead of a gain. It is heated to the temperature of the chimney gases and passes out uselessly. Thus, if this excess of air is heated 300 degrees Fahrenheit higher than the temperature of the atmosphere, the loss per pound of fuel is $50 \times 0.24 \times 300 = 3{,}610$ British thermal units.

If the heat value of the fuel is 12,000 British thermal units per pound, there is a loss of $3{,}610 \div 12{,}000 = 30$ percent.

This explains why so many power plants have low efficiencies. It is generally within the power of the engineer in charge to regulate the air in such a way that higher efficiencies can be obtained, but he overlooks or side-steps the opportunity. He is satisfied to run the furnace "by guess" instead of scientifically. He looks upon a $CO_2$ recorder as a "highbrow institution" which is not needed by experienced and practical men.

To the knowledge of the writer there is no better means for learning the correctness of proportion of air to fuel than through the use of the $CO_2$ recorder. Get a continuous recorder if possible. Continuous recorders cost a little more at first, but in the end they will be found worth while.

Also, after installing a recorder and getting the plant agoing nicely, don't suddenly "forget all about" the recorder and stop keeping records. The function of the recorder is to "maintain" a high boiler efficiency constantly. No matter how skillful the fireman, it is well to keep his work constantly checked up on the records.

Brooklyn, N. Y. W. F. Schaphorst.

## How to D sign a Boiler

(*Continued from page 327.*)

require. Foundations should always be carried to "hard-pan," but in no case shall they be less than 4 feet in depth below the original ground line, or "yard level," as it is termed by civil engineers.

Table 21 gives the approximate bearing values of different classes of soil.

It is the general practice to carry foundations to sufficient depth where the soil is good for a bearing pressure not less than 4,000 pounds per square foot.

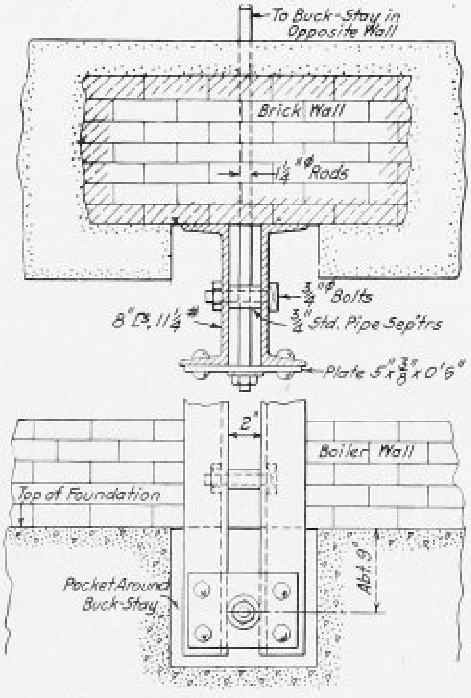



Fig. 116.—Buck-Stay Construction

TABLE 21.—BEARING POWER OF SOILS AND ROCK

Dry, hard, yellow clay, "boulder clay," dry sand or gravel—6 tons per square foot.

Compact camp sand, hard sand clay, hard blue clay—5 tons per square foot.

Medium blue clay—3½ tons per square foot.

Soft clay—2½ tons per square foot.

### Pile Foundations

Where the condition of the soil is very poor or a satisfactory bearing cannot be obtained at a reasonable depth, such as in marshy territory, concrete or wood piles must be driven into the soil to carry the load. Such piles, usually from 15 to 30 feet in length, are driven at centers of 3 to 4 feet, and their tops carried flush with each other to a point about 4 feet below yard level. The soil above the tops of the piles is then excavated and a heavy reinforced concrete slab is laid over them, and upon these the foundation proper is constructed. Wood piles are usually good for a bearing pressure of 10 to 12 tons, each depending upon their depth; they are usually 12 inches diameter at the top. Concrete piles, generally always reinforced, are good for bearing pressures up to 25 tons per pile; their diameter is about 15 inches.

(*The End.*)

## PERSONALS

J. W. Fox, valuation engineer of the Central of Georgia Railroad, has resigned to become affiliated with the Lawrence Construction Company, Augusta, Ga.

Charles H. Bromley, associate editor of *Power* for over eight years, is giving up this position to take up engineering and commercial executive duties with the Richardson-Phenix Company, Milwaukee, Wis.

O. L. Merkt, for fifteen years affiliated with Westinghouse, Church, Kerr & Company, New York, has become assistant chief engineer of the American Can Company, with headquarters in New York.

Fred J. Passino, formerly assistant district manager of the New York territory of the Independent Pneumatic Tool Company, Chicago, has been appointed district manager of the company at Pittsburgh.

George F. Downs, president Lackawanna Steel Company, Buffalo, has been elected a director of the American Iron and Steel Institute to fill the vacancy caused by the death of Charles H. McCullough, Jr.

E. W. Englebright, engineer, Union Pacific Railroad, New York City, with his entire staff, has been transferred to Omaha, where his office will be consolidated with that of E. E. Adams, assistant to the president.

C. T. Smith, formerly with the Chicago Pneumatic Tool Company, has become affiliated with the sales force of the National Sales and Trading Company, Cleveland, Ohio, and will have charge of the railroad supplies department which the company has just inaugurated.

C. E. Lester, who was general superintendent of the 19th Grand Division, Transportation Corps, and superintendent of the locomotive and car shops of the American Expeditionary Forces at Nevers, France, has recently been commissioned as a Lieutenant-Colonel of Engineers in the Reserve Corps.

A. L. Whipple has been appointed representative of the Locomotive Stoker Company, Pittsburgh, Pa., with offices at 50 Church street, New York. Before becoming connected with the Locomotive Stoker Company he was vice-president and acting general manager of the Railway Improvement Company, New York City.

John T. Coleman, assistant chief inspector of the Chicago department of the Hartford Steam Boiler Inspection and Insurance Company, has been transferred from the main office of that department in Chicago to its branch in Detroit in order that he may have more direct supervision of the company's inspection service in the territory adjacent to the latter city.

Arthur Cutts Willard, professor of heating and ventilation in the department of mechanical engineering at the University of Illinois, has been appointed head of the department to succeed Dean C. R. Richards, who, since his election as dean of the College of Engineering and Director of the Engineering Experiment Station, has continued to serve as the acting head of the department of mechanical engineering.

Charles E. Patterson, comptroller of the General Electric Company, Schenectady, N. Y., has been elected vice-president of that company. Mr. Patterson was formerly associated with the New York Central Railroad and the American Locomotive Company. He aided in the development of the Interstate Commerce Commission's accounting system for railways, and was appointed chairman of the standing committee of the Electric Manufacturers' Council, which evolved the standard accounting cost system for the electric manufacturing industry.

## TRADE PUBLICATIONS

Dravo Superheater.—In this bulletin published by the Dravo Company, of Milwaukee, Wis., the general construction and applications of the Dravo superheater are given. Photographs and diagrams are used to illustrate various installations of the equipment.

The Oxygraph.—Apparatus for cutting steel up to 20 inches thick with oxy-acetylene or oxy-hydrogen is described in a pamphlet issued by the Davis-Bournonville Company, Jersey City, N. J. Dies and shapes may be cut according to a drawing, pattern or template, with speeds up to 18 inches per minute.

Aids to Industry.—The latest pamphlet of the Independent Pneumatic Tool Company, Chicago, Ill., illustrates various new types of "Thor" piston air drills and pneumatic hammers and a short description of each. Tables of operating data for each class of tools give an excellent idea of the efficiency of the equipment.

Nonpariel Insulating Brick.—This 72-page booklet sent out by the Armstrong Cork Company, Pittsburgh, Pa., describes in detail the character of nonpareil bricks, tests which have been made upon them, and typical methods of using them in various structures. It is well illustrated with photographs and tables containing information in connection with insulation problems.

Power Transmission Machinery.—The A. & F. Brown Company, Elizabethport, N. J., has sent out a 130-page catalogue containing complete descriptions and specifications for the various products of the company, which include gears, shafting, bearings, friction clutches, pulleys, fly wheels and other power equipment. General information that will prove useful in planning the layout of a power plant is also given.

New Principles in Welding.—Catalogue No. 20 of the Bastian-Blessing Company, Chicago, Ill., describes a new non-flashback principle in oxy-acetylene welding and cutting which is accomplished by the use of Rego apparatus. It is claimed that production may be increased by eliminating the flashback and that a decided saving in gas consumption results. Detailed descriptions of the apparatus and fittings are given.

Machinery Quarterly.—The first issue of a bulletin which will be published every three months by Joseph T. Ryerson & Son, Chicago, Ill., has been sent out. This book contains up-to-the-minute facts, specifications and descriptions of a representative line of Ryerson equipment. One or more machines or tools of each class is illustrated and the specifications of it given in detail. Complete data on any particular type of machinery will be supplied by the company on request.

Complete Foundry Equipment.—Foundry layout and operation from the early days to the present are described in an illustrated catalogue sent out by the Whiting Foundry & Equipment Company, Harvey, Ill. The founding of metals as it exists today is of comparatively recent origin, since the cupola furnace for melting iron was only introduced in America 100 years ago. In fact, the last forty years have seen the greatest development of this industry. The data contained in the catalogue, describing each of the various departments of a modern, well-equipped foundry, are intended for the benefit of those who contemplate entering the foundry business and who have no broad personal knowledge of its requirements.

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## Selected Boiler Patents

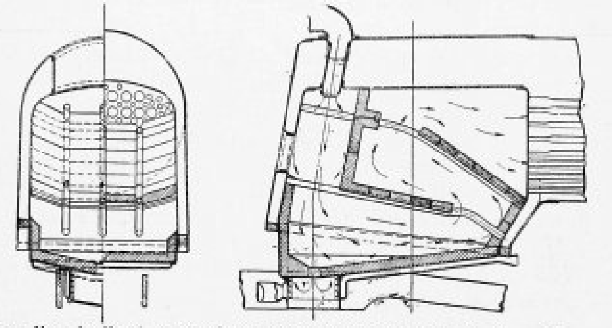
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney,
Washington Loan and Trust Building,
Washington, D. C.

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

1,307,364. LOCOMOTIVE FIREBOX. ALONZO G. KINYON, OF CHICAGO, ILLINOIS, ASSIGNORS TO POWDERED COAL ENGINEERING & EQUIPMENT COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF DELAWARE.

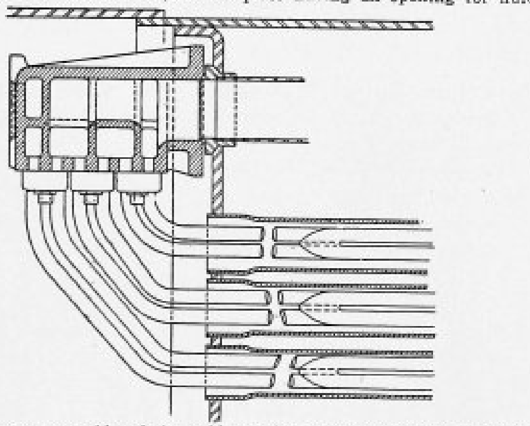
*Claim.*—In a locomotive firebox, upper and lower sets of longitudinally



extending inclined supporting pipes, upper and lower baffle walls supported on the respective sets of pipes and a substantially upright wall near the front of the firebox, but spaced from the front to provide a passage adjacent the same, a burner for pulverized fuel communicating with said passage at the top thereof, and a hearth having an opening directly beneath said passage. One claim.

1,304,910. STEAM SUPERHEATER FOR BOILERS. JOHN GEORGE ROBINSON, OF MANCHESTER, ENGLAND, ASSIGNOR TO THE SUPERHEATER CORPORATION, LIMITED, OF LONDON, ENGLAND.

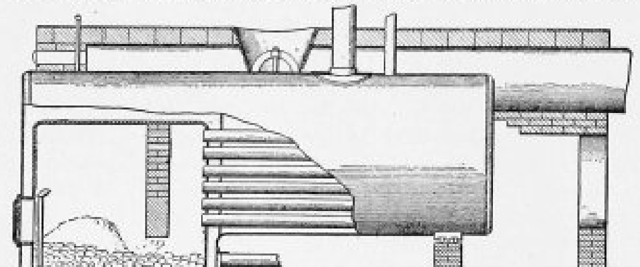
*Claim* 1.—The combination, with a plate having an opening for fluid



and a recess to one side of the said opening, of a pipe communicating with the said opening and provided with a fastening block, said block having also a hole arranged in line with the said recess, a screwthreaded stud projecting from the said plate at the bottom of the said recess, and a box nut engaging with the stud and securing the fastening block to the plate. Three claims.

1,306,628. BOILER FURNACE. THOMAS J. ROBINSON, OF CHICAGO, ILLINOIS.

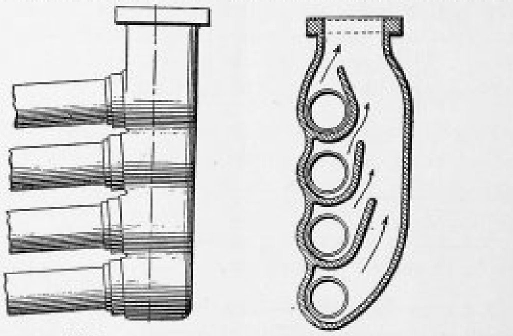
*Claim* 1.—In a boiler, a furnace having a grate, said furnace having side walls consisting of water legs rising from the sides of the grate,



hollow nipples secured to the inner walls of the water legs above the grate and between its ends and communicating with the interior of the water legs, enlarged caps closing the inner ends of said nipples, a firebrick arch composed of a plurality of bricks, the end bricks having shouldered recesses interlocking with said caps and being supported on said nipples, and a baffle wall supported on said arch and rising to the crown sheet of the furnace as and for the purpose specified. Two claims.

1,305,163. HEADER FOR BOILER ELEMENTS. CHARLES RADIGUER, OF ST. DENIS, FRANCE, ASSIGNOR TO THE SOCIETE ANONYME DES ETABLISSEMENTS DELAUNAY-BELLEVILLE, OF ST. DENIS, FRANCE, A CORPORATION OF FRANCE.

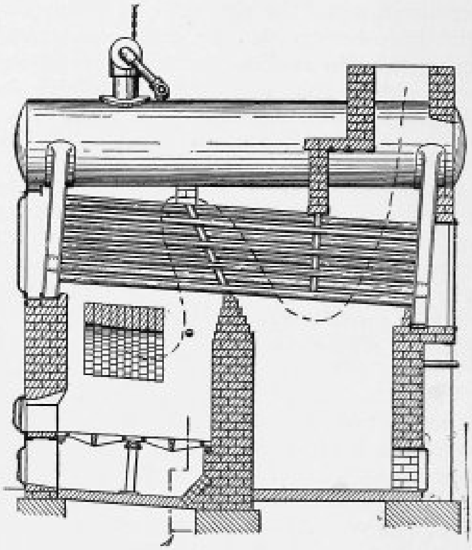
*Claim* 1.—An upper header for watertube boiler elements, having ribs extending inwardly and upwardly from one side wall thereof and form-



ing compartments which are open at the top, one end wall of the header having inlet tube-receiving openings alined with the compartments, said header having a passage with which all of the compartments communicate, the passage being arranged between the ribs and the side opposite to that by which said ribs are carried. Two claims.

1,334,548. BOILER PLANT. LESTER W. MENDELL, OF BROOKLYN, N. Y., ASSIGNOR TO LAWRENCE BARNUM AND JAMES J. MILDON, BOTH OF NEW YORK, N. Y.

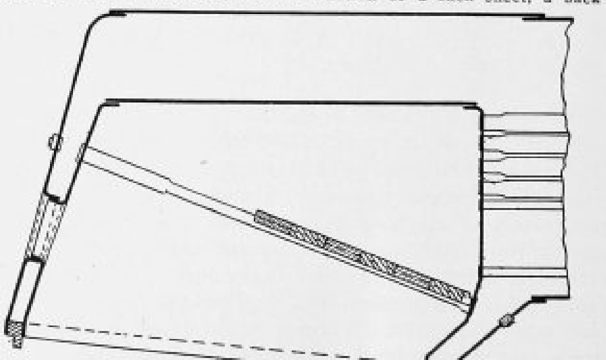
*Claim* 1.—In a boiler plant, the combination of a boiler, a setting for the same provided with a firebox, a stack, a coking arch located below



the forward portion of said boiler, and leaving at the rear of said firebox an upwardly extending passage between said coking arch and the rear wall of said firebox for the discharge of the products of combustion, with a nozzle located in a substantially transverse vertical plane at the rear of said firebox, and pointing in a downwardly inclined direction toward the rear portion of said firebox from one side of said firebox, the axis of said nozzle passing below the level of the central portion of the lower surface of said arch, so that the stream of discharged steam does not interfere with the free passage of gases from the lower surface of the central portion of said arch to said stack. Four claims.

1,337,486. LOCOMOTIVE FIREBOX ARCH. GILBERT E. RYDER, OF LEONIA, N. J.

*Claim* 1.—In a locomotive, the combination of a back sheet, a back



tube sheet, an arch tube comprising two cylindrical portions secured to the sheets respectively and a plurality of spaced parallel branches connecting the cylindrical portions, and a plurality of arch bricks, supported by the branches. Seven claims.

# THE BOILER MAKER

DECEMBER, 1920

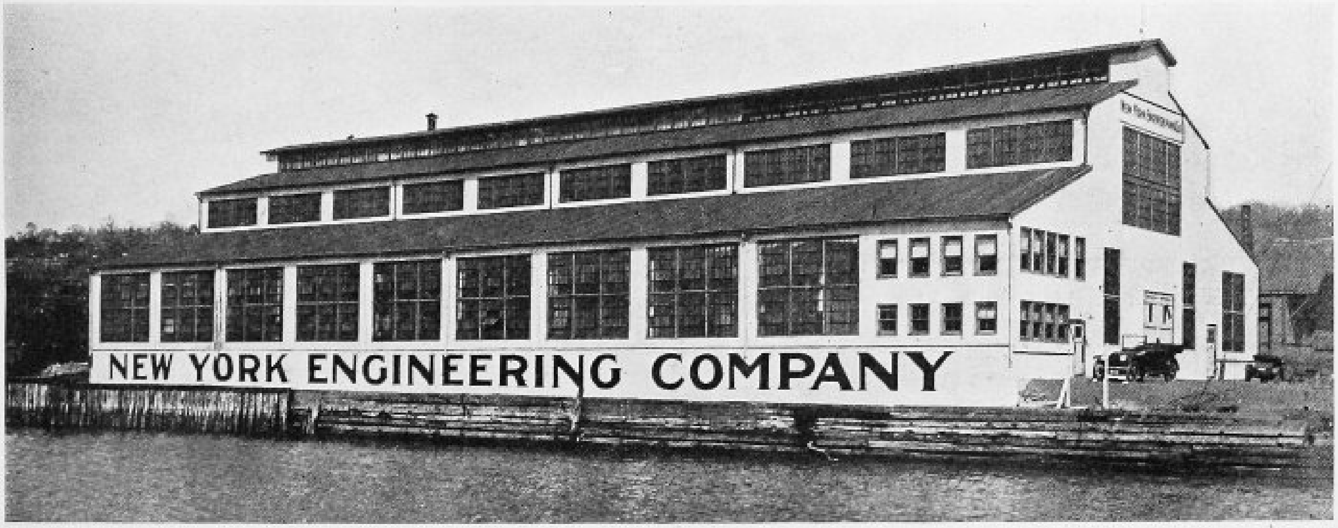



Fig. 1.—General View of Yonkers Plant Where Ludlum Boilers Are Built

# Construction of the Ludlum Watertube Boiler

**Methods Developed by New York Engineering Company for Reducing Boiler Production to Machine Shop Basis**

With the increased demand for marine boilers during the last three years, especially for those of the watertube type, a great many engineering organizations working on machinery construction have devoted certain of their facilities to boiler production. Among these, the New York Engineering Company, of New York City, which had until 1918 been engaged chiefly in the construction of mining machinery, built and equipped a new plant at Yonkers, N. Y., for carrying on the construction of Ludlum watertube boilers. In organizing and equipping the plant every effort was made to reduce the fabrication of boilers to as nearly a machine shop, or, better, a manufacturing basis, as possible. This attempt at departing from accepted boiler shop methods has resulted in a highly efficient system of production.

The plant was designed and built under the supervision of the engineering force of the company. It was commenced in June, 1918, and the first boiler was turned out before the end of the year.

The administration offices of the company are located in New York City, as well as the engineering and sales departments. The main shop is in Yonkers, in charge of a general manager and a small non-productive staff of office clerks, tool room and supply clerks and a shipping force. The third unit of the company consists of a machine shop, also in Yonkers, where fittings for saddles, reinforcing pads for outlets, special valves, safety valves and the like are produced.

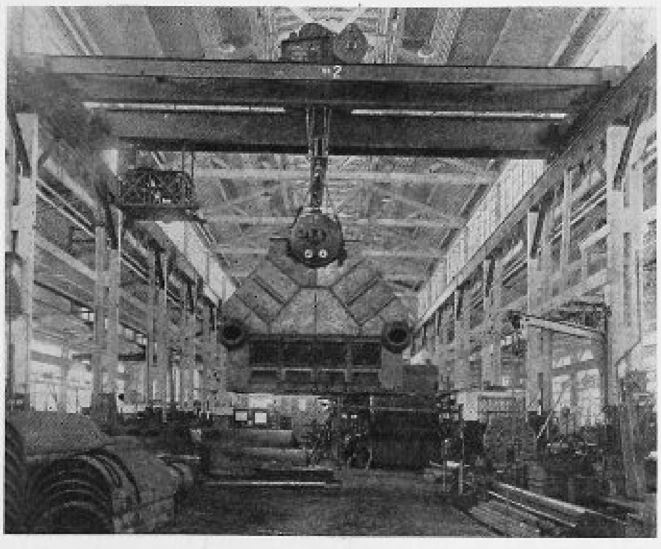


Fig. 2.—Transferring Boiler Complete from Assembly Department to Testing Department on 25-Ton Chesapeake Crane

### Description of Boiler Shop

In general, the main boiler shop is in three bays—the center bay, 200 feet in length, 50 feet wide and 50 feet high, while the east and west bays are each 200 feet in length, 35 feet wide and 20 feet high. Transportation facilities are excellent and the plant may be supplied with raw material by rail, motor truck or by water. A spur of the New York Central Railroad tracks runs through the center bay, so that finished boilers may be loaded directly onto cars for shipment, or onto lighters at the company's dock.

The center bay of the shop is fitted with a Chesapeake 220-volt, 3-phase electric crane having a 25-ton capacity, which is used to handle material and the finished boilers from one part of the plant to another in the

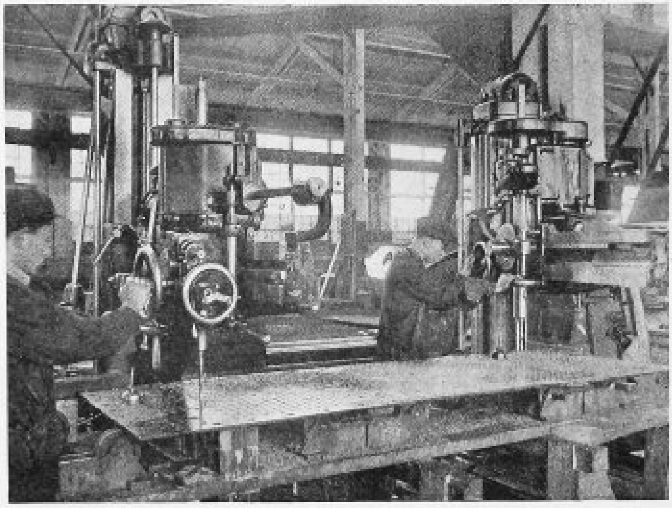


Fig. 3.—Twin 4-Foot Radial Drills Set for Synchronous Drilling Operations

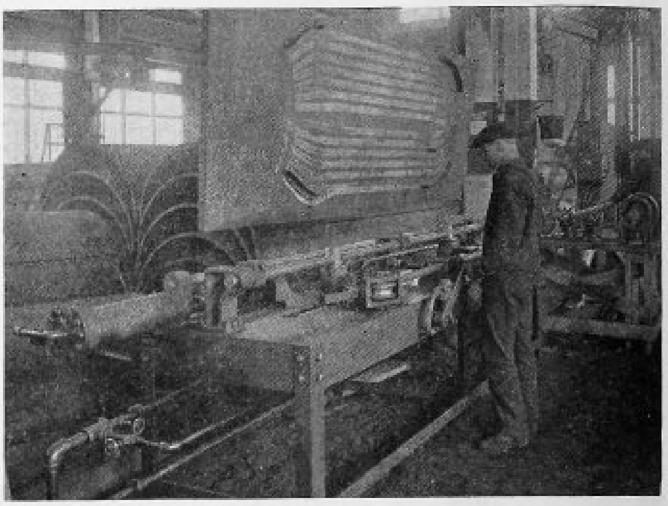


Fig. 5.—New York Engineering Company Design Hydraulic Tube-Bending Rolls, Shaping Tubes by Template Method

process of construction, or to load them onto cars or trucks for shipment. Each side bay is equipped with a 5-ton, floor-controlled electric crane, while the larger machine tools have jib cranes and trolleys for service or for purposes of handling the material being worked on them.

Electric current is furnished by the Public Service Company at 7,200 volts and is stepped down at the transformer house located at the northern end of the plant to 220 volts for machine power and 110 volts for lighting.

### Heating System for Shop

A point that was carefully considered in the design of the structure was the heating system, which consists of overhead steam coils located just under the roof in the three bays where the cold air entering for ventilation is heated and circulated. This system makes possible an automatic gravity drain from the pipes to the boiler. Wall space is also left available for tools, which would otherwise be taken up by pipes.

A Ludlum boiler is used for the heating system as well as for running tests on any new devices or equipment developed in the work that need to be tried out. Superheaters are fitted to this boiler and it is operated to conform to state regulations. The interior of the building is painted white and the tools painted a light French gray, so that natural daylight may be utilized most effectively in lighting the shop by reflection. It is also much easier to keep the tools clean and in repair when painted in this manner. The artificial lighting system, especially designed for the plant, consists of a series of lights in each bay fitted with "Ivanhoe" reflectors, having 200-watt lamps in the center bay and 100-watt lamps in each side bay.

Fire mains having a pressure of 130 pounds at the valves are distributed through the plant. The shop force has been

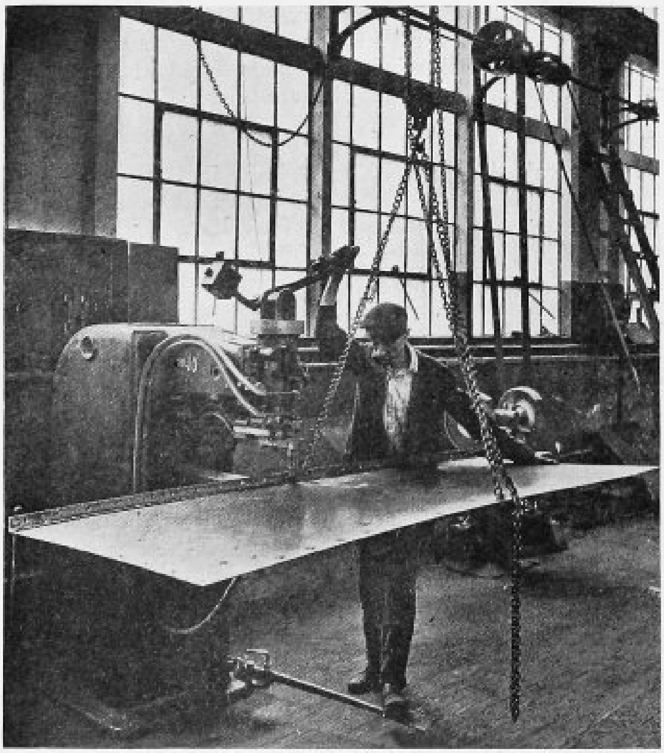


Fig. 4.—Thomson 20-Kilowatt Spot Welder Used in Fabricating Boiler Casings

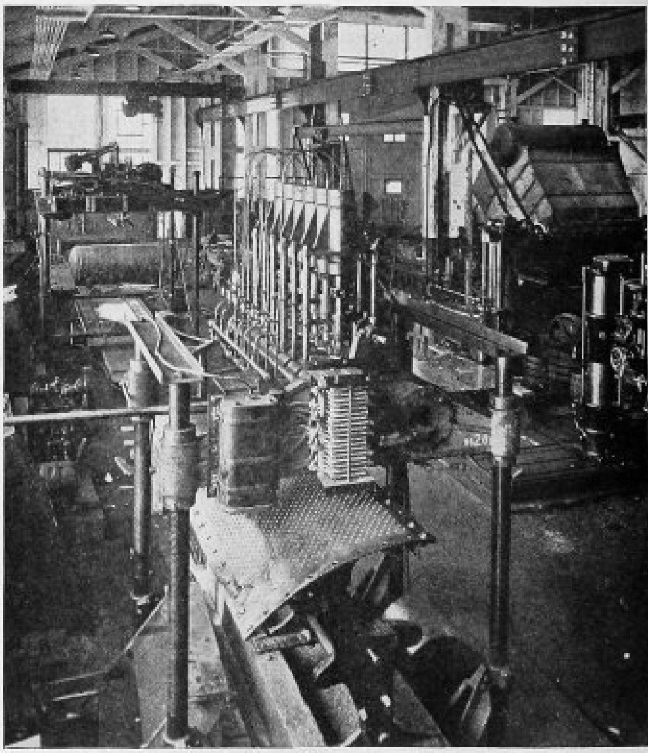


Fig. 6.—Special Hydraulically Controlled Feed and Table Travel, Six-Spindle Rivet Hole Drill Press

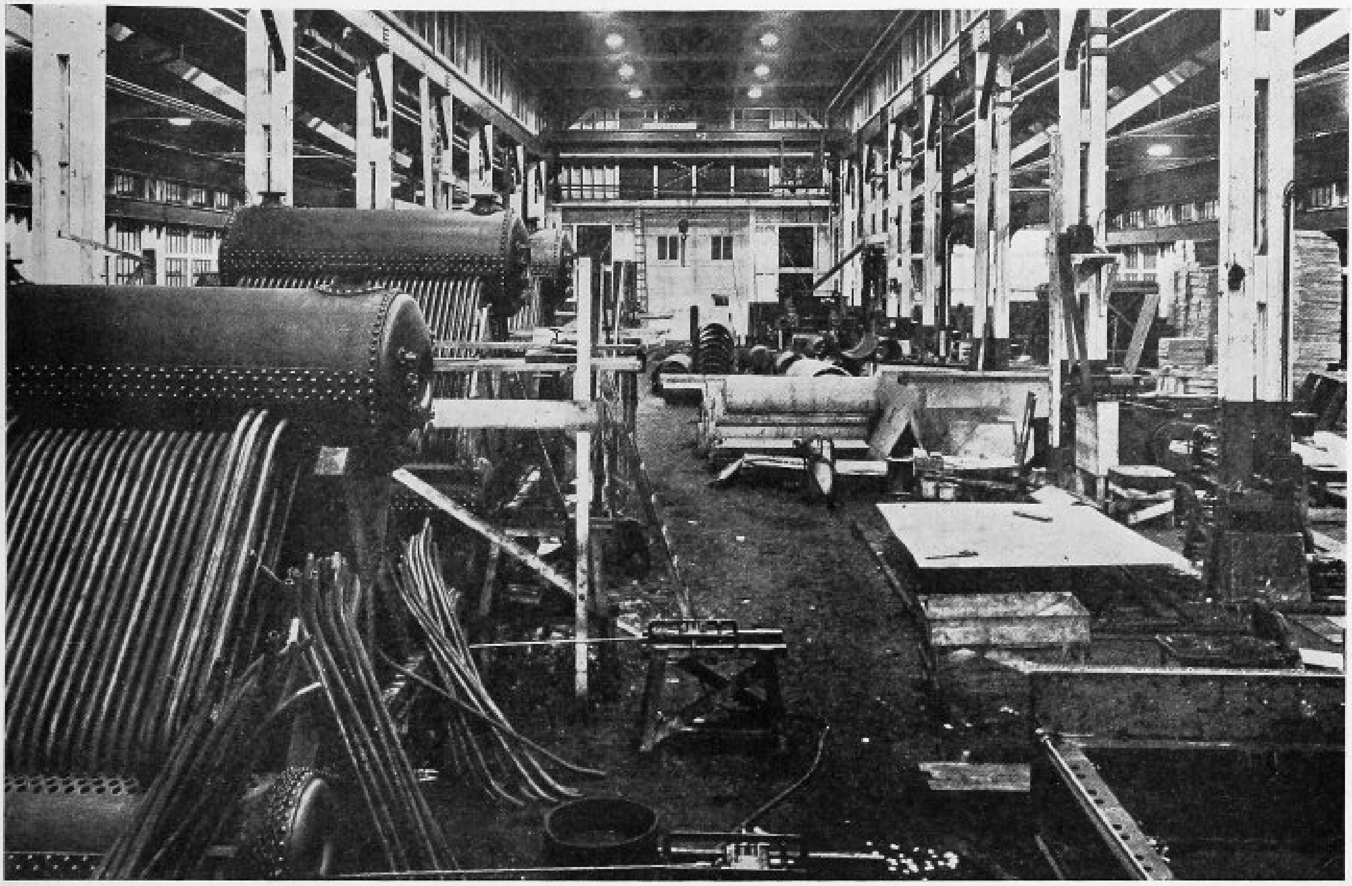


Fig. 7.—Drums Arranged on Assembly Racks for Installation of Tubes

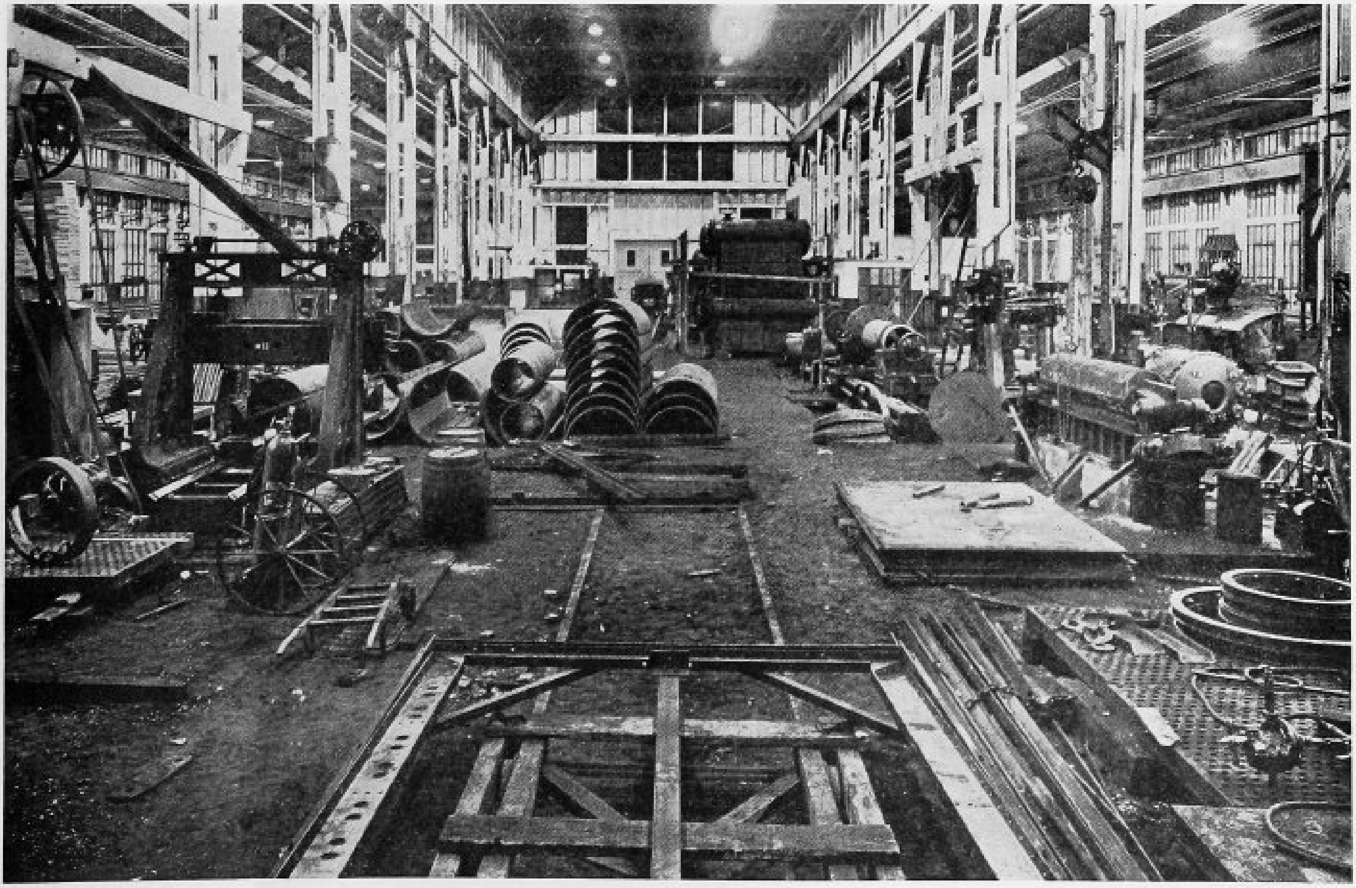


Fig. 8.—Center Bay of Plant, Showing Plate Planer and 300-Ton Plate Bending Press

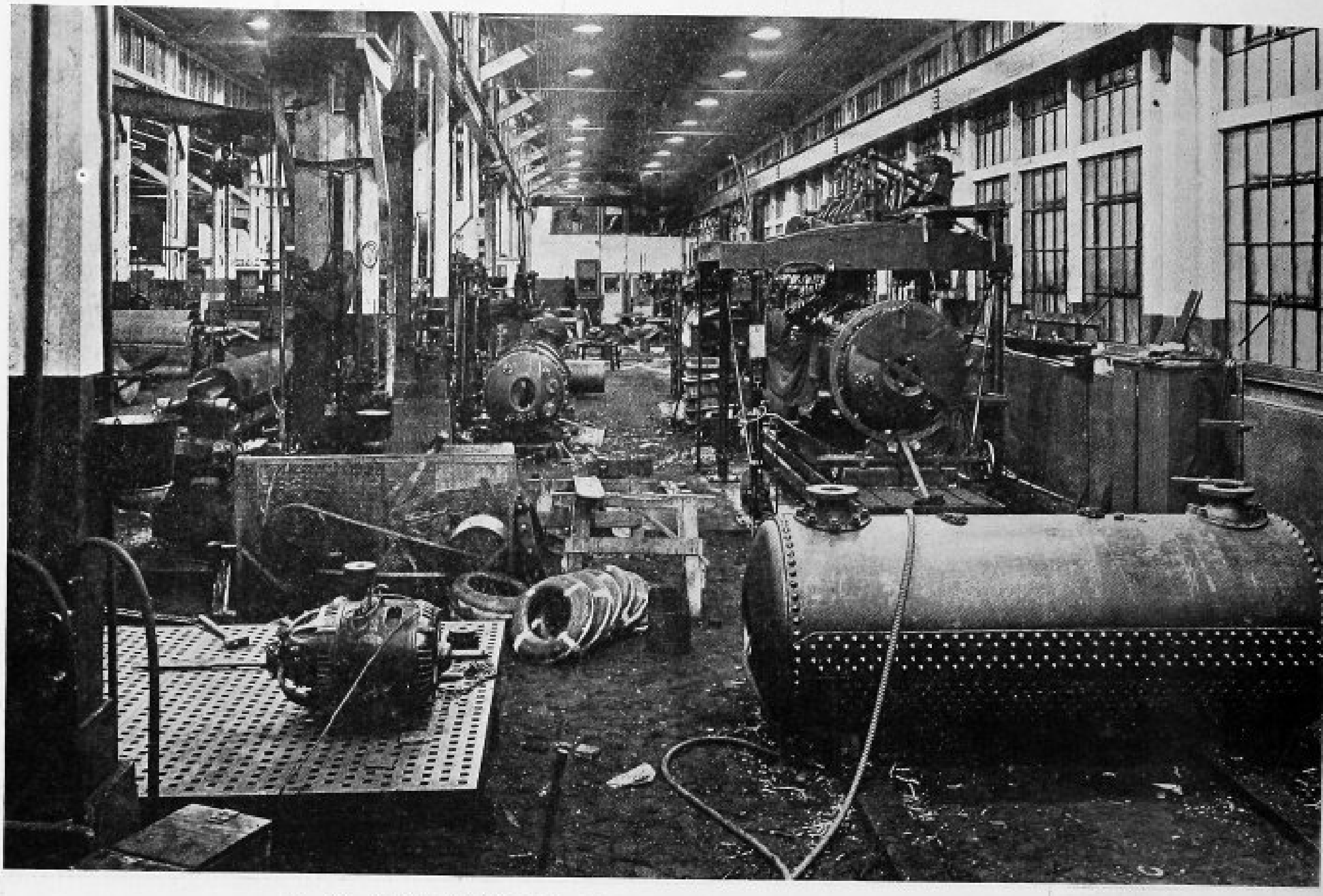


Fig. 9.—Multiple Spindle Tube Hole Drill Having Capacity of Six 2-Inch Holes

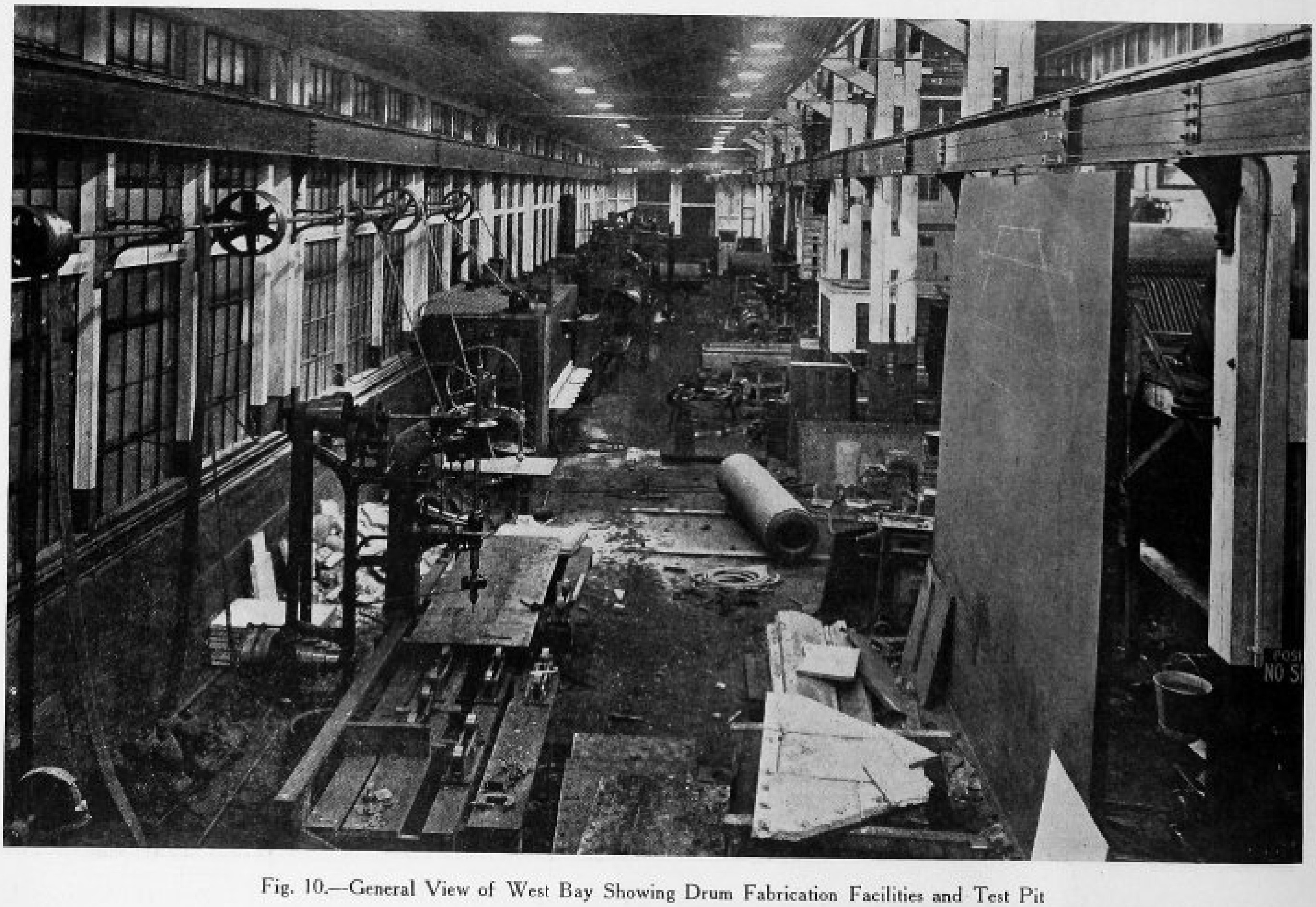


Fig. 10.—General View of West Bay Showing Drum Fabrication Facilities and Test Pit

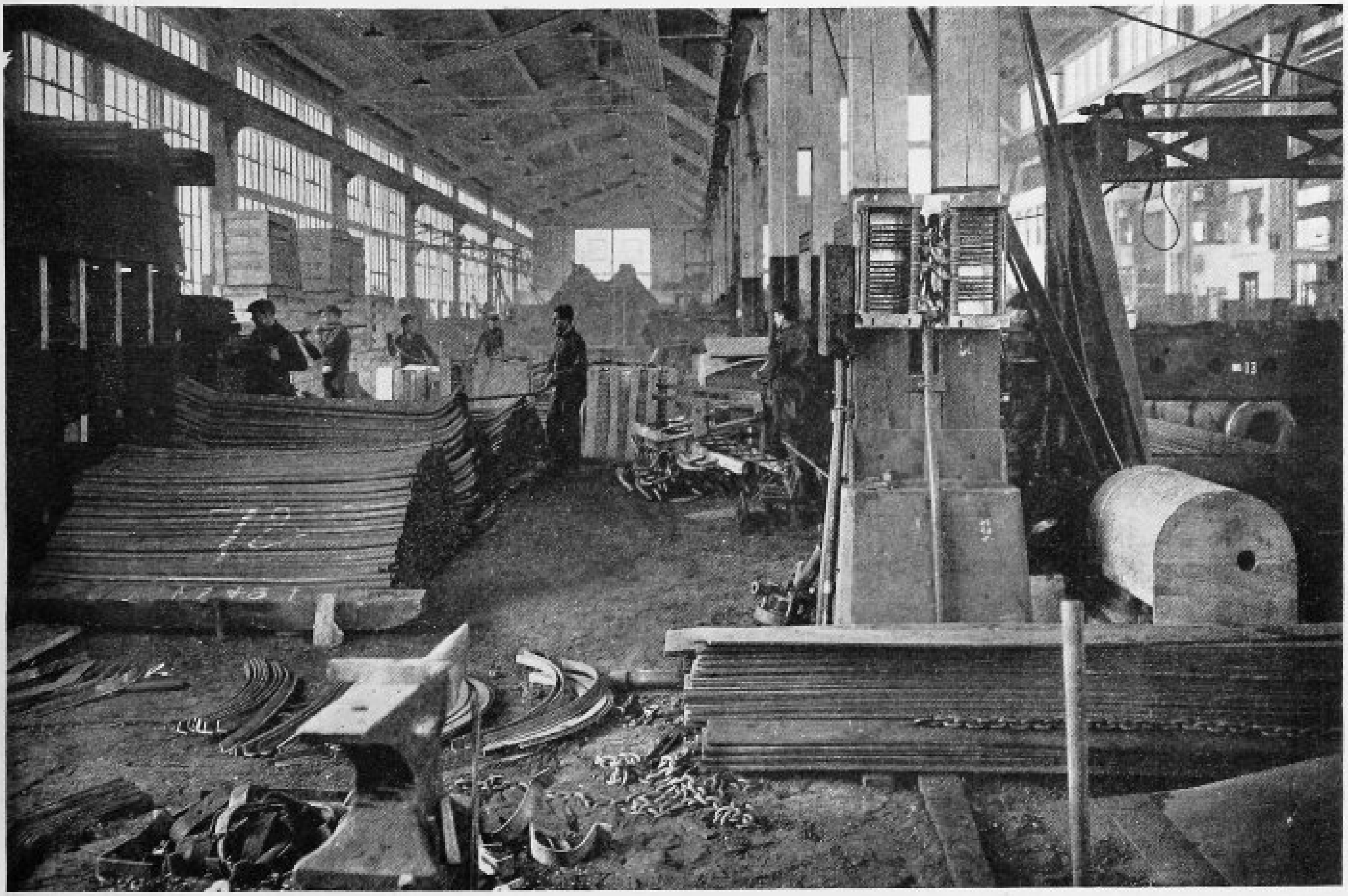


Fig. 11.—Tube Department Located in East Bay Where Tube-Bending Machine and Polishing Equipment Are Located

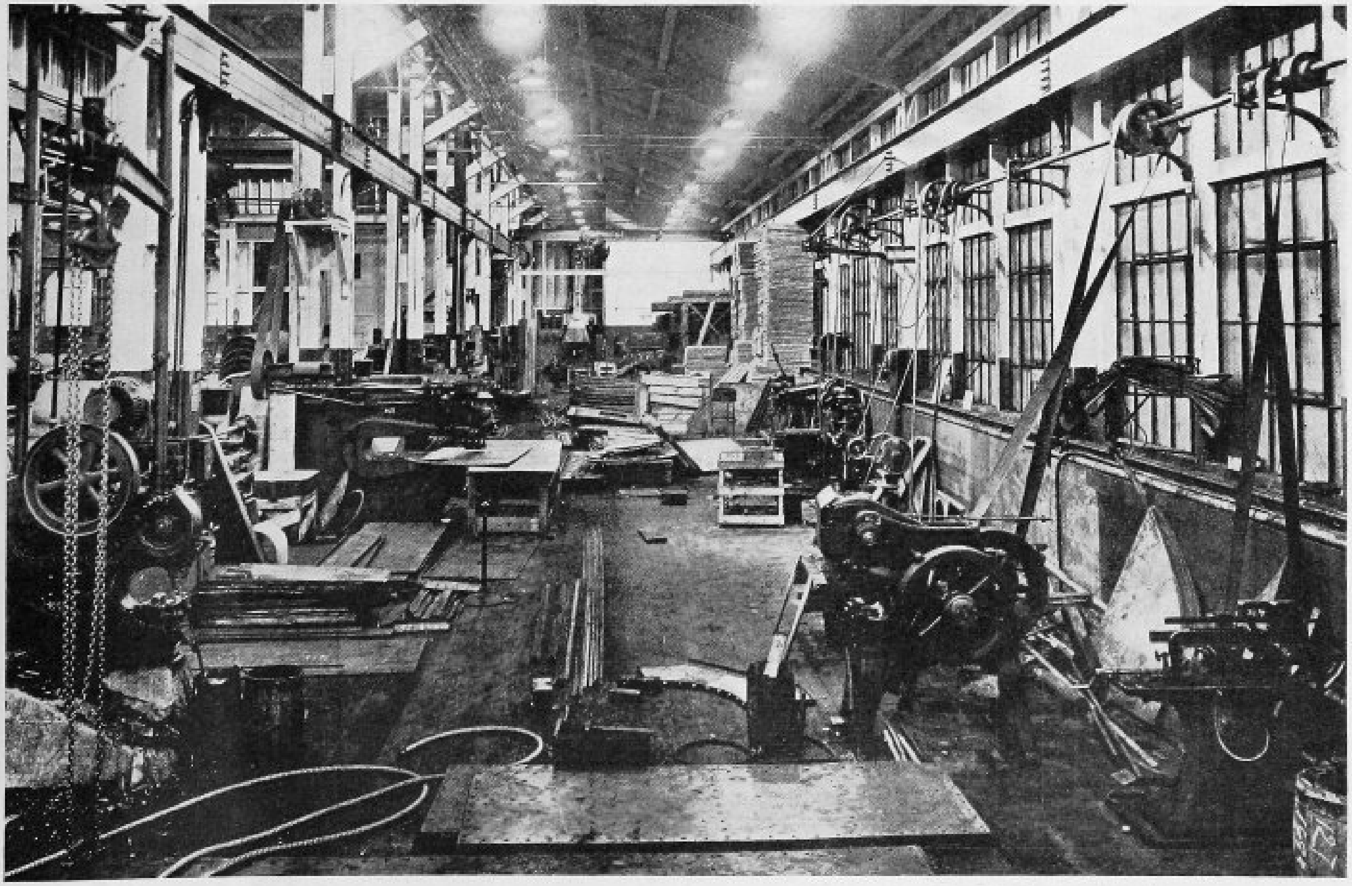


Fig. 12.—East Bay of Shop in Which Department Casings Are Made and Tubes Bent Ready for Installation

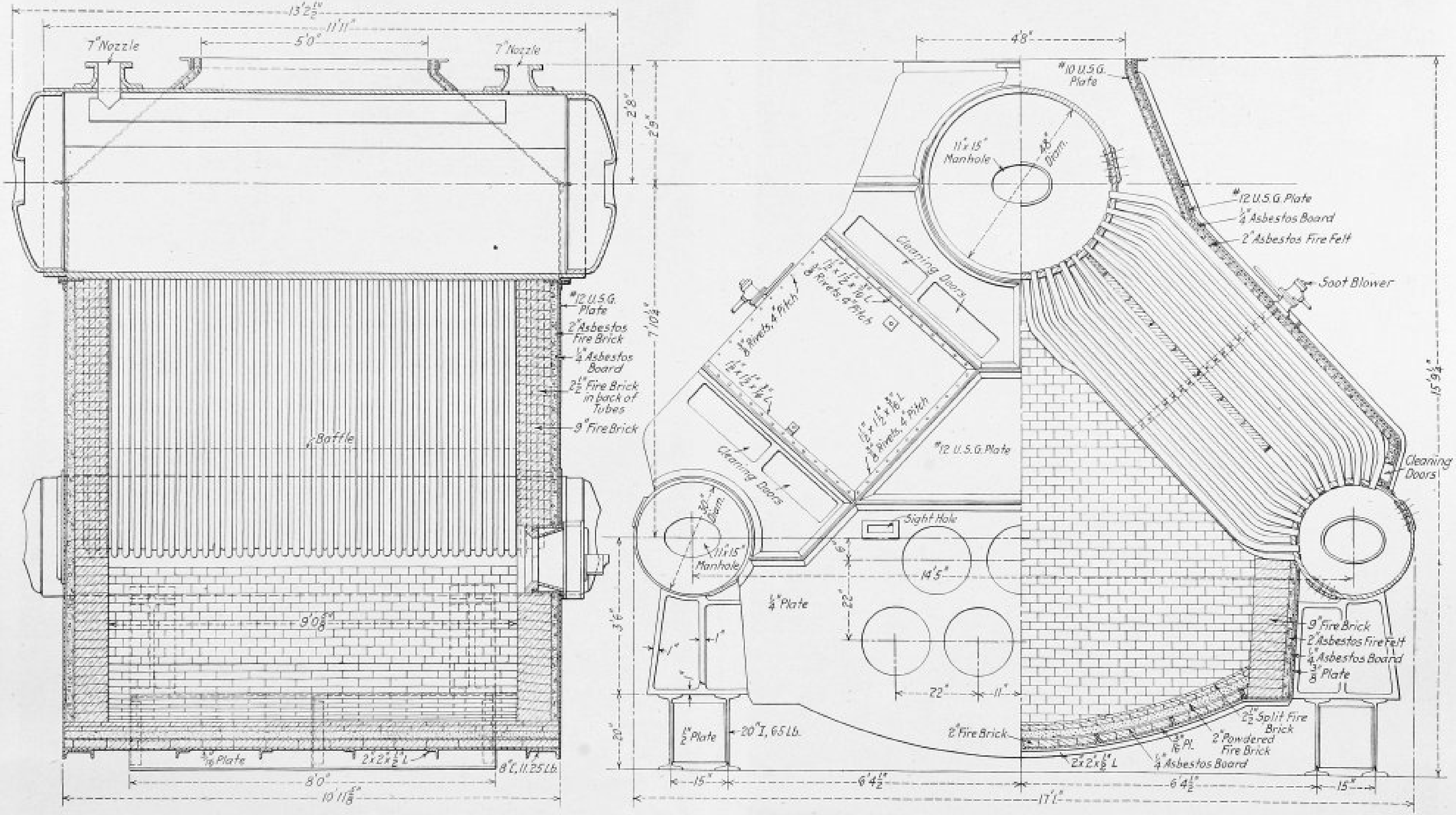


Fig. 13.—Watertube Boiler Built by the New York Engineering Company for Experimental Work at the Naval Station, Annapolis, Md. This Boiler Embodies Special Features of Design so That it is Well Adapted to Test Work. Arrangements Have Been Made in the Construction to Accommodate Practically Any Type Superheater That Might Be Installed

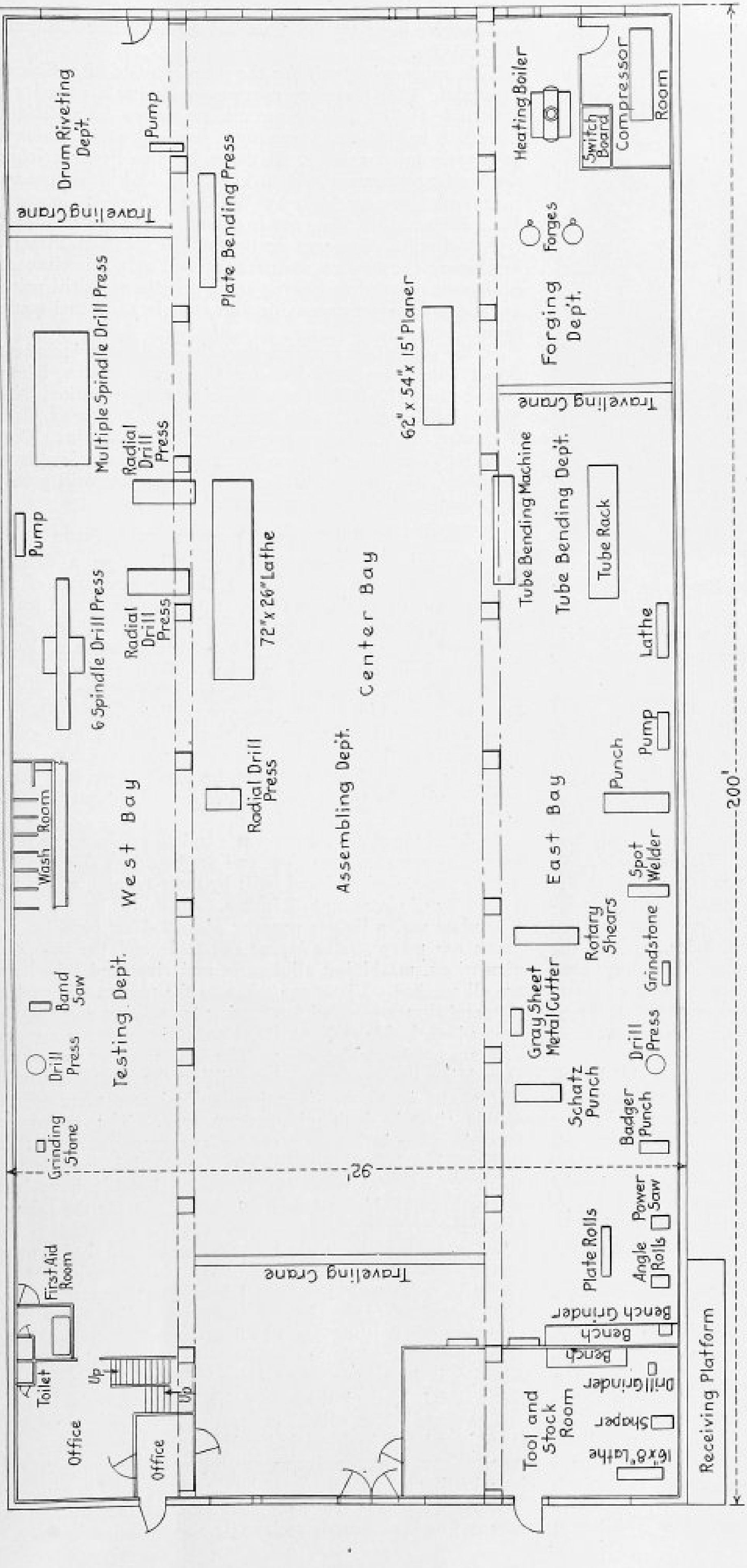



Fig. 14.—General Floor Layout of New York Engineering Company Shop at Yonkers

carefully drilled in the handling of hose reels, so that the fire protection is quite adequate.

The organization may be divided into the following departments:

- Executive and administrative section.
- Sales force.
- Purchasing department.
- Engineering, designing and drafting departments.
- Laying out department.
- Riveting and calking crews.
- Machine shop section.
- Casing department.
- Assembly gang.
- Crane and material handling crew.
- Shipping department.
- Subsidiary machine shop.

## Machine Installations for Production

In laying out the machinery in the shop a definite plan was followed, so that productive efficiency could be aided by the best location of all equipment. Modern machine shop practice requires that certain tools be driven by individual motors, while others may be arranged to the best advantage for group drive. The principle of combining group and individual drives has been applied in this boiler shop, thus carrying out the policy of manufacturing boilers in numbers rather than building them individually.

The main crane built by the Chesapeake Machine Company, Baltimore, Md., is of the 220-volt, 3-phase type having a lifting capacity of 25 tons. Auxiliary cranes of 5 tons capacity each are installed in the side bays.

A 300-ton plate bending hydraulically actuated press is used to shape the drums and longitudinal butt straps, to form the boiler nozzles and other hot or cold press work. This machine was designed and built by the company.

For machining plates a Niles, Bement, Pond 62-inch by 54-inch by 15-foot plate planer is installed.

Among the lathes in the shop are a 16-inch by 8-inch turret machine of the Lehmann Machine Company, St. Louis, Mo., type, and a 72-inch swing by 26-foot bed Fiefield Machine Company lathe.

Plate and angle rolls made by the company have a capacity in the case of the plate rolls of 3/8-

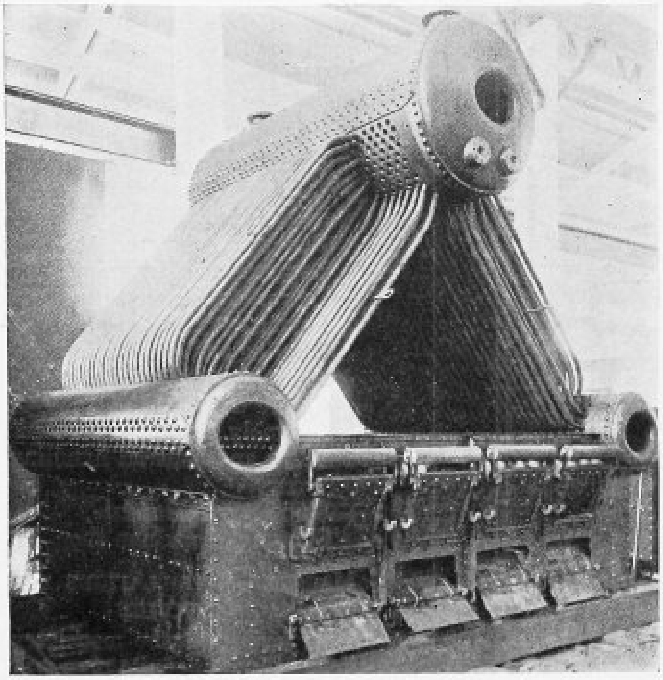


Fig. 15.—Coal-Burning Ludlum Boiler About Ready for Fitting the Casing

inch material. The angle rolls in the shop are used mainly in bending the reinforcing angles for the casings, which are 1½ inches by 3/16 inch.

### Drilling Equipment Complete

A multiple spindle drill press and a six-spindle tube hole drilling machine are used for drilling rivet holes in the drums and seams, and the tube holes. Both these machines were designed and built at the plant. The feed and table travel of the rivet hole drill are hydraulically actuated and adjustments are provided for different diameter drums. This machine has a capacity of six 1-inch holes. The tube hole drill, also hydraulically controlled, has an automatic spacing device and automatic table travel. This machine has a capacity of 2-inch holes. Two 4-foot radial drills made by the Western Machine Tool Works, Holland, Mich., and by the Morris Machine Tool Company, Cincinnati, Ohio, have been set up for synchronous work such as the drilling of drum heads simultaneously. In addition, there are a 4-foot Prentiss radial drill and a 20-inch Snyder plain sliding head drill installed.

Firebox sheets and other plate work are cut on Quickwork Company, St. Marys, Ohio, shears having a capacity for plates up to ⅜ inch. For lighter plates a sheet metal cutter made by the G. A. Gray Company, Cincinnati, Ohio, is used, capable of cutting plates up to 3/16 inch.

An automatic hydraulic tube bending machine built by the company has a capacity of one 3-inch tube or three 1-inch tubes. Both ends of the tubes are bent simultaneously. A polishing, burring and cutting off machine, also built by the company, is placed adjacent to the rolls.

Punches include a number 11 type Badger Tool Company, Beloit, Wis., machine, and another punch with a 36-inch throat having a capacity of 1-inch holes in 1-inch plate. A third punch which is used is of the universal Schatz Manufacturing Company, Poughkeepsie, N. Y., type, having a punching capacity of ⅞-inch holes in ½-inch plate, a shearing capacity of ½-inch or ⅝-inch by 3-inch bars, a cropping capacity of 1-inch square bars and of 1⅛-inch round bars. This machine is also used to crop angle irons 3 inches by 3 inches by ¼ inch on the square and 2½-inch by 2½-inch angle irons on the miter.

Welding of casing sheets is carried out on a 20-kilowatt spot welder built by the Thomson Spot Welder Company, Lynn, Mass.

The compressing unit for the shop consists of a Chicago Pneumatic Tool Company compressor having a capacity of 250 cubic feet of free air per minute, driven by a Reliance Electric & Engineering Company, Cleveland, Ohio, 75-horsepower synchronous motor. In the tool room a Potter & Johnston Machine Company, Pawtucket, R. I., 15-inch shaper and a universal grinder built by William Sellers & Company, Inc., Philadelphia, Pa., are installed. A number of Dean type hydraulic pumps made by the Worthington Pump & Machinery Corporation are used, as well as a miscellaneous equipment of band and swing saws, grindstones, drill grinders and a complete pneumatic and electric hand tool equipment.

In the subsidiary machine shop the equipment includes a 5-foot lathe; two Reed-Prentice Company, Boston, Mass., lathes; three J. J. McCabe Machinery Corporation, New York, lathes; two Davis Machine Tool Company, Inc., Rochester, N. Y., lathes; one Gooley & Edlund, Inc., Cortland, N. Y., metal cutter; one Juengst shaper; one Beaudry & Company, Inc., Boston, Mass., forging hammer, drill presses and other machine shop equipment.

### Routing Material Through the Shop

The fabrication processes in general follow a definite routine through the shop; that is, the pressure parts of the boilers come in as raw material at the north end and travel through their various stages in the west bay. The casing parts and tubes also enter at the north end and are simultaneously built up in the east bay. Both sections of the boiler reach the south end of the side bays and are brought together for assembly in the center bay. From here the boiler, complete except for fittings, is picked up by the main crane and carried to the north end of the center bay and here made ready for final hydrostatic and steam tests. Then it is taken from the plant by trucks and shipped by rail or water directly to the ship for which it was built.

In detail the plates for the water and steam drums or pressure parts come into the shop and are bent in a 300-ton hydraulic press, designed and built by the company, which has a capacity of plates up to 2 inches. All drums have a heavy tube plate and a lighter wrapper plate. After bending, the plates are taken to the laying out table and the principal dimensions, machining allowances and rivet and tube holes are all marked. Plates are taken to the planer, trimmed to size, and then assembled for turning the calking edges of the drums both inside and out. The ends of the drums are also lined up for fitting the heads. The drums are then ready for assembling the heads and for drilling the rivet holes with butt straps in place. The longitudinal seams are of the double riveted, double butt strap type. The straps are formed on the hydraulic press to the same curvature as the shell. Rivet holes are drilled on the multiple spindle machine previously described. Two radial drills have been arranged to drill both heads simultaneously for the sake of speed and accuracy.

After drilling, the drums are taken apart and the burrs removed from the rivet holes and the scale cleaned from the seams in order to insure tight joints. The drums are then reassembled ready for riveting. One precaution taken to be sure that the finished drum is tight is to hold the parts together by a body bolt at each side of the hole being riveted. Riveting is done by either an Allan bull riveter or with pneumatic tools. In the latter case a live holder-on is used.

The drum is then calked and moved to the test pit, where it is subjected to a hydrostatic head of twice the working pressure. From here the drums are taken to the multiple tube hole drilling machine designed by the engineering department. Finally, the drums reach the south end of the bay and are mounted on the assembly rack or jig and the tubes inserted.

### Process of Tube Fabrication in East Bay

The tubes of cold drawn seamless steel thoroughly annealed come in at the north end of the shop and are first put through the polishing machine, which removes the scale on the outside and the burrs from both outside and inside. From this department they are taken to the tube bender, which operates under hydraulic pressure, where tubes up to 3 inches in diameter are bent one at a time to any desired curvature to which the machine has been set. Tubes down to 1⅝ inches are bent individually. The template method of bending tubes insures a perfect fit when they are assembled in the drums.

The tubes are then taken to the south end of the east bay, where they are fitted to the drums which have already been placed in the assembly rack. A special pneumatic expander is used to expand and flare the tubes in the drums.

### Construction of Casing

In the west bay the casing is built up while the pressure parts are under construction. Heavy sheet steel plates are used in the furnace construction and form a foundation for the whole structure. The entire casing is practically fabricated in this department. The casing proper consists of sheet steel lighter than the furnace sheets, with insulating material bolted to it. Another steel sheet is fastened inside this. Sections are bolted together and reinforced with angle irons and tees. Electric spot welding is used in the construction of the casing instead of riveting. Steel pieces are cut out by rotary "Quickwork" shears, while lighter cutting is done on the "Gray" metal cutter. The firebox is lined with firebrick secured to the plates by means of special bolts. Between the brick and the casing a heavy lining of insulating material is fastened, and the whole covered with silica cement, which vitrifies on the application of heat and binds the entire lining in a solid heat resisting mass. The furnace front is arranged in this department with openings for either coal or oil firing. When the firebox is completed the pressure parts are placed on top and the casing built up. After this operation the boiler is moved to the north end of the center bay where the smokehood and fittings are assembled, and the drums drilled for water and steam gages and the like. Another hydrostatic test is given the boiler to be certain that all pressure parts are tight, and it is then painted and moved to the yard. Here the steam test is given it and the entire system boiled out with soda ash to remove grease and scale. It is finally shipped complete for installation.

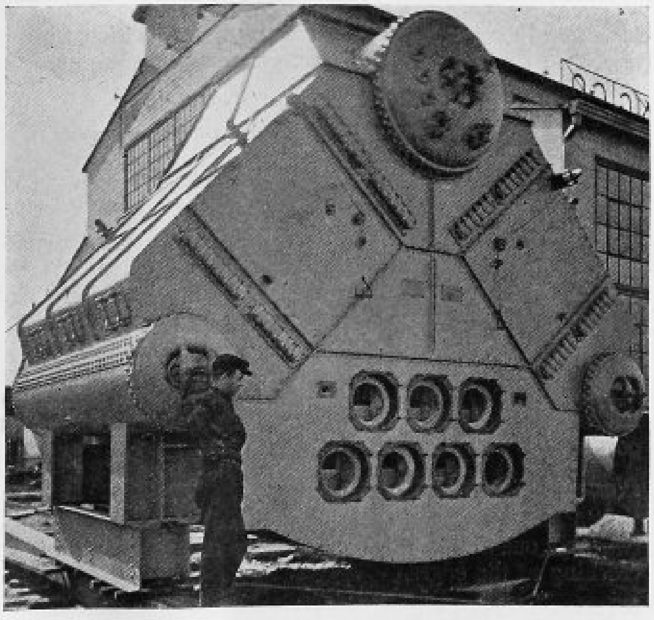


Fig. 16.—5,000 Square Foot Heating Surface Watertube Boiler for Naval Experimental Station at Annapolis

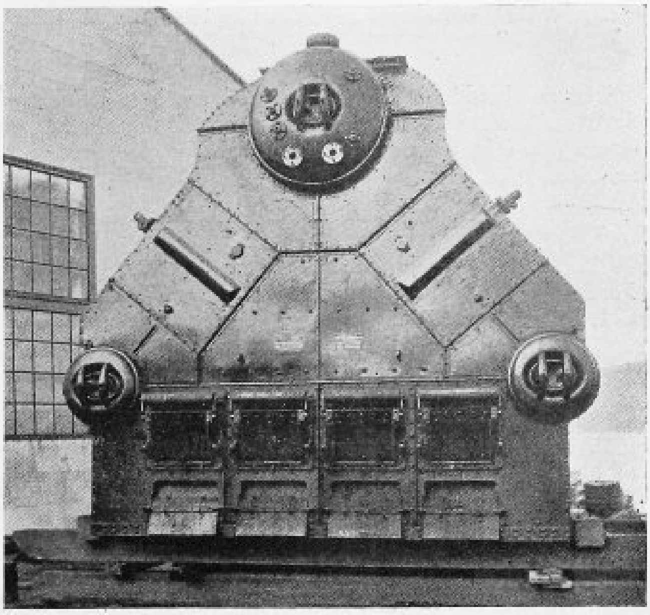


Fig. 17.—Coal-Burning Boiler Ready for Shipment at Dock

### Soot Blower in Boiler

A feature of the Ludlum boiler is the arrangement for thoroughly cleaning all tubes from the outside without interfering with the operation of the boiler. This is accomplished by four automatic soot blowers built in on each side of the boiler, consisting of steam pipes recessed in the casing and directly connected with the steam outlet. These pipes are fitted with nozzles or jets, and as the tubes of the boiler are so arranged that there is a clear opening through each bank across the entire width of the field, each of these steam nozzles plays directly through this opening. The pipes containing these nozzles may be rotated by a hand device so that the entire banks of tubes are swept clean. After the tubes have been cleaned, steam is shut off automatically in all of the jets when the operator releases the rotating handle.

### Baffling Arrangements in Boilers

Baffling consists of a watertube baffle located directly over the fire. This baffle is obtained by giving a slight offset to the first bank of tubes directly over the fire, which throws them back against and into the next row of tubes, thereby forming a solid wall of watertubes which acts as a baffle belt extending upward to within about a foot of the bottom of the main steam drum. At this point the tubes are opened slightly in order to permit the passage of the gases around to a second baffle. This baffle consists of a flat plate placed in the middle of the banks of tubes extending from the steam drum downward toward the water drum. This method of baffling can be varied to suit any special requirements. In fact, certain of the boilers being built for the United States Navy have no other baffling than the tubes themselves.

The Ludlum type boiler is well adapted to the installation of any type superheater and to furnish any degree of superheat required.

### Experimental Boiler for the Navy

Of special interest because of its large size and extremely high pressure is the boiler built for the United States Naval Experimental Station at Annapolis, Md. This boiler is 15 feet high, 17½ feet wide and 12 feet deep, with a furnace

(*Continued on page 373.*)

## Standard Specifications for Boiler Rivet Steel*

The specifications for this material are issued under the fixed designation A-31; the final number indicates the year of original issue, or, in the case of revision, the year of last revision.

### A.—REQUIREMENTS FOR ROLLED BARS

#### MANUFACTURE

*Process*

1. The steel shall be made by the open hearth process.

#### CHEMICAL PROPERTIES AND TESTS

*Chemical Composition*

2. The steel shall conform to the following requirements as to chemical composition: Manganese, 0.30-0.50 percent; phosphorus, not over 0.04 percent; sulphur, not over 0.045 percent.

*Ladle Analyses*

3. 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 metal. The chemical composition thus determined shall be reported to the purchaser or his representative, and shall conform to the requirements specified in section 2.

*Check Analyses*

4. Analyses may be made by the purchaser from finished bars representing each melt. The chemical composition thus determined shall conform to the requirements specified in section 2.

#### PHYSICAL PROPERTIES AND TESTS

*Tension Tests*

5. (a) The bars shall conform to the following requirements as to tensile properties: Tensile strength, pounds per square inch, 45,000-55,000; yield point, minimum pounds per square inch, 0.5 tensile strength. Tensile strength does not need to exceed 30 percent.

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

*Bend Tests*

6. (a) Cold Bend Tests.—The test specimen shall bend cold through 180 degrees flat on itself without cracking on the outside of the bent portion.

(b) Quench Bend Tests.—The test specimen, when heated to a light cherry red as seen in the dark (not less than 1,200 degrees F.), and quenched at once in water the temperature of which is between 80 degrees and 90 degrees F., shall bend through 180 degrees flat on itself without cracking on the outside of the bent portion.

*Test Specimens*

7. Tension and bend test specimens shall be of the full size section of bars as rolled.

*Number of Tests*

8. (a) Two tension, two cold bend and two quench bend tests shall be made from each melt, each of which shall conform to the requirements specified.

(b) If any test specimen 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 section 5 (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.

#### PERMISSIBLE VARIATIONS IN DIAMETER

9. The diameter of each bar shall not vary more than 0.01 inch from that specified.

#### WORKMANSHIP AND FINISH

*Workmanship*

10. The finished bars shall be circular within 0.01 inch.

*Finish*

11. The finished bars shall be free from injurious defects and shall have a workmanlike finish.

#### MARKING

12. Rivet bars shall, when loaded for shipment, be properly separated and marked with the name or brand of the manufacturer and the melt number for identification. The melt number shall be legibily marked on each test specimen.

#### INSPECTION AND REJECTION

*Inspection*

13. 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 work which concern the manufacture of the bars ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the bars are 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.

*Rejection*

14. (a) Unless otherwise specified, any rejection based on tests made in accordance with section 4 shall be reported within five working days from the receipt of samples.

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

*Rehearing*

15. Samples tested in accordance with section 4, which represent rejected bars, 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.

### B.—REQUIREMENTS FOR RIVETS

#### PHYSICAL PROPERTIES AND TESTS

*Tension Tests*

16. The rivets, when tested, shall conform to the requirements as to tensile properties specified in section 5, except that the elongation shall be measured on a gage length not less than four times the diameter of the rivet.

*Bend Tests*

17. The rivet shank shall bend cold through 180 degrees flat on itself without cracking on the outside of the bent portion.

*Flattening Tests*

18. The rivet head shall flatten, while hot, to a diameter two and one-half times the diameter of the shank without cracking at the edges.

*Number of Tests*

19. (a) When specified, one tension test shall be made from each size in each lot of rivets offered for inspection.

* Adopted, 1901; revised, 1909, 1912, 1913, 1914. By American Society for Testing Materials. Serial designation, A31-14.

(b) Three bend and three flattening tests shall be made from each size in each lot of rivets offered for inspection, each of which shall conform to the requirements specified.

WORKMANSHIP AND FINISH

*Workmanship*

20. The rivets shall be true to form, concentric, and shall be made in a workmanlike manner.

*Finish*

21. The finished rivets shall be free from injurious defects.

INSPECTION AND REJECTION

*Inspection*

22. 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 rivets ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the rivets are being furnished in accordance with these specifications. All tests 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.

*Rejection*

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

## Disastrous Crown Sheet Failure*

BY A. G. PACK

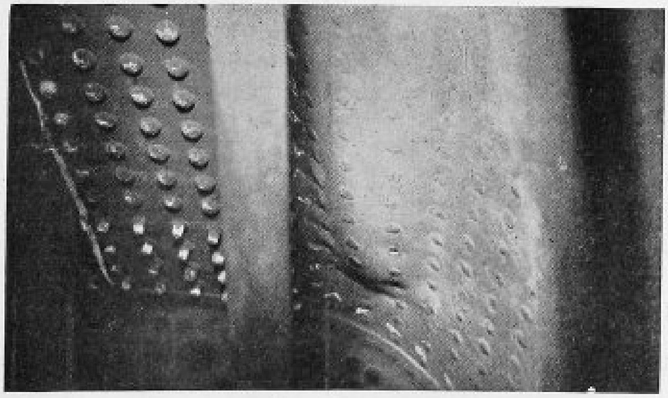
Locomotive 2015, pulling Lehigh Valley passenger train No. 2 eastbound, left Buffalo station at 11:23 P. M. This train consisted of one baggage car, three passenger coaches, five Pullman cars, and one dining car. After attaining a speed of approximately 45 miles per hour and while nearing Cheektowaga, N. Y., at 11:35 P. M., the crown sheet of the locomotive failed, permitting the steam and water contained in the boiler to escape and enter the cab, resulting in the fatal injury of both the engineer and fireman.

The engineer stopped the train and was taken to the hospital, where he died on the following day. The fireman, who was badly burned, jumped and was dead when found.

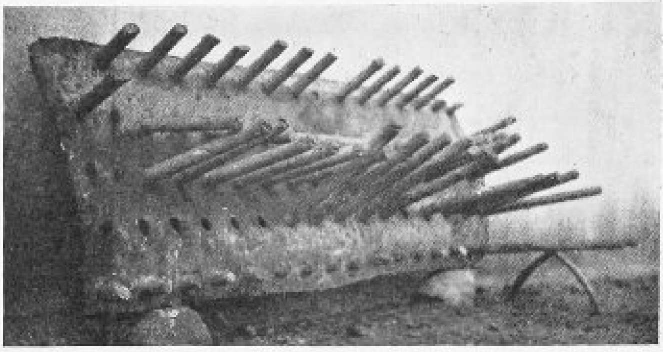
The locomotive was of the 4-6-2 type and was equipped with a straight top radial stayed boiler, with an allowed steam pressure of 215 pounds per square inch.

The crown sheet which failed was supported by 12 longitudinal and 26 transverse rows of button-head stays 1⅛ inches in diameter spaced approximately 4 by 4 inches, and the first four transverse rows were expansion stays. The remainder of the crown sheet, together with the side, door and throat sheets, was supported by 1-inch stays with driven heads and spaced approximately 4 by 4 inches, except the four longitudinal rows on each side of the button-head stays, which were 1⅛ inches in diameter. In what is usually termed the breaking zones there was a partial installation of flexible staybolts.

* Abstract of report of the chief inspector of locomotives, Bureau of Locomotive Inspection, covering investigation of an accident to Lehigh Valley Railroad locomotive 2015 at Cheektowaga, N. Y., July 25, 1920.



Bulged Part of Crown Sheet at Which Point Steam Escaped from the Boiler



Pocketed Area of Crown Sheet 68 Inches Long, 16 Inches Wide, in Which There Were 37 Broken Bolts and 12 Others Which Had Not Broken

Examination revealed that the crown sheet had pocketed to a depth of 4 inches on the right side between the sixth and tenth longitudinal rows and between the second and nineteenth transverse rows of crown stays, or 68 inches long, and 16 inches wide. In the pocketed area were 37 broken bolts, and 12 others which were not broken, from which the sheet pulled, leaving their holes entirely open, and it was from these holes that the steam and water escaped from the boiler through the firebox into the cab, causing the deaths previously referred to.

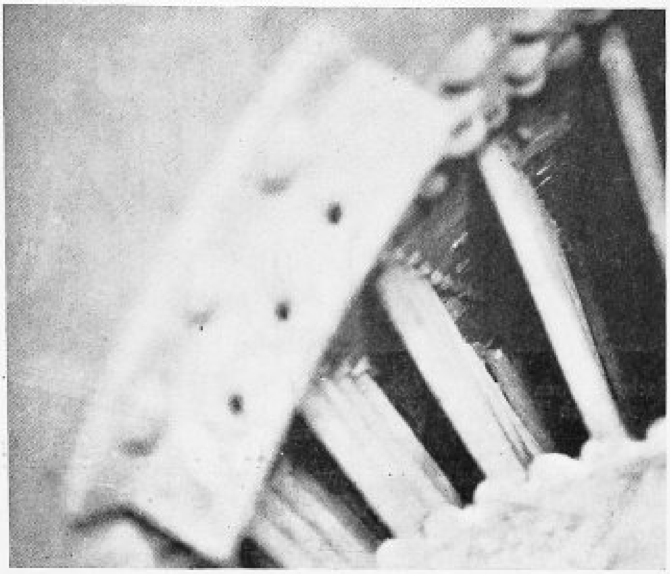
There were numerous defective stays outside the pocketed area. Fifteen of these were next to the pocketed area, 6 of which were broken entirely, while the remaining 9 were badly fractured. In the same relative location on the left side there were 19 broken and 6 fractured bolts that could be seen from the inside of the boiler.

All of the broken stays included in the pocketed area of the crown sheet were broken at the wrapper sheet. After the pocketed section of plate was cut out, an examination of the ends of the broken bolts showed that they were coated with considerable scale, and when considering that the thickness of scale on the flues, which had been in service for about 11 months, was approximately 1/32 inch and that the ends of the broken stays were above the waterline and not submerged as were the flues, it is reasonable to believe that these stays had been broken for some time or previous to the last monthly inspection, July 5, at which time the railroad company's inspector swore that the crown stays and staybolts were left in "good" condition and that no bolts were renewed.

As further evidence that these bolts had been broken for some time, the records of the railroad company show and their inspector stated that this class or locomotives is comparatively easy on bolts. The records examined covering several locomotives of this class show that 4 broken stays in the area of crown sheet which pocketed were the greatest number found at any one time, and when it is considered that 37 were found broken at the time of investigation it is apparent that they had not all broken within a reasonably recent period.

The railroad company's records show that on August 29, 1919, a hydrostatic pressure of 269 pounds was applied to this boiler, and that 55 bolts were renewed at that time, none of which were in the crown sheet.

After careful consideration of all facts brought out during



Steam Space Between Firebox and Outside Sheet Showing Point Near the Wrapper Sheet Where the Stays Broke

this investigation, it is evident that this accident was due to broken crown stays, thus rendering that portion of the crown sheet without sufficient support, which permitted the boiler pressure to force it off of other crown stays which were not broken and allowed the steam and water to escape through the holes so made. It is our opinion that some of these bolts were broken prior to the last inspection on July 5 and that they could have been detected by a proper inspection as required under the law and rules.

This accident forcibly illustrates the importance of hammer testing crown stays and staybolts. Our inspectors have often found that the requirements were being grossly ignored in this respect and that crown stays were not being hammer tested as required by the rules. It has often been found that immediately after the railroad company's inspector had completed his inspection honeycomb was still adhering to the crown stays, which is positive evidence that they had not been properly hammer tested.

Apparent disregard for safety as well as the law and rules is demonstrated by the action of certain employees of this carrier responsible for the inspection and repair of locomotives, one of which admitted in the presence of two Federal inspectors and an assistant chief inspector, as well as several officials of this railroad, that he did not perform the work for which he made report on July 5, although he had sworn before a notary public that such had been done. Included in this report was the air brakes, and when questioned he admitted that he knew practically nothing about air brake equipment. This admission reflects on the mechanical officials for assigning a man to make inspections and tests of equipment without knowing that he was capable of properly performing such work and by not properly supervising the work so as to see that the requirements of the law and rules were complied with.

Attention is directed to the fact that the violence which attends many crown sheet failures was absent in this case, and had this locomotive been equipped with automatic fire doors such as recommended in the last three annual reports of the chief inspector of the bureau of locomotive inspection, instead of the old swing type doors, two of which were in use, the fatalities in this case might have been avoided.

As previously stated, all of the broken bolts were found broken at the wrapper sheet, and had telltale holes been drilled in such bolts, as required by rule 26 covering bolts shorter than 8 inches, the steam escaping from such holes would have given warning of the dangerous condition existing. Therefore, it is recommended that all crown stays and staybolts, regardless of their length, have telltale holes not less than three-sixteenths inch in diameter drilled deep enough in their outer end to extend at least one-half inch beyond the inside of the plate.

The subject matter of this report describes what may be expected where the requirements of the law and rules are not complied with, and in order that the safety of employees and travelers on the railroads may be promoted, in accordance with the spirit and intent of the law, it is respectfully recommended that this report be made public in such manner as the commission may deem proper.

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## Examination Questions for Inspectors*

Q.—Describe the functions of a blowoff pipe and where should it be located?

A.—The blowoff pipe, valve and connection complete is for the purpose of blowing out periodically the loose scale and sediment that collects in the bottom of the boiler. It should be located at the bottom near the rear end, and it should be protected against the hot gases from the furnace by the use of a baffle.

Q.—How would you make an internal and an external examination of a (a) new boiler, (b) old boiler?

A.—(a) New Boiler, Internal. See that no tools, lamps or any materials have been left in; see that all braces, tube ends, valve and pipe openings are as they should be.

External. See that all valves, pipes and attachments are in working condition and correctly placed and connected.

(b) Old Boiler, Internal. Note condition of braces, tube ends, plate surfaces with regard to corrosion and incrustation and other foreign matter. Look for cracks, loose or leaky rivets, loose braces or broken stays.

External. Examine all valves, fittings, pipes and passages and see that they are in good working order and clear, and free from leakage. Also examine furnace, walls, blowoff pipe and external tube ends and internal tube surfaces.

Q.—What would you do in case you found the watertubes blistered slightly?

A.—Blistered tubes are dangerous when subjected to high pressure. Rather than take the risk, cut out and replace any blistered tubes. If new tubes cannot be secured at once, or if for any reason the blistered ones cannot be taken out, then reduce the pressure temporarily until the new ones can be put in.

Q.—What would you do if you discovered a lap crack?

A.—Lap cracks should be cut out and, if necessary, replace the entire outside sheet. A lap crack is too dangerous a thing to fool with.

Q.—What is a fusible plug and where should it be located in the following types of boilers? (a) Horizontal return tubular, (b) locomotive, (c) vertical tubular, (d) Babcock & Wilcox, (e) Heine, (f) watertube, (g) Scotch marine.

A.—A fusible plug is a shell of brass filled with tin which melts at about 450 degrees F. It will not melt while covered with water, but when uncovered, owing to low water, the tin melts and permits the steam to blow into the furnace, thus causing a warning.

The location of fusible plugs is as follows:

(a) Horizontal return tubular boilers.—In the back head not less than two inches above the upper row of tubes.

(b) Locomotive type.—In the highest part of the crown sheet.

(c) Vertical.—In an outside tube not less than one-third the length of the tube above the lower sheet.

(d) Babcock & Wilcox.—In the upper drum not less than six inches above the bottom of the drum.

* Continued from the November BOILER MAKER.

(e) Heine.—In the upper drum not less than six inches above the bottom of the drum.

(f) Watertube.—Same as Babcock & Wilcox and Heine.

(g) Scotch marine.—In the combustion chamber top.

Q.—What is the difference between a fire tube and watertube boiler?

A.—In a fire tube boiler the gases of combustion pass through the tubes and the water is around them. In a watertube boiler the gases pass around the tubes and the water flows through them.

Q.—Why do fire tube boilers have the ends of the tubes beaded, and watertube flared?

A.—The ends of the tubes in fire tube boilers are beaded to save the ends from possible burning, and also to brace the ends. In the watertube boiler the ends of the tubes are not beaded nor is any bracing required. Also convenience in replacing tubes suggests no beading.

Q.—Why are brass pipes with a cross required in the installation of water column connections, also brass, copper or bronze required in siphon pipe to steam gage?

A.—Brass pipes are required as they will not corrode nor choke up like iron ones will. The cross fitting permits of ready cleaning of the pipes and passages. Also, brass piping permits the making of easy bends.

# Elementary Mechanics for Boiler Makers

BY WILLIAM C. STROTT*

*In order to understand certain points in the design of boilers, a working knowledge of applied mechanics is necessary. For this purpose the author of the series of articles on horizontal return tubular boiler design has given the following explanation of the fundamental principles on which the development of all structural work is based.*

In previous issues of THE BOILER MAKER the subject of boiler head staying has been more or less thoroughly discussed. With reference to the method of staying the upper segments of the heads of return tubular boilers, the reader will recall a statement which was made in the author's treatise "How to Design and Lay Out a Boiler," that "the actual stress in a diagonal stay is greater than the direct load."

Many of our readers do not understand this theory, and the author has been requested to write a short article bearing on this subject. For reference, the following paragraph is reprinted from the July, 1919, issue, page 202:

"We will suppose, now, that by working to the limits obtained by formulas (5) and (6) fourteen braces can be laid in. The total steam pressure on the segment is $935 \times 150$ or 140,250 pounds. Then the theoretical load carried by each brace is $\frac{140{,}250}{14}$, or 10,018 pounds. We say *theoretical* because this is the load that would be carried by each brace if it were a direct stay, but they do not resist in a *straight line* the load transmitted to them by the boiler head because they are placed in a diagonal position."

Fig. 1 illustrates how diagonal braces are attached to a boiler.

For this reason the actual stress in each brace is greater than the direct load, and by setting up practical conditions this fact may be proved experimentally as follows:

Let two ordinary spring balances be suspended between strings from two points some distance apart, as illustrated in Fig. 2, and to the lower ends of the strings attach a known weight $W$ (the weight should not, however, be such that it will stretch the springs beyond their capacity).

Suspend the model flat against a drawing board or on the wall of a room, and on paper conveniently placed project a line as $oA$ vertically upward from the point of intersection $o$ of the strings and weight. This line should be drawn to some convenient scale, as one inch to the pound, which will then represent the magnitude of the vertical load. From the upper extremeity of line $oA$ draw lines parallel to the diagonals, as indicated by lines $A$ and $AB$. We shall now have represented what in applied mechanics is termed a parallelogram of forces. The length of lines $oB$ and $oC$ will then represent to the same scale as that of line $oA$ the magnitude of the stress in the diagonals and should equal the reading on the scales.

For example, assume the weight $W$ to be 15 pounds and the length of the vertical line $oA$ 15 inches. Then, after completing the force diagram, if the length of the diagonals $oB$ and $oC$ measured 10 inches, the reading on the scales would be 10 pounds, for, it will be remembered, that we are working with a scale of one inch to the pound. Any other convenient scale would serve the purpose, and in some cases a rather small one would be necessary, for it might not otherwise be possible to include great weights on an ordinary drawing board or wall.

Let the student now increase the distance between the supports and he will discover that the reading on the scales has also increased. This means that as the angularity @ which the diagonals make with the direction of force is increased the stress in the diagonals will increase.

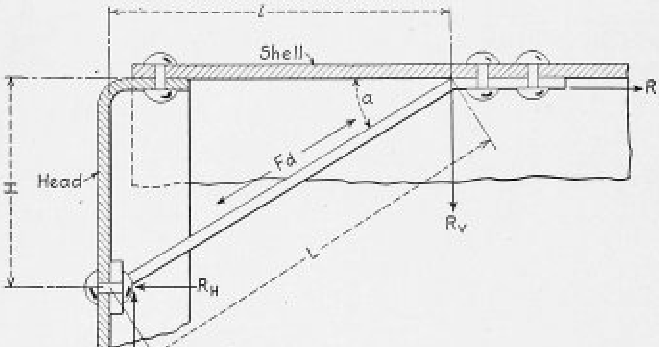



Fig. 1.—Method of Attaching Diagonal Brace to Boiler

In order to prove this, let us consider the condition presented in Fig. 3, in which case the distance between the points of supports has been increased to such an extent that the angularity @ of the diagonals is but slightly less than 180 degrees.

Project lines $oA$, $oB$ and $oC$, as was directed in the case of Fig. 2, and it is at once apparent that a high stress is created in the diagonals. The stress rapidly increases as

*Engineering Department of The Koppers Company, Pittsburgh, Pa., formerly designer, Blaw-Knox Company, Pittsburgh, Pa., and Union Iron Works, Erie, Pa.

angularity @ increases, until it finally reaches its maximum value an instant before the diagonals assume the true horizontal position.

When in that position there should be no force registered by the scales, because theoretically the diagonals are no longer

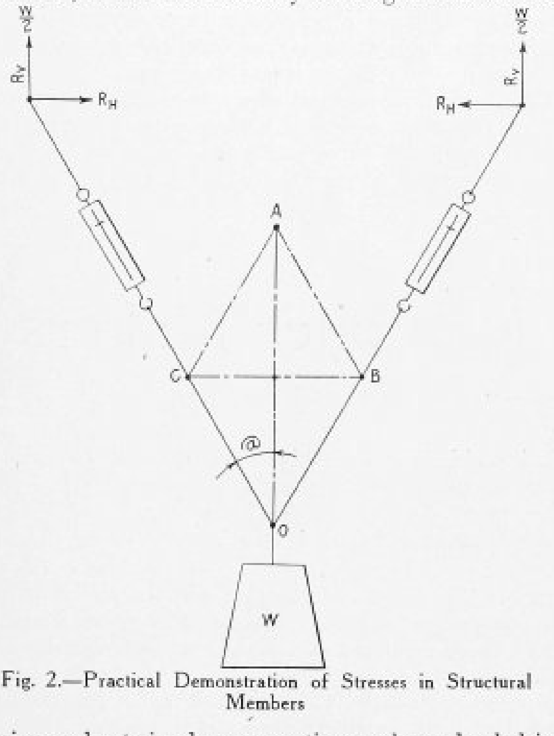


Fig. 2.—Practical Demonstration of Stresses in Structural Members

in tension and act simply as a continuous beam loaded in the center. Actually, however, a very high tension will be registered by the spring balances which is only due to the fact that considerable stress must be applied to the strings in order to make them exactly horizontal and prevent the weight from sagging them in the middle.

That the stress in the diagonals becomes zero when the spring balances are perpendicular to the weight may now be proved by trying to construct a force parallelogram for that condition as illustrated in Fig. 4.

Project line *oA* to the proper scale to represent the magnitude of the vertical load *W* and then extend lines *AB* and *AC* parallel to the spring balance lines as was previously directed in connection with Figs. 2 and 3. Because the balances are in this case not in a diagonal position, lines *AC* and *AB* will therefore never intersect them; hence a force parallelogram is not possible of construction and the stress

student will realize the stress he had to exert in bringing the spring balances into line, he can readily imagine the same condition of stress existing in a horizontal beam when subjected to a load.

On the other hand, as angularity @ is decreased the diagonal stress will decrease, as the student may readily prove by continuing the experiment. Finally, when the angularity becomes zero, which occurs when the spring balances are parallel to each other and in a vertical position as illustrated in Fig. 5, each spring balance will then register exactly one-half the suspended weight, or, in our case, one-half of 15 pounds, or 7½ pounds.

If, instead of suspending the model from two fixed points, the student will now support the upper ends of the strings, one from either hand, he will feel, in addition to the vertical pull, a decided tendency of the system to draw his hands together in a horizontal direction. He will furthermore discover that this tendency increases when the distance between his hands is increased, but decreases when he moves his hands closer together, and disappears entirely when the spring balances are hanging vertically downwards. This horizontal force is created by the diagonal lines due to their tendency to assume the vertical position, and evidently results in a compressive stress between the points of support. The magnitude of this horizontal force can also be scaled from the force parallelograms previously constructed on Figs. 2 and 3. One-half the length of the horizontal line *CB* projected between the points of intersection of the diagonals *oB* and *oC* will represent to the same scale as that of the other lines the compressive force between the points of support; that is, if line *CB* measured 14 inches, then one-half of 14 inches, or 7 inches, would be the graphical representation to a scale of 1 inch to the pound of the horizontal reaction in the supports, or 7 pounds.

Many students will wonder, in the case of Figs. 2 and 3, why the total length of line *CB* does not represent the compressive force between the supports, and they will argue that, since not only one but both diagonals are acting, the stress in the upper line ought to be equal to the sum of the horizontal forces. Their argument is correct, insofar that each diagonal *creates* a separate horizontal thrust, but they should not lose sight of the fact that these two forces are *pulling against each other;* that is, one diagonal causes 7 pounds horizontal stress, which the other diagonal resists with, of course, an equal but opposite thrust.

### Reactions to Applied Forces

In connection with the above-mentioned argument, the reader will evidently recall a statement he has heard at one

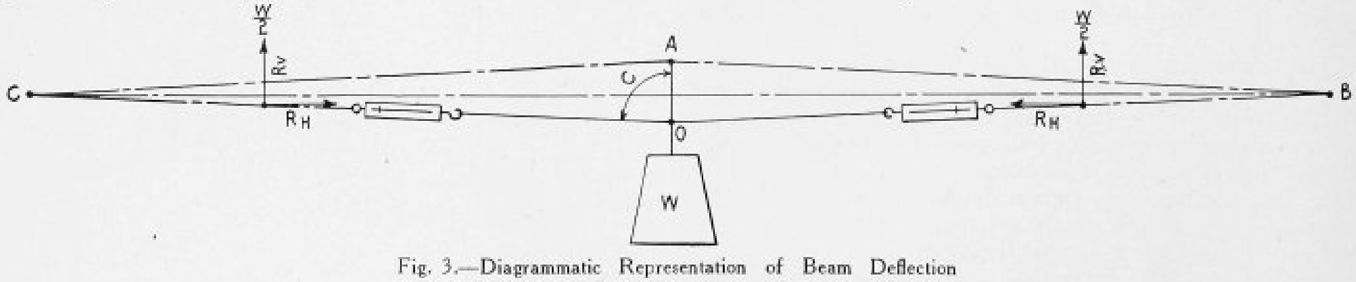


Fig. 3.—Diagrammatic Representation of Beam Deflection

in the horizontal lines is zero. We know that even a horizontal beam, when loaded, is subjected to tensile stress, but the "beam theory" is, however, an entirely different proposition, in which case the stress created is due to the resistance of the beam to bending or deflection.

Nevertheless, any beam will deflect, however slightly, if not due to an externally applied load or force, then due at least to its own weight, and it is this deflection which obviously places the beam in a slightly diagonal position, and we literally have the condition illustrated in Fig. 3. If the

time or another that when two men, one stronger than the other, are pulling on opposite ends of a rope, that pull in the rope will be equal to the sum of the force exerted by both men. The sheer ignorance of this belief hardly requires proof. An interesting example is in a "tug o' war" contest. If the two teams, one at each end of the line, are evenly matched they will stand still; that is, each team is simply reacting against the other with an equal and opposing force, and their combined effort is simply to dissipate the force created by each. Hence the stress in the rope is equal only to the pull of one team. Imagine one team as being suddenly removed and their end of the rope anchored to a post. Could we then argue that the post is pulling against the team? No, for the post simply reacts. The principle in either case is the same. Now, suppose one team to be growing weaker and no longer able to react equally against the other. The result is that the stronger team will pull the other towards it and the stress in the rope will be only that created by the resistance of the weaker team, for the reason that the stronger team can exert no greater stress in the rope than that necessary to overcome the resistance of the other.

It is scarcely necessary to state that the vertical load on each of the supports in Figs. 2 and 3 would be one-half of the weight *W*, or in this case one-half of 15 pounds = 7½ pounds.

This force may also be scaled from the force parallelograms and is obviously equal to one-half of the length of the vertical line *oA*, or 7½ inches. The force parallelogram has now been divided into four similar triangles, each of which is called a triangle of forces for one-half of the load *W*.

### VERTICAL AND HORIZONTAL FORCES

In the case of our spring balance model we therefore find that each of the diagonals creates in itself two distinct forces, one being vertical and always equal to one-half the weight, and the other being a horizontal force whose magnitude, of course, depends on the angularity @ of the diagonals.

Had the angularity @ which the diagonals make with the vertical line been known, the various stresses could have been determined by trigonometry, but this will be taken up later. The purpose of the foregoing discussion has merely been presented to familiarize the student with the action of compound forces in a structure.

The force triangle presents one of the most important single fundamental facts in the whole science of engineering. Were its principle unknown, it would be impossible to accurately design machines or structures of any kind. This treatise would, therefore, be incomplete, unless some space were devoted to a discussion of the subject.

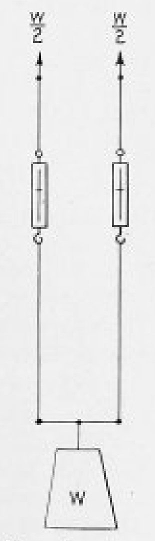


Fig. 5.—Angularity becomes zero when spring balances are parallel and in a vertical position

### COMPOSITION AND RESOLUTION OF FORCES

Work such as we have performed in connection with our model of the spring balance is termed the "composition and resolution of forces." For instance, in the case of our model we had a known weight *W* creating a certain stress in the diagonal members of the structure. We first determined these diagonal stresses and then proved that each diagonal member created two forces in the points of support, one horizontal and the other vertical. We now have the following statement:

"Two or more separate forces acting in the same or in different directions on a given point may be resolved into a single force known as the resultant, in which case each of the separate forces is termed a component."

It is easy to understand, when a number of forces act in the same direction on a given point, as in Fig. 6 (a), that the result is the same as though a single force equal to the sum of the smaller ones were acting alone.

The sum of the three single forces denoted in the above illustration at (a) would therefore be designated their resultant and its magnitude is (200 pounds + 100 pounds) = 300 pounds. The 200-pound and 300-pound forces are, of course, termed the components.

If the point or body on which these forces is assumed to act were free, it would move in the direction of the arrows with a force of 300 pounds behind it, but if the point be considered as fixed it would react against the forces with an equal and opposite force of also 300 pounds.

From this we come to the conclusion that for a body acted upon by any number of forces to be placed in equilibrium (balanced or at rest) it must be acted upon by an opposite force equally as great as the resultant of the component forces. In applied mechanics this opposing force is known as the

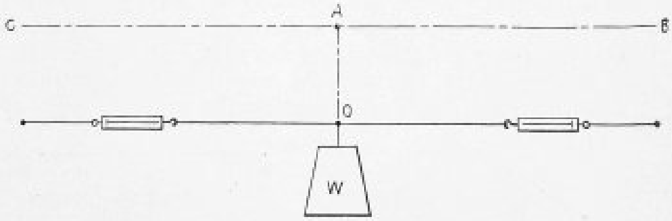


Fig. 4.—When Spring Balances Are Perpendicular to Weight, Stress in Diagonals Become Zero

Fig. 6.—Diagrammatic Representation of Resultant of Forces Acting in Same Direct Line

equilibrant, but in practice it is simply termed a reaction and is usually designated by the letter *R*.

Let us now consider the graphical representation of the forces in Fig. 6 (b). Here we have two forces of 300 pounds and 500 pounds directly opposing each other. It is obvious that the point or body on which these forces act, if free, would move to the left with a force of (500 pounds — 300 pounds) = 200 pounds, which would then be the resultant of these two component forces. If it were desired to hold the body in equilibrium, it should at once be clear to the student that another force of 200 pounds would have to be applied to the body in a direction opposite that of the 500-pound force, or in other words, the 200-pound and 300-pound forces would have to act together in order to balance the 500-pound force. When a body is acted upon by external forces it is said to be strained, or, as we have so frequently encountered the word before, stressed.*

All structures, in fact, are subjected to stress, if not from external sources, then due at least to their own weight. Therefore the members composing a structure must be correctly designed and proportioned so as to retain their equilibrium, otherwise collapse of the structure would result, regardless of the strength of its individual members.

The word structure in engineering refers not alone to a steel building or a bridge, but also to any built up member or group of members designed to resist stress. A steam boiler is a structure, so is a steam engine, although their functions are entirely different. The boiler must be made strong enough to be capable of generating steam up to the required pressure so as to drive the pistons in the engine cylinders. The steam engine, through the medium of the flywheel, transmits the potential (still) energy of the steam into kinetic (active) energy, thus converting the power developed by the boiler into useful work. Although the steam boiler gives out energy and is not acted upon by forces beyond itself, it is nevertheless subjected to stress by virtue of the pressure of steam within the vessel.

If a boiler is generating steam at a pressure of 150 pounds per square inch, the shell, braces, tubes, etc., are all reacting against this pressure with an opposite force of also 150 pounds per square inch. Consequently, if the various members composing the boiler structure are not in equilibrium, rupture will occur.

*The proper application of the words "stress" and "strain" has been the subject of considerable controversy among many authorities. Many have correlated the meaning of the two words, but the great majority seem to contend that "strain" is the over-application of "stress," thereby resulting in permanent injury to the material.

(*To be continued.*)

# Proper Care of Twist Drills as a Means of Economy

BY G. P. BLACKISTON

The time lost in the boiler shop due to replacing and regrinding twist drills represents a loss to the company that apparently could be very materially reduced if proper attention were given to the speed and feed of the drill in operation and the grinding of the points when dull.

In view of the fact that the most accurate mechanical appliances are employed in making the standard types of twist drills, and that every precaution is taken in each of the various operations involved from the laboratory test of the steel bars to the final inspection, it would appear that the majority of drill troubles are due to the improper care of these tools on the job.

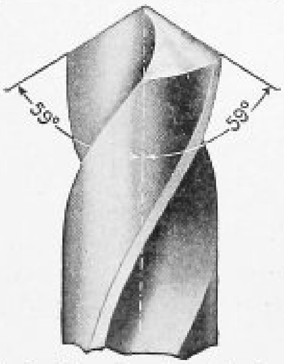



Fig. 1.—Length and Angle of Cutting Lip

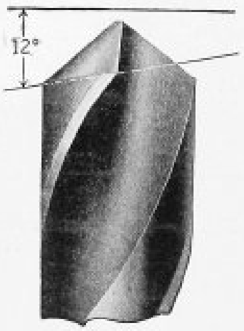



Fig. 2.—Correct Clearance Angles

Twist drills are designed to stand more strains in proportion to their size than almost any other tool and their life may be considerably lengthened by proper care, based on an elementary knowledge of their design.

### Drill Points

For most practical purposes it may be said that the form of the drill point determines the rate of production, accuracy of the hole and the frequency of regrinding. Experience and study of drill points have resulted in the universal adoption of the following rules as best suited for average conditions:

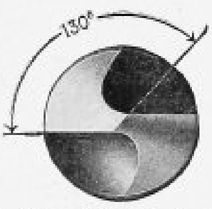



Fig. 3.—Correct Center Angle

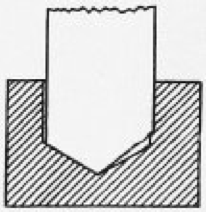


Fig. 4.—Result When Both Lips Are Not Ground at Same Angle with Radius

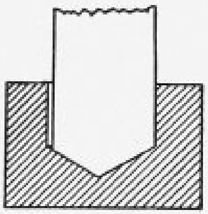


Fig. 5.—Result When Cutting Lips Are of Different Lengths

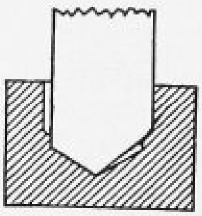


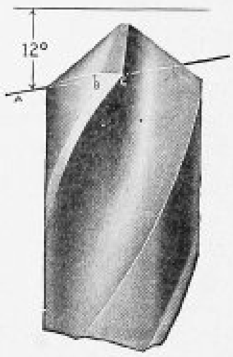
Fig. 6.—Result when lengths and angles are both incorrect

The angle of cutting lip with the axis of the drill should be 59 degrees and both lips should be inclined at the same angle and equal in length to the ones which are shown in Fig. 1.

Proper clearance or contour of surface should be provided back of the cutting edges, and this clearance must be identical on both sides. A clearance angle of about 12 degrees back of the cutting edges (Fig. 2) combined with a center angle of 130 degrees (Fig. 3) will provide a constantly increasing clearance towards the center and gives the best results for average work.

### Incorrectly Ground Drills

Fig. 4 shows a drill in which the lips have not been ground at the same angle with the axis. In this case all the work will be thrown on one cutting edge, creating an abnormal torsional strain on the drill and causing the edge to quickly become dull and spring away from its work.



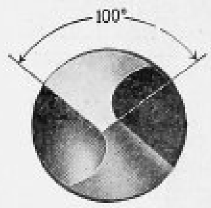




Fig. 7.—Side and End View of Drill with Insufficient Clearance

When the cutting lips of a drill have the same point angle but are of different lengths, the point will be off center or eccentric as shown in Fig. 5 and the hole drilled will be oversize to an extent equal to double the amount of this eccentricity.

If the drill point is ground both with lips at different angles and of different lengths, there will be a combination of the undesirable results given above as shown in Fig. 6.

Fig. 7 shows a drill with insufficient clearance both at the periphery and at the center. The line *A-B-C* is at an angle of 12 degrees, but there is no clearance immediately back of the cutting edges (*B-C*) and the excess of clearance at the heel (*A-B*) is of no value.

Another case of improper grinding is shown in Fig. 8. The angle of clearance in this case is 12 degrees, but this manner of grinding does not provide the proper contour back of the cutting edges, leaving them thin and weak and causing them to crumble under heavy feeds.

A common failing of drills not properly ground is their splitting along the axis as shown in Fig. 9, and such splitting is liable to occur from any of the faults listed above.

### Webs

Most twist drills are made with a gradual increase in the thickness of the web or center toward the shank. As the drill becomes shorter and the web thicker, greater force is required to drive it. This may be overcome by grinding away the excess thickness until the web is reduced to its original dimensions. The grinding should not extend too far up the flute of the drill, and care should be exercised to remove the same amount from each groove and not to injure the cutting edges. If too much metal is ground away, leaving the web thin, the drill is liable to split.

### General Notes

In order to prevent the drill from binding in the work, twist drills are made with a slight taper from point to shank. It follows, therefore, that when the drills are sharp the largest diameter will be across the cutting lips. Should the outer corners of the cutting lips become worn, the clearance of the drill in the work will be lost and binding will occur, which may damage the drill beyond repair.

When grinding high speed drills, care should be taken not to overheat them, and when heated they should never be plunged into cold water. Plunging a heated drill into cold water is likely to cause small surface cracks, which will reduce its efficiency and probably damage it beyond repair. This is also liable to happen by forcing the grinding on a wet grinder.

Broken or damaged tangs of drills are generally the result of an imperfect fit of the drill shank in its socket,

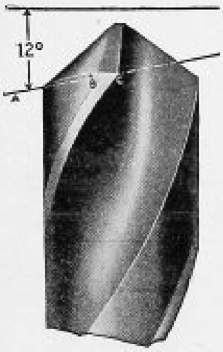



Fig. 8.—Another Case of Improper Grinding

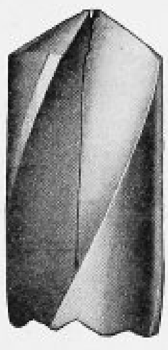


Fig. 9.—Split at Axis from Incorrect Grinding

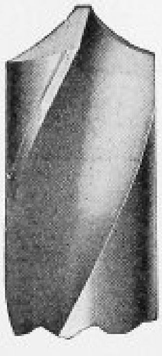
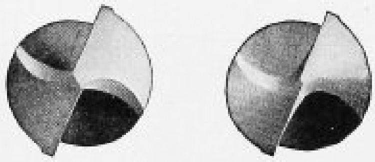


Fig. 10.—Thin and Weak Cutting Edges



Figs. 11 and 12.—Correct and Incorrect Grinding of Drill Webs

which may be caused by a worn-out socket, dirt or chips accumulating in the socket or bruises on the shank of the drill. In either case the driving power of the taper is reduced or destroyed, subjecting the tang to an abnormal strain.

A drill of either carbon or high speed steel that can be filed is not necessarily too soft for service. If drills were tempered so that a good file would make no impression, they would be too hard for general use.

### Speeds and Feeds

There are so many conditions affecting drilling operations that it is extremely difficult to establish any hard and fast rules for speeds and feeds.

Experience will enable the operator to determine the speed and feed best suited to varying conditions, but when drilling in commercial materials the tables below will furnish a guide and may be safely followed:

It should be noted that the highest speeds are those given for small drills. Small drills are very often run at a speed considerably less than that necessary to obtain the best results and excessive breakage is due primarily to this cause. These are delicate tools, and to insure good service the cutting edges should be kept sharp and care taken to see that they run true. A fine grade emery wheel is best suited for grinding small drills.

Assuming a drill to be properly ground, the rapidly wearing away of the corners of the cutting lips is an indication that the speed is too great, while a tendency of the cutting edges to roughen or break away in minute particles indicates that the feed is too heavy.

### Grinding Machines

Although it is possible to grind twist drills fairly accurately by hand, this work is more expeditiously and satisfactorily done on a twist drill grinding machine. There are several machines of this character on the market and their use is considered essential to good work and high production.

### Standard Twist Drill Gage

A handy and useful tool for users of twist drills is the "Standard Twist Drill Grinding Gage Chart and Scale." One edge of this gage is ground to suit a point angle of 118 degrees and graduated in a manner that allows the angle and length of cutting lip for a drill being ground to be readily checked. The other edge furnishes an accurate 4-inch scale graduated in thirty-seconds and sixty-fourths on one side and sixteenths on the other.

A table of speeds and feeds for drilling steel and cast iron is also given, a number opposite each 1/8-inch division showing a safe speed at which a carbon drill of corresponding diameter may be driven.

TABLE I.—SPEEDS AND FEEDS FOR CARBON STEEL DRILLS

| | | Mild Steel | Tool Steel | Cast Iron | Brass and Bronze | Drop Forging |
|---|---|---|---|---|---|---|
| | | Cutting Speed, Feet per Minute | | | | |
| | | 60 Feet | 30 Feet | 70 Feet | 150 Feet | 30 Feet |
| Diameter of Drill | Feed per Revolution | Revolutions per Minute | | | | |
| 1/16 | .003 | 3,667 | 1,833 | 4,278 | 9,168 | 1,833 |
| 3/32 | .0035 | 2,750 | 1,375 | 3,208 | 6,875 | 1,375 |
| 1/8 | .004 | 1,833 | 917 | 2,139 | 4,584 | 917 |
| 5/32 | .0045 | 1,527 | 764 | 1,782 | 3,820 | 764 |
| 3/16 | .005 | 1,222 | 611 | 1,426 | 3,056 | 611 |
| 7/32 | .0055 | 1,069 | 534 | 1,248 | 2,674 | 534 |
| 1/4 | .006 | 917 | 458 | 1,070 | 2,292 | 458 |
| 9/32 | .0065 | 825 | 412 | 963 | 2,062 | 412 |
| 5/16 | .007 | 733 | 367 | 856 | 1,833 | 367 |
| 11/32 | .0075 | 672 | 336 | 784 | 1,680 | 336 |
| 3/8 | .008 | 611 | 306 | 713 | 1,528 | 306 |
| 13/32 | .0085 | 567 | 284 | 662 | 1,419 | 284 |
| 7/16 | .009 | 524 | 262 | 611 | 1,310 | 262 |
| 15/32 | .0095 | 491 | 245 | 573 | 1,228 | 245 |
| 1/2 | .010 | 458 | 229 | 535 | 1,146 | 229 |
| 9/16 | .0105 | 412 | 206 | 481 | 1,031 | 206 |
| 5/8 | .011 | 367 | 183 | 428 | 917 | 183 |
| 11/16 | .0115 | 336 | 168 | 392 | 840 | 168 |
| 3/4 | .012 | 306 | 153 | 357 | 764 | 153 |
| 13/16 | .0125 | 284 | 142 | 331 | 709 | 142 |
| 7/8 | .013 | 262 | 131 | 306 | 655 | 131 |
| 15/16 | .0135 | 245 | 123 | 286 | 614 | 123 |
| 1 | .014 | 229 | 115 | 267 | 573 | 115 |
| 1⅛ | .015 | 204 | 102 | 238 | 509 | 102 |
| 1¼ | .016 | 183 | 92 | 214 | 458 | 92 |
| 1⅜ | .016 | 167 | 83 | 194 | 417 | 83 |
| 1½ | .016 | 153 | 76 | 178 | 382 | 76 |
| 1⅝ | .016 | 141 | 70 | 165 | 353 | 70 |
| 1¾ | .016 | 131 | 65 | 153 | 327 | 65 |
| 1⅞ | .016 | 122 | 61 | 143 | 306 | 61 |
| 2 | .016 | 115 | 57 | 134 | 287 | 57 |

TABLE II.—SPEEDS AND FEEDS FOR HIGH SPEED DRILLS

| | | Mild Steel | Tool Steel | Cast Iron | Brass and Bronze | Drop Forging |
|---|---|---|---|---|---|---|
| | | Cutting Speed, Feet per Minute | | | | |
| | | 120 Feet | 60 Feet | 140 Feet | 300 Feet | 60 Feet |
| Diameter of Drill | Feed per Revolution | Revolutions per Minute | | | | |
| 1/16 | .003 | 7,334 | 3,666 | 8,566 | 18,336 | 3,666 |
| 3/32 | .0035 | 5,500 | 2,750 | 6,417 | 13,750 | 2,750 |
| 1/8 | .004 | 3,666 | 1,834 | 4,278 | 9,168 | 1,834 |
| 5/32 | .0045 | 3,055 | 1,528 | 3,565 | 7,640 | 1,528 |
| 3/16 | .005 | 2,444 | 1,222 | 2,852 | 6,112 | 1,222 |
| 7/32 | .0055 | 2,139 | 1,069 | 2,496 | 5,348 | 1,069 |
| 1/4 | .006 | 1,834 | 916 | 2,140 | 4,584 | 916 |
| 9/32 | .0065 | 1,650 | 825 | 1,926 | 4,125 | 825 |
| 5/16 | .007 | 1,466 | 734 | 1,712 | 3,666 | 734 |
| 11/32 | .0075 | 1,344 | 673 | 1,569 | 3,361 | 673 |
| 3/8 | .008 | 1,222 | 612 | 1,426 | 3,056 | 612 |
| 13/32 | .0085 | 1,135 | 568 | 1,324 | 2,838 | 568 |
| 7/16 | .009 | 1,048 | 524 | 1,222 | 2,620 | 524 |
| 15/32 | .0095 | 982 | 491 | 1,146 | 2,456 | 491 |
| 1/2 | .010 | 916 | 458 | 1,070 | 2,292 | 458 |
| 9/16 | .0105 | 825 | 412 | 963 | 2,063 | 412 |
| 5/8 | .011 | 734 | 366 | 856 | 1,834 | 366 |
| 11/16 | .0115 | 673 | 336 | 785 | 1,681 | 336 |
| 3/4 | .012 | 612 | 306 | 714 | 1,528 | 306 |
| 13/16 | .0125 | 568 | 284 | 663 | 1,419 | 284 |
| 7/8 | .013 | 524 | 262 | 612 | 1,310 | 262 |
| 15/16 | .0135 | 491 | 246 | 573 | 1,228 | 246 |
| 1 | .014 | 458 | 230 | 534 | 1,146 | 230 |
| 1⅛ | .015 | 408 | 204 | 476 | 1,018 | 204 |
| 1¼ | .016 | 366 | 184 | 428 | 916 | 184 |
| 1⅜ | .016 | 334 | 166 | 388 | 834 | 166 |
| 1½ | .016 | 306 | 152 | 356 | 764 | 152 |
| 1⅝ | .015 | 282 | 140 | 330 | 706 | 140 |
| 1¾ | .016 | 262 | 130 | 306 | 654 | 130 |
| 1⅞ | .016 | 244 | 122 | 286 | 612 | 122 |
| 2 | .016 | 230 | 114 | 268 | 574 | 114 |

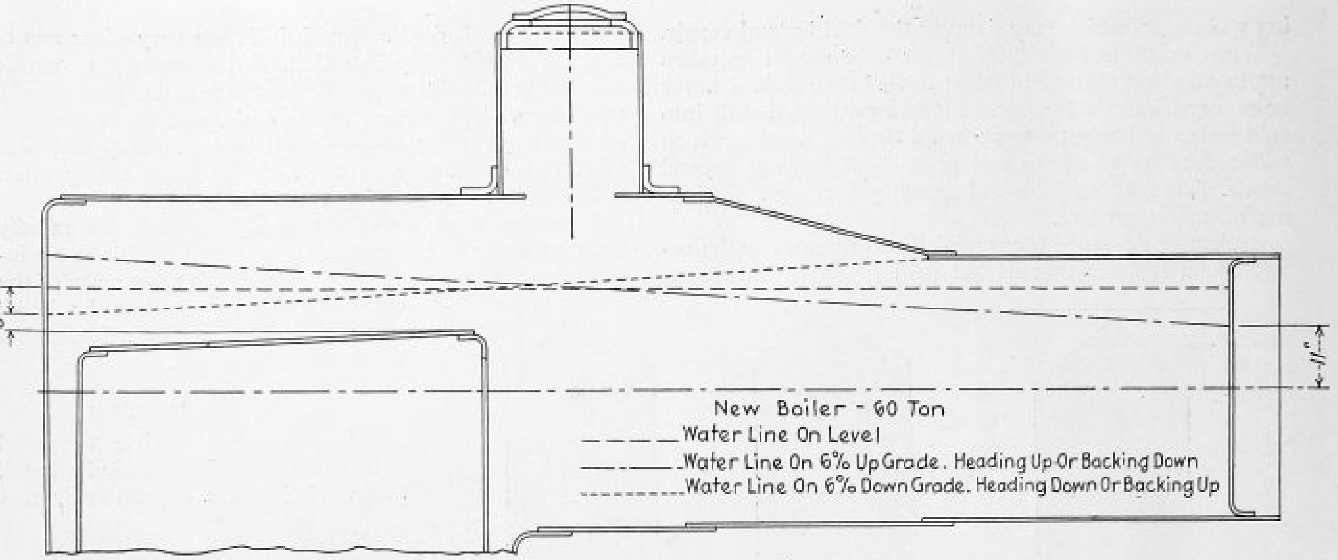



Fig. 1.—Wagon Top Boiler with Short Taper Course at the Center and the Dome Slightly Ahead of the Firebox Crown

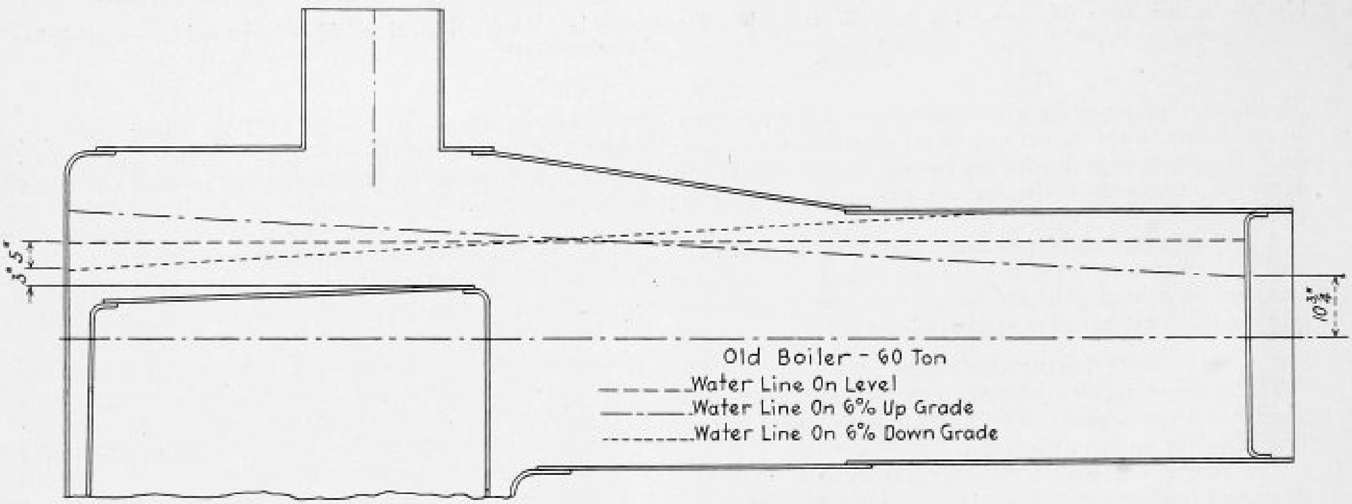



Fig. 2.—Wagon Top Boiler About Same Height Over Crown Sheet as in Fig. 1, and with a Slightly Longer Taper Course with the Dome Directly Over the Firebox

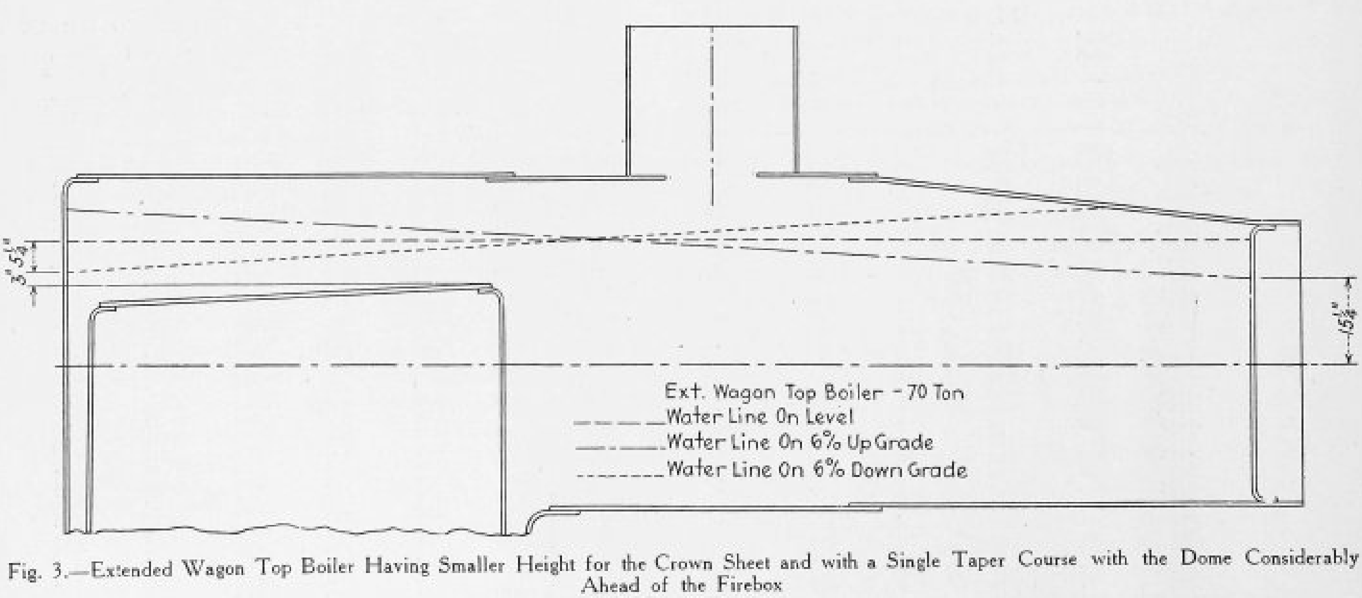



Fig. 3.—Extended Wagon Top Boiler Having Smaller Height for the Crown Sheet and with a Single Taper Course with the Dome Considerably Ahead of the Firebox

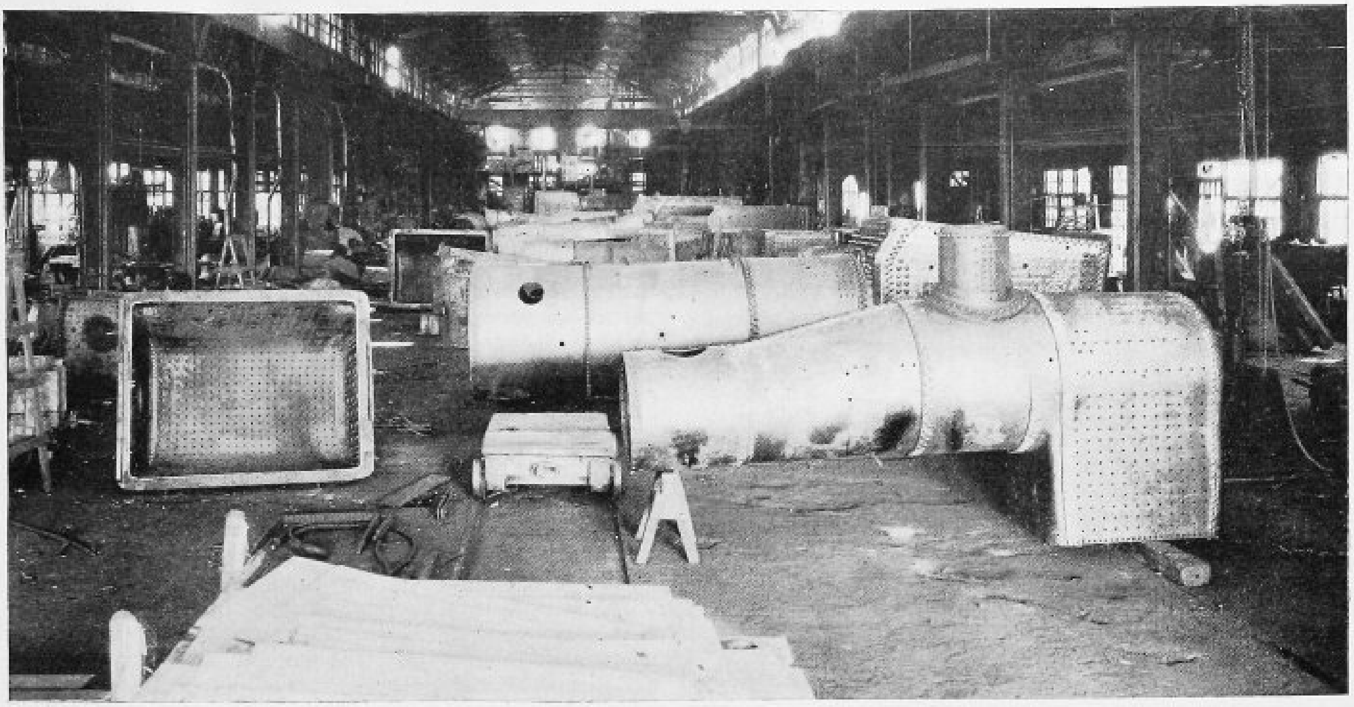


Fig. 4.—Shay Type Locomotive Boilers Under Construction in Shops of the Lima Locomotive Works

# Investigation of Water Level in Locomotive Boilers Operating on Grades

BY A. J. TOWNSEND*

The following investigation was undertaken to determine the effect which the general design of a small locomotive boiler has upon the waterline in the boiler with the locomotive operating on steep grades. For the study of conditions various types of Shay locomotives were used.

In order to prevent water being drawn into the cylinders of locomotives operating on grades, a design was prepared giving the maximum possible amount of steam space under the dome. The waterlines of boilers of different proportions under the same service conditions were investigated, and the results compared so as to get a boiler of suitable design.

The boilers investigated were of distinctly different design in regard to the location of the dome, the height of the roof sheet over the crown sheet and the shape of the front courses of the shell. Fig. 1 shows a wagon top boiler with a short taper course in the middle and the dome slightly ahead of the firebox crown, which is a new design for the 60-ton type locomotive. Fig. 2 shows a wagon top boiler with about the same height over the crown sheet and the taper course a little longer, but with the dome directly over the firebox, which was formerly used on the 60-ton locomotive. Fig. 3 shows an extended wagon top boiler with a smaller height over the crown and the taper course in front, but with the dome considerably ahead of the firebox, which is used on the 70-ton locomotive.

For the investigation the amount of water in the boiler was assumed to remain constant for both up and down grade and on the level, and two different grades were considered, 6 percent and 12 percent. The lowest reading on the gage glass was taken as 3 inches above the highest point of the crown sheet in accordance with the Interstate Commerce Commission rules.

As the lowest water level at the gage glass occurs when the locomotive is heading down grade, the waterline while on a down grade was readily determined for each boiler for both a 6 percent and a 12 percent grade. Then, assuming a constant quantity of water for each grade, the location of the waterline for the up grade and on the level was calculated.

The results of the investigations are shown in Figs. 1 to 3. The difference in the gage glass readings on the level and on the grades varies but little for the three types of boilers. From this it is evident that the shape of the front course of the shell does not materially affect the location of the waterline, and therefore need not be further considered.

Since the Shay locomotive must operate both backward and forward, it is evident that the most satisfactory location for the dome would be directly over the intersection of the waterline for the up and down grades. This point occurs at approximately the same distance ahead of the firebox for all three boilers. This point also varies but little in going from the 6 percent to the 12 percent grade, moving a little nearer the firebox and higher as the grade increases. From this it will be seen that theoretically the dome should be placed over the front of the firebox.

In view of these facts it is evident that with the dome properly located the steam space at the dome is directly proportional to the height of the roof sheet above the crown sheet. The greater this height, the less will be the possibility of water being carried over into the cylinders on grades and stalling the locomotive.

From these conclusions I would recommend the following:

That the general style of boiler shown in Fig. 1 be adopted, with a possible replacement of the two front courses by a single taper course.

That the dome be placed as near to the firebox crown as the radial stays will permit.

* Of the Lima Locomotive Works, Lima, Ohio.

That the vertical height between the roof sheet and crown sheet be made as large as possible to be consistent with the diameter of the boiler and the number of tubes required.

(*Continued on page 366.*)

## Work of the American Society of Mechanical Engineers Boiler Code Committee

*The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Anyone desiring information as to the application of the Code is requested to communicate with the secretary of the committee, Mr. C. W. Obert, 29 West 39th 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.

Case No. 259 (Reopened).—Is it allowable, under the requirements of the A. S. M. E. Boiler Code, to fit a high pressure steam boiler with a blow-off connection larger than 2½ inches in case it is to be used initially for low pressure steam or hot water heating, or will it be necessary under the requirements of paragraph 308 to apply two or more 2½-inch blow-off connections for the return connections to the boiler?

It is the opinion of the committee that a boiler could be initially fitted with a blow-off connection larger than 2½-inch size when intended for use as a steam or hot water heating boiler, and when converted to a steam boiler if to operate at over 15 pounds pressure, but not exceeding 100 pounds pressure, a reducing fitting could be used at the opening to reduce to the pipe size required for the blow-off connections by paragraph 308.

Case No. 285 (Reopened).—Is it permissible, under the rules of the Boiler Code, to use standard extra heavy cast iron flanges and fittings on pipe connections between boilers and attached type superheaters, and on the ends of superheater inlet headers for pressures up to 250 pounds per square inch? It is pointed out that neither the inlet pipe connections nor the superheater inlet flanges would be subjected to other than saturated steam temperatures.

It is the opinion of the committee that the flanges and fittings referred to may be made of cast iron, provided the temperature of the steam does not exceed 450 degrees F. as specified in paragraph 12.

Case No. 305.—Is it permissible, under the requirements of the Boiler Code, to connect sections of wrought steel headers, one of which is shrunk or forced over the end of the other, making a close fit and secured by means of bolts of ample cross-sectional area, the joint being calked or autogenously welded to insure tightness, the design of the joint to be such that it will be of ample strength, neglecting the holding power due to shrinking or forcing one section over the other and the holding power of the autogenous welding?

It is the opinion of the committee that while the construction described is not a desirable one, it is not prohibited by the Code.

Case No. 307 (Reopened).—Is it permissible to so locate the supporting lugs on horizontal return tubular boilers where more than four lugs are required and under paragraph 323 of the Code must be set in pairs, that those in each pair come closer together, or must the horizontal distance between the centerlines of rivets attaching the adjacent lugs to the shell be at least equal to the vertical spacing of rivets that is required for lug attachments in paragraph 323, as shown in Fig. 1 (page 270, September BOILER MAKER)?

There is no requirement in the Code specifying the distance apart of the lugs forming pairs as required by the last sentence of paragraph 323. It is the intent of the Boiler Code that the distance between the lugs should be such as to give at least ½ inch between the edges of the lugs and not more than 2 inches. The load should be equalized between the two lugs.

Case No. 310.—(a) Can a type of boiler other than the horizontal return tubular type have lap joints where the courses are over 12 feet long?

(b) With butt and double strap construction on longitudinal joints for boilers other than of the horizontal return tubular type, is it required that the tension test specimens be cut from the shell plate as provided in paragraph 190?

(a) The restriction in length of lap joints to 12 feet in paragraph 190 of the Boiler Code applies specifically to boilers of the horizontal return tubular type, and there is nothing in the rule which prohibits the construction of shells and drums of lengths exceeding 12 feet for other types of boilers.

(b) Inasmuch as the first sentence of paragraph 190 applies specifically to horizontal return tubular boilers, as pointed out in reply (a), it is the opinion of the committee that this prohibition does not cover other types of boilers.

Case No. 314.—Is it the opinion of the Boiler Code Committee that a lap joint reinforced with a cover plate should be considered as an ordinary lap joint and the requirements for factors of safety given in paragraphs 379 and 380 applied accordingly?

It is the opinion of the committee that a lap joint even though reinforced by a cover plate should be treated exactly the same as the simple form of lap joint, so that the factors of safety proposed in paragraphs 379 and 380 for lap joints would be applicable.

Case No. 315.—Is it to be understood that the requirements of paragraph 323 of the Boiler Code, relative to the location of lugs and the distribution of rivets attaching them to the shell, apply to the small sizes of boilers referred to in paragraph 324?

The requirements of paragraph 323 of the Code are clearly limited to horizontal return tubular boilers over 78 inches in diameter. It will be found that paragraph 325 gives the requirements for attaching the lugs.

Case No. 316.—Is it permissible, under the requirements of the Boiler Code, for a boiler manufacturer to stamp a boiler as A. S. M. E. Code Standard when it is fitted with a safety valve nozzle or connection that is adequate only for safety valves operating at high lifts?

The way designated in the Code in which the size of the safety valve or valves that shall be used on any boiler is determined is by their relieving capacity, and where the safety valve opening corresponds to that required from such a valve or valves the boiler is constructed in accordance with the A. S. M. E. Code in this respect and may be so stamped. The committee suggests, however, that where boilers are sold for a given operating pressure without knowledge of the type of safety valves that will be used, the safety valve openings be proportioned for the intermediate lifts and corresponding relieving capacities given in Table 15 of the Code.

Case No. 317.—If it is permissible, as indicated in Case No. 298, to fit a steam outlet nozzle with a wrought steel flange screwed to the outer end of the end neck to which the flange is threaded and peened over into a beveled part cut away from the flange, why should not this construction be acceptable for the fastening of the flange at the other end of the nozzle for attachment to the boiler shell?

It is the opinion of the committee that this construction does not conform to the requirement of the last sentence in paragraph 268.

# Improvised Methods at Nevers Shops

## Interesting Machines Adapted to Special Boiler Work in the American Expeditionary Force Locomotive Shops

BY C. E. LESTER

The opening of practically all new railroad shops usually is fraught with many difficulties in overcoming the handicaps caused by lack of foresight in supplying necessary hand tools, jigs, dies, home fabricated machines, etc., unless the shop is taking the place of an obsolete one, in which case such supplies are usually transferred. If this is the case the plant can go forward with production without delay.

The opening of the American Expeditionary Force locomotive shops at Nevers, France, 3,500 miles from the base of supplies, came at a time when there was no time to wait for equipment from the United States. The lack of a needed article simply meant that we got it in some way or made something else to take its place. Excuses never go in the Army. An order is given and the work is done. Some greatly needed tools and machinery were never on requisition (it was no small undertaking to originate a requisition for a railroad repair shop big enough to turn out seventy-five general repairs a month and almost perfectly equipped), others were ordered and cut off by some officer, who checked requisitions, and others were sunk in the submarine zone or lost amidst the thousands of tons of freight at the congested base ports of entry.

Quite necessarily we were required to improvise many things needed to operate a large shop. We repaired locomotives for all the railroads in France and also kept up the repairs on about 450 Belgian state railroad locomotives under lease by the American Expeditionary Force. European practices differ considerably from American. Firebox work was heavy on the Belgian locomotives and, as is common there, the firebox plates and staybolts were of rolled copper. The practice is to apply staybolts with telltale holes all the way through the bolt. You can rest assured that the drilling of a 6-millimeter hole through the center of a 27-millimeter copper bolt about 10 inches long is no easy matter. It was necessary that we provide measures for putting these holes in all staybolts, and as we applied new fireboxes there were large quantities to be handled.

### Machine for Drilling Staybolts

Such a thing as a machine for work of this kind was not among the shop equipment; however, we found two gun-barrel lathes in the machinery not installed—that is, two ordnance lathes for boring the hole through rifle barrels. These had been shipped to Nevers by mistake instead of to the ordnance department shops. These two machines were taken in and set up in the shop. Being shaft driven, it was necessary to erect a suitable superstructure to carry the motors and shafting prior to converting them into telltale hole machines. The conversion was made by modifying some of the parts and constructing new parts as shown by the details of Fig. 1. Copper being especially difficult to drill, the drills were formed and ground specially for this. We used nothing but drills 3 inches long. These drills were brought to proper length by oxy-acetylene welding a long shank to the body of the drill. It may be well to state that prior to the war that hollow rolled copper staybolt material was obtainable, but the town in Belgium where it was manufactured was occupied by the Germans during the time we needed it, and quite naturally none came through to the American Army.

### Fitting Flues

All flues that we encountered in both French and Belgian locomotives were of brass and quite light in weight. As I recall, they were about 0.08 inch in thickness when new, and in many of the old locomotives they were considerably thinner. The long slow taper of the swaged section of the flue used in the heavy copper sheets made the use of a horizontal swager preferable to a vertical one, and, due to the extreme lightness of the tubes, the volume of pressure necessary to properly swage them would not be exerted on the full length of the tube, using a back stop for the far end, as the flues

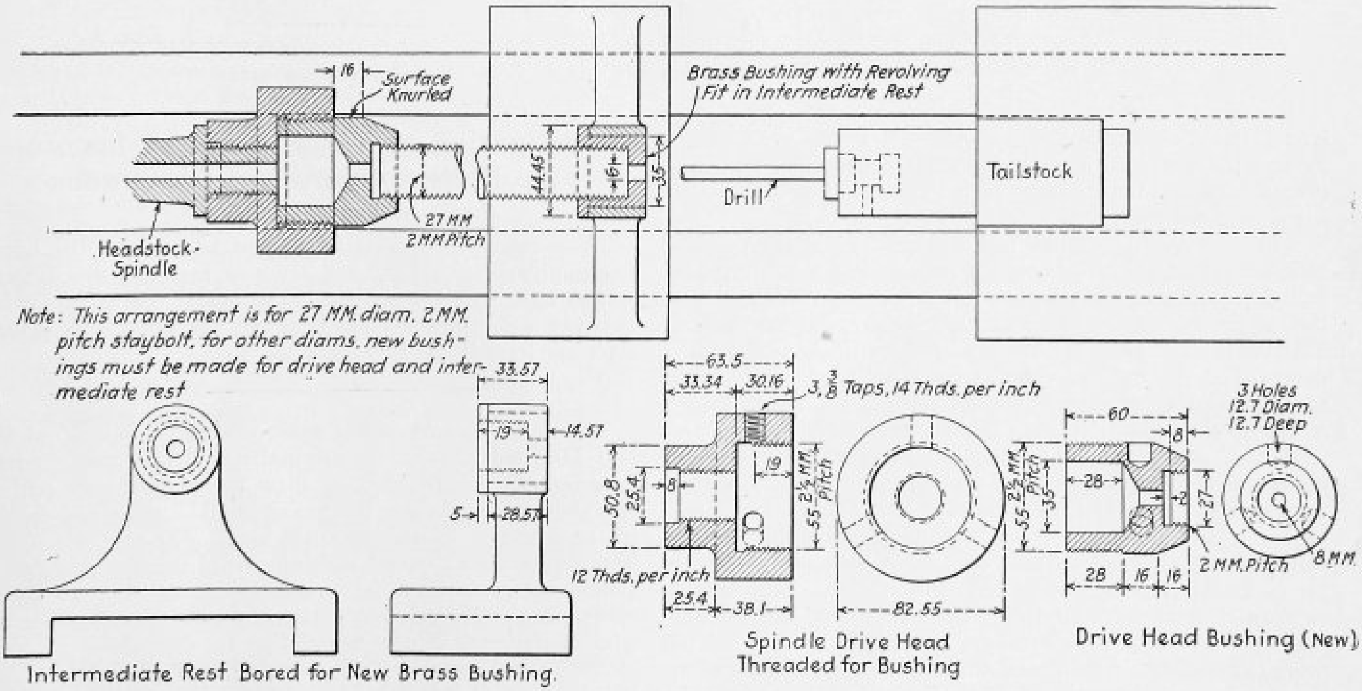



Fig. 1.—Details Involved in Converting Gun-Barrel Drilling Machine to Drill Telltale Holes in Staybolts

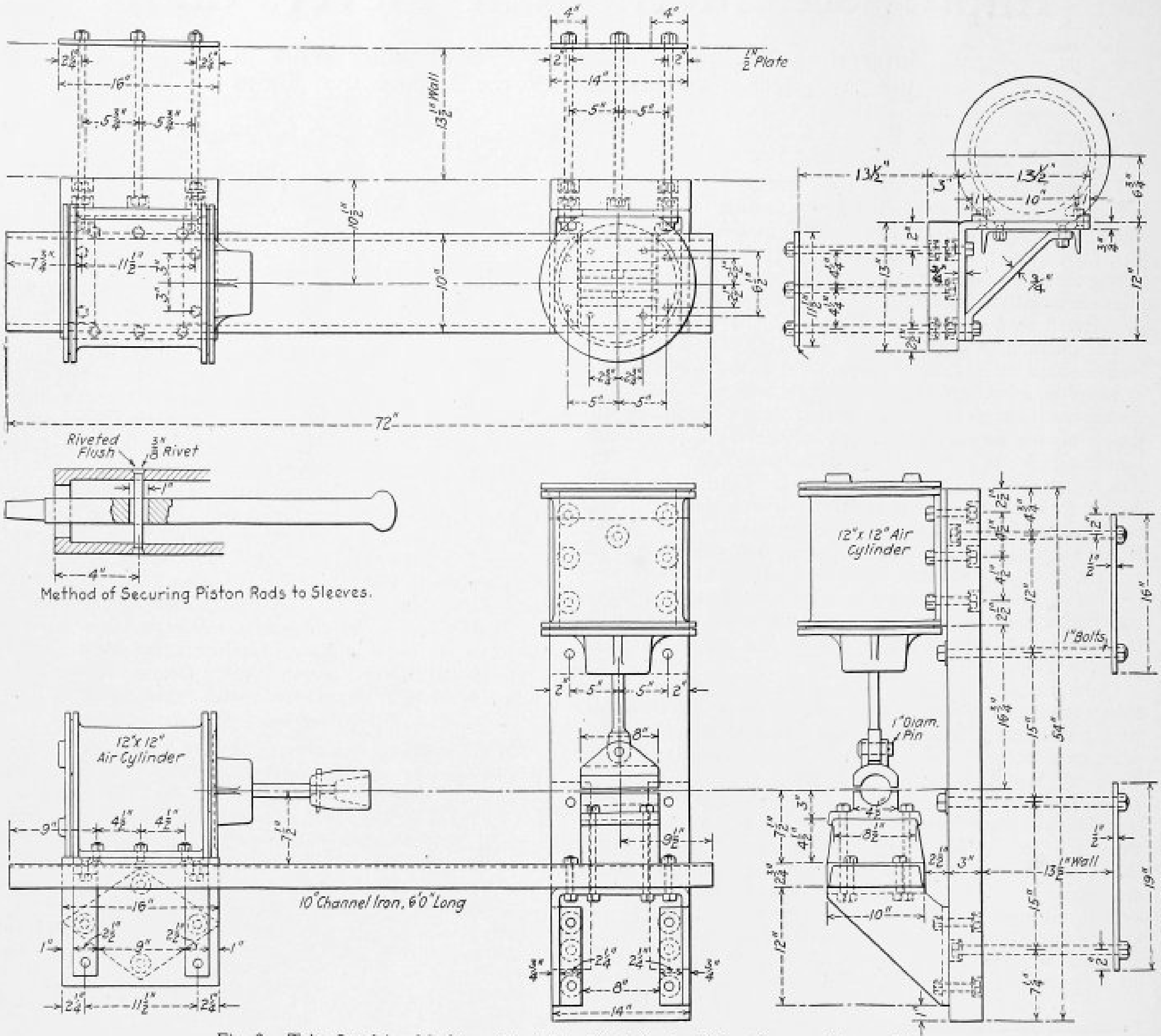



Fig. 2.—Tube Swedging Machine Adapted to Work in the Boiler Shops at Nevers, France

would buckle. While the piping is not shown on Fig. 2, the cylinders were so coupled up that one operator handled the machine and the operation of gripping the flue and swaging it required but one movement.

As shown by Fig. 2, this tool was improvised from a 12-inch air cylinder for the swaging process and a 12-inch air cylinder with a top and bottom swage block for holding the flue while swaging. The holding cylinder was set within about 3 feet of the swage block to nullify the buckling tendency of the light flues. The two sections were joined by a piece of 10-inch channel iron and secured stationary by 1-inch bolts through the walls of the structure.

We had no flue welder for safe ending flues, although experiments were being conducted toward that end when operations ceased. The flues and safe ends were prepared as for a butt weld and placed in an inclined rack where they would roll down to an oxy-acetylene operator who would fuse the pieces together, using bronze rods for a filler. This was a very satisfactory way of welding brass tubes and the practice prevails to a considerable extent throughout France. The practice is rather slow for steel or iron flues, yet I know of at least two small railroads in New York state that are safe ending flues in this manner.

## Investigation of Water Level in Locomotive Boilers Operating on Grades

(*Continued from page* 364.)

These recommendations have been adopted by the Lima Locomotive Works, Inc., and are now included in all Shay boilers built by the company. The actual results in service obtained with these engines bear out the theoretical advantages apparent in the investigation.

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The War Department has again offered for sale 56 of the 200 Decapod locomotives originally built for the Russian government. Eighty-seven of these locomotives were sold to American railroads and the remaining 113 were sold earlier in the year to a Washington law firm. The sale was made, however, under a contract which provided that the locomotives should not in any way be turned over to the Russian Soviet government. The sale has apparently been cancelled, for the War Department is now negotiating for the sale of 56 locomotives now located at Tulleytown Arsenal, New Jersey, and it is understood that the price will be approximately $25,000 each, as is and where is.

# An Improvised Press and Some Sundry Notes

BY JOHN S. WATTS

The following notes are taken from my own actual experience, and, while scrappy, may serve to help or warn some other fellow against making some of the mistakes that have been experienced.

Once upon a time in a small boiler shop we had four tanks to make, to be used for oil storage. Speaking from memory, these tanks were about 12 feet in diameter and about 25 feet long, to be laid horizontally. The heads were dished to a 12-foot radius and were of ¼-inch plate in one piece, since the pressure being only that due to the head when the tanks were full, namely, about three pounds per square inch.

The first attempt to dish these heads was by the regular hand flanging method; that is, a gang of men with wood mallets pounding the heated plate on a former block. The time being midsummer and the temperature at its highest, it was soon found impossible to keep the men on the job, as a plate so large will throw an insufferable heat for some considerable distance.

Moreover, it was impossible to reach to the center of the plate, except by standing up close to its edge, when the heat was too fierce to bear.

After struggling for a couple of days under these conditions without accomplishing anything, the attempt was given up, and having no hydraulic equipment available to press the plate we were in a quandary as to what to do until the following simple and effective solution was worked out.

Having already got the former block, which is really a female die, we cast a male die with a staple or U-bolt in it, capable of lifting the weight of the die. We then borrowed the slip hook from the skull cracker, used in our foundry for breaking up the scrap, and were once more ready for another attempt.

We placed the female die under one of the cranes, letting the male die hang by the slip hook just over it in a vertical line. We then heated the plate and laid it on the female die. When we pulled the trigger on the slip hook the male die fell onto the plate and dished it successfully at the first attempt.

### Construction of a Receiver Tank

We were asked by a customer to make a receiver tank to place in the steam line near the engine, to act as a reservoir and help to prevent the drop of pressure in the cylinder.

The size of the steam pipe being very much on the small side and the distance from the boiler being great, the fluctuations of pressure in the tank were severe and rapid, occurring once for each stroke of the engine.

The tank was made with dished heads, of ample strength for the pressure and well riveted up and calked. It was unquestionably a good job when it left the shop. Notwithstanding all this, the tank began to leak soon after being put to work and could not be calked to remain tight for any length of time.

The trouble was finally diagnosed as being due to the breathing of the heads, caused by the recurring pulsation of pressure, this breathing being sufficiently severe to cause the calking to open up.

The leaks were finally stopped for good by fitting substantial through stays which entirely prevented all breathing of the heads and so enabled the calking to be made permanently steam tight.

### Adapting the Punching Machine to a Variety of Jobs

The punching machine can be put to a variety of profitable uses, outside of its regular province, if a little ingenuity is exercised in getting up the necessary dies and tools.

For example, in flanging the side plates of elevator buckets, which are usually of thin material, the work is generally done by hand in the small shop having no hydraulic equipment. By making up a set of simple cast iron dies, these heads can be pressed cold in the punching machine at a very quick rate and at much less cost than by hand, as well as making a much superior job.

Of course, care must be taken in setting the dies that the space left for the plate between the dies is sufficient to accommodate the thickest plate, as otherwise something will get broken. Another point is that the machine used must be strong enough for the work. The power required to bend a steel plate cold can be calculated by multiplying the length of the bend by the thickness of the plate, and the product by the elastic strength of the steel.

As the power of punching machines is usually expressed in terms of the diameter of the hole it will punch through a given thickness of plate, which is equivalent to shearing a plate of that thickness and of a width equal to the circumference of the hole, we can calculate from that basis the plate it will safely bend.

The elastic strength being about two-thirds of the shearing strength, it follows that if a machine will shear a certain area of plate, it will bend cold a plate having 50 percent greater area at the bending line. If the plate is heated it will bend double the area it would bend cold, or three times the shearing area.

For example, a machine capable of punching a 1-inch diameter hole in a 1-inch plate is shearing the equivalent of 3.1416 square inches of plate, and will therefore bend cold a plate of $3.1416 \times 1.5 = 4.7124$ square inches, or practically a plate 38 inches long on the bending line by ⅛ inch thick. If the plate was to be bent hot, it would be equal to bending one 38 inches long by ¼ inch thick, or any equal area. From this example it will be seen that a comparatively small punching machine used as a former will handle a fairly large class of work in thin plates.

### Adjustable Multiple Punches

The punching machine could have a much larger output of small work if fitted with adjustable multiple punches and dies. These can be so arranged that two or more holes can be punched at once up to the capacity of the machine when working on repetition work. The punch and die holders should be made singly, so that they may be readily adjusted to suit varying sizes and pitches of holes.

### Precautions in Shipping Boilers

In shipping a boiler, great care should be exercised in inspecting it to see that no tools or other material have been left inside. The boiler should be thoroughly cleaned of all dirt, chips, etc., and all the openings closed up in such a manner that they cannot be easily tampered with.

Probably the best method is to bolt the valves on all the flanged nozzles and screw pipe plugs in the screwed holes. At the least, the flanged openings should have wooden blank flanges bolted securely in place.

If any of the openings are left unplugged, you may be sure that some mischievous boy will discover it and infallibly proceed to drop a few rocks or other débris into the boiler—why, I don't know, but the process seems to have an irresistible attraction to the average youth.

It is not necessary to stress the point as to the damage a boiler may get from having foreign material lying on its heating surface and eventually causing the boiler to get overheated at that point and develop a bag.

While the purchaser should make certain that the boiler is clean inside before putting it to work, the blame for any damage resulting from the presence of such matter in a boiler will generally be laid to the manufacturer.

The length of the tubes in a fire tube boiler should never exceed forty-eight times the diameter for natural draft, and would be much better if shorter. If the tubes are longer than that, the draft will be impeded.

### Tube Lengths in Boilers

For forced draft the ratio of length of tube to diameter does not have so much importance, but it would be well not to have the length over sixty diameters for the best results.

The space between the tubes should never under any circumstances be less than 3/4 inch, and a good rule is to make the pitch of the tube about 1 3/8 the diameter of the tubes. Closer spacing than this is liable to cause priming and makes it difficult to clean the scale from the tubes.

### Concavity of Tube Sheets

In vertical boilers I have frequently noticed that the furnace tube sheet is apt to be concave; that is, it forms a saucer-shaped depression, which tends to hold the sediment and deposits from the feed water just where they will do the most damage.

The tube sheet has a tendency to take this concave shape when being flanged, and great care should be exercised to overcome this, and preferably give the tube sheet a slightly convex shape so that the dirt and deposit can be flushed off by the hose when cleaning out the boiler.

This part of a vertical boiler is, at the best, difficult to keep clean, and it has been my invariable experience that when the tube sheet has this concave shape it will be found impossible (unless the feed water is unusually pure) to keep the tubes tight, owing to the tube sheet becoming overheated by reason of the deposit on the water side of the tube sheet.

In fitting concave heads in tanks it should be noted that these heads often fail by bulging. It will be seen that this bulging is accompanied by a deformation of the shell plate. This I have observed in actual failures.

A simple way to add strength to this form of head is to rivet a strap around the end, outside of the shell plate, which strap will obviously assist the shell plate to resist deformation, and so tend to prevent the head from bulging.

The correct way, however, would seem to be to make the head of the shape it takes after failure.

## Shipments of American Locomotives Show Large Gain

In the first eight months of this year the United States exported 1,150 locomotives to all parts of the world, nearly 200 more than in all of last year and more than twice as many as normally exported annually before the war. The largest purchases this year have been made by Belgium, Italy, France, Poland and Danzig.

Representing a rather large outlay of capital, locomotives are bought in quantity only as a definite step in the rehabilitation or extension of railroad lines, says *Commerce Monthly*.* A country imports rather than makes its locomotives either because it has not highly developed its manufactures or, as in the case of France, because its manufacturing has been so disrupted by war that domestic manufacture cannot supply its needs.

Before the war the export of locomotives was concentrated in the hands of the great steel-producing countries—Great Britain, Germany and the United States. Under these circumstances American sales to Europe were very small. During the war, however, the United States was called upon to supply locomotives to Europe, and in 1918 even sent 241 to England. Since the close of the war the United States has been the only country prepared to ship locomotives in quantity, and the exports from this country form the chief part of the international trade. As time goes on, British competition may be expected again to become an important factor in the trade, and Canada has also entered the field as a locomotive exporter.

* Published by the National Bank of Commerce in New York.

## National Pipe and Supplies Association Adopts Iron and Steel Pipe Terms

The following resolutions have been adopted by the executive committee and advisory board of the National Pipe and Supplies Association:

Whereas, the distributors of pipe for many years used terms to designate the various types and makes of pipe that have not been truly descriptive of same, and

Whereas, it is the desire of this association to co-operate in every way with the manufacturers in the development of trade practices and customs of accepted merit, and which will be fair and intelligible to the manufacturer, distributor and public alike,

It is hereby resolved by the officers and members of the executive committee and advisory board of the National Pipe and Supplies Association in their fall meeting, held in New York City on Thursday, November 11, that it is their judgment that the terms employed by the American Society for Testing Materials in differentiating between iron and steel pipe, viz., (a) welded wrought iron pipe, (b) welded steel pipe, should be accepted and adhered to by the distributors of both iron and steel pipe, this being in the interest of the manufacturers of the pipe, those who distribute it and those who use it, each being entitled to know clearly and without doubt the make and quality of the pipe involved in the transaction.

## Data Sheets of the Interpretations of the Boiler Code

As a result of the widespread demand from the steam boiler field, the Boiler Code Committee has inaugurated the practice of reprinting the interpretations issued at its regular monthly meetings and approved by the council, and these are now available for general distribution in data sheet form, trimmed to convenient size and punched for insertion in suitable binders. These data sheets begin with Case No. 200, which is the first case formulated by the Boiler Code Committee in interpretations of the 1918 edition of the Code; the cases from Nos. 1-199 have not been reprinted in this form, as with their incorporation in the new edition of the Boiler Code (edition of 1918) they are superseded and thus rendered of no further service.

These data sheets are available upon application to the office of the secretary of the Boiler Code Committee, at the prevailing rates charged by the publication committee for reprinted matter. They may be obtained singly or in complete sets from Case No. 200 up, as may be desired. Should it be desired to preserve them in a convenient form, this may be accomplished by ordering in addition a Boiler Code binder, this being fitted with clamping bolts for binding in not only the data sheets, but also the Boiler Code, if desired.

J. F. Boyd, formerly with the Cyclops Steel Company, has been placed in charge of sales of the Wetmore expanding reamers in the Chicago district, which includes Illinois, Missouri and northern Indiana. Mr. Boyd's office is at 846 Marquette building, Chicago, Ill.

The Falls Rivet Company, of Kent, Ohio, has just purchased from the Ohio Wire Goods Manufacturing Company, of Akron, Ohio, all the machinery, patents and patterns relating to the manufacturing of cotter pins and flat spring keys.

# The Boiler Maker

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

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Many requests have been made to the Boiler Code Committee of the American Society of Mechanical Engineers for copies of the interpretations of the provisions of the code. In order to make all decisions of the code available to those interested, a special loose-leaf data form with suitable binders has been developed in which the code and all proceedings of the committee may be filed. All cases from Number 200 are printed in this form, but those on which decisions were given before this have been incorporated in the 1918 edition of the code. Copies of all cases may be obtained from the secretary of the Boiler Code Committee of the American Society of Mechanical Engineers on application.

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In the study of boiler design, however elementary it may be, many problems involving a knowledge of applied mechanics occur. To supply information on this subject in such a manner that it might be used to supplement the recently completed articles on horizontal return tubular boiler design, the author of this series has written a short explanation of certain principles of applied mechanics that were involved in the former work.

The first chapter of the article deals with the "composition" and "resolution" of forces and an experimental demonstration of the manner in which forces applied to a structure react on the various members of the system. When acting forces are once known, it is the object of the designer, whether of boilers or sky scrapers, to incorporate such braces or supports that will counteract the stresses, or, in other words, since "all structures are subjected to stress, if not from external sources, then due at least to their own weight, the members comprising the structure must be correctly designed and proportioned to retain their equilibrium, otherwise collapse of the structure will result, regardless of the strength of individual members."

The second chapter on this subject will amplify the practical discussion of statics or structural mechanics, and these principles directly applied to the design of boiler braces and stays.

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Certain recommendations for the elimination of unsafe practices in locomotive operation have from time to time been submitted by the chief inspector of the Bureau of Locomotive Inspection in his annual and special reports to the Interstate Commerce Commission. The latest bulletin of the bureau giving details of the investigation of the Lehigh Valley locomotive accident last July, which is published elsewhere in this issue of THE BOILER MAKER, emphasizes the necessity of adopting practical safeguards for the prevention of disastrous locomotive boiler explosions. In addition to the advisability of utilizing safety devices, it is absolutely essential that inspections be made more rigid and conform more closely to the requirements of the law.

The crown sheet failure in this case would unquestionably have been prevented had the monthly inspection required by the bureau been carried out conscientiously. The boiler in no way bore evidence of overheating or strain, but in the section that failed, 37 crown stays were broken and the sheet pulled away from 12 others. When examined after the accident the ends of the stays were found to be covered with scale, which indicated quite conclusively that they had been broken for some time, probably for more than the twenty days since the last inspection. Failure to observe other rules led to the inspector's statement that the safety valves had been set at the time of the monthly inspection, when, as a matter of fact, the locomotive had not even been fired up that day. Although two steam gages are supposed to be used in setting safety valves, the investigation disclosed the fact that this provision had been disregarded.

In commenting on the accident, the chief inspector recommends that telltale holes be drilled in all crown stays and staybolts and that the former recommendation of installing automatic fire doors be required by the inspection laws.

The main point, however, emphasized by the report is that all inspectors responsible for the safety of the locomotives under their supervision do their work so that it will be absolutely above criticism.

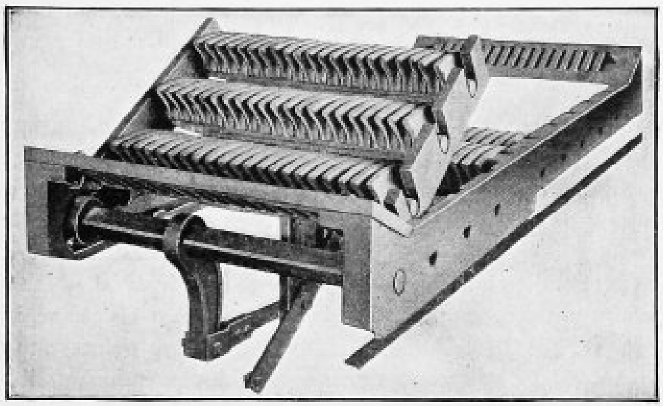
Wide attention has been called to this report, and it will have done a great amount of good if the standard of inspection is generally raised.

# Engineering Specialties for Boiler Making

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

### New Type Shaking Dump Grate

The dump grate has always been a necessary evil in the locomotive firebox, necessary for the removal of clinkers when cleaning fires at terminals, and an evil because of the "dead" surface of the dump or drop grate, from which it is impossible to remove the accumulation of ash while the locomotive is in operation between terminals. The effective grate area is, therefore, practically reduced by the area of the dump grate.



Front End of Grate, Showing Operating Shaft and Lifting Frames

In order that the entire area of the grate may be uniformly effective, the Hulson Grate Company, Keokuk, Iowa, has designed a locomotive grate in which the drop grate is replaced by three finger bars in a frame which may be swung upward about a shaft journaled at the front end of the grate frames. Standard Hulson finger bars are used in the lifting frame and they are shaken as a part of the front section of the grate.

The construction of the device is simple and will readily be understood by reference to the illustrations. It will be seen that the side and center frames are recessed at the front ends, the length of the recess being sufficient to take in the cast steel lifting frames of rectangular cross-section with trunnion bearings for the three standard finger bars. Square holes are cored through the ends of the lifting frames, which are reinforced with hubs to provide ample strength, and the frames are mounted on a 2-inch square wrought iron staff. This staff, with the lifting frames and a cast steel lifting arm mounted on it, is placed in the stationary grate frames, one end being slipped into a circular hole cored in the side frame and the other dropped into a slot in the center frame. When assembled, the slot in the center frame is closed by the front tie bar.

To permit the three finger bars in the lifting frame to be shaken with the remainder of the bars in the front section of the grate, the shaker arms of the bars in the lifting frame and those in the remainder of the section are connected independently, the two systems being united through a second connecting rod with one connection to each system. In order that the movement of the lifting frame may not interfere with the operation of the shaker rigging, the rod connecting the three finger bars in the lifting frame is extended forward so that when the finger bars are in their normal position its end is directly under the lifting shaft. The operating connection is made at this point so that when the lifting grate is open the finger bars retain positions parallel to each other and to the grates in the remainder of the section, but change their angular position relative to the lifting frame itself. Either with the lifting frame open or closed there is no interference with the shaking of the grates in the entire section.

The lifting grate is designed to swing through an angle of over 30 degrees and provides a vertical opening between the grate and the raised fingers of about 18 inches with a considerably larger horizontal opening under the lifting frame.

The operation of the Hulson finger grates, with their freedom from slicing action on the fire, tends to reduce the amount of clinkers to be removed at terminals and the design of the fingers is such that the grates dump much more freely when the bars are moved to the full extent of the shaking movement than is possible with the usual type of finger grates. Should heavy clinkers accumulate, however, the lifting section provides a means of clearing the grate with the least possible amount of effort. After all ash and clinker which will pass through the grates have been removed by shaking, the surface of the lifting section is cleared with a hoe, the material being drawn back towards the center of the firebox. The lifting section raised and all material still on the grates is pushed forward and dropped into the ash pan. The ledges at the bottom of the recesses in the grate frames are chamfered for practically their entire length, three short lugs being left to support the lifting frames when in the closed position. Any accumulation of clinker or ash on the ledges is thus prevented and the lifting grate will always freely drop back into place.

The lifting grate is operated from the cab, its normal position being closed, and a lock is provided to hold the operating lever in the open position when the lifting grates are raised. The possibility of the dump grate opening while the locomotive is in operation is thus entirely eliminated.

The usual location of the dump grate is at the front end of the firebox and the Hulson lifting section is designed for location at that point. Should lack of clearance under the arch in locomotives with shallow fireboxes interfere with this location, it may be placed at the rear of the firebox, in which case it swings up from the rear end, under the door.

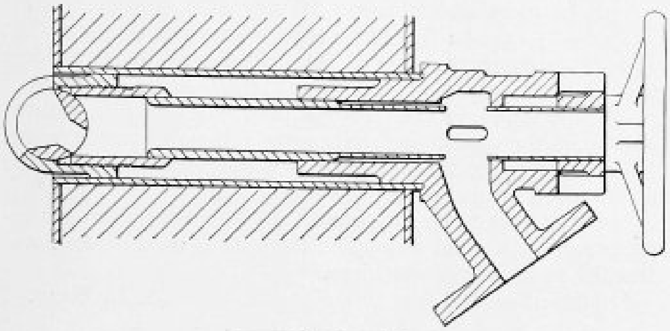
The device is simple and requires no expensive parts. The only special parts are the two cast steel lifting side frames, the square wrought iron shaft and the cast steel lifting arm. The only machine work required is the turning of journals.

Hulson Locomotive Grate With Lifting Grate Open

## Device for Cleaning Boiler Tubes

A soot blower produced by Hamilton & Hansell, Inc., New York City, has been designed for coal and oil burning Scotch boilers and other fire tube boilers, either marine or stationary, to meet the requirements of an automatic cleaner that would eliminate the hand method of cleaning both the rear plates and tubes.

The construction of this apparatus is shown in the accompanying illustration. It cleans the tubes from soot by means



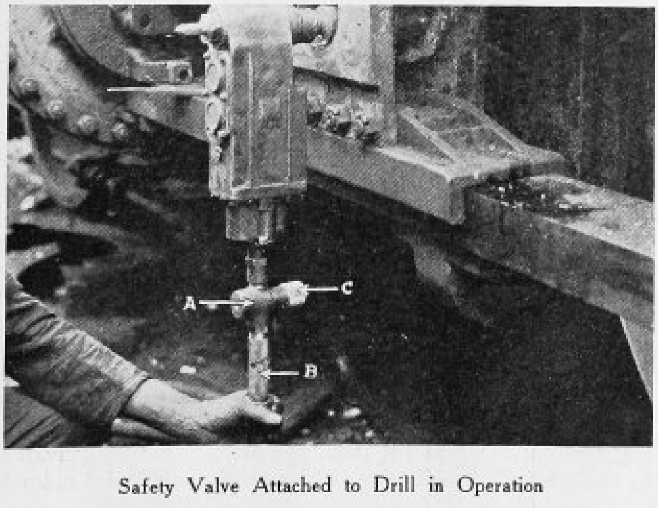
Steam Jet Soot Blower

of a steam jet of great force that does not strike the tube field in any one point, but over an extended line. By turning a single movable part of this apparatus, it is possible to cover the entire tube field in one revolution. By a simple adjustment of the ball-shaped nozzle, the apparatus can be made to suit any type of fire tube boiler. The various sizes required for boilers are obtained by the variation of the length of a single section of pipe, while other parts are unaltered.

## Safety Valves for Pneumatic Riveting Machines

A pneumatic safety valve has been adapted to the rotary drilling machine after several years of experimenting, for the purposes of decreasing accidents to machine operators, for increasing production and reducing the injury and breakage of cutting tools. The Pneumatic Safety Valve Manufacturing Company, Woonsocket, R. I., has recently sent out a description of the valves which it produces.

The pneumatic safety valve is made in one size only for numbers 1, 2, 3 and 4 non-reversible rotary machines, and its use does not require any change from present equipment. It may be attached directly to the machine in place of the customary air control handle. The air hose is then attached to a specially constructed handle which is furnished with each valve and the machine is then operated in the usual way. The air pressure is 85 to 95 pounds at the nozzle. When in




Safety Valve Attached to Drill in Operation

use, a cap nut shown in the accompanying illustration must be turned down to tighten the spring tension on the valve until the air passes freely to the machine without the valve closing. Now if the cutting tool jams or is set back by reason of abnormal resistance, a back pressure is created within the valve chamber, which closes the valve, shutting off the air, thus preventing the throw of the machine before it has caused any injury to the operator or to itself. Once the valve is closed it cannot open again until the operator closes the air control handle, which releases the valve to its normal position and opens the air line to resume work. If the air pressure is greatly increased or decreased, the valve spring tension must be adjusted to suit the new conditions.

## BUSINESS NOTES

A. S. Harvey has been appointed general sales manager of the United States Graphite Company. His new headquarters will be at Saginaw, Mich.

W. B. Currier, Jr., has been appointed general manager of the Cleveland Planer Company and the Cleveland Machine Tool Company, Cleveland, Ohio. Mr. Currier replaces D. B. Clark, who is no longer connected with either concern.

The Blaw-Knox Company (Blawnox), Pittsburgh, Pa., has established a new sales district in the South, with headquarters at Birmingham, Ala. Prescott V. Kelly, formerly connected with the executive sales department at Pittsburgh, is in charge of this office, which is located in the American Trust building.

The Graver Corporation, East Chicago, Ind., manufacturers of steel tanks and general plate construction, oil refinery equipment, water softening and purifying equipment, announces the opening of branch offices in the following cities: New York, at 280 Broadway; Pittsburgh, Pa., 62 Conestoga building.

The Monarch Soot Remover Company, Inc., of Troy, N. Y., having closed its Troy factory, has established a new machine shop and brass foundry in Wollaston, Mass., and has incorporated under the laws of Massachusetts. Bradford L. Ames, of Boston, is the president, and Leonard W. Newell, treasurer of the Wollaston Foundry Company, is the treasurer.

The Metal & Thermit Corporation, New York, has opened a branch office at 141 Milk street, Boston. Inquiries addressed there will have the personal attention of the New England district manager, Robert L. Browne. Orders, however, should continue to be addressed to the general office of this company at 120 Broadway, New York.

The Bourne-Fuller Company, Cleveland, successor to the Upson Nut Company, announces that all sales of its products in the eastern territory will henceforth be handled by its eastern sales office, Whitehall building, 17 Battery Place, New York, under the supervision of A. Schoonmaker, eastern sales manager. This territory includes New England, eastern New York, New Jersey, eastern Pennsylvania, Delaware, Maryland and eastern Virginia.

Fairbanks, Morse & Company, Chicago, has bought the entire business consisting of all stock on hand, good-will and liabilities of the Luster Machine Shop & Railway Equipment Company, 917 Arch street, Philadelphia, Pa. Fairbanks-Morse has opened a new branch at this address under the management of D. W. Dunn, and will sell its complete line of engines, motors, pumps, etc. The entire personnel of the Luster Machinery Company has been retained. E. J. Luster, former president, will be manager of the machine tool division of the Fairbanks-Morse Philadelphia branch.

# Letters from Practical Boiler Makers

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

## Competency

Initiative added to efficiency spells competency. The competent individual is not usual, and as a consequence attracts attention. This may not always be favorable, as he is usually a disturbing factor if only by comparison. For this reason the competent is rarely popular, although he is instinctively trusted.

Most men are competent up to a point and may be trusted to act within strictly defined limits. It is one qualification of an executive chief that he can successfully assign limits in a given case beyond which it is impractical to allow the individual to use his own judgment.

Trade skill means just this knowledge of limitation applied to practice. It is usual when a mechanic steps over the border line of his craft that he finds almost as many difficulties as the unskilled. Experience is therefore another consideration when we attempt to define specific competency.

Some men are natural competents as others are equally the reverse; the difference is one of native understanding. Competency in a specialized sense may even lead to forfeiture of understanding in other directions. Training to a single end is only accomplished at the expense of adaptability—of flexibility. Like over-trained muscles in a single direction which hamper rather than help in a new direction, specific training renders us of less effect outside the limitations we have imposed upon ourselves.

Yet here and there happens a man whom the ordinary and usual human limitation does not affect. Such a man is super-competent, having specialized adaptability in several directions. The average and normal man must be content to be reasonably competent in a single direction. Provided the limitations are narrow enough, a very ordinary man trained to a single end becomes competent within that scope.

Today the field of effort is so immense and the opportunity of experience is restricted to more or less single ends, that competency in any general sense is virtually impossible.

For this reason the world's work—or, for that matter, the work of a single concern—is carried through by sectionalized labor. Yet there must be co-ordination, supervision, continuity. To secure this is rarely the work of a single brain; most usually the direction consists of several individuals meeting at intervals to resolve difficulties and act as the representatives of the shareholders. In the multitude of counsellors, there may be wisdom, and the modern world is unwilling to centralize either responsibility or execution in a single pair of hands.

Such being, in fact, the case, the chain mail of business being a series of single links sufficient unto themselves, competency is evident in the narrow limits imposed. Since no one link is capable of repairing the default of its neighbor, the reliability of each must be real.

A prominent writer pointed out that, although the legal tradition in this country (England) goes back eight centuries and is based upon statutes at least 2,000 years old, so that when the question of guilt or innocence for serious offences is raised it is not a lawyer who settles the matter. It is a dozen ordinary individuals, untrained legally, who are impanelled and who have to agree.

It is the vindication of common sense as against the causuity of specialization. The lawyer is a competent exponent of his narrow field—the law. The judge imposes the penalty, but it is the ordinary citizen who decides.

The same idea of consultation and agreement runs throughout all business, and wherever the specialist is in evidence it is necessary that he should be able to convince the outsiders. It is often considered one of the tragedies of the technician that he has to explain to the uninitiated holding the reins of power, but unless he can do so his case must be weak, granted always on the part of authority some rational common sense. To be able to do this by no means easy feat is one of the attributes of competency.

It is not easy to be competent. It involves continuous readjustment of mental viewpoint, the appreciation of the novel and the scrapping of old ideas.

London, England. A. L. Haas.

## Efficiency of Boiler Patches

On page 309 of the October issue of The Boiler Maker a letter entitled "Methods Used in Computing Boiler Patches," by J. Weldon Melroy, was given in which he criticized the writer's article entitled "Diagonal and Horse-Shoe Patches," which appeared in the July issue. After carefully reading this letter it would seem that the writer failed to analyze the article or he has a very meager knowledge of boiler construction. In answer to his criticisms, the following is offered.

In the first paragraph of my article it is stated, "While the following method of computation does not cover all refinements, it forms a good basis and gives a close approximation to the working conditions and that the methods in question are not governed by inspection laws." Therefore, it is well to remember that the American Society of Mechanical Engineers' Boiler Code is not the authority in states not governed by special boiler laws. Furthermore, by careful examination of some state laws, it is found that a minimum shearing strength of steel rivets used is 42,000 pounds in single shear, except when the boiler is to be constructed to the A. S. M. E. standard, and as the methods outlined are for non-code boilers, it would be unreasonable to force code regulations, unless it were agreeable to all parties concerned.

The different shearing strengths for rivets as given were an oversight. However, one who is interested enough in the article to criticize, should have checked the efficiency as given by the formulas, and by so doing would have found in each case that 42,000 pounds was used. This also applies to the data given on page 193. Furthermore, those familiar with good shop practice would never consider the use of different shearing strength rivets in the same boiler.

Mr. Melroy seems to think it would have been well to specify the grade of steel that should be used in the repair work. However, if he is familiar with the different state laws—for example, the California law—he will find that firebox steel must be used in repairing California standard boilers, and firebox or flange steel may be used in non-code boilers of a tensile strength not less than 55,000. Therefore it is obvious that patch seams give little or no trouble under this rule. He should also remember that, regardless of the brand of boiler steel, 55,000 pounds tensile strength is the lowest generally accepted.

There is a generally accepted statement that the force tending to rupture a cylinder girthwise is one-half as great as that tending to rupture it longitudinally. This is equivalent to stating that the effective efficiency of a girthwise seam is twice as great as that of a longitudinal seam. Now the force acting on a unit of length on a diagonal seam is the component of the girthwise and longitudinal stresses. In the three types of seams with the plate, size and pitch of rivets the same, the efficiency of the seams will be identical, but the internal pressures they will withstand will depend on the directions of the seam with reference to the axis of the cylinder. Therefore it has greater efficiency by reason of its position.

In the method of determining the efficiency of the patch seams, two formulas are given, one showing the simplified method and the other the trigonometrical. However, it was not inferred that the trigonometrical formula was to be considered, except to find the ratio of a straight to a diagonal seam by those who questioned its holding power, and with a little study it will be found that the simplified form takes into consideration the latter formula approximately; therefore, it is needless to add the percent as found by the last formula. By careful study of the opinions and formulas of other writers it will be found in a number of instances each angle is taken into consideration. However, the formula given in the article gives about the same results without applying the use of constants, degrees of angles, etc.

At the top of page 194 in the first paragraph there is a statement the efficiency of the seam patch or its power to resist the major or circumferential stresses by reason of its diagonal position is found by the formula, which Mr. Melroy states I apparently intended to say.

Next to the last paragraph of his letter he states that the efficiency would be 73.5 by adding 57 and 26.5 percent. This is an error, for the total should be 83.5 percent.

Dallas, Tex. R. J. FURR.

## Ludlum Watertube Boilers

(*Continued from page* 353.)

volume of approximately 500 feet and a heating surface of 5,000 square feet, and a weight of 85,000 pounds complete. The boiler was built for a working pressure of 350 pounds per square inch and tested to 550 pounds hydrostatic pressure. The steam drum is 48 inches by 12 feet, with a tube sheet 1 13/16 inches thick. The water drums are 30 inches by 12 feet, with tube sheets 1 13/16 inches thick. Longitudinal seams on all drums are of the double butt strap, double riveted type.

The tubes are all cold drawn seamless steel number 10 gage, having an outside diameter of 1⅝ inches. The boiler casing is of number 10 gage steel plate backed with asbestos mill board and 2 inches of high tempered special insulating material. The combustion chamber has a 9-inch firebrick lining, backed with the same insulating material as above. The bottom of the furnace is shaped on the arc of a circle to allow for the proper expansion of the brick lining. The unit is equipped with cleaning openings for each bank of tubes and also with Ludlum automatic soot blowers operated by chain pulls.

This boiler was shipped by barge completely assembled, and on its arrival at the naval station it was simply necessary to set it on its foundation and connect up the piping and smoke stack.

### OUTPUT OF PLANT

Since it commenced operation, the shop has turned out, together with the production of mining machinery and dredges, 36 boilers for the National Shipbuilding Company, of Orange, Tex., to be installed in Shipping Board vessels. These boilers have a heating surface of 2,500 square feet each and a working pressure of 250 pounds per square inch.

Two boilers for the steamship *Cape Cod,* having a heating surface of 2,250 square feet and a working pressure of 225 pounds per square inch.

Four boilers for the *Newburgh,* each having a heating surface of 1,250 square feet and a working pressure of 125 pounds per square inch.

Two boilers for the *Alderman,* owned by the Brooks Steamship Company, New York, having a heating surface of 2,500 square feet and a working pressure of 225 pounds per square inch.

Two boilers for the *Argenta,* also owned by the Brooks Steamship Company and of the same type.

A number of boilers for freighters and tankers of the National Oil Company, having 2,500 square feet heating surface, to operate at 225 pounds pressure.

A 5,000 square foot heating surface naval boiler for the experimental station at Annapolis, as described above.

At present the shop is chiefly engaged in building a battery of twelve boilers for the battleship *North Carolina,* now under construction. These boilers have 6,200 square feet of heating surface and 1,000 square feet superheating surface—a total effective heating surface of 7,200 square feet. They are equipped with Dyson superheaters, arranged to give 100 degrees superheat at a pressure of 275 pounds. Certain Navy modifications such as a double casing and numerous cleaning doors have been followed on these boilers according to Steam Engineering Department specifications. It is an interesting fact to note that the *North Carolina* is the first battleship to be equipped with three drum type watertube boilers.

### WELFARE WORK OF ORGANIZATION

A club known as the Nyeco was formed by the 125 men employed at the plant a short time after work was commenced. This club was organized on the principle that justice in its fullest sense should govern all of its dealings and that the members would "endeavor to earnestly co-operate with the management to make all the economy possible in material, time and energy, and thereby raise the efficiency to the highest level in order to secure the benefits that are justly due." The constitution further states that the members are opposed to Bolshevism and to any other form of radicalism which aims to obstruct progress or affect the plant in any way.

A feature of the club is the complaint committee, which has worked successfully on numerous occasions when the decision of the management was questioned by certain of the men. In every case the opinion of the officers of the company was borne out and their decision carried into effect by the committee. The duty of the workmen's committee is to hear any specific complaints or disputes between employees and the foremen of departments. All matters must first be taken up by the employee with the foreman of his department and every attempt made between the two to settle the point in question, but should this prove impossible, the employee is allowed to present the matter to the committee for consideration and settlement. If it is necessary for the committee to confer with the management regarding the point in question, this is immediately done, so that the matter will receive prompt attention and settlement. In case the committee does not agree with the general manager or superintendent, the right always exists of appealing to the president of the company.

A sick benefit is maintained by the men of the organization, for which purpose each man is assessed a small amount each month. An amount equal to the total raised in the shop is subscribed by the company.

Co-operation between all departments in the organization has at all times been excellent, and production has not been held up for any reason in the two years that the plant has been in operation.

### SYSTEM OF BONUS PAYMENTS

The problem of reaching a standard basis for the payment of a bonus in boiler production at the plant was difficult, since few of the boilers being built at one time were duplicates. Work could not be directly compared from month to month on complete jobs, so individual operations such as the number of tube sheets laid out, the number of tubes bent, the number of feet of calking finished and the like were taken as standard units. All improvements in production measured by these units were returned in the form of special percentages to the men at the end of earh monthly period.

This basis was not entirely satisfactory, however, so the final form which the bonus system assumed was the payment of percentages on a total six months' production basis. All profits from the increased efficiency in the shop as indicated by the semi-annual reports were divided equally between the men and the company.

## A Handy Chart for Finding Volumes of Tanks

The accompanying chart will be found useful by anybody for determining the volume of a cylindrical tank without doing any figuring. All you have to do is, lay a straight edge across the chart from known point to known point and the problem is solved.

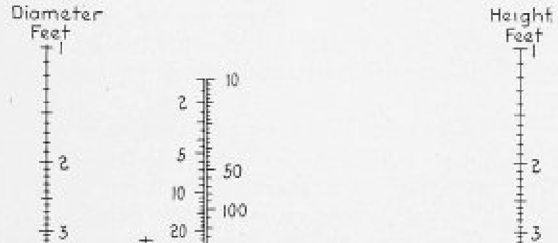



Chart giving volumes of cylindrical tanks

The best way to explain the chart is to give an example. How many gallons will a tank hold whose diameter is 10 feet and whose height is 20 feet?

Connect the 10 in column "A" with the 20 in column "D" and the answer found in column "C" is about 11,700 gallons, which is very close. The same act of laying a straight edge across the chart tells us immediately that the volume of the tank is practically 1,550 cubic feet (see column "B"). The exact answer is 1,570 cubic feet, which shows that the chart is indeed reasonably accurate, i. e., within 1.3 percent, although admittedly not absolutely accurate. Most graphical charts of this type possess a certain degree of inaccuracy, but they are useful because of their simplicity.

This chart may also be used "backwards"; for example, if you want to build a tank or buy a tank to hold a certain number of gallons or a certain number of cubic feet, find that "certain number" on the chart and swing your straight edge around it until you find the most economical or most desired height and diameter. A little practice will make the readings quite reliable.

New York. W. F. SCHAPHORST, M. E.

## PERSONALS

C. E. Bingham has been appointed supervisor of mechanical examinations of the Michigan Central, with headquarters at Detroit, Mich.

Ralph T. Bratt has left Olney & Warrin, Inc., and is now employed in the industrial department of the Locomotive Superheater Company, New York.

Arthur G. Spurlock, for the past four years treasurer of the American Refractories Company, has been appointed treasurer of the H. H. Robertson Company, Pittsburgh.

D. W. Frazer, formerly general manager of the Montreal Locomotive Works, Ltd., is now located in New York City. Mr. Frazer is vice-president of the American Locomotive Company.

G. Schirmer has resigned as sales engineer in the Detroit office of the Whiting Foundry Equipment Company, Whiting, Ill., and is now associated with W. C. Bennett, industrial engineer, Chicago.

C. W. Angerman, for six years chief draftsman for the Griscom-Russel Company, Massillon, Ohio, has entered the employ of the Lucius Manufacturing Company, Canton, Ohio, as chief mechanical engineer.

C. F. Meyer, assistant secretary of the Landis Machine Company, Waynesboro, Pa., will leave shortly for an extended trip to the Orient in the interests of the company. Mr. Meyer will visit England, India, the Dutch East Indies, Australia, Philippine Islands, China, Japan and Hawaii.

L. R. Fedler has been appointed district manager for the Keller Pneumatic Tool Company in the Milwaukee district, with offices at 915 Majestic building, Milwaukee. For the past twelve years Mr. Fedler has been associated with the sales organization of the Chicago Pneumatic Tool Company in the Milwaukee territory.

C. W. Adams, general foreman of locomotives on the Michigan Central, with headquarters at St. Thomas, Ont., has been promoted to superintendent of shops, with jurisdiction over the locomotive department, and with headquarters at Jackson, Mich., succeeding W. C. Bell, who has been transferred to Bay City, Mich.

John A. Talty, assistant superintendent of equipment and equipment inspector for the New York Public Service Commission, Second District, has taken a position as special engineer with the Franklin Railway Supply Company, New York. Mr. Talty began railway work in 1883 as freight brakeman on the Erie Railroad. He consecutively served as foreman and locomotive engineman on that road and then as air brake instructor on the Westinghouse air brake instruction car on the Erie. Later he took a similar position with the Scranton Correspondence School. From 1900 to 1910 he served as road foreman of engines on the Delaware, Lackawanna & Western. In the latter year he joined the force of the Public Service Commission as assistant supervisor of equipment and equipment inspector, inspecting locomotives and cars and investigating accidents, and he now leaves that position to go to the Franklin Railway Supply Company.

## TRADE PUBLICATIONS

VENTILATING EQUIPMENT.—The Batterman & Truitt Company, Chicago, has recently issued a revised catalogue of ventilating equipment including fans driven by pulley and direct current or alternating current motors.

ELECTRIC CRANES AND HOISTS.—A descriptive catalogue of electric cranes and hoists and of a horizontal boring mill has recently been issued by the Milwaukee Electric Crane Manufacturing Company, Milwaukee, Wis. Illustrations showing the cranes under construction and in operation make this an interesting catalogue.

WELDING AND CUTTING APPARATUS.—A complete line of gas welding and cutting apparatus manufactured by the Bastian-Blessing Company, Chicago, is described in a catalogue recently issued by this company. Ten complete sets of apparatus are fully described and illustrated, each one containing complete equipment for carrying out particular classes of work. In addition, specifications for the individual items manufactured by the company are given in detail.

GRAB BUCKETS.—Two small folders describing the various types of grab buckets manufactured by the Blaw-Knox Company, Pittsburgh, have recently been issued. One of these pamphlets gives full details and specifications of the "bull dog" bucket designed for especially heavy service. Photographs and illustrations showing the use of the buckets and diagrams and tables, dimensions and other structural details of the various sizes are given. The second pamphlet discusses the principles of lever arms as applied to the design of Blaw buckets.

MACHINES FOR MEN.—In a recently issued catalogue the Brown Portable Conveying Machinery Company, Chicago, suggests some of the means that might be taken to increase production by the substitution of machines for men. The cost of handling goods is particularly open at this time to vast improvements, and any device that can save or conserve labor in this direction deserves consideration. The application of various machines manufactured by the company are described and illustrated in detail, as well as the brief descriptions of each machine.

CRANE COMMENTS.—The latest issue of the periodical bulletin of the Industrial Works, Bay City, Mich., gives some very interesting examples of the application of industrial locomotive cranes to salvage work and other material handling and structural work.

THERMIT MILL AND FOUNDRY PRACTICE.—The uses of the thermit welding process as applied to repair work in mill and foundry practice are described in a catalogue issued by the Metal & Thermit Corporation, New York. In this book descriptions are given of repairs to broken belt rolls, crank shafts, shears, locomotive frames, replacement of broken pinion teeth and the like. This is the third edition of the Thermit Mill and Foundry pamphlet and brings up to date the instructions explained in the last edition and covers several classes of repairs not previously described.

MAKING PANEL BOARD HISTORY.—Benjamin-Starrett standardized panel boards are described in a pamphlet issued by the Benjamin Electric & Manufacturing Company, Chicago. This panel is built up of unit sections made to certain fixed standards. Parts are interchangeable and carried in stock in quantities. Practically any type of panel board or cabinet can be made up from the standardized fixtures.

STANDARD RADIUS LATHE AND PLANER TOOL.—Lathe planer and shaper tools arranged for taking either concave or convex cuts are described in a pamphlet of the R. G. Smith Tool & Manufacturing Company, Newark, N. J. Illustrations of the various types and sizes of cutters are given, together with the price lists for the complete sets and individual tools.

## ASSOCIATIONS

### Boiler Makers' Supply Men's Association

President—Frank J. O'Brien, Globe Seamless Steel Tubes Company, Milwaukee, Wis.

Vice-President—William B. Wilson, Flannery Bolt Company, Pittsburgh, Pa.

Secretary—George B. Boyce, A. M. Castle & Company, 91 Connecticut street, Seattle, Wash.

Treasurer—Stephen H. Sullivan, Ewald Iron Company, Chicago, Ill.

### International Brotherhood of Boiler Makers, Iron Ship Builders and Helpers of America

Louis Weyand, Acting International President, suite 315 Wyandotte building, Kansas City, Kans.

Frank Reinemeyer, International Secretary-Treasurer, suite 315 Wyandotte building, Kansas City, Kans.

James B. Casey, Editor-Manager of Journal, suite 312-314 Wyandotte building, Kansas City, Kans.

William Atkinson, Acting Assistant President, suite 315 Wyandotte building, Kansas City, Kans.

International Vice-Presidents—Joe Reed, 1123 East Madison street, Portland, Ore.; Thomas Nolan, 700 Court street, Portsmouth, Va.; Joseph Flynn, 111 South Park avenue, Little Rock, Ark.; M. A. Maher, 2114 Eighteenth street, Portsmouth, Ohio; E. J. Sheehan, 7826 South Shore Drive, Chicago, Ill.; John J. Dowd, 953 Avenue C, Bayonne, N. J.; R. C. McCutcheon, suite 15, La Salle Block, Winnipeg, Man., Can.; Joseph P. Ryan, 7533 Vernon avenue, Chicago, Ill.; John F. Schmitt, 1489 North Fourth street, Columbus, Ohio.

### American Boiler Manufacturers' Association

President—A. D. Schofield, J. S. Schofield's Sons Company, Macon, Ga.

Vice-President—G. S. Barnum, The Bigelow Company, New Haven, Conn.

Secretary and Treasurer—H. N. Covell, Lidgerwood Manufacturing Company, Brooklyn, N. Y.

Executive Committee—W. C. Connelly, The Connelly Boiler Company, Cleveland; C. V. Kellogg, The Kewanee Boiler Company, Chicago, Ill.; F. C. Burton, The Erie City Iron Works, Erie, Pa.; F. G. Cox, Edge Moor Iron Company, Edge Moor, Del.; W. A. Drake, The Brownell Company, Dayton, Ohio; W. J. Mohr, John Mohr & Sons Company, Chicago, Ill.; E. C. Fisher, The Wickes Boiler Company, Saginaw, Mich.; W. S. Cameron, Frost Manufacturing Company, Galesburg, Mich.; E. R. Fish, Heine Safety Boiler Company, St. Louis, Mo.

### Master Boiler Makers' Association

President—Charles P. Patrick, Mgr., Chicago, Wilson Welding Repair Company, Chicago, Ill.

First Vice-President—Thomas Lewis, general B. I., L. V. System, Sayre, Pa.

Second Vice-President—T. P. Madden, general B. I., M. P. R. R., 6947 Clayton Avenue, St. Louis, Mo.

Third Vice-President—E. W. Young, general B. I., C. M. & St. P. R. R., 81 Caledonia Pl., Dubuque, Iowa.

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## Selected Boiler Patents

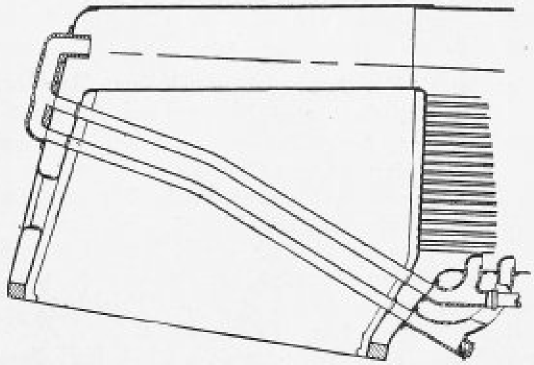
Compiled by

GEORGE A. HUTCHINSON, ESQ., Patent Attorney, Washington Loan and Trust Building, Washington, D. C.

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

1,303,953. CIRCULATION AND FEED DEVICE FOR LOCOMOTIVES. LE GRAND PARISH, OF NEW YORK, N. Y.

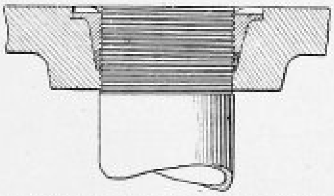
*Claim* 1. The combination with a locomotive boiler having a firebox, water spaces, and a normal circulation tube of substantially uniform



flow capacity throughout, extending through the firebox rearwardly and upwardly, and connecting water spaces to establish normal circulation of water therebetween, of means for utilizing said tube as a heater of feed water, comprising a feed water delivery member communicating with the tube at the forward end thereof without restricting the same, whereby feed water may be injected into said tube. One claim.

1,304,414. BOILER TUBE CONNECTION. WILLIAM F. TRIPLETT, OF GRAND JUNCTION, COLORADO.

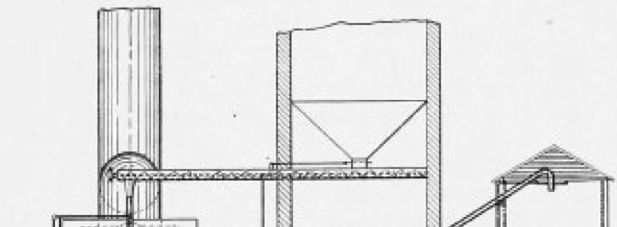
*Claim*.—A boiler tube connection comprising in combination a flue sheet provided with an opening surrounded by an inwardly extending integral flange, the inner portion of said opening being cylindrical and



threaded, the intermediate portion of said opening being frusto-conical and of greater diameter than said cylindrical portion, the outer portion of said opening being countersunk, a boiler tube having its end threaded through said cylindrical portion, and having its extremity extending to the outer surface of said flue sheet, a gasket of relatively soft material surrounding the threaded end of said tube and disposed within the smaller end of said frusto-conical portion of the opening, an internally threaded thimble engaged upon the threaded end of the tube and having a frusto-conical outer periphery conformingly engaging within said frusto-conical portion of the opening, and an outwardly extending annular flange on said thimble seating within the countersunk portion of said opening. One claim.

1,333,104. FURNACE. WILLIAM E. EWING, OF HOUSTON, TEXAS.

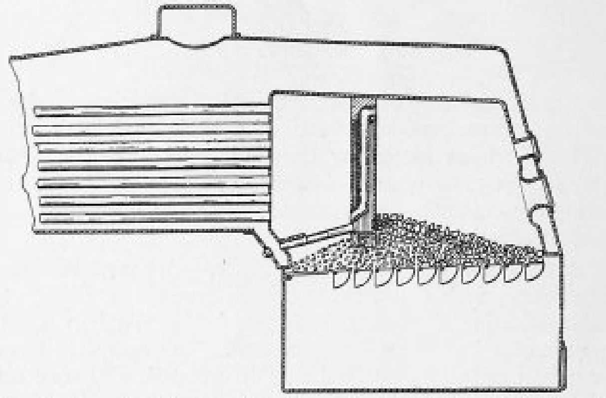
*Claim* 1.—A furnace for boilers having a combustion chamber in the rear end thereof, formed with inclined walls which converge down



wardly a discharge pipe underneath said chamber, and communicating therewith, and provided to receive the ashes therefrom, an air pipe entering the front of the furnace and formed into a coil underneath the chamber, a fuel down spout entering said air pipe through which fuel may be delivered to said furnace, means for delivering fuel to said down spout, and means for generating a fluid current through said air pipe whereby the fuel is discharged into the furnace. Four claims.

1,306,180. FURNACE. OTTO H. HERTEL, OF GLENELLYN, ILLINOIS, ASSIGNOR TO CONSUMERS COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

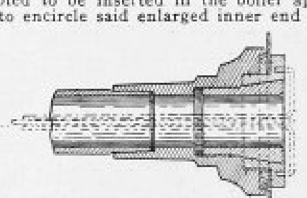
*Claim* 1.—The combination with a furnace having a combustion chamber, a boiler and water legs connected therewith forming the side walls of said combustion chamber, of a hollow arch connected at its sides with



said water legs for the flow of water and extending from the top of said combustion chamber downwardly to the normal fuel level, said arch dividing said combustion chamber into a front coking zone and a rear combustion zone, pipes extending across the combustion zone and connecting the lower end of said arch with said boiler for the flow of water, said arch having passageways there through for the flow of gases and carbon from the coking zone to the combustion zone, and baffle plates supported on said pipes for causing thorough mixture of the heated gases of said combustion zone with the gases and carbon emerging from said passageways. One claim.

1,334,072. BOILER CONNECTION. ORVILLE F. BENNETT, OF HAVERHILL, MASS.

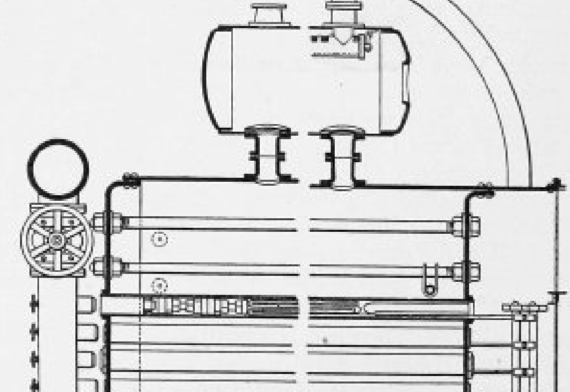
*Claim* 1.—A boiler connection comprising a nipple having an enlarged inner portion, adapted to be inserted in the boiler aperture, an axially split ring adapted to encircle said enlarged inner end portion within the



sides of said aperture and having a flanged end adapted to engage the inner surface of the boiler, and a coupling sleeve adapted to be threaded on the outer end of the nipple and to seat at its inner end against the outer surface of the boiler. Five claims.

1,335,974. STEAM SUPERHEATERS. PERCY ST. GEORGE KIRKE, OF WESTMINSTER, LONDON, ENGLAND.

*Claim* 1.—A boiler heating and superheating system comprising a boiler, a passage for hot gases within said boiler, said passage having a



refractory heating chamber for higher temperatures in communication with a steam superheating chamber, also forming part of said passage, a superheating means within said superheating chamber, and a second refractory chamber within said passage for lower temperatures and in communication with said superheating chamber. Two claims.