INDEX TO

The Boiler Maker

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THE BOILER MAKER

JANUARY, 1913

Large Boilers for New Baldwin Locomotives

The Baldwin Locomotive Works, Philadelphia, Pa., has recently completed twenty-five large Mallet articulated compound locomotives for the Great Northern Railway, and also four Pacific and eight Mikado type locomotives for the New Orleans, Mobile & Chicago Railroad. The latter boilers, Figs. 1 and 2, are chiefly of interest in that they are used interchangeably on locomotives having both the 4-6-2 and 2-8-2 wheel arrangements, since all of these boilers are alike in construction and dimensions and the boiler accessories, such as throttles, superheaters and steam pipes, are interchangeable.

The boiler shell has a straight top and the superheater is of the Schmidt type. Attention may be called to the dome, Fig. 4, which is formed on a hydraulic press from a single piece of flange steel. This style of dome is being extensively used by the Baldwin Locomotive Works. The safety valves and whistle are mounted on an auxiliary dome, which is located back of the main dome and is placed over a 15¼-inch opening in the boiler shell. This permits ready access to the boiler for inspection purposes without disturbing the throttle valve and rigging.

The longitudinal seams are all placed on the center line and, in accordance with the usual practice at the Baldwin Locomotive Works, are welded at the ends. Designed for a working pressure of 185 pounds per square inch, the boilers have a minimum diameter of 66 inches. The firebox is 66 inches by 102 inches. There are 24 tubes 5⅜ inches diameter and 175 tubes 2 inches diameter, all with a length of 19 feet 3 inches. The total heating surface of the firebox is 162 square feet, of the tubes 2,403 square feet, making a total of 2,565 square feet. There is a superheating surface of 550 square feet and a grate area of 46.8 square feet. The total weight of the Pacific engines is 197,800 pounds and of the Mikado type 196,100 pounds.

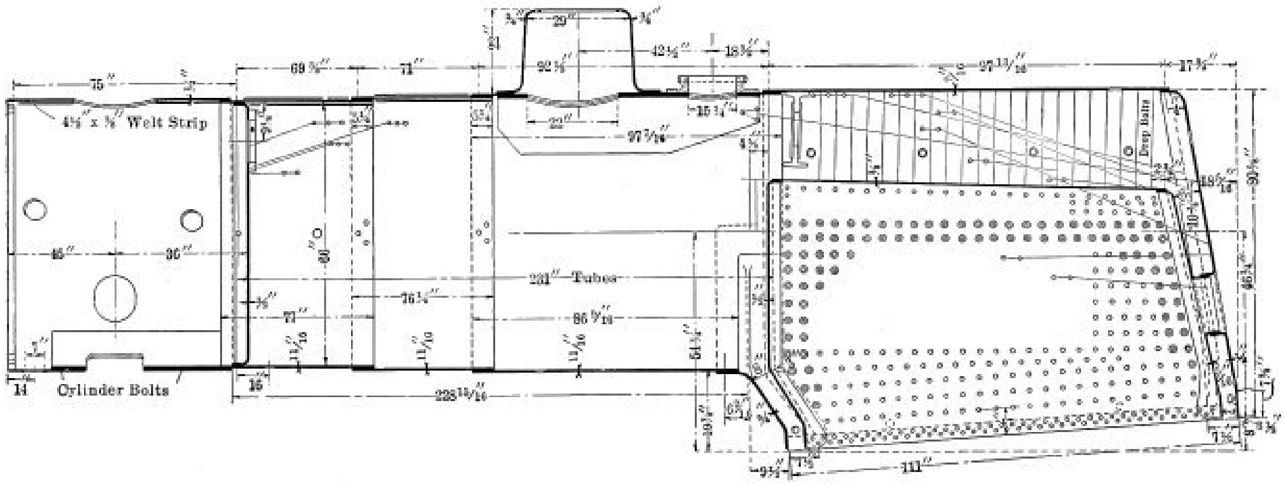

FIG. 1.—BOILER FOR THE NEW LOCOMOTIVES OF THE NEW ORLEANS, MOBILE & CHICAGO RAILROAD

The boilers of the Great Northern Mallet locomotives, Figs. 3, 5 and 6, are of the Belpaire type with tubes 24 feet long. Seventeen of these boilers burn coal and eight are oil burners. The firebox has a combustion chamber 58 inches long and the crown sheets of the firebox and combustion chamber are in one piece with the sheet above the chamber stayed with Tate flexible bolts. The back head of the boiler above the crown is stayed by ten gusset plates, and these in turn are braced by longitudinal stay rods which are riveted to the boiler shell. Especial attention has been given to providing water spaces of ample width around the firebox and combustion chamber. The flat sides of the outside shell above the crown are braced by two rows of transverse stays. Those in the upper row are screwed into the sheets. The lower stays are pinned to T-irons and have jaws which are forged solid with the rods.

The boiler has a conical barrel, the front ring is 90 inches in diameter, which is increased to 102 inches at the dome. The dome is 33 inches in diameter and 10½ inches in height. The safety valve and whistle are mounted on a casting 26 inches in diameter, let into the boiler shell in order to keep the height within the necessary limits.

The superheaters used in these boilers are of the Emerson type with separate castings for the saturated and superheated steam headers. The headings are vertical and bolted together in pairs. There are twenty-one elements for each steam pipe, and each group of pipes may be removed independently of the other groups. The superheated pipes have ball-jointed connections with the headers. The pipes conveying the superheated steam to the high-pressure cylinders are cross connected by an equalizer, so that either cylinder may draw on both superheater sections for its steam supply.

The oil-burning equipment with which eight of these boilers are fitted is arranged in accordance with the Baldwin

Company's usual practice. The burner is placed in the front end of the firebox. Draft may be admitted immediately beneath it, and also through a chamber which is placed under

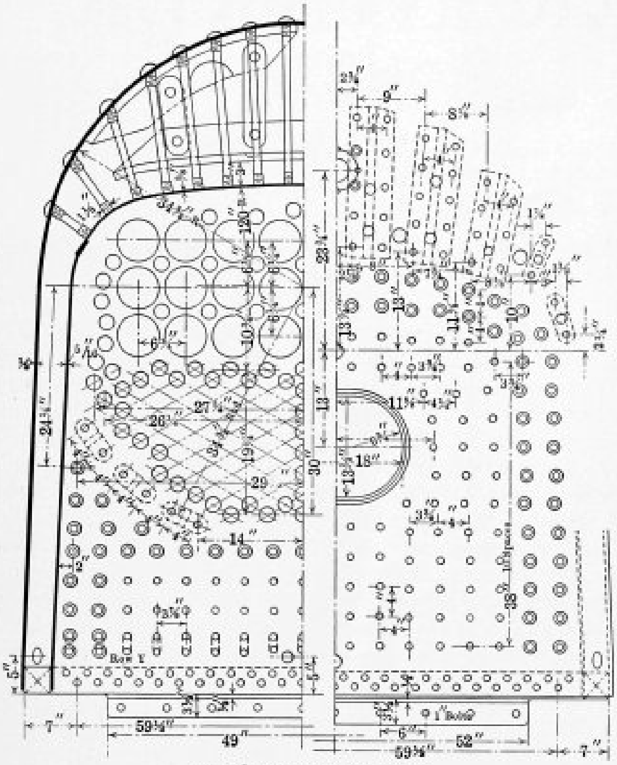

FIG. 2.—FIREBOX SECTIONS

the fire pan at the back. The oil, before it reaches the burner, passes through a heater consisting of a long piece of steam-jacketed pipe. The usual brick arch in the firebox is replaced by a firebrick wall across the throat of the combustion chamber. The ash pan is built in the form of two deep hoppers with swing bottoms.

The boilers have a grate area of 78.4 square feet, a total heating surface of 6,446 square feet and a superheating surface of 1,368 square feet. Of the total heating surface, 6,120 square feet is supplied by the tubes, 245 by the firebox and 81 by the combustion chamber. The boilers are designed for a working pressure of 210 pounds per square inch. The first course of the boiler barrel is 90 inches diameter, the dome course 102 inches diameter, and the thickness of plates 15/16 inch and 1 inch. The thickness of the side, back and crown sheets of the firebox is ⅜ inch and the thickness of the back sheet of the firebox is ⅝ inch. The firebox is 9 feet 9¼ inches long inside and 8 feet ¼ inch wide. There are 42 tubes 5½

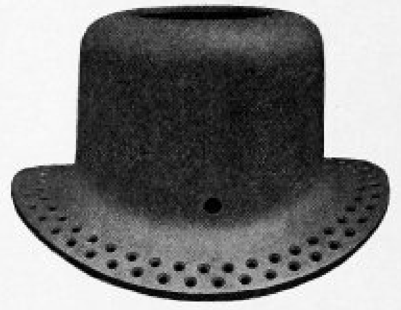

FIG. 4.—PRESSED STEEL DOME

inches diameter and 332 tubes 2¼ inches diameter with a length of 24 feet. The total weight of the locomotive is 200.9 tons.

Causes of Notable Boiler Explosions

Probably the most disastrous explosion which ever occurred was that of a horizontal tubular boiler in a large shoe factory at Brockton, Mass., on the morning of March 20, 1905. One part of the building became a mass of ruins, which took fire, and 60 of the 400 persons employed in the factory were either immediately killed or buried alive, and over 100 were more or less seriously injured.

Investigation revealed that the boiler burst as a result of a defect known as a lap-joint fracture. This is one which extends along the longitudinal seams of lap-jointed boilers, and is due to imperfect rolling of the plates when curving them. Sometimes the last few inches at each end slipped off the rolls and did not become bent to the true form. Then they had to be forced to the desired radius, which was often done with sledge hammers, the plate being placed over a "set."

Such obviously severe treatment seriously stressed the plate, and as, in addition, the true form was not obtained even after treatment, the subsequent riveting of the ends together tended to set up fracture. Some ignorant or reckless boiler maker would drill or even punch the holes prior to bending, and, under such circumstances, it is no wonder fracture developed. Unfortunately, the lap-joint fracture usually occurs on the inside of the overlapping plates, where it cannot be detected, and hence may develop while working until the boiler is weakened to the bursting point.

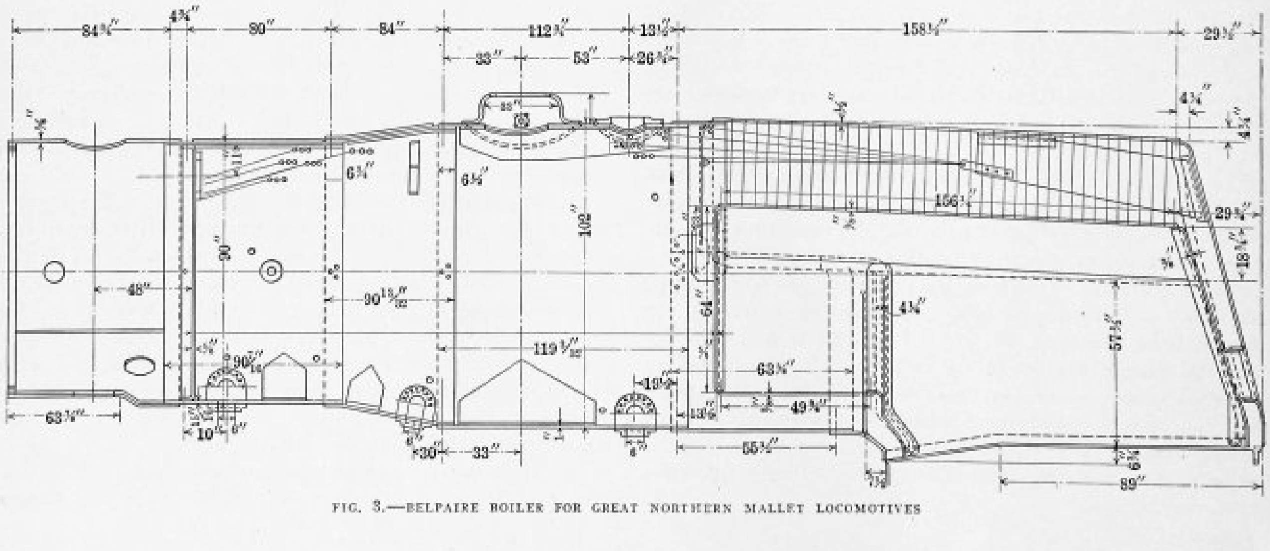

FIG. 3.—BELPAIRE BOILER FOR GREAT NORTHERN MALLET LOCOMOTIVES

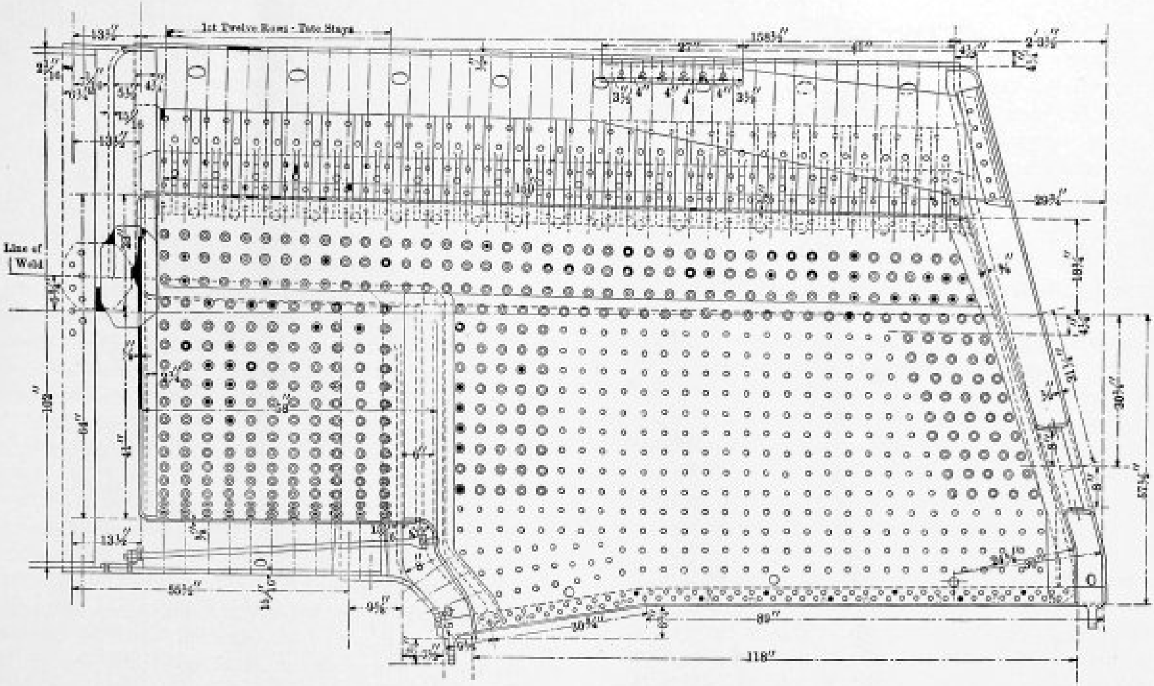

FIG. 5.—LONGITUDINAL SECTION OF FIREBOX

The boiler which failed at Brockton was periodically examined by an insurance company, and at the last inspection no defects were found, so that the boiler was apparently safe for the stipulated working pressure. This explosion did much toward doing away with the lap joint, and in the present best practice only butt joints are used for the longitudinal seams. With such joints the true cylindrical form of the shell is retained and any tendency to straining, either in constructing or working, is avoided. Where lap joints are still used, rolls are employed which are capable of rolling the plates clear to their ends.

Another disastrous explosion was that which occurred on board

H. M. S. Thunderer

in 1876, when 45 were killed and 33 seriously injured. This accident was due to the safety valves becoming inoperative, through faults in workmanship, such that when the wings expanded with the heat they became jammed. Probably this explosion would have been averted, if the boiler pressure gage had had a stop pin at the high-pressure end of the dial. At the time important steam trials were being conducted, and in the excitement and bustle it escaped notice that the pressure-gage pointer went completely around the gage and on past the zero mark again, so that it registered an apparently low-pressure, when the pressure had reached the bursting point.

An account of a terrible boiler explosion appeared in the *Vulcan* (the monthly organ of the Vulcan Boiler & General Insurance Co., of Manchester, England) for August, 1905. It stated that one of the boilers on board the

U. S. Gunboat Bennington

which was lying in the harbor of San Diego, Cal., burst and was immediately followed by the explosion of the powder magazine. All on board were either killed outright or horribly maimed, the dead and missing amounting to 60 and the injured to 75. According to this report, one of the port boilers had become defective and been recently repaired, and was supposed to have failed first, causing the others to fail and igniting the powder magazine.

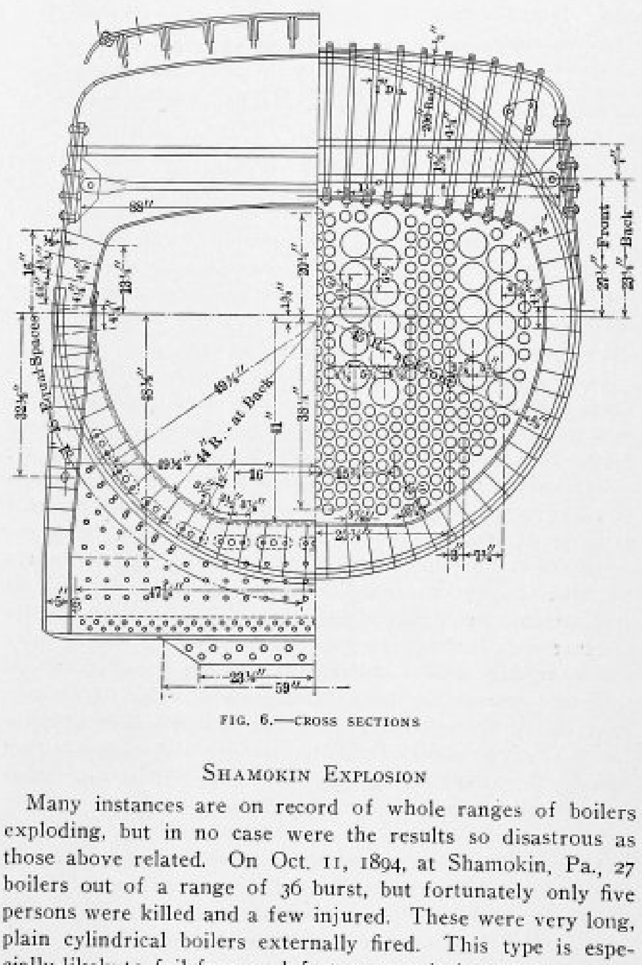

FIG. 6.—CROSS SECTIONS

Shamokin Explosion

Many instances are on record of whole ranges of boilers exploding, but in no case were the results so disastrous as those above related. On Oct. 11, 1894, at Shamokin, Pa., 27 boilers out of a range of 36 burst, but fortunately only five persons were killed and a few injured. These were very long, plain cylindrical boilers externally fired. This type is especially likely to fail from a defect commonly known as a seam rip. Being externally fired, the bottom of the shell is directly exposed to the intense heat of the furnace gases, while the top remains comparatively cool. The bottom consequently expands much more than the top, excessively straining the circumferential seams, which gives rise to fractures or seam rips extending for various distances round the seams. Fortunately, seam rips usually occur when the boilers are being cooled down for cleaning or inspecting, but occasionally they occur without warning when the boilers are at work, and not uncommonly the fracture extends completely around the shell; then unless the boilers are well stayed longitudinally, a violent explosion results.

EXPLOSION AT REDCAR, ENGLAND

On June 14, 1895, a similar explosion occurred at Redcar, in Yorkshire, England, when 11 out of 15 boilers exploded, killing 12 persons, and injuring 9 others. These boilers were nearly 70 feet long, and the company which insured them had reported quite a number of seam rips and advised cutting the boilers into two parts and lashing the ends together by longitudinal stays to minimize the risk of failure. Unfortunately, the advice was not acted upon. The danger of these long, externally fired boilers has been long recognized, and happily this type is now fast becoming obsolete.

ANOTHER MULTIPLE BOILER EXPLOSION

occurred at Friedenhutte, Germany, in July, 1887, when a whole range of 22 boilers gave way, killing 12 people and injuring 35 more. These boilers were of the ordinary elephant type, fired by blast-furnace gas. It is supposed that an explosive mixture of blast-furnace gas and air collected in the flues and became ignited and that the shock from this explosion caused the boiler to let go.

A WATERTUBE BOILER EXPLOSION

Watertube boilers are commonly supposed to be immune from serious explosion, but this is fallacious. In December, 1907, at St. Louis, a whole range of seven such boilers exploded, six of them being blown to pieces, while the remaining one had a large number of tubes blown out. Eight people were killed and 21 seriously injured. According to *Locomotive*, one of the tubes of the first boiler burst, but whether as a result of scale, overheating, or other defect it is not known. This tube bursting, probably tore out the others, until the whole boiler was blown to pieces, which doubtless led to the explosion of the next boiler, and so on.

At present boiler explosions are less frequent than before the advent of the various boiler-insurance and inspection agencies, and the more vigilant inspecting of boilers, both during construction and working. Really disastrous explosions are comparatively rare, and such as do occur are usually from carelessness and neglect, or even recklessness, as was the case with the explosion at York, Pa., August 10, 1908. This explosion, a full account of which was given in *Power*, August 25, 1908, was due to sheer recklessness. The boiler was an old one, the plates were badly wasted and cracked, neither pressure nor water gage was attached, and the safety valve was practically useless, having been known to blow off but once in eighteen years. A boiler worked under such conditions should be expected to explode. Steam boilers now are rarely worked without suitable fittings, and generally are periodically examined by experts, so that defects are discovered and corrected before they become serious.

Every year knowledge of both the construction and working of steam boilers becomes more and more thorough, and with the exercise of care and skill on the part of those operating the plant, together with periodical and vigilant inspection by experts, boiler explosion should soon become almost a thing of the past.

A little book entitled "The Distington Multiple Boiler Explosion and Other Multiple Boiler Explosions," recently published by the chief engineer of the National Boiler & General Insurance Co., Manchester, England, gives a full account of an investigation into the cause of the explosion of four boilers at a large iron works, together with an account of seventeen other multiple explosions. Those interested in the subject will find it well worth reading.—*Power*.

Patching a Boiler

The following is an account of a breakdown that occurred under trying conditions when I was chief engineer of a Greek steamer. I took on a contract to take the steamship *Spiridon* from Cardiff to Constantinople, the vessel having been purchased by a Greek company from a South Wales company. Two days after I signed the contract we had to put to sea without my being able to thoroughly examine the multitubular boiler, which had been out of commission for three years. We left Cardiff on the morning of October 14 and experienced terrific seas in the Bay of Biscay. My assistant and I were kept imprisoned for three days, and had our food lowered down the after ventilator by the cook, whose galley was within reaching distance.

After having been awake for the most part of the time I lay down on a locker exhausted, and then slumbered, only to be awakened in a few minutes by a terrific report, which seemed to shiver the ship from stem to stern. The two firemen rushed up the ladder, and had to be brought below again by divers threats. My assistant, when he could find me in the midst of a scalding, seething steam, shouted that he thought the circumferential seam had "started" on the bottom of the boiler.

It did not take long to find out that something more serious than a seam had gone, for the water in the gage glass was dropping very rapidly. I ordered the fires to be drawn out—there was nothing else for it. We tried to keep the boiler full with the pumps, but that was useless.

As soon as the boiler emptied (it took seventeen minutes only) I crawled under the boiler and found near the circumferential seam at the front end a hole about 1 inch by 1½ inches and for a radius of about 2 inches the plate was very thin.

We looked around the engine room and found two pieces of plate ½-inch thick, 3 inches by 2½ inches. One piece we heated and "stepped" to fit into the joint of the seam on the inside, and the other simply curved to the sweep of the shell on the outside. Through the centers of these plates we drilled 1-inch holes. Two joints of asbestos cloth were cut and a 1-inch bolt passed through the plate on the inside and through the boiler shell and the outside plate, leaving the nut on the outside to facilitate screwing up tightly. To make doubly sure, we made some cement and covered up the inside plate about ½-inch thick and allowed it to set.

From the time the engines stopped to starting up again occupied exactly fourteen and one-half hours, and there were only three of us doing the work. Eight days after this we arrived in Turkey, having carried a full head of steam (135 pounds gage.) F. CHRISTIANSEN.

New York.

MASTER BOILER MAKERS' ASSOCIATION.—It is well known that the Master Boiler Makers' Association is an earnest advocate of self-improvement for its members. It has always been one of the main objects of the association to inculcate by precept, example and its work in the minds of its members the value of co-operation and helpfulness to each other. The Society is committed to the enlightenment of those engaged in the craft, so that they may become better qualified for advancement and higher responsibilities. In order to increase the usefulness of the association along these lines an earnest appeal has been issued to the boiler manufacturers and railroad officials to use their influence and co-operate in every way to secure the enrollment of all their foremen boiler makers in the membership of the organization. This appeal should be received with hearty approval.

Tests of Old Boilers*

BY ALEX M. GOW†

On June 6 and 7, 1911, three horizontal tubular boilers, designated as Nos. 301, 302 and 303, were tested to destruction with hydraulic pressure at Ishpeming, Mich. The boilers were owned by the Oliver Iron Mining Company, and had been in operation for about thirty years at No. 1 Hard Ore Boiler House, Lake Superior Mines. The boilers had been condemned on account of their age by the Hartford Steam Boiler Inspection & Insurance Company as an unsafe risk, although they showed no signs of deterioration from their thirty years' service—there being no evidence of pitting or corrosion.

Inasmuch as it will probably be necessary to maintain a boiler plant for the next twenty years at the location where these boilers have been, it was decided to install new boilers and test the old ones to destruction to determine whether they were unfit for service, and whether any deterioration of any kind had taken place which was not in evidence from an external and internal inspection.

The three boilers were identical in construction with the exception that boiler 302 contained 112 3-inch tubes, while boilers 301 and 303 each contained 83 4-inch tubes. Each boiler consists of five courses of ⅜-inch sheets, double lap-riveted with ¾-inch rivets, spaced on 2-inch centers.

Pressure was obtained from a hand pump capable of producing a pressure of 300 pounds, and, in addition, the pump of a hydraulic wheel-press was connected to the waterline for additional pressure as required.

To determine the expansion of the shell, a steel tape was passed around the boiler, and the movement of the tape was observed to determine the increase in circumference of the shell. Attempts were also made to determine the diametrical expansion with a micrometer gage set against the side of the boiler, but the observations on this gage were not satisfactory. The measurements upon the steel tape, however, were fairly accurate.

BOILER NO. 302

This boiler was built about 1877 by Kendall & Roberts, of Boston. The sheets bore the brand "Bay State Homo." The accompanying log of the test, made June 6, 1911, gives in detail the behavior of the boiler under the successive pressures to which it was subjected.

At 275 pounds pressure the cast iron manhole frame broke in two with a loud report, and the sheets were ruptured. At the time of the rupture the steel tape showed that the circumference of the boiler had elongated approximately 3/16 inch.

TABLE 1.—LOG OF TEST, BOILER NO. 302

Time.	Pressure Pounds Per Square In.	Observations.
10:12		
10:14	60	
10:15	93	
10:18	100	
10:18½	125	1/16-inch elongation in circumference.
10:20	140	
10:20½	170	
10:21	180	Seams weeping slightly.
10:21¼	195	
10:22	200	5/32-inch elgonation in circumference.
10:22½	210	
10:24¾	220	
10:25	230	3/16-inch elongation in circumference.
10:25½	240	All longitudinal seams leaking.
10:27½	250	
10:28	260	
10:28½	275	Manhole frame broken.

After the rupture the tape resumed its initial position, indicating that at 275 pounds pressure the shell had taken no permanent set. While there had been some leaking of longitudinal seams there was no evidence of serious distress at any part of the boiler. The heads showed no sign of bulging and the tube ends remained tight.

Test pieces cut from the shell immediately over the fire showed an average tensile strength of 60,460 pounds, with 22.5 percent elongation, 53.7 percent reduction in area and an elastic limit of 36,690 pounds. The analysis of this sheet showed: Carbon, 0.13; sulphur, 0.026; phosphorus, 0.097; manganese, 0.27. The test pieces were cut both transversely and longitudinally of the sheet, but it was impossible to tell from the way the test pieces broke in which way the sheet had been rolled. It is very evident that there had been no deterioration of the steel in this sheet. Test pieces were also taken from a sheet at the top of the boiler, where it was not subjected to the action of the fire. These test pieces gave an average of 70,145 pounds tensile strength, with an elongation of 20.12 percent, an elastic limit of 39,060 pounds and a reduction of area of 47.05 percent.

In addition to the test pieces cut from the sheets as mentioned, a section was taken out of the longitudinal seam. Upon being pulled in the testing machine the joint gave an efficiency of 60 percent of the plate, breaking through the rivet holes. This seam showed no evidence whatever of deterioration, and was as good as the day it was laid up. Subjected to cold bending tests the test pieces from the sheets above the fire bent to 180 degrees, flat, without fracture.

BOILER NO. 303

Boiler No. 303 was built about 1879 by Kendall & Roberts, of Boston. The sheets bore the inscription "Nashua Iron & Steel Company, Nashua, N. H.," and an encircled Indian head, and were stamped "cast steel, 60,000 pounds." Inasmuch as this boiler was identical in construction with boiler No. 302, which had developed its weak point in the manhole frame, and as it was desired to put a greater pressure on the boiler than the manhole could stand, it was decided to remove the frame and put on a ⅝-inch patch, secured by patch bolts, in place of the cast iron frame.

On the morning of June 7, pressure was applied to the boiler in the same manner as to boiler No. 302 the day before. The log shown in Table 2 gives the observations in detail:

At 300 pounds pressure the patch and one plug began leaking so badly that the pumps could not gain, and it was necessary to reduce the pressure and calk the leaks. At 10:45 the pressure was again applied, and upon obtaining 300 pounds there was noticeable distress on one head, with leaking of tubes and springing of the beading. The steel tape indicated that the boiler was increasing in diameter. The leaks were such that the two pumps were not able to gain over 300 pounds pressure, and at this pressure thirteen of the patch bolts sheared. The manhole sheet expanded approximately ½ inch with no rupture. It being impossible to replace the patch, and the head having shown evident distress no further attempt was made to burst the longitudinal seams. The steel tape showed that the boiler had expanded about 1/16 inch, and it did not resume its normal diameter.

Test pieces cut from the sheet immediately over the fire showed a tensile strength of 60,186 pounds; elastic limit, 38,280 pounds; elongation, 21.5 percent, with 54.52 percent reduction of area. Analysis of the steel gave: Carbon, 0.17;

* From *Power*.
† Assistant chief engineer, Oliver Iron Mining Company, Duluth, Minn.

TABLE 2.—LOG OF TEST, BOILER NO. 303.

Time.	Pressure Pounds per Square In.	Observation.
10:00	15	
10:01¼	20	
10:01½	30	
10:03	90	
10:03¼	110	1/16-inch elongation in circumference.
10:05	150	
10:05¼	160	Seams begin to weep.
10:06	170	
10:06½	180	3/32-inch elongation in circumference.
10:07½	220	
10:08	225	⅛-inch elongation in circumference.
10:08½	240	One girth seam leaking.
10:09½	250	5/32-inch elongation in circumference.
10:11	270	
10:11½	275	3/16-inch elongation in circumference.
10:12½	280	
10:13	285	7/32-inch elongation in circumference; tubes beginning to leak.
10:15	295	
10:16½	297	Could obtain no more pressure by hand pump; pressure let down and hydraulic pump cut in. Boiler resumed its normal diameter; no permanent set.
10:25	175	
10:26	195	1/16-inch elongation in circumference.
10:27¼	255	
10:28¼	275	
10:28¾	295	
10:29	300	7/32-inch elongation in circumference.
10:30	300	Seams leaking badly and some leaking at the ends. Stopped pumping to calk one patch bolt and tighten one plug.
10:34	...	Pressure let down.
10:45	...	Started pumps again.
10:46	125	
10:46¼	145	Stopped pump to roll one tube.
10:53	145	
10:55	160	1/32-inch increase in circumference.
10:55¼	180	
10:55¾	210	1/16-inch increase in circumference.
10:56	230	
10:56½	250	3/32-inch increase in circumference.
10:56¾	270	
10:57	...	⅛-inch increase in circumference.
10:57¼	285	
10:57½	295	Tubes leaking. Head shows signs of distress.
10:58	300	Beading on tubes is sprung.
10:59½	295	7/32-inch increase in circumference.
11:00	300	13 patch bolts sheared.

sulphur, 0.023; phosphorus, 0.097; manganese, 0.29. Test pieces cut from the sheet at the top of the boiler showed a tensile strength of 56,400 pounds; elastic limit of 37,230 pounds, and an elongation of 27.25 percent, with 64.88 percent reduction of area. Analysis of this steel showed: Carbon, 0.25; sulphur, 0.021; phosphorus, 0.092; manganese, 0.37.

BOILER NO. 301

Boiler No. 301 was identical in construction with boiler No. 303. It was purchased at the same time and the sheets bore the same brand. It was tested in the same manner, and the log of the tests in Table 3 shows the observations:

At 260 pounds pressure the manhole casting broke in identically the same manner as that upon boiler No. 302, first tested. The steel tape, however, showed that the boiler had taken a permanent set of ⅛-inch elongation in the circumference, probably due to slight movement of the longitudinal seams, which showed signs of distress.

Test pieces taken from a sheet immediately over the fire showed a tensile strength of 60,780 pounds; elastic limit, 33,100 pounds; elongation, 26.5 percent; reduction of area, 61.62 percent. Analysis as follows: Carbon, 0.13; sulphur, 0.022; phosphorus, 0.105; manganese, 0.20. Test pieces taken from the top of the shell, not subjected to the fire, showed a tensile strength of 61,680 pounds; elastic limit of 38,820 pounds; elongation, 19.75 percent, and a reduction in area of 50.80 percent. Analysis as follows: Carbon, 0.18; sulphur, 0.022; phosphorus, 0.085; manganese, 0.28.

TABLE 3.—LOG OF TEST, BOILER NO. 301, JUNE 7, 1911.

Time.	Pressure Pounds Per Square In.	Observation.
10:15	...	Pump started.
10:15½	55	
10:17	85	
10:17½	100	
10:18½	150	1/32-inch increase in circumference.
10:20	155	
10:20½	180	Seams weeping.
10:21	205	Flues leaking a little.
10:21½	225	
10:22	235	Leaking at manhole.
10:22½	250	3/32-inch increase in circumference.
10:23½	255	
10:24	260	Manhole broke; ⅛-inch increase in circumference.

The tests for tensile strength and the chemical analyses were made at the works of the Illinois Steel Company, South Chicago, through the courtesy of P. E. Carhart, inspecting engineer. Twelve test pieces were measured with a micrometer, and showed a maximum thickness of sheet of 0.380 inch; minimum thickness, 0.364 inch; average, 0.373 inch. This variation in thickness is no greater than would be expected in nominal ⅜-inch boiler plate, and showed that there had been no appreciable reduction of thickness by reason of corrosion on the surface of the plates.

The boilers had been originally built to carry 100 pounds pressure, but inasmuch as, allowing the longitudinal seams an efficiency of 60 percent of the plate, this would give a safety factor of but 3.75, the working pressure had been fixed at 80 pounds, giving a safety factor of 4.70. It is evident that the weak point of each boiler was the cast iron manhole ring. Boiler No. 301 broke at this point at a pressure of 260 pounds. With the pressure of 80 pounds the safety factor at this point was, therefore, but 3.25.

Had this cast iron manhole ring broken in service it is not probable that an explosion would have resulted. The rupture in boiler No. 302 occurred when the manhole ring broke at a pressure of 275 pounds. When the manhole ring on boiler No. 301 broke in identically the same manner, at a pressure of 260 pounds, the sheet was not ruptured. Furthermore, when the patch bolts sheared at a pressure of 300 pounds on boiler No. 303, the sheet was not ruptured. It is fair, then, to assume that had a manhole ring let go in service at a pressure of from 80 to 100 pounds, no rupture of the sheet or explosion of the boiler would have followed. But upon this point there is room for a difference of opinion.

SUMMARY

It is evident from the above tests that there had been no deterioration in the quality of the material, and it was such as would pass to-day for good boiler plate. The one sheet from the top of boiler No. 302, that had a tensile strength of 70,000 pounds, showed slight cracks under the cold-bending test to 180 degrees, flat. The fracture in every case was good, and no one of the test pieces showed the slightest indication of lamination or lack of homogeneity.

All in all, the boilers were as good as the day they were made; the material was excellent, the workmanship was admirable and subject to only one criticism—the rivet holes had not been reamed. With this exception the workmanship could not be improved upon. In no way, shape or form had the boilers deteriorated by the thirty years' service to which they had been subjected; the water furnished had been of uniformly good quality; they had received excellent care and attention. At times they had been fired very hard, sometimes with wood, sometimes with coal, at other times with a mixture of wood and coal.

It is interesting to note in this connection that the Bay State Iron Works, which made the steel for boiler No. 302, had, according to a list of rolling mills and steel works published in 1882, one 6-gross-ton Siemens open-hearth steel furnace, with an annual capacity of 2,800 net tons of ingots. The Nashua Iron & Steel Company, Nashua, N. H., had one 10-gross-ton Siemens open-hearth steel furnace. These furnaces must have been among the earliest Siemens open-hearth furnaces built in the United States, and these boilers among the very early ones built from such material.

Locomotive Boiler Inspector's Report*

After the appointment by the President of the chief inspector and the two assistant chief inspectors of locomotive boilers, a conference was held in Washington, D. C., for the purpose of forming an organization to properly enforce the provisions of the locomotive boiler inspection law. Owing to the fact that the effective date of the law was July 1, 1911, it was essential to use the utmost diligence in effecting an organization which could properly supervise the inspection and testing of approximately 63,000 locomotives which were subject to the law.

Section 4 of the act provided that the territory comprising the several States and Territories and the District of Columbia, be divided into 50 locomotive boiler inspection districts, so arranged that the service of the inspectors would be most effective, and so that the work required of each inspector would be substantially the same.

In making this division of territory it was necessary to consider, in addition to the number of locomotives in each district, the density of traffic, the number and location of inspection and repair points, the facilities for making repairs, the amount of travel necessary to properly cover the district, and the most advantageous location for the office of the inspector.

A map is given in the report which indicates the present arrangement of the districts, which is practically identical with the original arrangement, no material revision having become necessary. A copy of this map, together with a tentative circular governing the qualifications and eligibility of applicants, was immediately furnished the Civil Service Commission to enable it to make proper announcement of an examination to secure eligibles from which certification might be made to fill the positions of district inspectors of locomotive boilers. During the interim a list of questions to be propounded to applicants with respect to construction, repair, operation, testing and inspection of locomotive boilers was prepared, which list, after having been approved by the Inter-State Commerce Commission, was also furnished the Civil Service Commission to be used as part of its examination.

In preparing this list of questions and determining the proper preliminary qualifications for applicants, the expressed purpose of Congress in passing the law, namely, "to promote safety," was constantly borne in mind. A careful examination of the accident records which were available disclosed the fact that a large percentage of personal injuries were attributable to failures of locomotive boiler appurtenances or fittings as well as the boiler proper. As a consequence all applicants who, by reason of their experience, were familiar with the construction, operation, testing and inspection of locomotive boilers and their appurtenances were made eligible to take the examination, provided their experience in railroad service had been recent enough to insure their being familiar with modern equipment and conditions. As a result the inspectors who were appointed through the examination conducted under the auspices of the Civil Service Commission came from the several branches of locomotive service. They are all skilled in various branches of mechanics necessary for the proper inspection, maintenance and operation of locomotives, as well as being particularly qualified to investigate accidents resulting from failure from any cause of a locomotive boiler or its appurtenances.

Section 5 of the law required each carrier subject to its provisions to file its rules and instructions for the inspection of locomotive boilers with the chief inspector within three months after the approval of the act. It further provided that in the event any carrier failed to do so, it then became the duty of the chief inspector to prepare such rules and instructions, which, after approval by the Inter-State Commerce Commission, would become obligatory upon such carriers. In order that the carriers might be fully cognizant of the requirements respecting the submission of these rules, a letter directing attention to Section 5 of the law was addressed to all the carriers subject thereto. Notwithstanding this notice only 170 out of an approximate 2,200 carriers complied therewith. A careful comparison of these rules disclosed the fact that they were practically all either copies of rules which had been promulgated by the Master Mechanics' Association or were substantially the same. The desire of the carriers for a uniform set of rules governing the inspection and testing of locomotive boilers and their appurtenances therefore became apparent. With this end in view a standard code of rules governing the inspection and testing of locomotive boilers and their appurtenances was prepared. They were then discussed at a series of conferences with a committee representing practically all of the railroads affected by the law and a committee representing the interested employees. As a result certain tentative rules and instructions were decided upon. After the submission of these rules and instructions to the Inter-State Commerce Commission for its approval, there came on a hearing, after due notice, on the 29th day of May, 1911. All the parties appearing at such hearing were fully heard in respect to the matter involved, and the proposed rules and instructions having been fully considered by the Commission, it was ordered that they become effective on July 1, 1911, and shall be observed by each and every carrier subject to the provisions of the locomotive boiler inspection law as minimum requirements.

Among the more important requirements of the rules are the following: The filing of specification cards for all locomotive boilers subject to the act, which shall give their description and general design, and the inspection and testing of all boilers at regular and proper intervals.

The specification card is required to be filed in the office of the chief inspector, and embodies in connection with the general design of the boiler the principal dimensions, material and thickness of the boiler sheets, description and measurement of seams, the tensile strength of the various parts as shown by tests to which the material was originally subjected, the result of the calculations of the stresses to which the principal parts are subjected and from which the factor of safety and the proper working pressure can be computed.

From the data thus obtained it is possible at all times to determine the strength of any boiler in service and to fix the safe working pressure. The information thus collected forms a permanent record, and as new locomotives are constructed, or the specifications for locomotives which are on file are altered in any manner, proper check and notation is made thereof.

The calculations given on these specifications are being carefully checked, and those which contain errors are returned to the railroad company for correction before being filed. The importance of this checking is demonstrated by the fact that serious errors have been found in about 6,000 specification cards out of a total of 34,000 filed.

By the terms of the Commission's order of June 2, 1911, the railroads were given until July 1, 1912, to file specification cards for locomotives for which accurate drawings were available, and until July 1, 1913, to file specification cards for locomotives for which accurate drawings were not available.

Section 6 of the law provides "That each carrier subject to the act shall file with the inspector in charge under the oath

* First annual report of the chief inspector of locomotive boilers to the Inter-State Commerce Commission.

of the proper officer or employee a duplicate of the report of each inspection required by such rules and regulations, and shall also file with such inspector under the oath of the proper officer or employee a report showing the repair of the defects disclosed by the inspection." In accordance with this provision the rules require inspections of various parts of the boiler to be made at certain prescribed intervals, and reports properly certified to be filed with the district inspector. In order to reduce to a minimum the number of reports required a combination report showing the defects disclosed by the inspection and the repairs made was adopted. These reports show the date the safety valves were set and the pressure; the date on which steam gages have been tested; that the boiler has been washed and gage cocks and water-glass cocks properly cleaned and repaired; that injectors were tested and left in good condition, all steam leaks repaired; the condition of flues, fire-box sheets, stay-bolts and crown stays; the number of stay-bolts and crown stays renewed, and the date of the previous hydrostatic test. These reports, together with the information which the inspectors obtain during their regular inspections, enable them to keep in close touch with the general condition of equipment and have repairs made when necessary.

A copy of this report or a special quarterly card showing that inspections had been made in accordance with the rules, and that the locomotive is in a safe and proper condition to operate must be displayed in the cab of the locomotive.

Before being put into service and at least once every twelve months thereafter, every boiler must be subjected to hydrostatic pressure 25 percent above the working steam pressure, thoroughly inspected, and a special report of the defects found and repairs made must be filed with the district inspectors.

In addition to the above-mentioned requirements special tests and inspections of all boiler appurtenances are required, and it is made the duty of the railroad company to know that all locomotives are in a safe and proper condition to operate before they allow them to be used. This places the burden of the inspection and the responsibility for the condition of all locomotives on the carriers, which was the manifest intent of the law.

The tabulated statement of inspections contained in this report gives a complete list of locomotives inspected and defects found on each railroad, but is not a complete record of the work performed by the district inspectors during the year.

While many railroads had reasonably efficient rules governing the inspection of locomotive boilers and their appurtenances before the law was passed they were not uniformly complied with. In many cases the date of inspection was governed by traffic conditions rather than by the condition of the locomotive, resulting during periods of heavy traffic in locomotives being kept in service long after they were due for inspection and in need of repairs. For this reason much of the time of the inspectors has been consumed in checking the work performed by the railroad company's inspectors and their records of repairs in accordance with Section 6 of the law, which provides that "The first duty of the district inspectors shall be to see that the carriers make inspections in accordance with rules established or approved by the Inter-State Commerce Commission, and that carriers repair the defects which such inspection discloses before the boiler or boilers or appurtenances pertaining thereto are again put in service."

The reports of inspections which the law requires the carriers to file with the proper district inspector each month are also a source of valuable information relative to the general condition of locomotives.

When making regular inspections of equipment district inspectors are instructed to report all defects which exist. This practice has been objected to in numerous instances by representatives of the railroads, on the ground that certain defects which had been reported did not constitute violations of the law. These objections were given consideration, but investigation usually disclosed the fact that they originated at points where defective conditions existed, and were due to a desire on the part of local officials to avoid censure for permitting such conditions. While the work of the district inspectors might be materially reduced by not reporting defects until they became violations, as some railroads seem to desire, and then take action as provided in Section 9 of the law, the present practice of reporting and insisting on the prompt repair of all defects before they become serious has been so productive of good results that it will be vigorously continued, as we believe the purpose of the law can be best served by endeavoring to prevent violations rather than by waiting until violations occur and then filing suits to enforce the penalty. However, this should not be construed as meaning that suits will not be filed if necessary to enforce the provisions of the law or the lawful orders of any district inspector.

The investigation of accidents as provided by Section 8 of the law has occupied a great deal of the time of the district inspectors, and is one of the most important of their duties. Two hundred and fifty-five accidents have been investigated during the year, and in each case the necessary action has been taken to avoid, if possible, a recurrence of similar accidents.

In the more serious accidents the investigation has been conducted, wherever possible, by the chief or one of the assistant chief inspectors. The data obtained from the specification cards and from the monthly and annual reports are always available for use in making accident investigations, and when additional information can be obtained by so doing tests are made of the boiler material to ascertain whether it conforms to the required standard.

Inasmuch as it is of the utmost importance that all accident investigations be conducted promptly, the headquarters of one of the assistant chief inspectors were established at Denver, Col., where he could keep in close touch with this work in the Western territory and have all investigations conducted without unnecessary delay to equipment. This has also resulted in materially reducing the traveling expenses necessary to the proper supervision of the work in that territory.

Locating the offices of the district inspectors in Federal buildings wherever proper space could be obtained has also resulted in a substantial reduction in expenses, thirty-five of the district offices now being so located. One inspector is located in the office of the chief inspector at Washington, and two in the office of the assistant chief inspector at Denver. It has therefore been necessary to rent office space at only eight points, as in several instances it has been practicable to have two district inspectors occupy the same office.

The summary of the tabulated statements contained herein discloses the following:

Number of locomotives inspected	74,234
Number defective	48,768
Number ordered out of service for repairs	3,377

In addition to this the following locomotives were required to be strengthened or changed to comply with the requirements of the law or permanently removed from service:

Number having pressure reduced to insure a proper factor of safety	699
Number having seams reinforced by welt plates to insure a proper factor of safety	327
Number permanently removed from service on account of defective condition	698
Number having the lowest reading of water-glass ordered raised to comply with the law	992

Number having lowest gage cock ordered raised to comply with the law.............................. 408
Number ordered strengthened by having braces of greater sectional area applied..................... 351
Number requiring additional support for crown sheet.. 116

It will thus be seen that a total of 6,968 locomotives were either held out of service for repairs or changed and strengthened to conform to the requirements of the law or permanently removed from service.

This work has been accomplished without the necessity of resorting to the courts in a single instance to enforce the requirements of the law or the lawful orders of the district inspectors. Of the 3,377 locomotives which have been ordered out of service only five cases have been appealed to the chief inspector, in three of which the orders of the district inspectors were sustained and two reversed.

In this connection it is but fair to state that in our efforts to carry out the provisions of the law we have had the co-operation of the railroad officials on practically all roads. Wherever we have met with opposition it has usually been found to be due to the lack of a proper organization or necessary appropriation to properly perform the work as required. A marked improvement in this condition of affairs is, however, already manifest, and the necessary action is being taken to bring about a proper observance of the law in all cases.

Section 8 of the law provides that all accidents resulting from failure from any cause of a locomotive boiler or its appurtenances resulting in serious injury or death shall be reported to the chief inspector and investigated. Under this provision accidents which occur while locomotives are being inspected, repaired and tested in shops and round-houses which were formerly classed as industrial accidents must be investigated and are included in this report. Inasmuch as a large percentage of accidents which occur are of this character, no fair basis exists from which a comparison with previous accident records can be made.

During the earlier part of the year the requirements of the law relative to reporting accidents to locomotive boilers and their appurtenances were apparently not fully understood by all carriers, in consequence of which many such accidents were not reported to the chief inspector of locomotive boilers in accordance with Section 8 of the law. For this reason, and also because a full corps of inspectors had not at that time been appointed, quite a few accidents were not investigated. Therefore the cause assigned by the railroad company in its report to the accident division has been used in our compilation. Every accident is being investigated at the present time and active steps are being taken to correct all faulty conditions discovered.

Much of the progress that has been made during the year can be attributed to the fact that the law was so wisely planned and skillfully drawn that very little difficulty has been experienced in applying it to every case that has arisen. No amendment or revision of the law is, therefore, recommended at this time. JOHN F. ENSIGN,

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MECHANICAL ENGINEERS' MEETING.—The annual meeting of the American Society of Mechanical Engineers was held at the Engineers Societies building, New York, Dec. 3-6. Besides an elaborate programme of professional sessions the special features included the presentation of the John Fritz medal for 1912 to Robert Woolston Hunt, in recognition of his contributions to the early development of the Bessemer process.

TWENTIETH CENTURY STAYBOLT.—We are informed by the inventor of the Twentieth Century Flexible Staybolt, described in our last issue, that the rights for its manufacture can be obtained by any railroad which desires to adopt the bolt.

Cleaning Boiler Tubes

BY FRANK C. PERKINS

It is undoubtedly true that in every well-equipped boiler plant it is fully as essential that the tubes be periodically cleaned in the most careful and thorough manner as that the engines and generators in the power house be properly lubricated. Various forms of apparatus have been devised for this purpose, and some of them are shown in operation in the accompanying illustrations.

In Fig. 1 a vacuum tube cleaner is seen with the steam turned on ready to enter the tubes. It is connected with a line steam pipe and properly released of all condensation prior to entering the tubes or flues of the boiler. At the head of the cleaner there is a small counterbored aperture, which aids in

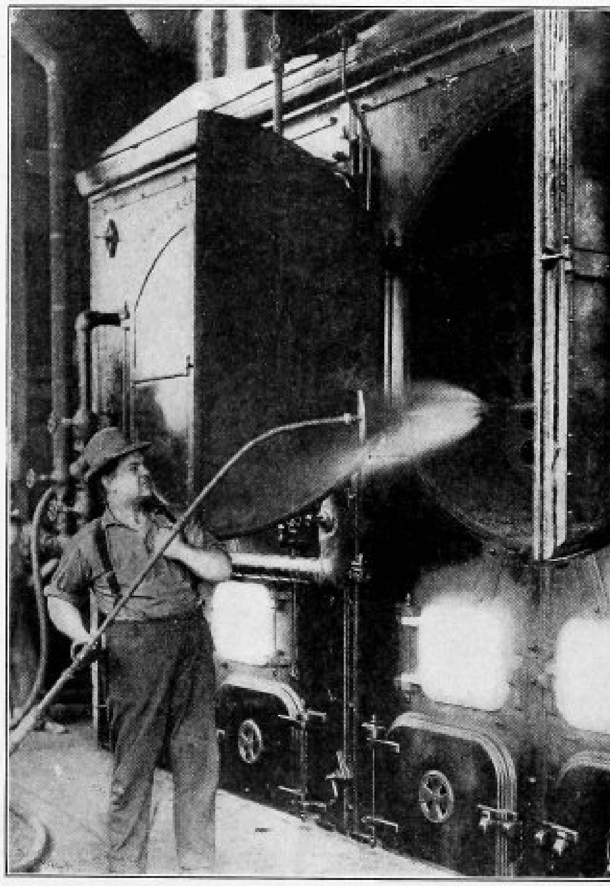


FIG. 1

relieving the condensation and also aids in causing an agitation of the soot in the tubes or flues as the cleaner enters the same. In operation it may be stated that the vacuum tube cleaner is admitted into the tube about 6 or 8 inches, or up to the shield, which acts as a valve, driving the steam to the rear end of the tube and causing an agitation the full length.

It is maintained that by gradually pulling out the same, the vacuum that is formed relieves the tubes of soot and scale, although with this vacuum tube cleaner it is absolutely essential to have the fires in good condition, burning freely with the damper opened to its full extent and the draft doors open a trifle so as to create a circulation and aid the cleaner in its work.

The steam is superheated, making it impossible to cause contraction by the effect of cold air to the tubes or parts in the combustion chamber of the boiler. It is maintained that if the fires are in the condition as above stated the heat or flame follows the head of the cleaner as it is withdrawn from the tube, due to the strong vacuum that is created.

It is claimed that with a cleaner of this description a pressure of 10 or 15 pounds is sufficient, while a far greater steam pressure and greater volume is necessary with tube cleaners not utilizing the vacuum principle.

Fig. 2 shows a Sterling boiler-cleaning device for cleaning the vertical tubes. It will be noted that the operator is located outside the boiler on a platform or scaffold in a comfortable position, and can feed the cleaner into one tube after another with little physical effort. Instead of having to support a weight of heavy hose and cleaner he has his hand on the crank, which easily and quickly answers to his will. When one tube is finished he draws the machine into the funnel, and by a swinging movement of the feeding device he centers the funnel over the next tube to be cleaned, and proceeds as before. It requires only one moment to make this adjustment. It is not necessary to turn off water until the drum is finished; this is a great saving of time. It is claimed that as he can work only by ear and touch, anyway, he is really in a position to do a better job than he would be in the drum.

The feeding device consists of a funnel, through which the turbine cleaner is guided into the tube, a stand which supports the funnel and on which the funnel is swung to be adjusted to the different tubes, and a set of shafting, which is jointed and snapped together with a trigger. This shaft is in section, so it can be easily handled and used in the limited space between boilers. In each section of shaft is a spool and rack on which the hose is rolled. The shafting is held in the center of the manhole by a tripod, rigidly placed.

Extending from this tripod is the feeding device proper for feeding the hose into the tube. This feeding device consists of two capstan shaped rolls, which enclose and grip the hose, and which are geared together so that when one is turned by the crank the other turns. There is provision of squeezing these onto the hose as tightly as may be desired, as the "capstan rolls" are lagged with leather which grips the hose. This feeding device is adapted for use with air and water-turbine cleaners, or with any other turbine cleaner that can be used in a Sterling boiler.

Where scale is of moderate thickness it is claimed that the modern turbine cleaner is utilized to advantage. The ball-bearing cleaner is simple and easily handled, and is adapted where water pressure of 150 pounds or more is available. The water is fed into the rear of the machine and passes through ports in the frame, and from thence to the flanges of the turbine wheel and out through the front of the case. The thrust bearing cleaner is of the turbine type, but instead of taking up the end thrust with balls a thrust collar is used on the front end of the shaft. The front and rear bearings are located at each end of the shaft and the wheel is supported in between.

These turbine cleaners are designed for 150 pounds pressure, but is claimed that on account of the efficient form of turbine wheel they can be operated through quite a range of pressures. All rubbing surfaces are well lubricated by a copious supply of water, forced both front and rear; bearings cool and insuring easy running; should any end play develop it can be taken up without difficulty.

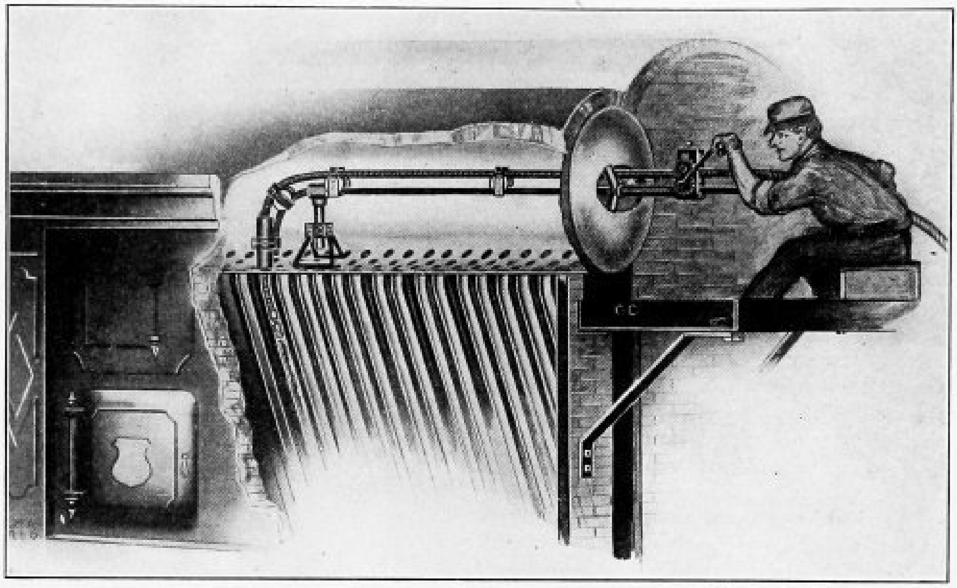


FIG. 2

A Pioneer Boiler Shop

Among the oldest and best boiler shops in the Missouri Valley is the Missouri Boiler Works, at Kansas City, Kan., of which Mr. Harry Darby is president. This was established in 1892 by Mr. Darby, and has been in active operation ever since. This shop has a wide reputation for good work. Among large contracts last year was the installation of tanks of the Peet Bros. Manufacturing Company, of Kansas City, a contract amounting to about $42,000. The boilers in the famous Coates House and the Gillis Theater, landmarks before the war, were built and installed by Mr. Darby's father, Henry C. Darby. This was the first boiler work of Mr. Darby, Jr. In June, 1903, during the big flood in Kansas City, Mr. Darby constructed the famous suspension water pipes which carried the only good water to the Kansas Cities during the flood, which prevented a possible disastrous fire and water famine. The pipe was constructed with slip joints and made with great difficulty and hardship. For this work Mr. Darby was given a vote of thanks from both city councils. Mr. Darby has still in his employ the first boiler maker that came to Kansas City, Mr. Gene Daly, who is 72 years old. Mr. William Leas, Kansas City, Mr. Darby's foreman, was also another pioneer boiler maker around Kansas City. Mr. George Packer, the present superintendent of the Missouri Boiler Works, was a fellow boiler-maker apprentice with the present Mr. Darby years ago in the railroad shops, and has been associated with Mr. Darby ever since.—*Ryerson's Monthly Journal.*

Geometry and the Circle

BY JAMES F. HOBART, M. E.

"Say, Mr. Hobart, why do we have to multiply a square by .7854 when we want to find the area of a circle?"

"Good morning, John. Your inquiry is very much to the point, and is about as interesting as the old question, if 4 × 7 is 23, what would one-third of 11½ be? Supposing you stated the question a little better. You don't multiply a square by .7854, you square the diameter of the circle—that is, you multiply the diameter by itself. If it is 4 inches in diameter you multiply 4 by 4, which gives 16, and then you multiply 16 by .7854."

"Yes, that is what I mean, but why do they call that multiplying business 'squaring?'"

"Because you have a single dimension—length. You multiply it by another similar dimension—width—and that makes an area of equal length and width, or a square. Therefore they call it a square because it actually makes a square surface from two linear dimensions."

"Gee! that's simple enough. Wonder why I had not thought of that myself. But where does that .7854 come from, anyway, and it is such a bad decimal, too? It is hard to remember, and I have to write it down every fifteen minutes to remember it the other fourteen."

"Let me tell you how to remember that constant very easily. You don't have any trouble in bringing to mind the other constant—old π—the ratio of a circumference to the radius?"

"What the 3.1416? No, Mr. Hobart, I have that chalked down where it never gets away from me again."

"Well then, John, when you want the other constant, .7854, and can't remember all the figures, just take π and divide it by 4, that will give you the constant showing the relation of the area of a square to the area of its inscribed circle."

"Oh, say, Mr. Hobart! is that where the area constant comes from? Say, that is another of the confounded simple things that make a fellow trouble when he forgets to remember them. Cracky! I never knew .7854 was a quarter of π before."

"That is what it is, and you can always get the constant as long as you remember π."

"But why do they call it pi, anyway? What sort of a name is that?"

"They call it pi for the reason that that is the pronounciation of a Greek letter represented by the character π, and mathematicians universally use that character to denote the relationship of diameter and circumference. There are a lot of other Greek letters used for representing things which you will rub up against before you have got through with shop geometry."

"But how did they find out that a 1-inch square made just .7854 square inch when the corners were rounded off to a true circle?"

"I will try and tell you, John, but it is a rather difficult problem to understand. Before you can fully comprehend it you have got to learn a little about triangles. Now don't bank too much on .7854 being one-fourth of π. It just is, that's all; and it has nothing to do with the method of determining that it is so."

"Say, Mr. Hobart, that π letter is mighty handy for writing instead of 3.1416. Why don't they have something to represent .7854?"

"That's another thing that happened, or that never happened. If you want to express .7854 algebraically you must write it $\frac{\pi}{4}$, and that is the character that is used for expressing the area constant."

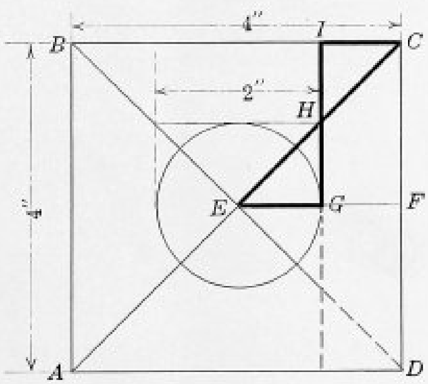


FIG. 1.—AREA OF TRIANGLES AND SQUARES

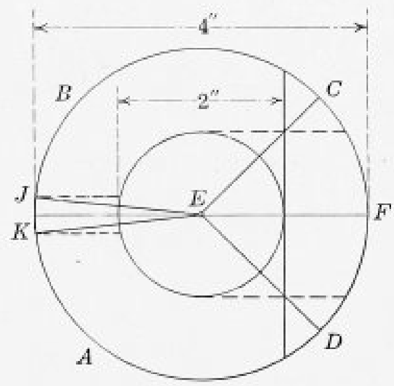


FIG. 2.—AREA OF CIRCLES

"One other thing, Mr. Hobart, why do you call this thing 'constant'?"

"Well, that is another matter for which there is no reason, except that those figures are constant and never change. They just gave them that name, that is all. You will find a whole lot more to that as you get wise to geometry. Now we will take the area constant business. Here is Fig. 1. The sides *A B* and *B C* are each 4 inches long. Now how many square inches are contained in the square?"

"Why, that's easy, 4 × 4 = 16 square inches."

"That's right, John. Now if we cut the square twice across diagonally from *A* to *C* and from *B* to *D*, each of the pieces will be one-fourth of the square, won't it?"

"Yes, Mr. Hobart, and each of them will contain 4 square inches."

"That's right. Now we will put another letter *E* in the middle of the square, and after we make the cuts we have triangle *C E D*. This we know has an area of 4 square inches, but we want to prove it. We know the distance *C D* is 4 inches, but we do not know the distance *C E*. We will put another figure, *F*, half-way between *C* and *D*, and we know that the distance *E F* is 2 inches, for it is just one-half of *C D*, and *E F* is equal to *C F* or *F D*."

"Yes, I see that all right."

"All right. Now we call the line *C D* the base of the triangle, and the distance $E F$ the altitude of the triangle. To find the area of any triangle we multiply one-half its altitude by its base. We place another letter, G, half-way between E and F, and we know that $E G$ or $G F$ equals one. Now if we multiply $C D$, which equals 4, by $G F$, which equals 1, we have 1×4 equals 4, or exactly the area of the triangle $C D E$."

"So that's the way they figure triangles, is it? I saw the boss figure one the other day, and he just multiplied $C D$ by the whole height $E F$, and then divided by two."

"That's all right, John. It makes no difference whether you divide $E F$ by two before you multiply by $E F$ or afterwards. You might multiply $E F$ by $F C$, which is half of $C D$. The answer will be four, the area of the triangle in either instance."

"But what does that have to do with .7854?"

"It has everything to do, John, and we will get at it in a few minutes. Just take a look at the little triangle $E G H$, Fig. 1. If we imagine this cut off, turned around and fitted at $H I C$, then it just completes the rectangle $C F G I$, and if we cut off the remainder of the triangle $C D E$, and patch it on to the other end of the rectangle at D, we have a figure 1 inch wide and 4 inches long."

"Yes, I see that, and that's why they multiply the base of a triangle by one-half of its altitude. That's a new one on me, and I will remember it, you bet!"

"Well, John, now we are ready for another step towards .7854. Take a look at Fig. 2, and you will find there the same figure with the triangle $C E D$ as before. Now we are sure that this is one-fourth of the area of the circle, for if line $C E$ were extended through to A, and line $D E$ were extended through to B, then it would form four perfect squares at E, same as in Fig. 1. Now the diameter of this circle is 4 inches, the same as a square. If we take the diameter for the base of the triangle $C D$, Fig. 2, we shall not come out right, for $C D$ in Fig. 2 is much less than it was in Fig. 1, because the corners of the square have been cut off, therefore we can't tell what the length $C D$ is; also, we can't multiply the length by one-half of $E F$, so we are stumped in trying to find one-fourth of the area of the circle in that way. But now let us shorten up the distance between C and D. Instead of taking one-fourth the circumference of the circle let us cut it down to a very narrow angle, as shown at $J K$."

"But we don't know the length of $J K$ any more than we did of $C D$."

"That's right, but we will get track of the length pretty soon and be able to measure it. Now you see the dotted lines extending from $J K$ form little triangles with the other lines $J E$, $K E$, so that if the height were cut in two in the middle the piece cut off would, if divided equally, almost fill out the rectangle $J K$."

"Yes, I see that, but we don't know whether the pieces at E would fill $J K$ exactly or not."

"That's true; but don't they fill it to a more perfect figure at the corners E, or the opposite side fill out at C or D?"

"Sure, Mr. Hobart, a whole lot better. But the corners on the $C D$ side are too big, they more than fill the triangles."

"That's it, John, now we will narrow up $J K$ some more. Instead of 1 inch as approximately taken at $J K$ we will take one-one-hundredth or one-thousandth of an inch. This makes the triangles very narrow, and they exactly fit in the rectangle shown."

"Sure, the smaller they are the nearer they fit."

"That's just the case. Now we will narrow down $J K$ still some more. Let's go the limit and narrow it down so far that we can't measure a piece."

"Say, Mr. Hobart, that's getting down pretty small. How wide will the strip be?"

"Very narrow, John. In fact, they won't have any width at all to speak of, we have divided them down so narrow that they are practically without width."

"Then how do we measure the width of them? We have got to know the length $J K$ before we can multiply it by one-half of $E F$."

"You are getting there, John. Now we will divide the entire circumference of the circle up into such short segments that the circumference $A K J$, etc., will appear to be a straight line along the edge of the little triangle $J K$. That being the case we will just imagine the entire circumference straightened out into a straight line $3.1416 \times 4 = 12.566$ in length. But we have straightened the circumference right out, and attached to the circumference our innumerable triangles with the width at bottom that can't be made any smaller, and each triangle is 2 inches high and runs to a point. Get that, John?"

"Yes, sir. You are straightening out the circle so the triangles are so many you can't count them, and then they stick up straight like the teeth of a comb."

"That's a mighty good way of stating it, John. There must be something in that head of yours besides a pint of soup. Now we have a lot of triangles 12.5664 inches long and 2 inches high. And if we multiply the length of these triangles by one-half the height, which is 1, we have 12.5664, which is the area of the circle rolled out into triangles."

"That's right, Mr. Hobart, that must be the area. But I don't see any .7854 in that?"

"You will in a minute. Now how many square inches were there in the whole square?"

"Sixteen, of course!"

"That's right, 16 inches in the square. Now when the corners of the square were cut off to make a circle you have 12.5664, don't you?"

"Yes."

"Then, for the minute, we will drop off the decimal and call the area of the circle 12 square inches while the area of the square is 16. Now what part of the square is the circle?"

"Why, I should think it would be twelve-sixteenths or three-fourths."

"That's right. Now we want to state the fraction in a decimal instead of a common fraction. How would you go about it?"

"Why, I should just divide the 3 by 4. That would give the decimal .75."

"Correct. Now let us get back to the exact area of the circle and take it in the same manner. Take 12.5664 and divide it by 16 to get it into a decimal at once. Now divide it out with your chalk on that piece of boiler plate, and what do you get?"

"As sure as I live, Mr. Hobart, it is .7854!"

"That's right, John, you have got the constant at last. Now do you know where it comes from?"

"I think I do. I will have to study the thing over a little more, but it seems to me that you juggle that circle around and make it into a lot of comb-teeth triangles in order that you could get the area of it. You found the area to be 12.5664, and divided that by 16 to get the decimal ratio between the square and circle areas, and you found the ratio to be .7854."

"Good boy, John! You sure will draw a foreman's pay yet; but look here, you and Bill haven't sent a single one of those questions over yet. If you don't get busy and dip out some dope for me I will be hanged if I don't give you some geometry that is so stiff that you can't bend it sideways with the biggest sledge-hammer in the shop!"

Boiler Manufacturers' Convention

The twenty-fifth annual convention of the American Boiler Manufacturers' Association of the United States and Canada will be held in Cleveland, Ohio, Sept. 2, 3, 4 and 5, 1913.

The Selection of Locomotives

In an instructive paper read before the American Society of Mechanical Engineers, in New York, December 5, 1912, Mr. O. S. Beyer, Jr., presented a comprehensive review of the various sizes and types of locomotives.

The principal types of locomotive available for passenger service are the Atlantic (4-4-2) type and the Pacific (4-6-2) type. The American (4-4-0) type, the Ten-wheel (4-6-0) type, and the Prairie (2-6-2) type have been employed to some extent, but except in unusual cases are not of special advantage. The latest development in passenger engines for severe mountain service is the Mountain (4-8-2) type. In some special cases, such as exceedingly heavy mountain service, the Mallet engine has been used.

The Atlantic (4-4-2) type locomotive is usually best adapted to a service in which the trains weigh about 300 to 350 tons behind the tender and the grades encountered are relatively light. Owing to its wheel arrangement it permits of a boiler of ample capacity in proportion to the cylinders. It has a short rigid wheel base and a short total wheel base. To get very high initial tractive efforts with locomotives of this type means exceptionally high axle loads, which are undesirable. Hence, when high initial and sustained tractive efforts are required for heavy trains weighing over 350 tons behind the tender operating over heavy grades, the Pacific (4-6-2) type is usually found to be better. The wheel arrangement of this type permits a still larger boiler, greater total weight on drivers with lower average axle loads, and large cylinders. In general, the full utilization of these features results in both higher initial and higher sustained tractive efforts, combined with better accelerative qualities.

For exceptionally heavy mountain service the Mountain type permits of still larger boiler capacities and greater total weights on drivers, and hence still higher tractive efforts. Several engines of this kind are in service on the Chesapeake & Ohio Railway, hauling trains weighing 600 to 650 tons over grades of 70 feet per mile at 25 to 26 miles per hour. Mallet engines have been introduced to a limited extent in passenger service. The Central Pacific Railroad has 12 Mallets which are hauling passenger trains on grades 116 feet per mile and 40 miles long. The Atchison, Topeka & Santa Fe Railway has two Mallet compound engines which were built to haul passengers trains. The service in both these cases is very severe and rather exceptional.

The Atlantic and Pacific type engines, under modern operating conditions, are, for high speed and high capacity passenger service, the most desirable types. Under certain circumstances, long continuous opposing grades may justify compounding in connection with these engines. The introduction of the high temperature superheater and the sectional brick arch has helped materially to increase the capacity, fuel economy and efficiency of passenger engines. The limitations of Atlantic and Pacific type passenger engines are principally controlled by the permissible wheel loads. When 60,000 to 63,000 pounds per pair of drivers is once reached, it is questionable, from many points of view, whether it is wise to go still higher. Hence, when greater tractive efforts are necessary than can be secured from an engine with 180,000 to 190,000 pounds on drivers it becomes a question of either reducing schedules, double heading, or introducing locomotives with an additional pair of drivers.

Recent developments have made available an exceptional field from which to select locomotives for freight service. It seems limited not so much by the extent to which it is possible to build freight engines as it is by the physical restrictions of the permanent way, the nature of the freight business hauled, length of trains, and topography of the road. These limitations are, of course, mostly very serious and, as far as track gage is concerned, insurmountable, except perhaps in some special cases. Many Moguls (2-6-0), Ten-wheel (4-6-0) and Prairie (2-6-2) type locomotives are in freight service to-day. Their capacities, especially the Mogul and Ten-wheel types, are hardly adequate for modern service conditions. The Prairie type, due to the possibility of equipping it with a liberal boiler and liberal grate area, has a few advantages over the others.

The type of locomotive which has been the standard on many of the American railroads in the past ten years is the Consolidation, or 2-8-0 type. It has been called upon to perform in services ranging from emergency passenger to slow heavy pusher and switching service. Engines of this type are being built for heavy and exacting freight service and their possibilities have not been exhausted. They utilize nearly the total weight of the engine for adhesive purposes. A leading truck of two wheels only is provided permitting of a slightly extended boiler and taking from the drivers only weight enough to secure good guiding qualities. The steaming capacity, firebox size and grate area are necessarily limited, since the entire boiler and firebox must be carried over the drivers. The handicap imposed by the boiler limitations has not, until recently, been very serious. Engines of the Consolidation type, having a maximum tractive power of 60,900 pounds, are in service to-day. The diameter of their drivers is small, 54 inches, and their total heating surface compared with the equivalent heating surface of a Mikado engine having the same tractive effort, is but 70 percent as great. The piston speeds of these large Consolidation engines, compared with the Mikado engine, are considerably higher.

The perfection of the high temperature superheater, the brick arch, and the Gaines combustion chamber opens up further opportunities for the Consolidation engine. The application of the superheater results in increased capacity which corresponds, roughly, to a 25 percent larger boiler capacity than it was possible to provide in connection with saturated steam engines. The brick arches permit increased amounts of heat to be utilized from the fuel burned on restricted grate areas. It should be possible to build Consolidation engines with good steaming capacities and economical fuel requirements that can develop as high as 54,000 pounds maximum tractive effort.

An offshoot from the successful Consolidation freight engine is the 12-wheel or 4-8-0 type. This type has not been widely introduced. It has an undesirable ratio between total weight and adhesive weight. The increase in the length of boiler made possible by the four-wheel truck in place of the two-wheel truck of the Consolidation engine nets but little in the direction of increased boiler capacity. The increase in the heating surface of the boiler is at the wrong end. To improve the steaming capacity of the Consolidation engine it is necessary to introduce modifications at the firebox end.

The introduction of such modifications has resulted in the Mikado (2-8-2) type engine. By placing a trailing truck underneath the firebox better boiler construction becomes possible; also a decided increase in effective heating surface, a deeper throat sheet and wider water legs are secured. However, as large a proportion of the total weight of the engine is not utilized for adhesive purposes as with the Consolidation type. By moving the firebox behind the drivers, it also becomes possible to enlarge the boiler diameter, and to increase the relative diameter of drivers, thereby permitting of lower piston speeds. The general construction of the Mikado locomotive is such that it permits of very ample steaming capacity and thus of high sustained tractive efforts. The application of the superheater and brick arch has further increased its capacity in this direction. It is most admirably suited to haul slow maximum tonnage freight trains one day and fast trains the next, a condition frequently met in railroad operation.

The size of Mikado locomotives for most roads is principally limited by the allowable weights on drivers. It seems to be generally considered that an individual axle load of 60,000 pounds for the better conditions of roadbed, as they are met with to-day, is very nearly the largest permissible. If so, the Mikado engine, as far as size is concerned, has very nearly reached its limit, and the demand for still larger engines will have to be met either by introducing another pair of drivers, making five pairs in all, or by resorting to the Mallet type. With their weight on drivers limited to about 60,000 pounds per pair, it is possible to build Mikados which have a maximum tractive effort of 60,800 pounds with very favorable sustaining qualities at high speeds. The utilization of the superheater and brick arch in connection with the well proportioned boiler and efficiently designed engine makes it possible for this size of locomotive to be operated without requiring excessive amounts of fuel, so that one fireman can handle all that is needed.

To get still larger capacities than are provided by the Consolidation and Mikado types, the Decapod (2-10-0) and the Santa Fe (2-10-2) types are available. The Decapod (2-10-0) type, like the Consolidation and Twelve-wheel types, has limitations as regards boiler capacity, in consequence of which it is practically adapted to slow service only. Its high proportion of weight on drivers, giving it a high ratio of adhesion is of advantage for this kind of service. The Santa Fe type permits of better boiler proportions than those of the Decapod type, just as the Mikado is better than the Consolidation. The additional pair of drivers enables a tractive effort about 20 to 25 percent greater than can be secured from the Mikado engine. Allowing 60,000 pounds per pair, the maximum tractive effort possible should be about 73,000 to 75,000 pounds, barring cylinder limitations. Several engines of this type now in service deliver a maximum tractive effort of 71,000 pounds. It is reported that they can be handled by one fireman without undue effort.

Locomotives with five pairs of coupled wheels have an exceedingly long rigid wheel base. This would introduce many complications should they be placed on territories where track curvature is frequent or severe. Furthermore, the exceptionally heavy pressures on the main pins and the heavy reciprocating parts justify expectation of maintenance difficulties. The long wheel base and the large number of heavy wheel loads in rigid order may be proportionately harder on the track than is the case with large Mikado engines.

Another type of engine which deserves consideration for freight service is the Mountain (4-8-2) type, which is similar to the Mikado in all its characteristics. Where fast freight service is abundant and high speed is frequent the additional advantages in guiding qualities secured by the four-wheel leading truck and the slightly increased boiler capacity are important.

The Pacific type engine for exclusive fast freight service, where grades are not severe and where this kind of service is heavy, is a very desirable type. A large number of these engines have been built for this service and are giving an excellent account of themselves.

The Mallet type offers quite as wide a field to choose from as the Pacific, Consolidation, Mikado and Santa Fe types combined. Mallet locomotives have been built on both the compound and the simple principle. The wheel arrangement permits of a great number of practical combinations. The application of the superheater and brick arch, feedwater heater and reheater, together with well proportioned boilers and the compound feature, has made possible units of large size and of good drawbar pull characteristics at different speeds. At the same time Mallets are economical in fuel consumption. The arrangement of the drivers in two independent sets, and the division of the total engine weight over these two sets, permit readily of meeting track and axle load limitations. Hence these engines offer a large field from which to make selection when the restrictions of the permanent plant are such that they cannot be overcome except by heavy expenditures.

Mallet engines can be built to deliver a maximum tractive effort of 140,000 pounds. This would mean engines with ten pairs of drivers, each having an average load of about 60,000 pounds. As long as 60,000 pounds remains the maximum average practical wheel load, while track curvature remains a consideration, and the gage of the track remains at 4 feet 8½ inches, thereby limiting the height of the center of gravity of engines, it is questionable whether an engine much larger than this can be built. It is not a size which has been reached to-day, although there are Mallet engines in service which have ten pairs of drivers.

A large number of Mallet locomotives are in road and pusher service whose tractive effort working compound range is from 73,000 pounds to 105,500 pounds. They are meeting with success from the fuel, operating and maintenance standpoints. The largest number of drivers under the engines referred to is eight pairs, the average weight per pair under the largest one being 58,560 pounds. Hence, 105,500 pounds tractive effort is not far from the maximum possible with eight pairs of drivers allowing 60,000 pounds per pair.

The types of switching locomotives available range from the six-wheel coupled to the ten-wheel coupled. Recently a Mallet compound engine has been placed in hump yard service by the St. Louis, Iron Mountain & Southern Railroad in order that long trains may be handled without breaking them up. Switching locomotives of five pairs of drivers have a rather long rigid wheel base, perhaps too long for the average yard conditions as they exist on many roads to-day. Locomotives with four pairs of wheels have a more suitable wheel base, and are capable of delivering comparatively high tractive powers. Locomotives of three pairs of drivers are the most universal in service to-day.

Fuel is the largest single item of locomotive operating expenses and therefore the most important. The fuel consumption may be divided into the following classes: (a) Fuel used while actually working on the road; (b) fuel used while drifting and waiting; and (c), fuel used at terminals for firing up. As locomotives grow larger their fuel consumption per unit increases, but not nearly in proportion to the increase in their size. It does not take very much more coal to fire a large locomotive than a small one. The fuel losses of a large locomotive due to radiation while waiting or drifting are but slightly larger than those of a smaller locomotive. The increase of fuel consumption of large saturated simple steam engines when working at their full capacity is more nearly in proportion to the increase in their size. The introduction of the superheater, feed-water heater and reheater, the increase in heating surface of the boiler, the brick arch, the utilization of compounding in large engines of the Mallet type, application of improved valve gear and compound air pumps, and more careful attention to the design of steam passages and steam engine efficiency, have accomplished remarkable results in keeping the fuel consumption of large locomotives down, so that their consumption per train-mile is increased but slightly over that of the recent types of smaller saturated steam locomotives.

Numerous tests and service records have revealed that large superheater Mikado locomotives which have been placed in service recently haul trains of 45 and 50 percent greater tonnage with the same amount of coal that was formerly consumed by the Consolidation locomotives they replaced. Even the coal consumption of Mallet engines with grate areas up to 100 square feet has not grown in any way proportionate to the increase in their hauling capacity. Modern engines when running at shortened cut-offs over those portions of the road other than the ruling grades exhibited a still greater economy than when working on the heaviest grades. Some service tests of recently built Mikado engines on the Delaware, Lackawanna & Western Railroad clearly demonstrated these facts. Their economy in fuel consumption as compared with that of the old Consolidation type, both operating over heavy grades at full load, was 20 percent. The economy effected over easy grades while running at shortened cut-offs was 39.3 percent, almost twice as much. The average was 29.1 percent.

The conclusions to be reached in regard to the fuel consumption of larger locomotives equipped with those fuel saving devices which have proved their merit is that it increases but slightly as their hauling capacities increase. It depends, of course, largely upon the size of locomotives in service as to what the actual increase will be on the train-mile basis over the consumption of the old engines, and this must be taken into consideration.

Summary.—In designing new locomotives all of the conditions must first be analyzed and then the design made to suit them. The actual design of the engine finally chosen may be approached with confidence because of accumulated knowledge and experience. Due to the great possibilities of favorably effecting operating results by building locomotives which are exactly suited to their work, a study of the conditions becomes vitally important. To show what these conditions are has been the object of this paper. The fact that the most powerful locomotives of most approved design are also the most economical should be more generally appreciated. It is to be hoped that the future will see more advantage taken of the modern locomotive in accordance with its possibilities in relation to grade revision and its ability to reduce operating expenses to a minimum. The ultimate benefits which will result will certainly be justified to the fullest extent.

Locomotive Development in 1912*

The number of locomotives ordered during 1912 was 4,515. When compared with recent years it will be seen that this volume is very satisfactory, as it has only been exceeded three times since we began keeping these records in 1901, namely, in 1902, when 4,665 were ordered, in 1905 when 6,265 were ordered, and in 1906 when 5,642 were ordered. The unfilled orders on the books of the builders are much heavier than last year, and there are inquiries for about 400 locomotives, so the year 1913 will have a good start.

The numbers of the different types ordered in 1912, compared with 1911, are as follows:

	1912.	1911.
Mikado	1,309	590
Consolidation	858	577
Switching	821	443
Pacific	594	486
Ten-wheel	364	238
Mallet	168	112
Mogul	61	127
Electric	75	133
Shay	23	15
Eight-wheel	8	27
Atlantic	5	9
Others	229	93

* From Railway Age Gazette.

The year 1912 will stand out in the history of locomotive development, not because of any very radical designs which have been introduced, but more because of the awakening of railroad officers at large to a more thorough appreciation of the necessity of careful design and better proportioning of parts with a view to the exact service which the locomotive will be called upon to perform. And, as stated by O. S. Beyer, Jr., in the paper recently presented before the American Society of Mechanical Engineers, "The fact is that the most powerful locomotives of most approved design are also the most economical."

With the heavier locomotives has come an increase in train loads. The Baltimore & Ohio has increased 26 percent within a few years; the Norfolk & Western, 7.75 percent; the Chesapeake & Ohio, 15.25 percent, and the Lehigh Valley, 4 percent, to quote merely a few of many examples. The Virginian is hauling 100 cars in a train, the goal towards which the road has been working, and trains of 5,000 tons are not uncommon elsewhere.

The traffic men are crowding the mechanical department for the last ounce of drawbar pull available, and the powers in control of the finances are looking to this heavy power as a means of obviating or meeting the necessity of reducing grades to lower the cost of transportation. In short, the locomotive is now coming to be regarded in the light of an engineering problem in its broad sense. Designers and operators are considering the machine as a whole, and not looking at it from the limited point of view that has prevailed in the past. This was especially emphasized at the recent meeting of the American Society of Mechanical Engineers, where, for the first time in its history, or, for that matter, the first time in this country, details were forgotten and the subject considered on the broad basis of its engineering and economic possibilities. It looks as though the steam locomotive was at last coming to its own.

It must be kept in mind that the larger locomotives have been equipped with the most approved fuel and labor-saving devices, while the old standard engines have not always had these aids. There would seem, therefore, to be great possibilities for some of these standard types if so equipped. For instance, the Pennsylvania Railroad built an Atlantic locomotive with a very large boiler and superheater; after it had been in service for a number of months it was put on the testing plant, where it developed a horsepower on a water consumption so far below anything that had ever been attained before, that it cut into the records of what would have been considered good practice for condensing engines in stationary practice a few years ago. Possibly a performance of this sort does not appeal to railway executives when stated in these terms, but when expressed by the statement that a locomotive of a given weight can haul a heavier train over the road in the same or better time than a standard engine, because of the greater steaming boiler capacity, it cannot be overlooked. And this is what actually occurs when the locomotive is properly proportioned and equipped with the best boiler capacity increasing devices, if they may be so called.

One cannot but have been impressed by the tests which have been reported during the year in which locomotives of the Mallet, Mikado or Pacific types have developed much greater power per unit of weight and fuel consumption than the older standard engines against which they were pitted. As a hauler of freight the Mikado is receiving an extensive application and is outclassing the consolidation, because it permits the use of a larger fire-box, and thus greater hauling capacity and higher sustained speed.

The Walschaert valve gear has come into general use on heavy locomotives, although for small locomotives the Stephenson gear is still used. There are, however, some indications that the Baker gear will encroach upon the prestige of the Walschaert gear. It is being somewhat extensively applied, and is possessed of some advantages over both the Walschaert and the Stephenson, in that it has no link and that it is possible to standardize the parts so that they are applicable to engines of different types.

In the use and selection of materials the heat treatment of steel parts bids fair to receive more attention than has yet been given it, and a far wider application. It is an old story, that of raising the elastic limit of a material and then following that rise by a corresponding increase of unit stresses. Now the problem with the high-speed heavy locomotives is to reduce the vertical stresses on the rails by a reduction in the weight of the reciprocating parts. Work along this line is to be taken up systematically, with the purpose of utilizing all of the reduction in weight that may be so obtained in lessening the vertical stresses.

But of all the economies that have been effected in locomotive operation the greater percentage is undoubtedly due to the superheater. And it is because of the evident saving in steam consumption, which it has produced, that it is now generally applied to new locomotives, and that to an extent that almost constitutes it a standard of practice. The most important and interesting development in superheater practice during the year has been its application to switch engines and the resulting elimination of black smoke and reduction in coal and water consumption.

Considerably over 300 mechanical stokers are now in service with a large number on order. It may safely be said that the stoker has passed through the experimental stage, although much is still to be learned in connection with its operation. Generally speaking, the best results are obtained by "starving the fire," or maintaining a fire so thin that the grates can be seen through it at all times. It is something of a problem to educate the fireman to do this. While the introduction of the superheater and the perfecting of the brick arch have reduced the fuel consumption per unit of work so greatly that there is not now the crying need for the stoker that it seemed would insure its general introduction as soon as it was perfected, still there is a wide field for its application, and the possibilities are that the year 1913 will see a large number of locomotive stokers installed.

Among the minor details the use of the power and screw reverse gear is extending. Not that the heavy locomotives cannot be handled without it, but its use so reduces the labor of the engineman that it encourages him to work the machine at a more economical point of cut-off than he would be apt to do if every change involved a violent exertion. In boiler construction we have reached 112 inches for the diameter of the shell and 24 feet for the length of tubes. As to what the possibilities are beyond this would be hazardous to say. But while long tubes may not be favored they have to a certain extent been necessitated by the long boiler shells that must be used. The filling of the extra length of the shell with a feed-water heater is not showing all the advantages that were expected, so that, with a space to be filled, the long tubes, with an ample combustion chamber at the rear, is favored in many places.

The most powerful locomotive built during the year was a Mallet for the Virginian. It has a tractive effort at starting of 138,000 pounds. Cylinders of the unprecedented diameter of 44 inches are used, and the total weight is 540,000 pounds. Its size, however, would not permit it to be used within the clearance limits of most roads.

The comparative tests of the Jacobs-Shupert fire-box and one of the radial stay type at Coatesville, Pa., attracted much attention, but the complete results are not yet available.

An important development for the year 1913 will undoubtedly be a more scientific study of the problem of combustion in the locomotive and modification in the design of the fire-box, and the practice of firing to take advantage of the knowledge thus gained.

A Remarkable Boiler Installation

The growth of the ferry business between Vancouver and North Vancouver has been so rapid that it has been with the greatest difficulty that the North Vancouver City Ferries (owned by the municipality of North Vancouver) have been able to keep up sufficient service to accommodate traffic, says the *Railway and Marine News*.

In 1909 the business of the private company operating the ferry between Vancouver and North Vancouver was taken over by the municipality of North Vancouver. At this time the ferry company had in its service a single-end steamer, known as the *North Vancouver Ferry No.* 1, and a ferry specially built for the service, now named *North Vancouver Ferry No.* 2, which was then known as the *St. George*. Less than two years ago the municipality contracted for a new ferry boat, known as *North Vancouver Ferry No.* 3, and considerably bigger than the other boats, and on her completion they inaugurated a twenty-minute service between the two ferry slips. The boilers on the *St. George* were of the Scotch marine type, and as they were getting old the management of the ferry decided to replace them. The excellent service given by the Babcock & Wilcox boilers in *Vancouver Ferry No.* 3 convinced them that this type of boiler was the type to use in the replacement of the old Scotch marine boilers. Accordingly, contract was let to Chas. C. Moore & Company, engineers, covering the furnishing of two Babcock & Wilcox boilers to take the place of the old Scotch marine boilers.

By the time the boilers arrived the ferry business had increased to such an extent that it was impossible to handle the service without retaining *Vancouver Ferry No.* 2 in commission. Bids were then taken from various concerns covering the removal of the old boilers and the installation of the Babcock & Wilcox boilers, and it was requested that bidders specify the amount of time the boat would be out of service.

On consideration of the proposals submitted, Mr. T. M. Heard, manager of the North Vancouver Ferries, submitted to the board of directors his suggestions as to how the job could be handled with the greatest expedition and dispatch. None of the bidders would undertake the job until the boat was taken off the run. Mr. Heard had carefully studied into the conditions attached to the possible method of installation and stated that he believed he could make the installation himself with less expense and with considerable saving in delay, and the board of directors empowered him to proceed in accordance with his best judgment.

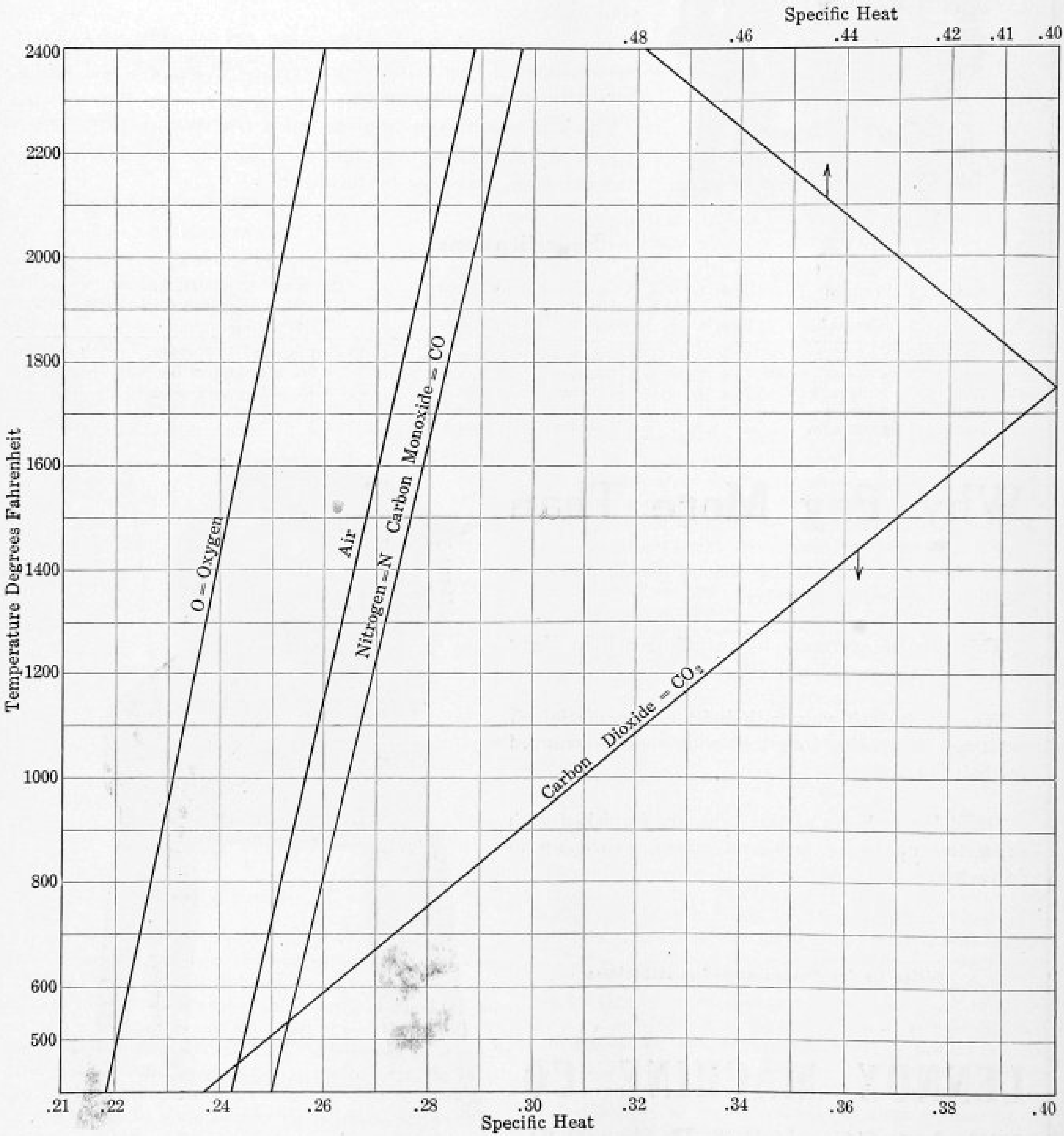
The old boilers were 8 feet in diameter and 10 feet 6 inches long, and in order to take them out the deck of the ship had to be removed. The manner in which Mr. Heard coped with the problem is an interesting one and is outlined herewith.

One of the teaming tracks was blocked off from traffic and the deck over the old boilers was removed. A hole was cut in the upper housing and the boat was operated on the other boiler, which was forced sufficiently to maintain the boat on her schedule. Temporary baffling was put in the up-take to permit cutting off the boiler from smoke connection, all the steam and feed connections were broken and slings placed around the boiler. On Sunday morning, August 10, the boat steamed over to the Canadian Pacific wharf and was placed under the shear legs and the boiler lifted from its setting and placed on skids over the opening of the runway. The boat was then put back on her course, having been out of service but two trips. The boiler was then skidded from above the opening and the work of installation of the Babcock & Wilcox boiler in the hull of the ship was proceeded with, the boat in the meantime maintaining her schedule and meeting with all the service requirements. On the completion of the erection of the Babcock & Wilcox boiler the new up-take and necessary steam piping were gotten ready for placement and a one night's job was made of putting these in place, the ferry being

ready for service on the Babcock & Wilcox boiler on the morning of August 31, only missing one additional trip. As soon as the boat was operating on the Babcock & Wilcox boiler, the decking was relaid, and with the ship still maintaining her schedule (and, in fact, having no difficulty in exceeding her speed requirements on the one Babcock & Wilcox boiler), the decking on the other side was removed and the other boiler prepared for lifting out of the ship. With a further delay of two trips while the boat was under the shear legs the second boiler was removed in a similar manner and the boat proceeded on her schedule.

On completion of erection of the second boiler, this was put into service without any further delay, so that the total time the boat was out of service in replacement of the Scotch marine boilers with the Babcock & Wilcox boilers was five trips.

The dispatch with which this was made makes it a record installation and reflects considerable credit on the care and foresight displayed by Mr. Heard in carefully planning the manner in which the work would be handled so as to be able to continue the service uninterrupted and with minimum expense.



SPECIFIC HEAT OF GASES AT VARIOUS TEMPERATURES, B. T. U. PER POUND. (SEE OPPOSITE PAGE)

Specific Heat of Flue Gas

In the solution of engineering problems relating to the transmission of heat from the gases of combustion to the water in a steam boiler or to the steam in a superheater, it often becomes necessary to take into consideration the specific heat of the gases.

The term "specific heat" may be defined as the number of British thermal units of heat necessary to be imparted to a pound of the substance in order to raise its temperature 1 degree F. The specific heat of water is greater than that of any other substance—at 39 degrees F. it is 1; that is, it requires 1 British thermal unit to raise the temperature of 1 pound of water from 39 degrees F. to 40 degrees F. The specific heat of all other substances is less than 1, and with most of them it increases as the temperature rises. This fact is not usually taken account of in engineering problems, and in the case of gases of combustion it has often been the cause of a wide difference between calculated temperatures and those actually found in practice.

The chart on page 18 shows graphically the value of the specific heat at atmospheric pressure for varying temperatures of the principal constituents of flue gas. The data for these charts was computed from the following formulas given in "Richards' Metallurgical Calculations":

Formulas for the specific heat of gases in British thermal units per pound of gas per degree F. rise in temperature:

O = oxygen = $.2104 + .0000208\,t$.
CO_2 = carbon dioxide = $.19 + .00012t$.
CO = carbon monoxide = $.2405 + .0000238t$.
N = nitrogen = $.2405 + .0000238t$.
Air = $.2335 + .0000231t$.
t = temperature of the gas in degrees Fahrenheit.

In the application of the chart to problems involving the specific heats of flue gas when the analysis is known, it is an easy matter to find the correct specific heat for that composition of gas, since the specific heat at any temperature of a mixture of gases is obtained by multiplying the specific heat of each constituent gas by the percentage of that gas in the mixture and dividing the sum of the products by 100.

For instance, assume it is desired to ascertain the specific heat of flue gas at 900 degrees when the analysis by weight shows

CO_2 = 14.7 percent.
CO = 1. percent.
O = 6. percent.
N = 78.3 percent.

From the chart the specific heat at 900 degrees of each constituent gas can be found, which when multiplied by the percentage in which it is present in the flue gas gives the following:

	Specific Heat at 900 Degrees.		Percent by Weight.	
CO_2 =	.292	×	14.7 =	4.29
CO =	.26	×	1. =	.26
O =	.228	×	6. =	1.36
N =	.26	×	78.3 =	20.36
				26.27

$$\frac{26.27}{100} = .2627$$ = specific heat of the flue gas at 900 degrees temperature.

In the same manner the specific heat of the same gas at a temperature of 2,000 degrees F. is found equal to .304.

From which it is seen that the specific heat of flue gas increases in value as the temperature rises.

To illustrate the use of the specific heat of gases, let us assume that it is desired to compute the heat given to a superheater per pound of gas passing over it when the temperature of the gas drops from 1,500 degrees to 900 degrees F. In problems of this nature the specific heat of the gas at the average or mean temperature is used. The mean temperature in this case = ½ (900 + 1,500) = 1,200 degrees F. If the gas is of the same composition as assumed above, the specific heat at 1,200 will be found by the same method of computation to be equal to .28 British thermal units. This means that for each degree change in temperature from 1,500 degrees F. to 900 degrees F. each pound of the gases of combustion will give to the superheater an average of .28 British thermal unit. For 1,500 degrees to 900 degrees, or 600 degrees change, 600 × .28 = 168 British thermal units will be available for heating the steam.

If the weight of coal burned and gas analysis are known it is an easy matter to compute the pounds of gas passing over the superheater per hour, which, when multiplied by the heat given up per pound of gas, gives the total British thermal units absorbed per hour by the superheater. "ENGINEER."

Patterns for a Ventilating Cowl*

BY H. M. SAUNDERS

We have here represented in profile (Fig. 1) a ventilating cowl such as is used upon sailing vessels and steamships, and by our Government upon its cruisers and battleships. These ventilators vary in size according to the use to which they are applied, and the nature and character of the conditions which surround them. The diameter at the base varies in different examples from 1 to 4 feet, and some of those used on

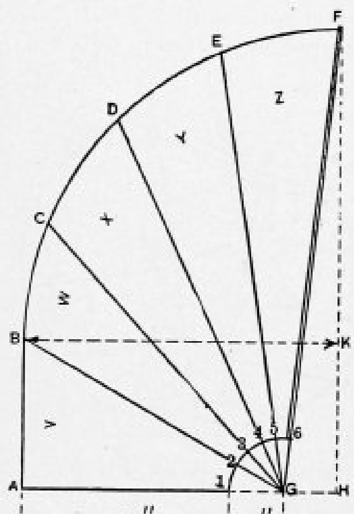


FIG. 1.—PROFILE OF COWL

our battleships are as much as 6 or more feet in diameter, but in their general proportion they remain practically the same in all cases, regardless of their size, the open face of the cowl as shown in Fig. 2 being twice the diameter of the base.

In the case shown in Fig. 2 the size of the base of the ventilator is 24 inches on a horizontal line, and its open face at top of 48 inches is not at right angles with the base, but is at an angle of from 80 degrees to 88 degrees, giving the angle AGF of the profile as the correct angle of the cowl. The radius of the lower circle, or throat of the ventilator, as shown from 1 to 6 in Fig. 1, is one-fourth the diameter of its base, which in this case would give a radius of 6 inches. In secur-

* From *The Metal Shop*.

ing the radius for the outside curve of the cowl, *B F*, shown from *B* to *K*, first outline the angle *A G F*, extending the line *G F* until the vertical line *F H* gives the height of the top from its base, which in this case is 54 inches. At point *A* of the base draw vertical line *A B*. The distance between lines *A B*

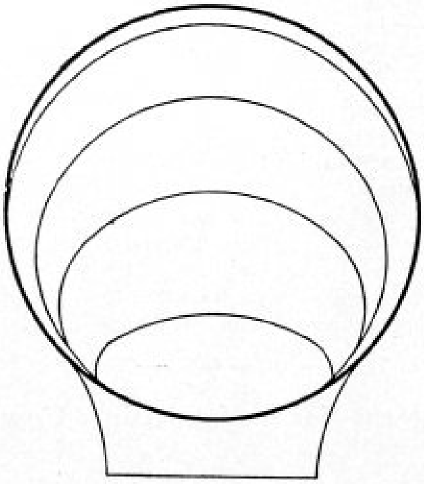


FIG. 2.—FRONT ELEVATION

and *F H*, as shown from *B* to *K*, gives the length of radius for the outer curve *B F* of the profile, which in this case is 36 inches. Set off 36 inches down from point *F* to *K* on line *F H*, thus obtaining *K* as the center and *K B* as radius for the curve *B F*. Thus we find that the proportional length of radius for the outer curve of the cowl, as shown by *B K*, Fig. 2, is one and one-half the diameter of the Base *A* 1.

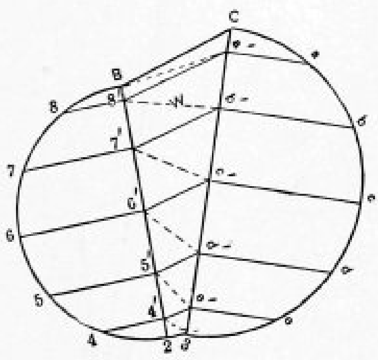


FIG. 3.—TRIANGULATION OF SECTION W

We next proceed to lay off upon the profile in Fig. 1 the various sections that go to make up the cowl. In the case of one of this size, only five, *V*, *W*, *X*, *Y* and *Z*, as shown, will be required. The first section *V*, on its outer profile, is a straight vertical line on the back, extending from *A* to the beginning of the curve at *B*. The remaining four sections, from *B* to *F*, are secured by dividing the quarter circle *B F* into four equal spaces. From the points of dimension *B*, *C*, *D* and *E* draw lines to *G*, cutting through the inner or throat

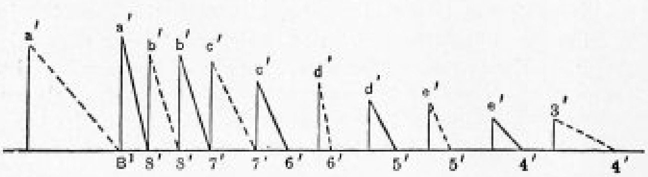


FIG. 4.—DIAGRAM GIVING TRUE LENGTHS FOR SECTION W

circle at points 2, 3, 4 and 5. This gives the five sections as explained. Section *V*, being practically straight, becomes similar to one piece of an elbow. The patterns for sections *W*, *X*, *Y* and *Z* are secured by the system of triangulation, two of which are fully developed and shown in Figs. 3 to 8 in-

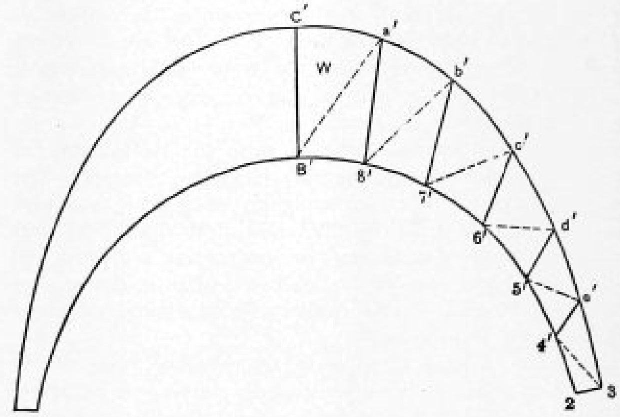


FIG. 5.—PATTERN FOR SECTION W

clusive. From each of these views the length of the various lines required in the formation of the pattern are determined.

To illustrate: Fig. 3 is a fully divided section of *B C* 3 2, lettered *W*. In securing its division first transfer its outline to another position as shown in Fig. 3 by corresponding letters and figures. On side *B* 2 of the section describe the half circle which divide into any suitable number of equal spaces, six being shown in this case. On the side *C* 3 describe another half circle as shown spaced off with six equal spaces, the same as be-

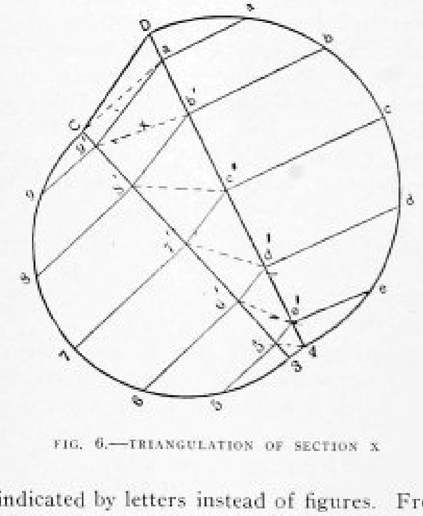


FIG. 6.—TRIANGULATION OF SECTION X

fore, but indicated by letters instead of figures. From the figured points on half circle *B* 2, and at right angles with the line *B* 2 draw lines, this obtaining points 4', 5', 6', 7' and 8'. In the same manner draw lines from points *a b c*, etc. This gives the lettered points *a' b' c'*, etc., as shown on line *C* 3. Connect the figured and lettered points in this view as shown, with both solid and dotted lines, as follows: *B* to *a'*, *a'* to 8', 8' to *b'*, *b'* to 7', etc. The two end lines *B C* and 2' 3', being center lines, are level lines and hence their true lengths may be applied directly in the formation of the pattern. The true lengths of all the intermediate dark or solid and dotted lines from *B a'* to 4', 3, must be determined, as none of them is a level line. What is true as to the development of section *W*, as shown in Fig. 3, is also true of the development of all other sections except section *V*.

The true lengths of lines that are used in section *W* are shown in Fig. 8. In determining the lengths of these lines, the process in the case of all the sections from *W* to *Z*, inclusive, is the same. So for the purpose of illustrating how those determined lines are secured we will take section *W*. The determined or true lengths of lines for this section are shown in Fig. 4. First, *B C* being a center and hence a level line, we may transfer it directly to the patterns when required. Next we have the dotted lines *B a'*, which length we place in a vertical position in Fig. 4, but as the two points *B* and *a'* are not of the same height, the point *a'* being the length of line *a' a* higher, we lay off that length in Fig. 4 from the base of the vertical line, thus obtaining the point *a'* of Fig. 4, when the slant line *a' B'* gives the true length. The next line in course is the solid line *a'* 8' of Fig. 3. This we transfer to a vertical position in Fig. 4. The distance to be set off from the base of this vertical line is equal to the difference in length of the lettered line *a' a* and figured line 8 8'. We thus obtain the oblique line *a'* 8' of Fig. 4, which gives the true length.

Next comes the alternate dotted line *b'* 8', whose length is set off as a vertical height in Fig. 4. The difference in height between lines *b' b* and 8' 8 of Fig. 3 is again set off from the base of the vertical line in Fig. 4, when the slant line *b'* 8'' gives the true length.

In like manner we transfer the lengths of all the solid lines of section *W* and set off the differences in height of the adjacent points, thus obtaining the slant lines or true lengths. Having thus determined the true lengths of all lines required in the formation of the pattern for section *W*, we next proceed to apply them as shown in Fig. 5.

Therefore, first transfer the line *C B* for the center of pattern shown by those letters in Fig. 5. The next line required in the development of the pattern is the dotted line *B a'* of Fig. 4. This line starts at *B* of the pattern, which is used as a center from which an arc is struck to intersect another arc whose radius is the space *C a* of Fig. 3 at point *a'* of the pattern, the space *C a* being one of the divisions of the half circle on side *C* 3 of section *W* in Fig. 3. We next use the solid line *a'* 8 of Fig. 4 as a radius and strike an arc from *a'* of the pattern to intersect an arc whose center is *B* of pattern and whose length is the space *B* 8', said space being one of the divisional spaces in the half circle on side *B* 2 of section *W*, also shown in Fig. 3. All of the dotted lines intersecting with the spaces on the lettered or upper side of the profile of the pattern and the solid lines all intersect with the spaces on the figured or lower side of the pattern as shown.

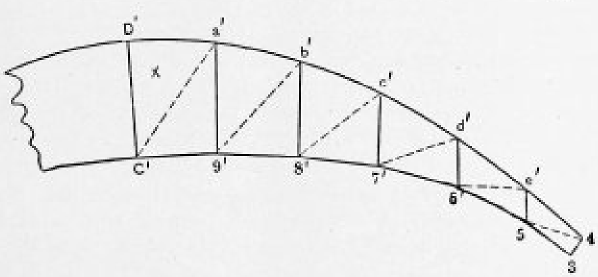


FIG. 8.—PATTERN FOR SECTION X

Connect the points thus established in the outline of the pattern and it completes the half pattern.

The pattern for piece *X* is shown in Fig. 8. This is obtained through the use of the diagram shown in Fig. 7. All patterns are procured in like manner from their respective elevations.

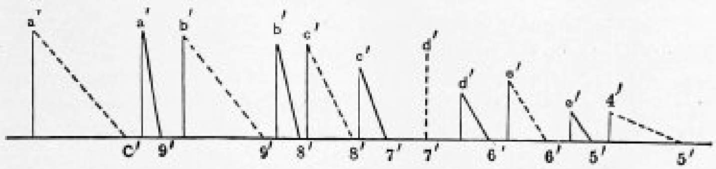


FIG. 7.—DIAGRAM GIVING TRUE LENGTHS FOR SECTION X

Talks to Young Boiler Makers

BY W. D. FORBES

Up in a small town, where there is considerable repairing to be done to the mill boilers in the neighborhood, I met a bright young boiler maker on whom I had kept my eye for some time. Not long ago I was up in that town and just at knocking off time I went to the shop where this young man worked and we walked down to my hotel together.

My young friend was blue, and after a while he told me his reason for being so. He said: "My old man is from the old country and there is not a man about here who is better at his trade. He has been good to me, and I know my trade as well as any fellow with my experience. I try to learn all the time, and I read THE BOILER MAKER, and that helps me a lot, but I am going to quit the trade, and this is just why.

"As I said, my dad is at the top of the heap in boiler making. I have been helping the boss, while the bookkeeper has been out sick, and I find that up here, where wages are not high, the run of men get $18 per week, while dad, who can work all around them, only gets $20 per week. Now either the ordinary man is getting too much for his work, or dad is not getting enough. According to my way of thinking, or looking at it, it don't pay to be the best workman. Now, what do you think about it?"

This young man has struck one of the "hard spots" in the boiler plate of life. What he told me is not new, but it is true. Of course, it may be said that the boss is at fault, he ought to recognize superior skill and pay more for it, but we all know what that would result in.

To my mind this system has risen largely because there are a lot of poor boiler makers who would have made very good grocery men, but they were not fired, as they should have been, when they started to learn the boiler trade, and this poor lot of boiler makers have to be carried by such men as my young friend's dad.

It would be an interesting thing, I think, if the readers of THE BOILER MAKER would express themselves on this very interesting and vital subject.

Not long ago I wrote about the lever and screw, and how that by neither could power be gained except at a sacrifice of speed or time. I have been asked to explain the ordinary pulleys, such as are usually used in a boiler shop. Now, exactly the same law holds in the operation of pulleys as it does in the lever.

We will suppose that we have a weight held up by a single rope (Fig. 1), and the weight is 1,000 pounds. We find that a certain rope will support this weight. Now it must be remembered that rope is measured by its circumference and not by its diameter—that is, what is called a "three inch" rope measures a little more than one inch across.

There is a table which gives the breaking strength of Manila ropes. This table has been found, by experiment, to be correct. It was made up by Mr. Spencer Miller. Of course it must be remembered that when hoisting a weight a rope must be selected which is considerably stronger than one which will just break with the load, and in every day practice it is well to have what is called a "factor of safety" of four, or, in other words, the rope should be four times as strong as the breaking strength shown in the table. If the rope is new it is quite safe to select one only twice as strong as is needed, yet it is generally wiser to stick to the safety factor of four.

Fig. 1 shows a 1,000-pound weight suspended by a single rope. If, now, the weight was suspended by four ropes as

FIG. 1

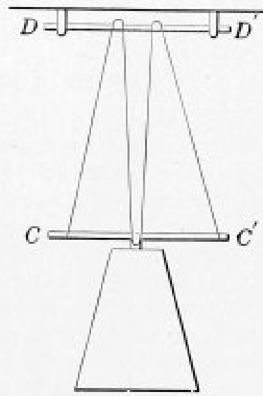


FIG. 2

shown in Fig. 2, it is evident that each of the four ropes could be one quarter as strong as the single rope shown in Fig. 1, and yet sustain the weight—that is, of course, if each rope took its proper proportion of the strain. This would be difficult to do if the ropes were knotted, but if the rope was made fast to the bar *C C'*, starting at *C* and passed up over the bar *D D'*, and down to the bar *C, C'*, and made fast at *C*, it is clear that the strains must be equal on all the ropes. Let me explain here, when a little mark is put a little above, and to the right, of a letter, or figure, as at *D'* and *C'*, it is read "*D* prime" and "*C* prime." This distribution of strains on ropes will be shown later where several pulleys are used.

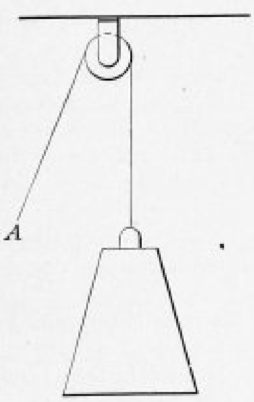


FIG. 3

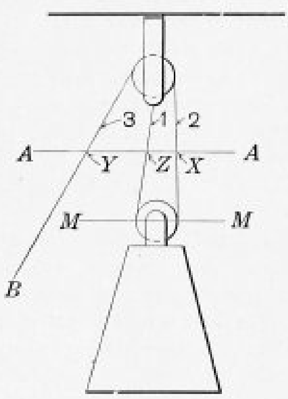


FIG. 4

Fig. 3 shows a pulley over which a rope is passed and sustaining a weight of 1,000 pounds. It will take a little more than 1,000 pounds pull on the end *A* of the rope to lift the weight, as there is a little friction in the pulley to overcome. The greater the number of pulleys there are in the hoist, the greater will be the friction.

If we rig up pulleys as shown in Fig. 4, we will have two ropes to sustain the weight, and it will take a little more than 500 pounds pull on the rope at *B* to lift the weight of 1,000 pounds, as the friction of the two pulleys must be overcome. This, at first sight, would look like a gain in power, as we lift the weight of 1,000 pounds with a pull of only a little over 500 pounds, but when we come to look into the matter we will see that the gain is at a sacrifice of speed, as we will have lifted the weight only half as far as we did when we put a 1,000 pounds pull on the rope. To explain this is not as easy as one might suppose, although it looks quite simple.

Referring to Fig. 4, we put a line *A A* across the three ropes, which cuts them at the points *Y, Z, X*. The rope 1 is made fast to the bracket which carries the top pulley. It then passes down around the lower pulley, then up around the top

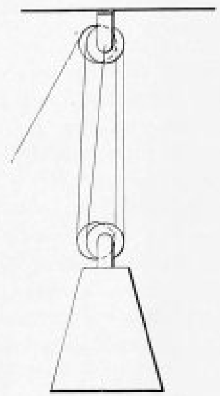


FIG. 5

pulley, and the power is applied at *B*. The rope 1 does not move when the rope is pulled, until the center of the lower pulley is reached, or where the line *M, M* passes across it. The rope 2 moves upwards when the power is applied at *B*, and the rope 3 moves downwards and, of course, these two ropes (which are really one) move the same distance.

If we suppose the line *A A* is just one foot above the center of the lower pulley, and we pull on the rope at *B* until the center of the lower pulley has risen to the line *A, A*, what has taken place? Rope 2 has been shortened one foot (i. e., the distance between the lines *A, A*, and *M, M*), and, at the same time, rope 1 has been shortened one foot, so it is clear that two feet of rope has been hauled over the upper pulley to raise the lower pulley one foot.

From this we can make a rule which will show how to find out how much a given power will lift with a single pulley, or any given number of pulleys. Multiply the number of ropes in the combination by the power applied, not counting the rope on which the power is applied. In Fig. 3 we would have

$$1{,}000 \times 1 = 1{,}000 \text{ pounds lift.}$$

In Fig. 4 we would have

$$1{,}000 \times 2 = 2{,}000 \text{ pounds lift.}$$

If we have a double pulley, as Fig. 5, we would have

$$1{,}000 \times 4 = 4{,}000 \text{ pounds lift.}$$

There is something else to remember, however, and that is the amount of rope which has in each case been overhauled. In Fig. 3 one foot of rope would have been overhauled, in Fig. 4 two feet of rope would have been overhauled, in Fig. 5 five feet, and so from this we have another rule that will show how much rope will be overhauled in raising a weight a given distance. Multiply the distance the weight is to be raised by the number of ropes in the pulleys, not counting the one the power is applied to.

It can be seen at once that with several pulleys, as in Fig. 5, the strain on each rope must be equal, as it was in Fig. 2, when the rope was a single piece looped over the bars, and it follows that as the number of ropes are increased their size can be decreased, and yet sustain the same weight.

The Boiler Maker

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NOTICE TO ADVERTISERS.

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

Another year has passed and still the number of States in which the construction and inspection of steam boilers are governed by effective laws is pitifully small. Massachusetts, Ohio, Minnesota and Montana stand alone in this respect, and in their splendid example lies a ray of hope that similar action will not much longer be delayed in a number of other States. Let the present year be the turning point toward widespread uniform boiler legislation in every State in the country.

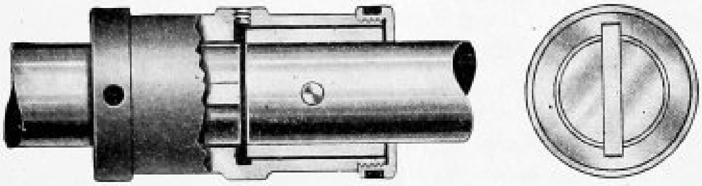
In the first annual report of the chief inspector of locomotive boilers, recently published, there is tabulated a complete list of the total number of locomotive boiler accidents which have occurred during the year, giving the nature or cause of the accident and the number of persons killed and injured. According to these statistics, there were in all 856 accidents, 91 persons killed and 1,005 injured. Of the total number of accidents, 243 were due to defective squirt hose and connections, 165 were due to burst water glasses and 94 were the result of crown sheet failures, making 58.5 percent of the total number of accidents due to these three causes. The greatest number of fatalities resulted from crown sheet failures, 54 persons being killed in this way. Twenty-seven persons were killed through explosions of the shell of the boiler, thus making the failure of boiler shells and crown sheets responsible for 89 percent of the fatalities. The greatest number of injuries were caused by defective squirt hose and connections, 245 persons being injured in this way. One hundred and sixty-eight persons were injured by burst water glasses, and a like number were injured by crown sheet failures. With a knowledge of these facts, there is no reason why the railroads should not in a very short time practically eliminate a very large percentage of such accidents with their consequent injuries and fatalities. The constant failure of certain boiler accessories can certainly be prevented, and while it may be impossible to eliminate entirely crown and shell failures, yet a well-designed and well-built boiler, if properly handled and periodically inspected, should prove, above all else, a reasonable guarantee of safety.

The fact that the present age is, in every sense of the word, an age of progress, is no more fully realized than when the present-day achievements in mechanics and engineering are compared with the practice of even a decade ago. The prevailing tendency in the last few years in the development of locomotive boilers has been increase in size and power coupled with greater economy and also some tendency towards standardization, although progress in the latter direction leaves much to be desired. Very considerable gains in economy of operation have resulted from the adoption of superheaters, and it is now becoming common practice to use superheaters on all types of locomotives. Second to the superheater, perhaps, the brick arch should be classed as the most effective means for reducing fuel consumption. The increase in the size of the locomotive has resulted in large diameter of boiler shells and increased length of tubes. Mechanical stokers have been given a thorough try-out, and the experimental stage in their construction and application is practically passed over, so that standard types of mechanical stokers are now being quite generally adopted with good results. The direction in which to look for further development lies probably in the design of the firebox and in the means for securing more perfect combustion under the conditions which must be encountered in locomotives. In stationary boilers of the fire-tube type development is looked for principally in the quality of material rather than in improved construction. The design of the horizontal tubular boiler has changed very little of late, except in the matter of furnaces, settings and accessories. On the other hand, watertube boilers have undergone a continual development in design, in order to meet the increasing demands of modern power plants, with the result that a distinct advance has been made from the viewpoint of efficiency and economy of operation; but in order to duplicate the admirable records of old boilers which have been in almost continual use for twenty or thirty years, with apparently no deterioration in the quality or strength of the material of which they were constructed, it is evident that the quality of modern boiler steel must be given first consideration in present-day boiler practice.

Engineering Specialties for Boiler Making

An Improved Steel Coupling for High or Low Speed Shafts

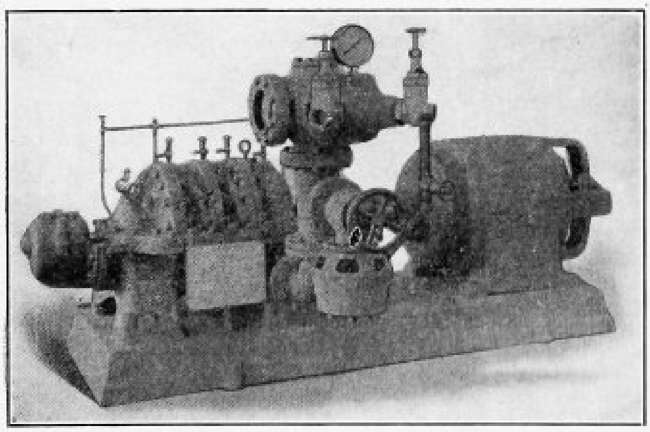
A new form of flexible coupling, made entirely of crucible cast steel and to dimensions especially suitable for this material, is being introduced by McEwen Bros., Wellsville, N. Y. This McEwen coupling, as it is called, and as illustrated herewith, is said to have the smallest diameter and mass, and therefore the smallest inertia of any truly flexible coupling on the market. The keys extend clear through the shafts, are set at right angles and are arranged to permit a marked degree of misalinement, yet because of ample key-bearing surface and the exceptionally good lubrication from packing of heavy oil or soft grease, there is no noise or tendency toward serious wear. The design is particularly good for withdrawals parallel to the shaft axis, and very small clearance is required for



removing any part. This type of coupling was first used, and has been given its severest test upon McEwen Bros. pumps, direct connected to steam turbines running twenty-four hours per day for months at a time. The satisfaction which it has given under these high speeds and other severe conditions as reversible motor drive for machine tools, would seem to indicate a general usefulness for blower, rotary pump, motor, generator and turbine and line shaft connections and on other machinery of any speeds.

New Centrifugal Fire Pump

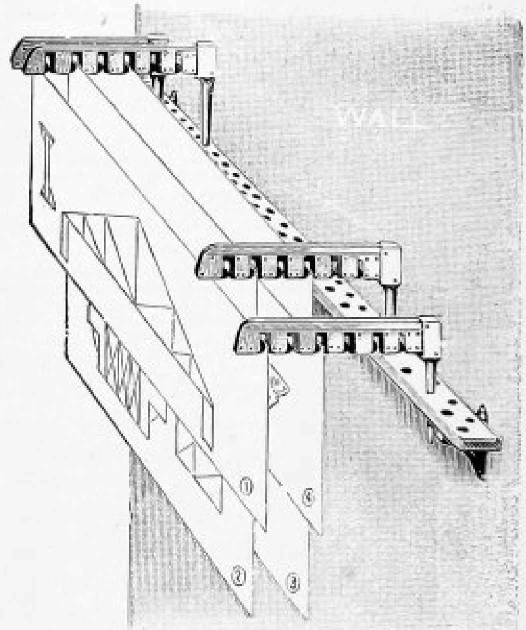
A new design of centrifugal fire pump has just been developed by The Goulds Manufacturing Company, Seneca Falls, N. Y., and is handled in England by Messrs. Gillespie & Beals,



Amberely House, Norfolk street, The Strand, London. The outfit is furnished complete with pump, electric motor (a. c. or d. c.) or steam turbine, bed plate and all fittings required by the fire insurance companies, and it has been approved by the Association of Mutual Factory Fire Insurance Companies. Four sizes are furnished, with capacities of 500, 750, 1,000 and 1,500 gallons per minute, being sufficient for two, three, four and six effective fire streams respectively. All working parts are made of bronze to prevent any corrosive action from the water. The outfit illustrated is a 500-gallon equipment for two effective streams. With 250-foot leads of smooth hose and 1⅛-inch nozzle, the pressure at the nozzle is 50 pounds per square inch. This will produce an effective stream in a moderate wind at a vertical height of 70 feet and a horizontal distance of 63 feet. The motor with this outfit runs at 1,700 revolutions per minute and has an output of 50 horsepower. The overall dimensions of the complete outfit are: Length, 9 feet 7 inches; width, 6 feet 3 inches; height, 4 feet 9 inches.

Engineers' Photo Drying Rack

H. Schery & Company, Manchester, has placed on the market a convenient device for drying engineers' prints. The construction of the rack will be seen from the illustration. The

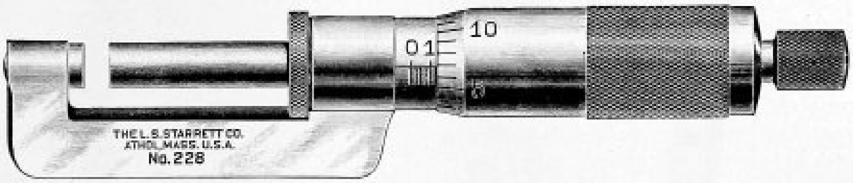


mere insertion of the print into the clip will hold it securely, and a touch of the finger will release it again. The print is stretched out evenly over the whole surface and will, therefore, dry without creasing or crumpling. A number of prints can be dried at the same time occupying a very small space.

The New Starrett Hub Micrometer

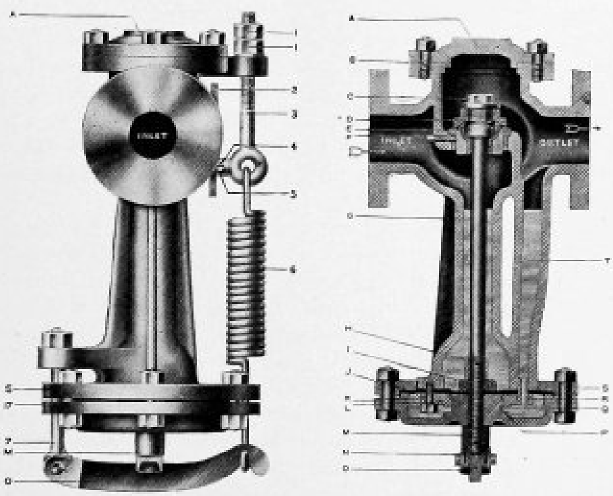
Until recently the only method of measuring hub thicknesses has been to lay a straight edge on one side of the hub and put a steel rule through the bore, reading the thickness on the opposite side from the straight edge. Sometimes when the total diameter of the wheel or gear was small a pair of calipers was slipped over and the thickness of the hub calipered in the usual manner. A new Starrett micrometer, manufactured by the L. S. Starrett Company, Athol, Mass., does away with liability of error common with the rule or caliper method, because the measurement is made direct and the micrometer reading insures absolute accuracy. The feature of this micrometer is the frame, which instead of flaring out in a semi-circular form, as do ordinary micrometers, is offset only slightly from the center line of the spindle. By making the frame narrow it may be easily inserted in holes as small as ¾ inch diameter.

The new micrometer has the combined speeded thumb piece and ratchet stop that have been a feature of other Starrett micrometers, and it also has the lock nut. The speeded thumb piece gives a smaller periphery for the thumb to turn, which greatly increases the speed with which the micrometer may be set. The thumb piece is also a ratchet which acts as soon as a slight pressure has been applied to the work being measured, thus preventing excessive pressure being applied to the work, as would be easily possible with a micrometer screw, which is forty threads per inch. The lock nut is useful to make a gage of the micrometer, as when a large number of pieces must be made to a certain size.



Auld "Quitetite" Reducing Valve

The Auld "Quitetite" reducing valve illustrated, which is manufactured in Scotland by David Auld & Sons Company, Ltd., of Glasgow, and in the United States by Schutte & Koerting Company, Philadelphia, Pa., is a useful boiler accessory for cases where it is desired to use reduced pressure steam. The valves are specially designed for accurately reducing from any high pressure down to any lower pressure which may be desired, so that they will hold this reduced pressure constant irrespective of fluctuations on the initial or boiler side, and also when no steam is being used on the outlet side of the valve. With these valves it is claimed that it is quite possible to maintain a constant reduced pressure of two or three pounds on the outlet side, while the boiler pressure may be as high as 250 pounds per square inch. There are two branches, one on each side of the valve, one of which is the inlet and the other the outlet. High-pressure steam enters through the inlet and acts between valve (*D*) at the top and piston (*P*) at the bottom, which are the same area, and, therefore, in equilibrium on the high-pressure side. Reduced pressure is obtained by screwing up adjusting nuts (1) on the spring bolt (3) until the pointer on the spring bolt is opposite the figure on the scale representing the reduced pressure required. Acting through the lever (o), at the bottom of the valve, the expansion of spring (6) opens up the valve between the inlet and outlet branches, and passes steam at a reduced pressure to the outlet side. When the pressure of this reduced steam tends to rise above that required it closes the valve by acting on the back of valve (*D*) and chamber (*Q*). When the pressure tends to fall, the tension of spring (6) overcomes the force holding the valve closed, and thereby opens the valve, allowing it to admit more steam to the low-pressure side, and in this way the reduced pressure is kept constant. A flexible diaphragm is fitted at the lower end of the valve body, which, it is claimed, makes a frictionless steam-tight packing between the stationary and movable lower parts of the valve. This diaphragm is protected from the action of steam by water of condensation which collects in the lower part of the valve and keeps the diaphragm cool. The valve is manufactured in all sizes, from one-half inch upward.



Personal

Harry B. Hare, assistant secretary and assistant treasurer of the Otis Steel Company, Cleveland, Ohio, was killed Dec. 28 in an automobile accident. Driving his car home late at night, he ran into a deep sewer excavation. He died a few minutes after reaching a hospital. He was 42 years of age and had been connected with the company 12 years, having been first associated with the sales department. He was a member of the University, Euclid, Union and Athletic Clubs and the Chamber of Commerce, Cleveland. Mr. Hare was treasurer of the Supply Men's Association of the American Boiler Manufacturers' Association and also vice-president of the Boiler Makers' Supply Men's Association of the Master Boiler Makers' Association.

G. Mihleisem, assistant general boiler inspector of the Coast lines of the Atchison, Topeka & Santa Fe Railroad, has been appointed boiler foreman with headquarters at La Junta, Col., vice Rance Johnson, transferred.

Val. Rich, for many years foreman boiler maker of the Chattanooga Boiler & Tank Company, Chattanooga, Tenn., was promoted to the position of superintendent of the company Jan. 1. No doubt his many friends will be pleased to learn of his "New Year's present."

James F. Hobart, M. E., a contributor to this journal and an inventor and designer in the research department of the Diamond Match Company, Barbarton, Ohio, resigned Dec. 5 to become superintendent of the Hanna-Breckinridge Machine Company, Fort Wayne, Ind. Mr. Hobart assumed his new position on Dec. 9, and will be busily engaged in systematizing and introducing improved methods in the largest machine shop in the world devoted to the rebuilding of wood-working machinery and the manufacture of hollow blast grate bars.

Miss Alice B. Chute, of Youngstown, Ohio, has the unique distinction of being the only female master boiler maker in the world. Miss Chute obtained her technical education in drafting and the boiler making trade with the Variety Iron Company, Cleveland, Ohio. She advanced to the position of assistant to the president of this company, but a change in the management caused her to resign and take a position with the Enterprise Company, Youngstown, Ohio, some twelve years ago. For six years she personally directed the shop work. An interesting photograph was published recently in the *Pittsburg Gazette Times* showing Miss Chute supervising and directing the placing of a large tank which forms part of an automatic sprinkling system on the top of the new Park Theater Annex, a ten-story building in Youngstown.

Technical Publications

OFFICIAL PROCEEDINGS OF THE WESTERN RAILWAY CLUB FOR THE YEAR 1911-1912. Size, 6 by 8¾ inches. Pages, 278. Numerous illustrations. Chicago, 1912: The Western Railway Club.

This volume contains the complete official proceedings of the Western Railway Club, an organization which meets once each month during the year, except in the summer, and discusses a wide range of subjects relative to safe and economical railway operation, and to the construction, maintenance and service of railway machinery, motive power and rolling stock. The papers read before this club during the past year, which are of particular interest to boiler makers, are on the subjects of oxy-acetylene welding, locomotive lubrication, water treatment and boiler troubles. Abstracts of some of these papers have already been published in our columns, but in this volume will be found the text in full, together with the complete discussion of the papers.

COAL. By E. E. Somermeier. Size, 6 by 9 inches. Pages, 175. Illustrations, 8. New York, 1912: McGraw-Hill Book Company. Price, $2 net.

This book treats of the composition, analysis, utilization and valuation of coal. The data and descriptive matter given are largely based upon private notes and upon information scattered through books and the various publications in the engineering press. It is the intention of the author to present this data in such a form as to be readily applied and interpreted, and readily utilized by those who have an active interest in coal, which means practically everyone who is concerned with the generation of power. Three distinct classes of readers have been kept in mind in arranging the book, namely the mechanical and power plant engineer, the chemical engineer and chemist, and the non-technically-trained business man and operator who has to do with the buying and selling of coal.

THE THEORETICAL AND PRACTICAL BOILER MAKER AND ENGINEERS' REFERENCE BOOK. By Samuel Nicholls. Size, 4¾ by 7¼ inches. Pages, 273. Numerous illustrations. New York, 1912: J. S. Ogilvie Publishing Company. Price, $2.50.

It would seem a somewhat difficult task to compile a book which would be equally useful for the practical workman in the boiler shop and the engineer who has to design the work. This book, however, covers such a wide range of topics essential to a thorough understanding of the work of boiler making, that it will be found a useful aid in the drawing office of the engineer as well as in the hands of a layer-out or foreman boiler maker who directs the actual construction work. The aim of the author, as expressed in the preface, has been to express everything as clearly as possible, so that no formulæ will be encountered which cannot be easily mastered by anyone possessing a fair knowledge of arithmetic. The book begins with a table, giving the diameters, circumferences and area of circles, information which is indispensable in boiler work. Tables are also given of the dimensions for internal and external angle iron and tee bar hoops, with rules for ascertaining the required length of a straight bar for the formation of any hoop which is likely to be used in a steam boiler. These are followed by tables of weights of different materials and shapes commonly used in boiler making. The subject of the strength of boilers is taken up in detail, and the methods of calculating various parts are explained by examples. A very complete chapter is given on riveting, which is accompanied by tables giving the pitch and diameter of rivets for different thicknesses of plate. An important chapter is that discussing the repairs of steam boilers. Welding, construction, setting, boiler power, incrustation and calculation of the ordinary lever safety valve are also discussed in detail. The last chapter in the book is upon templet work, and this the author considers as of more importance than any other given in the volume. We quite agree with the author as to the importance of templet work in boiler making; but we think that it deserves a more extended treatment than is accorded it in this chapter. The simple problems explained present no insurmountable obstacles to the beginner, but the actual application to sheet metal work requires further study than is outlined in this volume.

PERKINS' TABLES. By Lyman B. Perkins. Size, 5 by 7½ inches. Pages, 361. Hartford, Conn., 1912: Lyman B. Perkins. Price, $5.

This book contains a large number of convenient tables for use in the calculations for safe working pressures on boilers, compiled by a man who is a past assistant engineer of the United States navy, and who has been employed in various capacities for 25 years by one of the large boiler inspection and insurance companies, and at the present time is holding a certificate of competency as an inspector of steam boilers in the Commonwealth of Massachusetts. Evidently the author has found, and apparently appreciates the fact, that any one else who has regularly or occasionally the duty of calculating the safe working pressures to be allowed on boilers also finds that this work is not only tedious but objectionable as a source of possible errors and waste of time in checking up and correcting the original work. Realizing this, he has set to work and compiled the actual values, calculated absolutely in accordance with simple rules governing particular cases, of the safe working pressure to be allowed on boilers. The results obtained and tabulated in the book were derived by the use of whole numbers and decimals, if any existed, to such an extent that the tabulated results are practically absolutely free from error. Where particular laws or rules governed calculations, such laws and rules are absolutely adhered to. Those familiar with the usual procedure for obtaining the safe working pressure of the boiler know that it requires at least four operations of multiplication and division after certain values entering into the computation have been calculated by numerous other computations. The tables published in this book cover these operations to the extent that only a single multiplication and a simple division are required to obtain the result.

The first tables in the book give the bursting pressures of thin hollow cylinders without a joint. Next comes the subject of head bracing, with complete tables for the ordinary sizes of heads commonly used. Following this are tables of segmental areas. Then, practically the rest of the book, or about three hundred pages, is given up to tables showing the strength of riveted joints. These tables include lap and butt joints calculated for sixteenth-inch variations in pitches for lap joints, and for thirty-seconds in variation in close pitches and butt joints; for the different tensile strengths found stamped on the plates, both iron and steel; for the various shearing values of iron and steel rivets approved by use or special law; for thicknesses of material varying by thirty-seconds inch from one-quarter inch up to fifteen-sixteenth inch. A complete table of pitch joint efficiencies is tabulated, which is calculated in strict compliance with the law as given in the rules of Board of Boiler Rules of the Commonwealth of Massachusetts recognizing the specific value given to the shearing of steel rivets, the crushing value of steel plates, and also the least thickness of butt straps estimated with each thickness of plate. In addition to these tables on joint efficiencies two separate tables are given which may properly be termed keys to efficiency calculations, as they are provided to reduce to a minimum the labor of calculating the efficiency of a pitch joint. The methods of calculating these efficiencies are fully explained on pages immediately preceding the tables.

This book is most assuredly a valuable aid to boiler makers.

Letters from Practical Boiler Makers

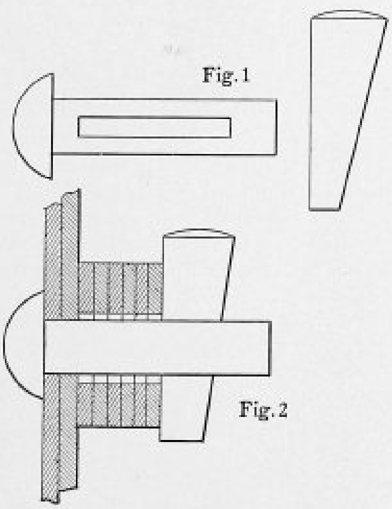
Camber in Plates of Ninety Degree Elbow

If you allow a late convert to the subscription list of your journal to take up your valuable space, I would like to say a few words suggested by Mr. Linstrom's article in the November issue, entitled "Construction of a Ninety Degree Elbow." In the mild and salubrious climate of Alabama, when a conical section of pipe is made, it is customary to put a certain amount of "camber" in the sheet. If made otherwise we generally find the rivet holes in the round about seam do not all lie in the same plane. This state of affairs is liable to cause friction not only between the drift pins, reamers and plates, but also between the layer-out and the boss. If Mr. Linstrom will kindly explain how he avoids the unpleasantness, I am confident he will receive the applause and thanks of the laying-out world.

Ensley, Ala. C. G. REEM.

Tank Maker's Assembly Bolt

Some devices of considerable merit are extremely local in their application. It is not the least of the benefits of the technical press that methods and kinks perfectly well known and widely used in a particular section of the country are given a wider audience. In every branch of manufacturing this is the case. A man, even though he has traveled about a good deal and worked in a number of shops, cannot possibly cover the ground of experience in the same way that a good technical journal can do. It is even possible by quite casual reading of the technical press to adapt ideas used in other branches of the craft to one's own particular problems.



APPLICATION OF ASSEMBLY BOLT

The bolt illustrated is believed to be one of the numerous instances above referred to. It may be quite well known to some and absolutely new to others.

It is a bolt used for the assembling of tank sheets for riveting, and its value is undeniable, since tank makers working piecework in London use it to the exclusion of any other device.

It is purchased from bolt makers as an ordinary article of commerce, and its cost is little higher than ordinary screwed bolts and nuts.

Each riveter has a box of a portable type, containing some grosses of washers and some dozens of the bolts illustrated. A blow with a hammer suffices to fasten or slacken out, and it is quite effective in use with gages up to ¼-inch plate and rivets to ½-inch diameter.

In one tank shop known to the writer it would be difficult to find a screwed nut and bolt. When it is considered that the work is by the piece and the prices are low (the cost of finished light gage tanks are always a marvel to me), the saving of time over a screwed bolt and nut is considerable.

Fig. 1 shows the bolt and cotter, while Fig. 2 shows the application to a pair of sheets. The sketches are self-explanatory. A. L. HAAS.

London, England.

Convenient Rules for the Layer Out

The following are simple rules which possibly will be of some use to those who are learning or practicing laying out. They may be well known to some readers, but at any rate they have come in very handy at times for the writer.

Figs. 1 and 2 show the method of finding the radius for laying out a flaring article. Let us assume that a flaring

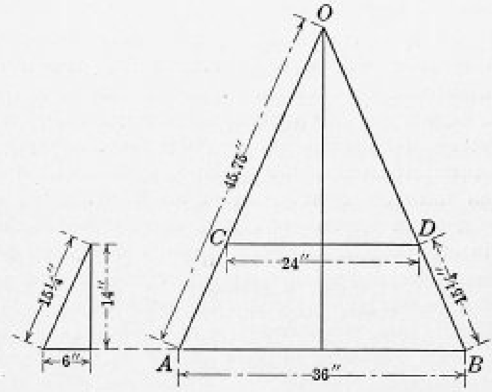


FIG. 1 FIG. 2

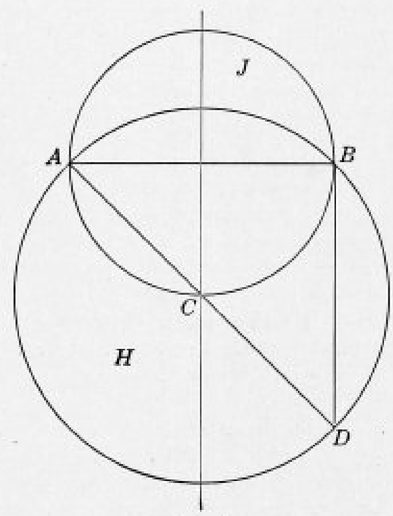


FIG. 3

piece must be laid out whose base, *A-B* (Fig. 2) is 36 inches and top, *C-D*, 24 inches. The rule is to multiply the large diameter by the slant height and divide by the difference between the large and small diameter. In this case, if we refer to Fig. 1, we will see that the slant height is 15¼ inches. Thus $36 \times 15\frac{1}{4} = 549$, and 549 divided by 12, the difference between the two diameters, gives us 45.75 inches, the length of the radius of the large end or base. Of course the trammels will have to be set from *O* to *D* for laying out a small end. Fig. 1 shows how to get the length of the slant height if there is an equal flare all around.

Fig. 3 shows the method for obtaining a circle whose area is twice the area of a given circle. Let J be the given circle; draw the diameter, A-B, and at right angles to it from B draw the line B-D, equal to the length of the line A-B or the diameter. Then draw A-D and bisect A-D, obtaining the point C. Using C as a center and with a radius C-A, draw the circle H, which will contain twice the area of J.

Springfield, Ill. JOHN COOK.

A Timely Word of Advice

In the October issue of THE BOILER MAKER, one of your correspondents, who signs himself W. J. Silver, has something to say which I think might convey a wrong impression to some of our younger readers. In reading through this communication it struck me that although we must not forget to have something in our paper for the younger readers, there is a limit which must be observed, unless we want to lose the older and more experienced subscribers to these columns. Therein, I think, must be the difficulty of an editor, *i. e.*, to cater for all the various subscribers to his paper. It must be understood that I do not in any way wish to cast adverse reflections on Mr. Hobart's excellent articles. Far from it. What I do say is that while we must never forget to have something which will be of interest to the younger readers, and which must be easily understood by them, it is of the utmost importance that we also have a great deal that will both interest and advance in knowledge those subscribers who are further advanced in the profession. It might also easily be taken from the communication referred to that algebra, etc., is quite an unnecessary study and not worth the while spent in studying same. How far on can anyone get when studying boiler making, or any other engineering subjects, without a knowledge of algebra and mathematics? Alas! not far. There is no advantage for a man who is going to drive rivets or use a calking hammer all his life, for example, to have any technical training; for of what use will it ever be to him? But is not technical training in all its branches of the greatest importance to the apprentice who aspires to become the boss? It not only sharpens him up but teaches him to think for himself, which surely is of some value.

We want our apprentices to use their brains as well as their hands. What I would say to our apprentices is: Go ahead, see and learn all you can, you can never know too much, and there is always something to learn if you only keep your eyes and ears open. Hard work and perseverance will always bring a reward which is well worth the trying for.

Lincoln, England. F. A. GARRETT.

Tanks for Export

There are problems to be faced in the tank business other than those of material, labor and manufacture. The cost of freight and transport forms one of the serious items for the consideration of the trade.

Large shipments of this class of goods are made from the United Kingdom to the Colonies. Australia, a notoriously dry country, is one of the best customers, taking quantities of galvanized tanks for water storage purposes.

Shipment freights are either deadweight or measurement of 40 cubic feet to the ton, vessels having the option of charging whichever method is in their favor. The writer has known a steamer of 4,000 tons get paid for 6,000 tons of cargo by loading boiler plate and pig iron at deadweight rates and fitting up the remainder of her space with lightweight measurement cargo at space rates. This fact is one of the inner secrets of the freemasonry of shipowning not usually understood by shore side folk.

Quite a lot of tank trade is indirect. It is by no means necessary for the maker of galvanized tanks to ship direct. Some of the largest customers are makers of packet goods like soap and cocoa. Regular trade sizes of galvanized tanks are filled with packet goods, to the detriment of the packing-case trade. A tank forms an ideal packing case when made as a closed article with a manhole; it is both watertight and air proof—moisture-laden air cannot get at the inclosed goods. Being filled tight, the tank of light gage suffers little from handling. It is possible practically any day of the week by taking a stroll through the London docks to see this method of packing for shipment in operation.

The tanks after being emptied of their contents find a ready local sale through merchants to settlers, who obtain an article of utility at a reasonable cost. Needless to say the problem of reduction of shipment charges has exercised many minds and various solutions have been made.

Open-top cistern tanks are nested in fours and sixes to reduce freight charges, while one is unable to utilize the packing-case method owing to the fact of their open top condition. With tanks of larger size, which are by reason of their dimensions a more serious problem, and which are more liable to damage also, a different solution must be sought.

One of the most interesting ways of meeting the difficulty is by means of the knock-down tank, usually of cube dimentions, to facilitate interchangeability of component plates. Each plate has two opposite edges flanged square with a radius of 2 inches center; the flanging is done cold. The two flat edges, as well as those flanged, are punched to the same layout with the same multiple punching machine. One plate in each six is fitted with a manhole opening and a manhole in the center of the plate. All the plates are galvanized.

Recently the writer had the opportunity of seeing a pile of such sheets ready to be boxed for shipment. The ease with which such tanks can be assembled for riveting was demonstrated by two men erecting twelve such tanks in the even hour. The correspondence of the rivet holes was exact. A sufficient quantity of galvanized snap-head rivets are sent with an excess of 5 percent above actual requirements. Riveting is done at the destination, cold; the head of the rivet being inside the tank, is protected by its coating from corrosion. Each corner has a triangular hole formed by the intersection of the three flanged portions of the sheets coming together; ¾-inch rivets with large flattened heads fill these, being knocked down hot.

Tanks of 4, 5 and 6 feet cube are usual dimensions, the thickness being ⅛ inch and 3/16-inch plate. Considerable care is needed in starting to make up a quantity so that strict interchangeability is maintained. In fitting up, canvas strips can be employed to joint the seams; but assurance was given that it is possible using the thicknesses cited to obtain with care a tight tank without such aid.

Holes are all punched from the joint side of the sheet, so that no burr to separate the seams exists. Whatever burr is on the outside of the tank when assembled assists to tighten the rivet and seam as the rivets are knocked down.

Another knock-down commercial article made in quantities is the contractors' galvanized wheelbarrow, several patents whose terms have now expired having been obtained for methods of construction permitting nesting for shipment. The bodies are completely riveted and finished and nesting closely together by reason of their tapered form. Twelve bodies occupy less space than one entire barrow made up. The iron work of the frames all comes adrift for bundling while the wheels pack flat together. In this case, also, the entire job must be strictly interchangeable.

Methods of saving freight are worth consideration. Their adoption is a gain to the community at large when considered from the widest standpoint. It is conservation of resources and economy of the highest order, whereby no one is the loser. Justification of existence whereby two blades of grass are grown in place of one has been often quoted. Such methods as are herein indicated are to the gain of all and to the hardship of none.

TANK MAKER.

Countersunk Riveting in Sheet Metal

The writer was recently designing a sheet metal article in which two portions touching were required to have relative movement. The design would be spoiled if these two portions were other than flat to each other, any gap or distance being precluded by the necessity of the design—so much so that the leading feature of the device and the *raison d'etre* of the job would be entirely spoiled if the difficulty could not be overcome.

The two portions in question had to be fastened in some manner or other to the remainder of the device. From considerations of cost, welding of any kind was out of the question. To secure thin gage sheet to ¼-inch metal without undue sacrifice of strength by riveting was the problem, and the solution must be cheap.

Discussing the matter one day with a friend in the business, he came forward with a solution of the question of this troublesome thin gage riveting worthy of wide application and consideration by everyone interested. It solved my difficulty, and in making the kink known I hope to be of service to all in the craft.

Countersunk riveting under its normal application cannot be successfully done with material less than 3/16 inch in thickness. Even here the strength of the finished seam is much inferior to snap-head riveting. Using thinner gages, 18 or 20 S. W. G., countersunk riveting is usually regarded as totally impossible.

The illustration shows the kink which got over the trouble. A piece of 20 S. W. G. sheet is to be attached to material ¼ inch in thickness. The one-quarter material has the holes

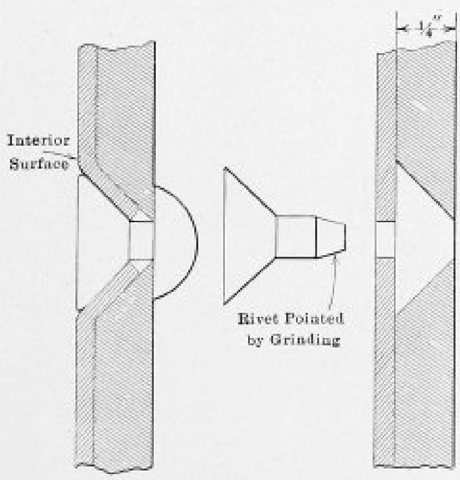


Fig. 1 Fig. 2

HOW THIN METAL WAS COUNTERSUNK RIVETED

drilled through, and same are countersunk on the side to which the thin material is to be fastened. Prior to the countersinking of the holes, the 20 S. W. G. sheet is marked through, using the ¼-inch plate as a templet. The actual rivets were 3/16 inch diameter. In the center of the holes, as marked on the 20 S. W. G. sheet, ⅛-inch holes were punched. The rivets used were first pointed by grinding and drawn through the two thicknesses, assembled by the use of a tool having a drilled clearing hole and a snap. The rivet was placed head downwards on an iron block, and with the 20 S. W. G. sheet under the job placed over the tail of rivet, a blow with the snap tool, using the clearing hole, entered the rivet. A couple of blows seated the rivet head, drawing in the 20 S. W. G. sheet to the shape of the countersunk head of rivet. Knocking down the tail of the rivet and finishing with the snap completed the rivet. Common sense and a trial hole is needed to determine the exact amount of countersink to be made by the drill.

The job when completed was all that could be desired. The 20 S. W. G. surface was smooth with no projections, the head of the rivet being just below the surface of the sheet, while the distortion of the sheet, being quite local in the hole, had no effect on the finish of surface.

The strength of the finished job is undeniable, and when galvanized and completed, exactly what was originally desired.

There seem numerous possibilities for this method of construction where projections are undesirable, say, where a cover has to be fitted to an article with a hoop or angle stiffener for opening. It would seem applicable up to and including ⅛-inch sheet by the use of suitable-sized rivets, the thicker gages requiring a larger rivet for its successful use.

Where handles have to be fitted to sheet metal articles seems another practical application, even where two rivets at each end of the forged handle are fitted trouble is subsequently experienced by the loosening of the rivets. Handles are usually of sufficient thickness to make the adoption of the kink possible. In fact, attachment of heavier material to thin gage sheet being usually unsatisfactory should lead to its adoption universally in this direction.

A. L. HAAS.

London, England.

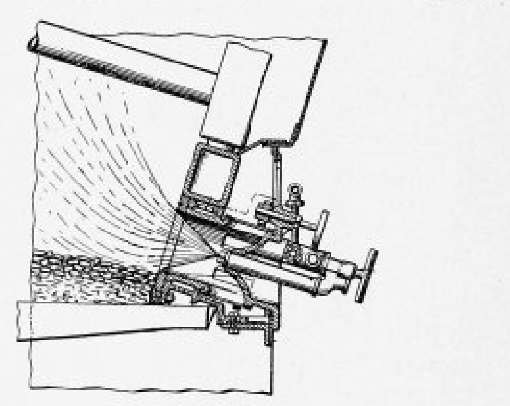
Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

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

1,039,586. PURIFICATION OF WATER. JOHN PATTEN, OF BALTIMORE, MD.

Claim 1.—The combination of a closed chamber, means for discharging water thereinto, means associated with said closed chamber for subjecting water flowing through the same, to the action of live steam



for removing corroding gases from the water, pipes connected with said closed chamber for discharging said gases mixed with steam to the atmosphere, and means in the circuit of said pipes for utilizing said gases and steam to do work. Two claims.

1,039,818. STEAM-PIPE SHIELD. MARION SANDERS, OF POPLAR BLUFF, MO., ASSIGNOR OF ONE-HALF TO GUS LYNCH, OF POPLAR BLUFF, MO.

Claim 2.—A protecting shield for the return bends of superheating steam pipes, comprising a cone-shaped body that includes a head portion of not greater thickness and width than that of the return bend to which it is applied, the said head portion of the shield having a concaved seat for receiving the outer end of the return bend and a socket, the said outer end of the return bend having a lug for engaging with the socket. Three claims.

1,040,088. BOILER-TUBE SCRAPER. CHARLES JOHN WRIGHT AND BRITTON BELL, OF KELOWNA, BRITISH COLUMBIA, CANADA.

Claim 1.—A device of the class described, comprising a tubular head, a bearing member slidably mounted therein, toggle levers pivoted to the bearing member and to the head and radiating therefrom, scraper members carried by said levers, a shank connected to the head, a handle connected to the shank, means slidably and rotatably mounted in the shank

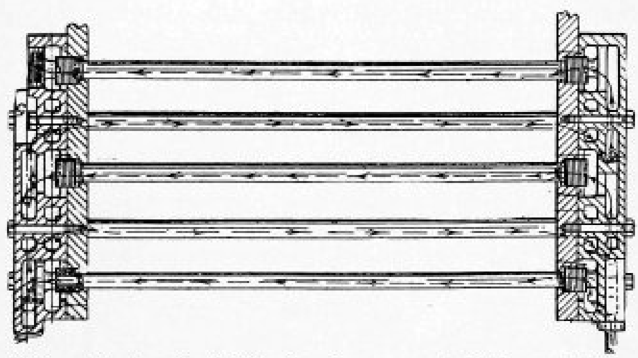
and engaging the bearing member for adjusting the separation of the head and bearing member and means including an operating member arranged adjacent the handle, and means normally acting on said adjusting means to force the bearing member toward the head and expand the toggle levers. Two claims.

1,038,172. SUPERHEATER. JAMES M. McCLELLON, OF EVERETT, MASS.

Claim 2.—In a boiler, the combination with a boiler shell having a fire-box at one end and a smoke chamber at the other, of superheating tubes extending through said shell and projecting at one end into the combustion chamber of the fire-box and at the other end into the smoke chamber, means to protect said tubes from contact with the water in the shell, means to connect the latter end of said tubes with the steam-generating space of the boiler, and a connection at the other end of said tubes for delivering superheated steam therefrom. Four claims.

1,038,024. STEAM GENERATOR. PAUL A. TALBOT, OF SEATTLE, WASH.

Claim 1.—A header adapted for connecting boiler tubes lying at different levels having a circulating passage with its bottom elevated in its



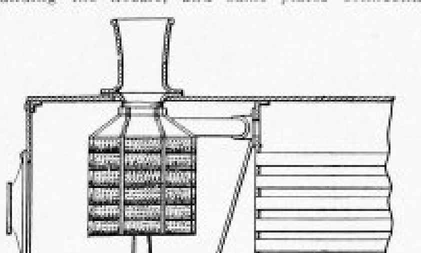
middle portion to a level higher than the upper part of the upper tube. Ten claims.

1,038,004. BOILER. CHARLES W. SEDDON, OF PROCTOR, MINN.

Claim 1.—The combination, with a boiler and a feed-water pipe having a discharge nozzle within the steam space of the boiler, of a pan arranged below the discharge nozzle and making a tight joint with the sides and front flue sheet of the boiler, the pan being highest at the rear and being inclined downwardly to the flue sheet, whereby the feed-water will be held within the pan until it has risen sufficiently to flow over the rear end thereof. Three claims.

1,037,898. SPARK-ARRESTER. ANDREW WALTER GRAHAM, OF BRADFORD, PA., ASSIGNOR OF TWENTY-FOUR AND THREE-FOURTHS ONE-HUNDREDTHS TO RANSOM G. LANDON AND TWENTY-FOUR AND THREE-FOURTHS ONE-HUNDREDTHS TO JOHN C. McCREA, BOTH OF BRADFORD, PA.

Claim 1.—A spark arrester comprising a nozzle, a plurality of spaced panels surrounding the nozzle, and baffle plates connecting adjacent



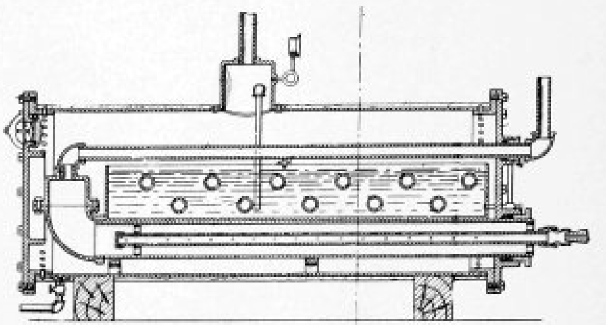
panels and provided with a plurality of openings that are surrounded by spark disintegrating teeth. Fourteen claims.

1,040,127. WATER-GAGE. HORACE S. BONESTEEL, OF GREEN BAY, WIS.

Claim 1.—In a water gage for steam boilers, the combination of a container of non-magnetic metal having integral vertical guides formed on the inner surface and extending longitudinally thereof adapted to be connected to the steam and water spaces of the boiler, a float in the container, a magnet strapped to the upper end of the float and having one end arranged between the said vertical guides to prevent turning of the magnet and the float. Two claims.

1,041,188. STEAM-GENERATOR. WILLIAM H. STEWART, OF KANSAS CITY, KAN.

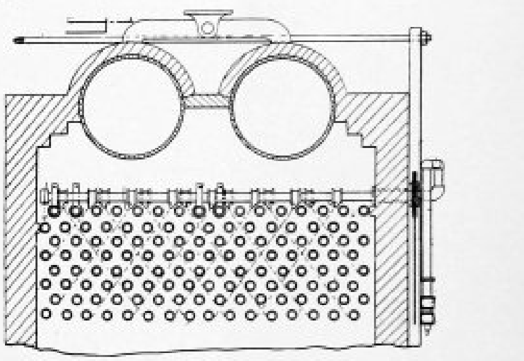
Claim 1.—A generator embracing a steam-chamber, a water receptacle within said steam chamber, communicating with a source of supply and



opening into the chamber to discharge steam therein, and a heater within said steam chamber free of contact with the water. Four claims.

1,041,141. BOILER-FLUE-CLEANER SYSTEM. JAMES MOORE, OF BOSTON, MASS., ASSIGNOR TO THE VULCAN SOOT CLEANER COMPANY OF PITTSBURG, PA., OF DUBOIS, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—In a flue-cleaner system, a flue, a rotatably-mounted fluid distributing pipe arranged at an angle to said flue, a feed pipe therefor,



a supply pipe to which the feed pipe is connected, and a plurality of nozzles interposed in the pipe and each provided with an outlet disposed obliquely to the axis of the pipe. Five claims.

1,039,768. OIL-BURNING PROVISION FOR BOILER FURNACES. LUTHER D. LOVEKIN, OF PHILADELPHIA, PA., ASSIGNOR TO SCHUTTE & KOERTING COMPANY, OF PHILADELPHIA, PA., A CORPORATION OF PENNSYLVANIA.

Claim 1.—In a combined coal and oil-burning furnace, the combination with the boiler housing, grate, water tubes, and mud drum adjacent one end wall of the housing and below the water tubes and above the grate, of an air box on the inner side of said end wall with a tubular extension lying between the mud drum and the grate, a check plate structure uniting with said mud drum and the inner wall of the air box proper to provide an air chamber surrounding said extension, and a nozzle for injecting oil into the furnace through said extension. Nine claims.

1,039,815. HEADER FOR WATER-TUBE BOILERS. BROR F. SAFBERG, OF BARBERTON, OHIO, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—A boiler tube header having on the face thereof a series of bosses, said bosses having tube holes the center lines of which are inclined alternately to the right and left of a plane perpendicular to the face of the header. Six claims.

1,041,325. FURNACE FOR STEAM BOILERS. EDGAR CONISTON MILLS, OF MANCHESTER, ENGLAND.

Claim.—In combination, a steam-boiler, a furnace external to said steam-boiler for providing heat for steam generation in such boiler, a casing for said furnace having walls and roof inclosing a chamber forming by its lower part a fuel-chamber to hold a fire-bed and by its upper part a secondary combustion space for secondary combustion above the fire-bed in said fuel chamber so that both the fuel chamber with the fire-bed therein and the secondary combustion space for secondary combustion are wholly free of contact of water-cooled plates and having within the walls and roof a plurality of air-cells each extending in the direction of and for the greater part of the length of the furnace from front to back and spaced from one another and with a plurality of orifices for each air-cell extending from the air-cells to which they are respectively connected and entering into the secondary combustion space in the chamber and above the fire-bed in the fuel-chamber therein and means to conduct air to the said air-cells whereby air will pass to said air-cells and being heated therein by absorption of heat, will pass thence through said orifices into the secondary combustion-space for secondary combustion above the fire-bed in the fuel-chamber in said chamber. One claim.

THE BOILER MAKER

FEBRUARY, 1913

Electric Welding Applied to Boiler Work

Reference was made in the March, 1912, issue of THE BOILER MAKER to the successful application of electric welding in the Hornell shops of the Erie Railroad, where a great variety of work is carried out in repairing not only locomotive boilers and fire-boxes but also various parts of machinery, such as cylinders, wheels, driving tires and broken and worn machine tool parts. No less an extensive application of electric welding has been made in the shops of the Central Railroad of New Jersey at Elizabethport, N. J., and through the courtesy of Mr. J. J. Mansfield, chief boiler inspector of this road, a representative of THE BOILER MAKER was permitted to inspect a great many of the repair jobs which have been made recently in this way and also to witness the operation of the welding apparatus.

The electric welding apparatus used in the Central Railroad of New Jersey shops was manufactured by the C & C Electric & Manufacturing Company, Garwood, N. J. While this installation was made less than a year ago it is stated that the machine has long since paid for itself in the savings made possible over the old-time methods of repairing boiler and machinery parts. The cost of doing such work by electric welding as compared with former methods is roughly in the ratio of 1 to 5. Outside of the wages of the single operator the cost of operating the machine averages about 20 cents per hour.

The range of repair work for which electric welding can be successfully applied is almost universal wherever machinery is used. A feature that is of particular advantage in a railway boiler shop is the fact that repairs can be made in place without the necessity of stripping or dismantling the locomotive. One of the principal uses in the railway boiler shop, of course, is for fire-box repairs in the application of half-side sheets and patches, and for closing up cracks around mud-rings between stay-bolts and rivets, and at the flanges and in the bridges of flue sheets. Where a crack occurs between stay-bolts the entire part of the sheet around the crack can be cut out and filled in solid with new metal, through which new holes for stay-bolts, etc., can be drilled. The metal added in this way is found to be soft and ductile, and offers no obstacle to drilling and machining as circumstances may re-

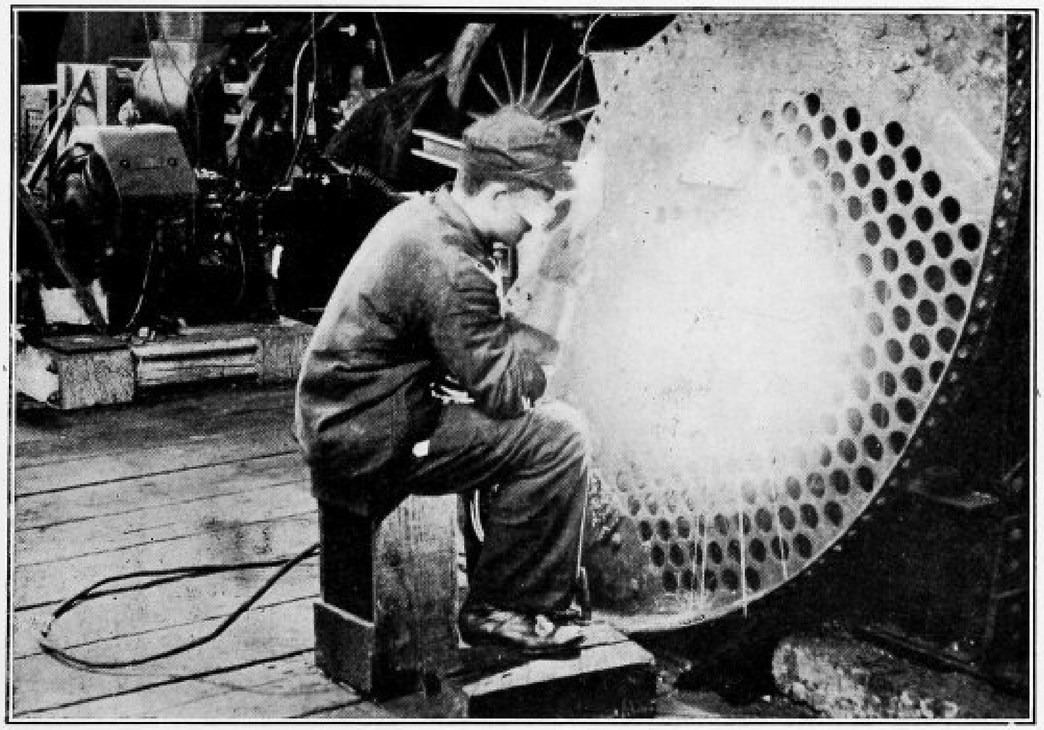


FIG. 1

quire. Besides saving costly patching electric welding is equally applicable to repairing fractured frames, driving wheels, castings and also for reclaiming pneumatic tools, drills, etc., which have become worn out or broken by usage. The feasibility of welding tubes in the flue sheet by electricity has also been demonstrated, the most successful method for this work, we understand, being to expand and bead the flue in the usual way, and then to weld the outside so that the flue can be cut off flush with the straight sheet without damaging the sheet in any way.

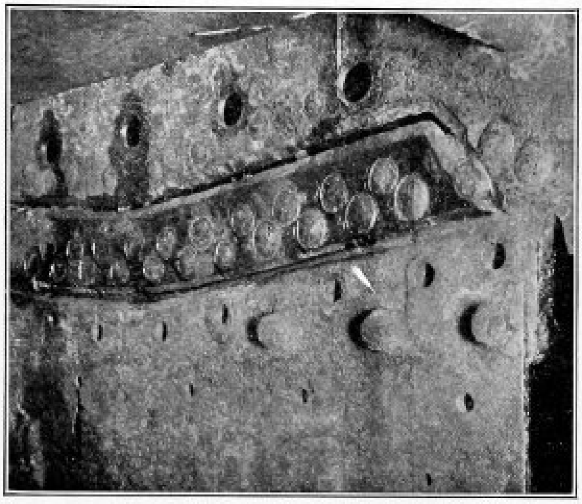


FIG. 2

A complete description of the electric welding apparatus and its uses was given in a paper read by Mr. L. J. Hibbard before the Pittsburg Railroad Club, from which the following is taken:

Electric welding is divided into two distinct methods, namely, the resistance method and the arc method. The first is subdivided into butt welding and spot welding, and outside of welding rails in street railway service is little used in the field of railroad engineering.

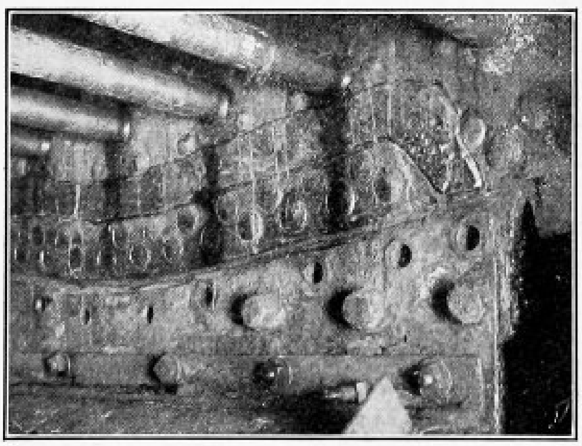


FIG. 3

The second or arc welding method is self-explanatory, and is also sub-divided into two distinct methods, one being the carbon electrode and the other the metal electrode.

The art of welding with the carbon electrode has been employed about thirty-two years, Bernados being given credit for first employing it on the softer metals. Since that time, like all other operations, it has undergone change after change, until at the present time, instead of requiring a large amperage, it is accomplished from machines of as low as 300 amperes. This method is employed principally upon heavy work, such as iron and steel castings, locomotive frames, driver wheel spokes, drawhead castings, etc. The carbon electrode method requires usually over twice the current employed by the metal electrode. The potential at the work is, as a rule, between 50 and 60 volts, while the current runs from 300 to 500 amperes. The method consists of bringing the carbon in contact with the object being repaired and an arc drawn; this arc raises the object metal to a state of fusion, while at the same time a metal rod or bar, placed in the arc by the operator, is also brought to a state of fusion, and both are fused together into a homogeneous structure. Very often punchings, filings and small pieces of metal are placed around the cavity to be filled, and are gradually fused or run in by a circular motion of the electrode. The carbon method has often been questioned on account of the welded section becoming hard and difficult to machine; but this is due to faulty operation and not to the method itself. There are a great many iron and steel foundry companies to-day using this method and afterward machining all their castings. The trouble experienced lies in the formation of iron oxide or slag, but the operator can distinguish the color from that of the metal itself, and by a circular motion of the arc the oxide or slag is brushed away from the cavity. A small gutter is usually cut from the cavity through which the oxide or slag is continually drained as it forms.

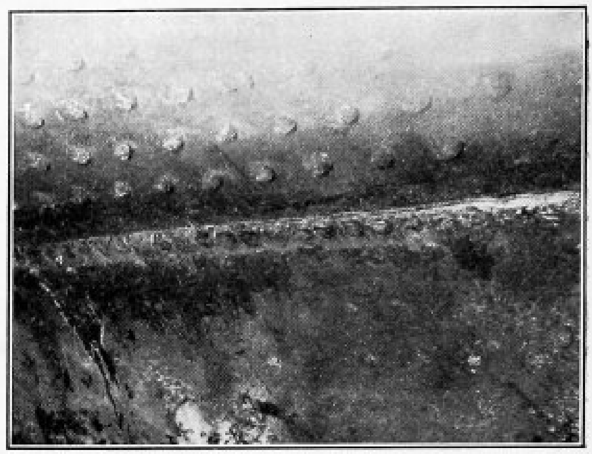


FIG. 4

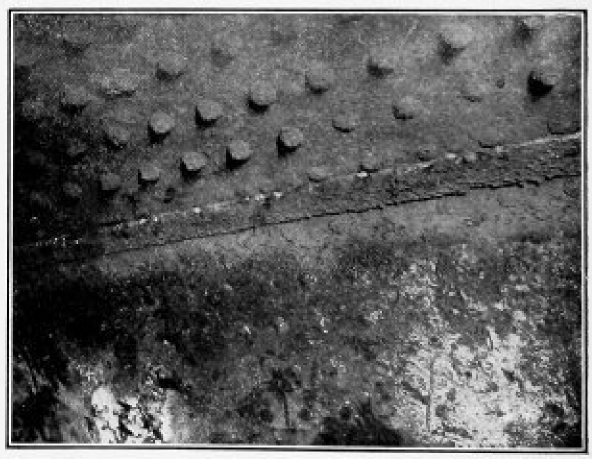


FIG. 5

Another great use to which the carbon arc is being employed is the cutting out of sections of fire-box sheets when found necessary to build in a patch. This is a quick operation, and while the cut is not as fine as that obtained by the gas methods, it serves the purpose and at the same time bevels the section to which the patch must afterward be welded. The carbon method is valuable in shops, particularly on heavy work.

A short time ago a steel car was held out on account of a broken draft gear steel casting. A wire to the foundry found that a shipment of this casting could not be made under two weeks. The casting was removed and welded and the car returned to service within sixteen hours. This is only one instance of hundreds where time and money are saved.

The metal electrode process employs a lower voltage than the carbon electrode. The potential difference at the work varies from 25 to 40 volts, according to the nature of the work. It is particularly essential that the voltage be kept constant, because fluctuation disturbs the arc and is apt to make the weld imperfect. The operator in a short time, with a little practice, becomes skilled enough to determine the current necessary upon merely the inspection of the work. In the process of operation the electrode is brought in contact with the work and quickly drawn back, forming an arc which immediately brings the work to a state of fusion and the electrode itself begins to discharge minute molten increments of repairing metal. The operator continues the process through this arc formation until the electrode has been wholly used up, after which another is inserted in the holder and the work continued.

The principal work to which the metal electrode process is employed is the welding of fire-box cracks and open seams; also tubes are welded in place, as well as the repairing of broken bridges in the flue sheet. Perhaps the most striking advantage of this process over all other welding methods is the ease with which cracks and corroded seams in the crown sheet can be welded. An operator can stand directly underneath the arcing electrode and never find it necessary to step aside on account of the detaching increments failing to become firmly welded to the work. The work is always Vd out, either by a pneumatic tool or any other successful cutting device, and the process of filling in is started at the bottom of the V.

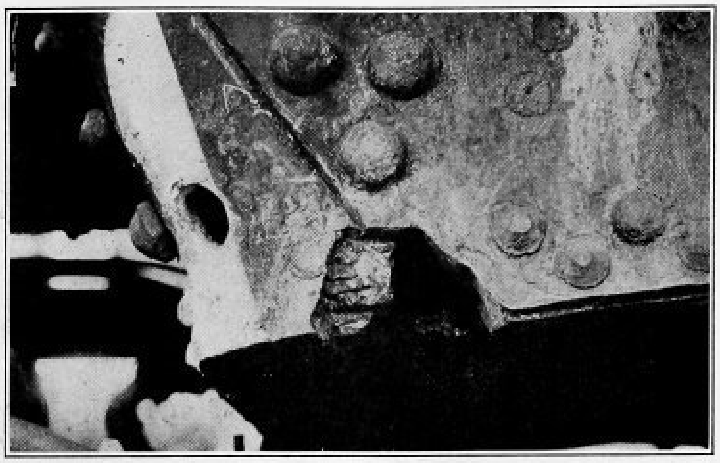


FIG. 6

The best operating electrode is found to be 3/16 inch in diameter, and the current varies from 140 to 150 amperes, according to the nature of the weld. This is quickly determined by the operator when he is cutting into the metal to prepare for welding. All the work accomplished by the carbon electrode method is also accomplished by the metal electrode, and in addition to this all classes of boiler sheet and tube work. Another great advantage of the metal electrode method is the concentration and holding of the heat within a small area. The work beyond a few inches of the weld is quite cool after the weld has been accomplished, and there is no tendency of cooling strains forming to crystalize or rupture the metal. It will be easily seen that this method has a decided advantage over the gas methods on account of the localization of the heat, because one of the greatest faults of the gas methods is the severe contractions of large areas after the welds have

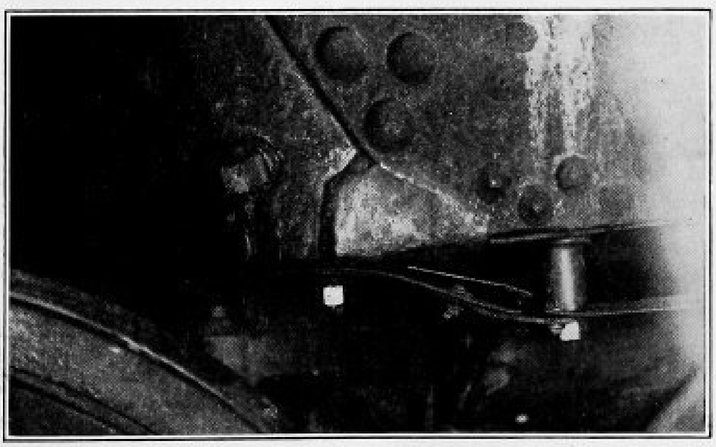


FIG. 7

been made. Patches 10 feet long 13 inches wide have been welded in fire-boxes and no signs of distortion are indicated.

Welding Machines

There are several types of machines, each type having certain advantages—machines operating the metal electrode alone, and others operating solely the carbon electrode, while a third machine combines the two features and operates both electrodes. Railroads using different types claim that the principle is practically the same in all classes with the metal electrode, although the carbon electrode, if properly operated, is found to work faster on heavy work. The carbon is often used in cutting out cracks for preparing work for the metal electrode. This is particularly true in the welding of locomotive frames and fire-box sheets. The *multiple-unit* machine type of construction is similar to other metal electrode machines, with the exception that several men can operate from the same machine, the number of men operating from one machine being regulated by the capacity the machine is wound for. The work accomplished by the arc method of welding, particularly that of the metal electrode, is so extensive and covers such a broad field that the possibilities of its application are unlimited. It has been expressed by many using the arc method of electric welding that in their opinion it is but a matter of a short time when this method will supersede all other systems.

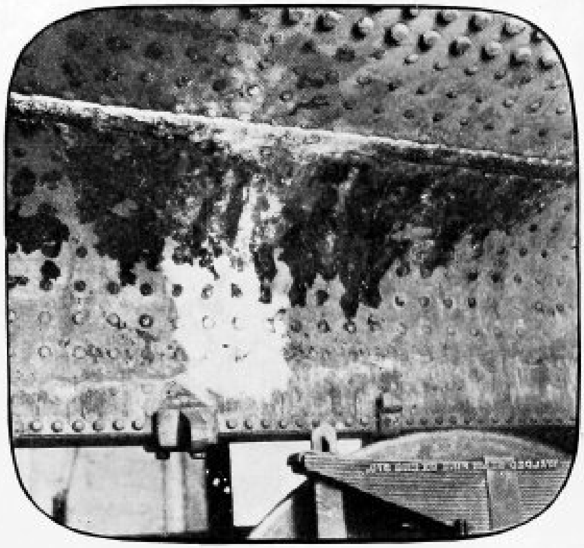


FIG. 8

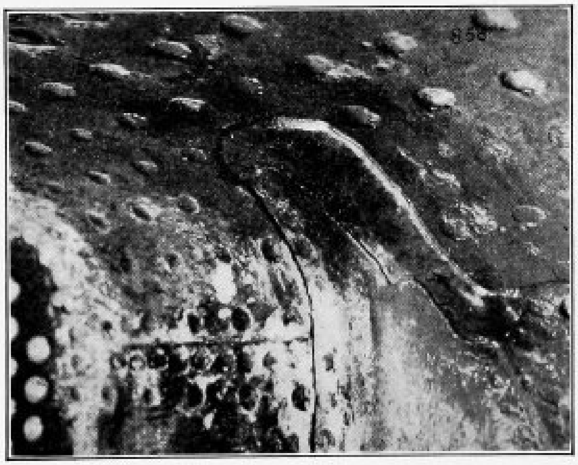


FIG. 9

Fig. 1 shows an operator working with the metal electrode upon a flue sheet which has several broken bridges. Fig. 2 shows a patch that has been cut out and the new one riveted in place ready for welding with the metal electrode. The patch was 5 feet long by 10 inches wide, and was located in the flue sheet between the mud-ring and the grate water-bars. Fig. 3 shows the weld finished. Fig. 4 shows a portion of a badly corroded seam, and Fig. 5 shows the seam welded. Fig. 6 shows a mud-ring of a very large engine which was broken through at the left front corner and repaired by the metal electrode. The broken ring was drilled, chipped and then welded by filling in 74 cubic inches of solid metal. Fig. 7 shows the work completed. If it had been necessary to remove the mud-ring and repair it in the blacksmith shop the expense would have amounted to about $118. This work was done at a complete cost of $32.07.

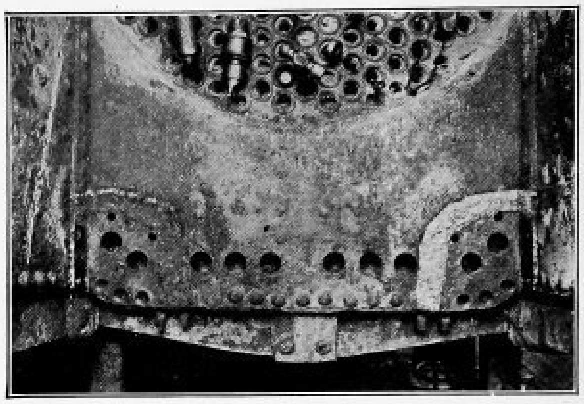


FIG. 10

Fig. 8 shows the electric welding of a long seam in a fire-box. The longitudinal seams between the side sheets and crown sheet were so wasted away by calking that the engine was sent to the shop for a new fire-box. The seams were welded their entire length, approximately 6 feet 10 inches, by the metal electrode method, averaging 3 inches in width and 3/8 inch in thickness. Had the engine received a new fire-box it would have been necessary to strip it and remove the boiler to the boiler shop. The total cost of building in a new fire-box, including stripping, etc., would have cost over $777. These seams were welded in complete, including everything, for $56.40.

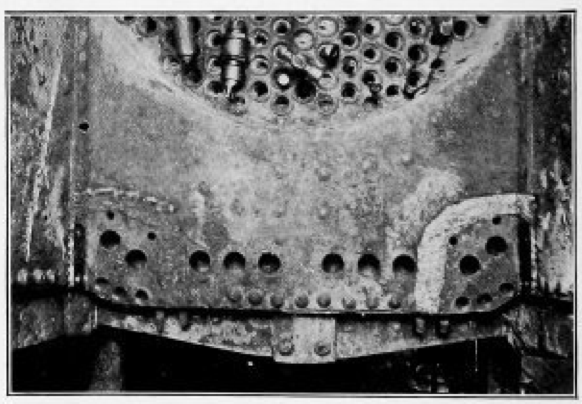


FIG. 11

Fig. 9 shows a very large crack welded with the metal electrode. This crack extended from the side sheet up into the crown sheet. It took no more time to weld this crack than it would have had the entire crack been on the side sheet.

Fig. 10 shows the two lower corners of a flue sheet cut away at the mud-ring. There was a very bad break at both corners, and the sections were cut out with the carbon electrode to prepare them for a patch. Fig. 11 shows the patches welded in position. Two men were used on this work, each man working on a patch. This tends to demonstrate the speed with which fire-box troubles can be remedied when a system is used that will allow for the operation of more than one man at the same time. The operators are subjected to practically no heat and there are no dangerous gases by which they may be overcome.

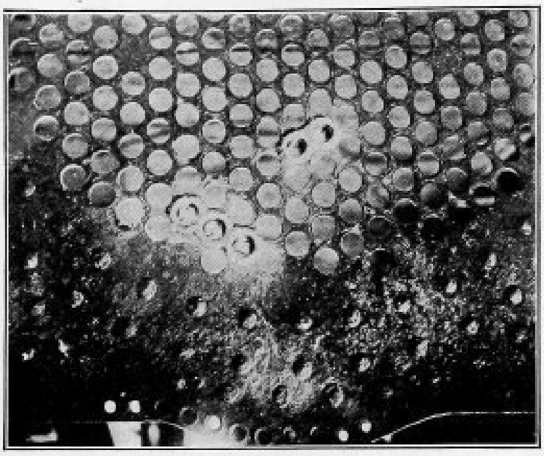


FIG. 12

Fig. 12 shows flue sheet with a few tubes welded in position by the metal electrode. Fig. 13 shows the tubes trimmed and ready for service.

Flue welding is the latest step in the operation of the metal electrode. It is being done on several railroads with the greatest of success, and from carefully kept data it is found that very little trouble is experienced with flues welded by the metal electrode. One railroad at the present time is welding complete sets of flues in thirty-six different locomotives.

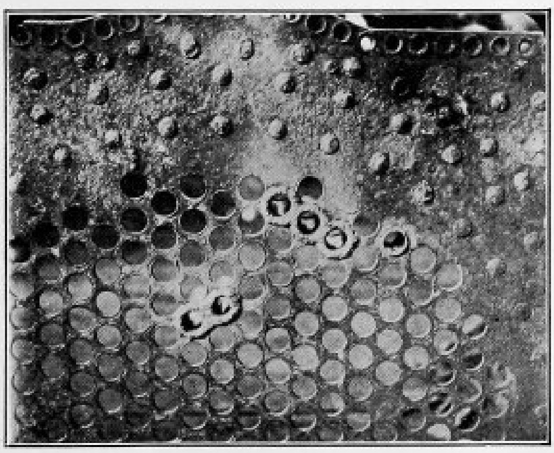


FIG. 13

CONCLUSION

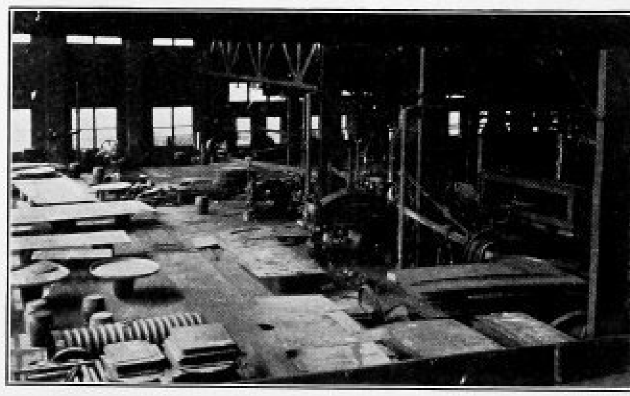
The welding equipment is simple, consisting of a motor generator set of special construction with certain automatic switchboard regulations. The art of welding is very easy, because it is necessary only to maintain a constant arc, and the operator in a few trials becomes thoroughly familiar with it. The amount of current is quickly determined when the arc is first made and the board is then set for the proper amperage. As soon as an operator, however, becomes accustomed to the method he usually gets the proper regulation by merely inspecting the work. The automatic arrangement of the switchboard is such that the motor generator set is always protected from short circuit. It is also positive in action on the make-and-break of the arc.

There is nothing constructed of iron and steel, whether castings, forgings or rolled, regardless of size, that cannot be welded by the metal electrode. Tensile tests of welded bar iron and steel show from 90 percent to 100 percent efficiency. These tests have been made at laboratories independent of the welders. Carefully kept data of different railroads show the metal electrode work to cost from 50 percent to 10 percent that of older methods.

The process eliminates all danger of fire or explosion, and the voltage used is so low that the operator is subjected to absolutely no danger. The absence of danger, coupled with the ease and economy of operation, and the elimination of severe contraction or cooling strains, tends to make electric welding the ideal process for the modern railroad shops of to-day.

Union Iron Works, Erie, Pa.

The accompanying picture was taken from the overhead traveling crane in the laying-out and punch department of the Union Iron Works at Erie, Pa. This firm has erected a special building for storing plates and for laying out punching work. The reader will notice that the building is so located as to give the best of light for laying out and punching, which is so very neccessary in this part of the business. The company makes a specialty of building high-pressure boilers, boiler breeching, stacks and tanks. They also manufacture a patent watertube boiler invented by Mr. Chas. S. Hooper, who is at present manager for the concern. Mr. Hooper has been with the Union Iron Works for about twenty years.



VIEW OF LAYING-OUT DEPARTMENT

Boiler Explosion at Howland, Me.

From a report published in *Power*, two of the seven return-tubular boilers of the Howland Pulp & Paper Company, Howland Me., exploded at 8:30 A. M., Jan. 20, killing two men, injuring several others, and wrecking the boiler house. The explosion completely wrecked the boiler house and demolished the setting of the remaining five boilers. Two steel stacks were knocked down, one falling on the mill, doing additional damage. The pump house and engine room were wrecked, and flying live coals started several fires which were put out without difficulty. It is reported that the boilers were twenty-two years old. They were insured by the Hartford Steam Boiler Insurance & Inspection Company, and were allowed to carry 80 pounds of steam. The loss is reported to be between $40,000 and $50,000.

Locomotive Boiler Inspection*

During the past year minor changes have been made in the regulations pertaining to the inspection of locomotive boilers, in the direction of increased uniformity in the requirements of this and other commissions. During the coming year other changes will be considered with a view to securing complete uniformity.

In this connection mention should be made of some embarrassment to which this department of the Commission's work is subjected by the difference in the requirements of this Commission and of the locomotive boiler inspection department of the Federal Government, and especially in connection with the number of certificates of inspection called for. The Federal law on this subject, which was recently adopted, embodied in large part the requirements and practice of this Commission which have been in force for over five years. With one exception, no substantial conflict between the Federal requirements and State requirements has arisen in this State. This exception relates to the number of certificates of inspection called for. It has been the practice of this Commission, following the State law on this subject, to require inspections and certificates thereof once every three months, or four certificates of inspection per year; and this has been found ample in the judgment of the Commission and its inspectors to satisfy every necessary requirement. The Federal authorities have, however, adopted a monthly certificate, and therefore demand twelve inspection reports a year instead of four. This subject has been taken up with the Federal authorities with the hope of reaching an agreement for the uniform adoption of quarterly inspection reports in accordance with the practice of this Commission. This effort has, however, met with no encouragement from the Federal authorities, who consider the monthly reports necessary. If the attitude of the Federal boiler inspection department remains unchanged, their practice will probably be adopted by this Commission, and duplicates of the Federal inspection reports will be accepted in this State, as it is considered unfair to the railroads, and unnecessary from the State's point of view, to continue the use of two systems of reports. The adoption of the Federal system will, however, require about 120,000 reports of State boiler inspection to be filed, or over three times the present number; some additional clerical force and increased office work on the part of the State boiler inspector will consequently be required. Judging by the experience of five years in the supervision of this work, this Commission feels that this increase in the number of reports and in the consequent clerical labor is entirely unnecessary, and its adoption is simply being contemplated for the sake of uniformity and as a choice of the lesser of two evils.

There are reported to this department records of inspection, etc., of 9,647 locomotive boilers. This number includes, besides those used constantly in the State, all others that the various companies believe it advisable to report in order that the locomotives may be used occasionally, should it be found necessary in New York State service. The report of the supervisor of equipment shows that there are approximately between 6,000 and 6,500 locomotives assigned to regular service in this State. Seventy-nine locomotives owned and operated by manufacturing concerns or contractors, and which are used on the right of way of steam railroad corporations, are included in the above total.

The total number of locomotives reported is shown by the following table:

	Number boilers reported to Commission	Number boilers reported for active service	Number boilers temporarily out of service
Grand total December 1, 1912....	9,647	7,853	1,794
Grand total December 1, 1911....	8,616	7,113	1,503
Differences	1,031	740	291

It is required by law that the boilers of all locomotives be inspected by competent inspectors at least once every three months, and that certificates covering such inspection be filed in this office. During the past year between 40,000 and 45,000 such certificates have been filed. These certificates are carefully checked and compared and all erroneous ones rejected. During the past year inspection reports have been rejected from two railroad inspectors on the ground that the men did not have the requisite experience to act in such capacity.

The regulations require that a specification card be filed giving the leading dimensions of each locomotive boiler in the State, and this information is used to determine the safe working steam pressure. Since Dec. 1, 1912, 1,372 of these cards have been filed. It was found that 29 of the boilers reported were carrying steam pressures in excess of what is thought to be good practice. In each case the companies reporting were immediately notified that the boilers were not in compliance with the requirements of the Commission, and were requested to make the required changes.

In connection with the specification card, a second form known as "Report of Alterations" is required. This report is to be filed whenever any changes are made in the information contained in the specification card on file. Its use enables the Commission's files to be kept correctly, and also enables the Commission's inspectors to check the effect of alterations on the safety of locomotive boilers. In a number of cases reports have been filed showing patches applied in such a way as to lessen materially the strength of the boilers. In these cases the companies have been notified immediately that the conditions must be corrected.

The following table shows the disposition of boilers reported during the past year:

Number of boilers reported for service December 1, 1911......	8,616
Number of boilers reported for service December 1, 1912......	9,647
Number of boilers sold or scrapped during the past year......	195
Number of boilers withdrawn from service, etc., during the past year	146
Number of specification cards filed during the past year.......	1,372

Owing to the increased office work in connection with the greater number of reports received, it has not been possible to inspect the usual number of boilers during the past year. Sixteen trips of inspection have been made and approximately two hundred boilers have been examined. The information obtained from such a limited number of inspections is not sufficient to form an opinion as to the general condition of the boilers as compared with previous years. The assistant supervisors of equipment have, however, in their general equipment inspections, assisted in the work of this department by reporting all violations of regulations, such as broken staybolts, steam leaks, etc., which have come to their notice. The results of these inspections are not included in the following table, but will be found in the report of the supervisor of equipment.

The following table gives the conditions reported by the boiler inspector:

Number of boilers reported for service December 1, 1912......	9,647
Number of boilers examined by State Inspector..............	206
Number of trips of inspection..............................	16
Number of places where inspections are made................	260
Number of boilers reported with defects....................	51
Number of boilers found not complying with regulations......	26
Number of boilers reported with broken staybolts in excess of the number allowed by regulations......................	13

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* From sixth annual report of the Public Service Commission, Second District, State of New York.

Number of broken staybolts found in above boilers	68
Number of broken staybolts reported with telltale holes hammered over or plugged to avoid renewal	12
Number of boilers reported with leaks which would have obscured the vision of the enginemen	7
Number of other leaks reported	31
Number of boiler mountings found not complying with regulations	5
Number of defective steam gages reported	7
Number of defective gage cocks reported	4

The regulations require that all accidents to locomotive boilers resulting in the death or injury of any person, and certain accidents involving crown sheets, whether personal injuries are sustained or not, be reported immediately by telephone or telegraph.

The following table gives a list of the boiler accidents reported during the past five years:

Cause of Accident	Number of Accidents					Number of Persons Killed					Number of Persons Injured				
	1908	1909	1910	1911	1912	1908	1909	1910	1911	1912	1908	1909	1910	1911	1912
Low water	12	4	4	4	5	8	6	1	4	3	15	6	5	6	8
Broken staybolts	..	1	..	..	..	..	..	..	..	..	..	1	..	..	..
Burst flue	3	..	4	10	8	..	..	..	1	..	3	..	4	11	9
Burst arch tube	1	..	..	..	1	..	..	..	..	..	1	..	..	..	1
Flue pulling out	1	1	..	1	1	1	..	..	..	..	1	1	..	3	1
Water-bar pulling out	..	..	..	1	..	..	..	..	..	..	..	..	..	1	..
Burst water-glass	1	5	1	7	8	..	..	..	..	..	1	5	1	7	8
Burst lubricator-glass	..	..	..	5	..	..	..	..	..	..	..	..	..	5	..
Pocket flue blowing out	1	..	..	..	..	..	..	..	..	..	1	..	..	..	..
Plugs blowing out, injectors, valves, etc.	6	1	2	8	12	..	..	..	..	..	6	1	2	9	13
Totals	25	12	11	36	35	9	6	1	5	3	28	14	12	42	40

The foregoing table shows that there have been no boiler explosions proper within this State in the five years during which the Commission has supervised this work, notwithstanding the fact that there are over 6,000 locomotives constantly in use within the State and a large number additional in service a portion of the time. We think that the Commission has accomplished considerable in the way of added safety by requiring the reinforcing of boilers having low factors of safety, the replacing of old boilers, and by insisting upon careful maintenance. It appears to be clear, however, that the main reason for the remarkable record of safety from serious explosion which this table shows is the fact that great efforts have been continuously devoted to the inspection and care of locomotive boilers as far as safety is concerned by the railroad mechanical officers. The question therefore naturally arises whether the large amount of effort given to this subject by the boiler inspection department of this Commission, as well as by the Federal authorities, is justified, in view of the very satisfactory record of safety from serious explosion above shown. Our experience indicates a fair answer to this question to be that, considered from the viewpoint of safety, the supervision given to this work by the railroad officers has been sufficient. The Government boiler inspection has, however, we think, been effective in securing a uniformly high degree of maintenance of locomotive boilers, with consequent diminution of steam leaks and resulting increased efficiency of service, and this conduces indirectly to increased safety of operation. We therefore think it advisable that this work should be continued as part of the general supervision of equipment and with a view to the maintenance of a high degree of efficiency of locomotive performance in this State. Our consideration of this subject, however, reveals no necessity for the practical duplication of the State boiler inspection by the Federal authorities, including the numerous reports involved; and the question must be faced in the future, whether the Federal inspection should not be discontinued in States such as New York, whose records already show a satisfactory system of locomotive boiler inspection, or if this be found to be impracticable, whether the present rigid State inspection should not be discontinued and the State laws on the subject repealed. If the latter course is decided upon, the Commission would be free to continue boiler inspection as part of the general inspection of equipment, and devote more or less attention to the inspection of boiler work as conditions on each road may indicate to be advisable.

The records show the ages of all locomotive boilers used in this State. On all railroads and manufacturing companies in the State 9,647 locomotives were reported for service Dec. 1, 1912, and the average age of these locomotives was 10.27 years. On Dec. 1, 1911, there were 8,616 locomotives reported for service in this State, the average age of which was 9.85 years. The following table shows the distribution of the boilers according to their ages:

No. of Boilers	Jan. 1, 1910.	Jan. 1, 1911.	Jan. 1, 1912.	Dec. 1, 1912.
Under 10 years of age	4,783	4,775	4,984	5,208
10 years and under 20 years	2,040	2,221	2,654	3,236
20 years and under 30 years	715	853	873	1,062
30 years and under 40 years	58	49	105	140
40 years and over	8	2	...	1
	7,604	7,900	8,616	9,647

The number of boilers built during the past three years and which are reported for use in this State is shown by the following: 1912, 416; 1911, 537; 1910, 521.

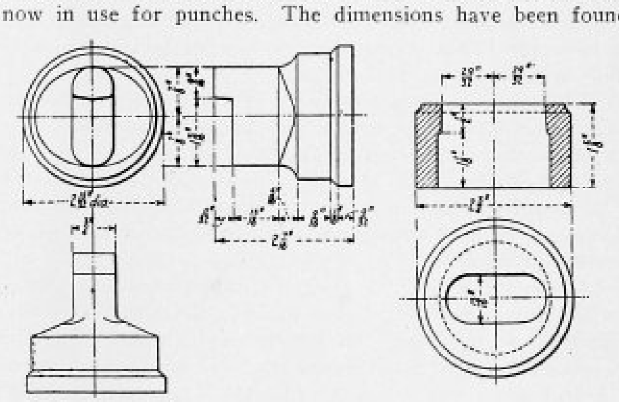
As a result of the requirements relative to the factors of safety for locomotive boilers, 29 of the locomotives reported during the past year have had the steam pressure reduced, seams reinforced, or have been withdrawn from service in this State.

The work of this department has been limited on account of insufficient force, and it is planned to extend the inspection work during the coming year by the appointment of an assistant boiler inspector.

A Ripping Punch and Die

BY EDWARD J. KNAPP

A punch patterned after the accompanying sketch was made with the end in view of expediting punching, saving a chipper's time and doing a good, clean job in cutting manholes, hand holes, circles and curves that cannot be cut with a shear or ordinary punch in structural material. The punch is made of ordinary tool steel and given the same clearances as those now in use for punches. The dimensions have been found



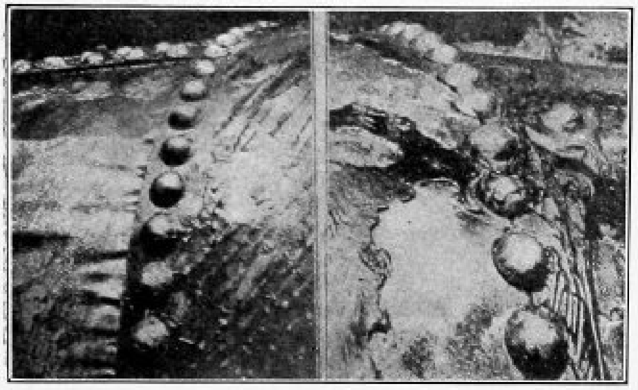
DETAILS OF THE RIPPING PUNCH AND DIE

practical for the general run of work, but can be changed to suit requirements. It is necessary to start with a lead hole or at the edge of the metal. The lead hole can be made when the rivet holes are punched, so an extra setting will not be necessary. This ripping punch cuts 1 3/16 inch of metal at every stroke and leaves a smooth edge which is easily dressed up with a file.—*The Iron Age.*

Repair of Large Steel Water Mains by Oxy-Acetylene Apparatus

In a recent issue of the *Acetylene Journal* an account is given of two successful repair jobs which were made in the field by oxy-acetylene apparatus on large steel water mains. The first was on a 36-inch main near Schenectady, N. Y., where a serious leak developed. The main had settled downwards in quicksand, with the result of rupturing a ring seam, pulling the joint apart about 5/16 inch. The pressure in the main at this point is approximately 90 pounds per square inch, and a considerable volume of water had to be taken care of, for, as a portion of the city would be without water if this main were shut off, it was continued in service except during the actual work of repairing the pipe.

The General Electric Company's Schenectady plant is located but a short distance from the scene of the break, and as soon as the pipe was sufficiently uncovered the people from there very kindly sent some of their most experienced



Abrasions Caused by Leak Joint as Repaired
WATER MAIN REPAIRED BY AUTOGENOUS WELDING

men with an oxy-acetylene equipment to try to weld the ruptured joint, and the attempt proved very successful.

Two torches were put in operation and the paint carefully removed. Then the metal was fused together where it was torn apart, as shown in the engraving. Additional material was then fused on to strengthen the joint and fill the abrasions shown in one view. These abrasions were caused by sand and water striking against the pipe, and some of them had cut nearly through the 5/16-inch plate of which the pipe is constructed.

After the welding was completed, the pipe was incased in reinforced concrete about 18 inches thick across the entire railway grade.

This was a very expensive piece of work on account of the depth to which the pipe was buried, and on account of the nature of the soil, although the cost of mending the pipe was less than $60.

It may be interesting to know that this steel pipe showed absolutely no corrosion after being in the ground approximately seven years.

The above-mentioned work is very similar to that performed on the Boulder pressure pipe line for the Colorado Power Company during 1911. Of course the work performed at Schenectady would not compare in size to the Colorado work.

The Boulder line was a pressure line 9,000 feet long, used to carry water from the top of one of the mountains to use in running turbines at the base.

The pipe ranged in thickness from 3/4 inch at the top to 1 3/4 inches at the bottom, with a diameter varying from 54 inches to 44 inches. All the field joints on this pipe leaked badly after the pipe was in service for a few months. The leaks extended over 4,000 feet of the pipe line. Welding with the oxy-acetylene process was adopted as the only means of repairing the joints without installing a new pipe line.

Portable apparatus was purchased and the work was carried on during the winter months. The work required the services of a number of operators for the greater part of the winter. When the work was completed the pipe was tested under a hydrostatic pressure of 825 pounds without showing signs of leakage. The pipe has been in service without signs of further leakage.

A new line, which was the only alternative had welding not been practicable, would have cost the company $250,000. A conservative estimate places the saving at a figure in excess of $150,000.

The trend in the manufacture of pipe and fittings which are required to stand high pressure, is toward the employment of the oxy-acetylene torch, and the results have been uniformly satisfactory. The use of the oxy-acetylene process for this type of work will undoubtedly increase as its advantages become known.

Value of Boiler Specifications

BY F. W ROSE

Nearly every issue of certain technical papers contains one or more accounts of boiler failures or explosions, which have been more or less destructive to life or property; many more accidents happen, accounts of which never reach the technical press. Some of these accidents could be eliminated if all boiler manufacturers were required to follow more closely high-grade specifications in the building of their boilers. Generally the purchaser depends on the manufacturer or his agent to tell him how the boiler should be built, or, more often, the purchaser tells the manufacturer that he wants a boiler of a certain size for a certain pressure, and nothing is said about the quality of material or workmanship.

All reliable boiler insurance companies have certain standards to which boilers must conform if approved by the company. If the purchase of the boiler is left to a responsible consulting engineer, it is his duty to see that the boiler is built according to high-grade specifications. The following aptly illustrates the advantages of buying according to specifications.

Specifications were issued for the purchase of a horizontal return tubular boiler, and the contract was let to a supposedly reliable manufacturer of high-grade boilers. The boiler was delivered ready for erection before an inspection was made by the consulting engineer, who rejected the boiler on the grounds that it did not conform to the specifications under which it was purchased. An inspection was then made by the inspector of a reliable insurance company. This inspector reported that eighteen new tubes must be put in before the insurance company would accept the boiler. The boiler was not accepted, and another boiler was furnished by the same company, but it did not conform to the specifications, and was likewise rejected; a third boiler, which did conform to the specifications, was furnished by another company.

There was nothing special about the specifications, and any first-class boiler shop could have lived up to them if they had so desired.

The principal objections to the first two boilers were that the tubes were too short to allow for proper beading, and were weakened from excessive rolling; the first boiler was several inches shorter than called for.

In all probability either one of the rejected boilers would have been installed had there been no specifications to which the manufacturer had to conform, and would perhaps have performed the service required. Nevertheless, there was a weakness which might have resulted in a serious accident, and after the accident there might not have been enough left of the boiler to determine the cause.

The two rejected boilers are still awaiting for some purchaser who will not know the difference between a high-grade boiler and an inferior one.—*Power.*

Piece Work

BY CONE HEAD

The whistle blew for the noon hour, and in a very few minutes Tommy, the apprentice boy, Heinie, the layerout and flanger, and Buck, the boiler maker, were seated close by the stove. For a little while their lunch baskets were given the closest attention, and then they began the regular noon-hour round of shop talk.

The subject under discussion that day was piece work, and judging from the noise they made the subject was very thoroughly discussed, but as they failed to have it settled satisfactorily they decided to lay it before old Uncle Fuller, the shop sage.

As the trio approached Uncle Fuller and the writer, Heinie, as usual, began the conversation. "Uncle Bent," he said, "you have been around a whole lot in your time, what do you know about piece work?"

"Hm! Best way in the world to get something for nothing that I know of," said Uncle Bent.

"I told you fellows so," said Tommy, "and when I get out of my time, me to the piece work woods. I know I can knock out some of these jobs in a hurry and make the 'mun,' and then I'll quit the 'biz.' I'm a cat on staybolts and flues, anyway."

"That's the way with you kids," said Uncle Bent, "you get on about three years of your time and you think you are world beaters, but somebody else is just a little bit ahead of you. Are you foolish enough to think you are going to make something at somebody else's game? Well, perhaps you can, but it is only once in a while, and that once begins with a large 'O.' Of course, I said getting something for nothing. Well, you see it is this way, the men hustle up so as to make as much as they can; then after they make good pay, the company decides that the schedule needs revision, and it gets the downward revision very much quicker than the tariff does that you fellows have been reading so much about. But, then, while the company gets a lot of work done cheaply in lots of cases, it is dear after all, as it will not last very long. But when a job falls down they don't give the credit to the piece work system. Now, in some shops when they get the piece work schedule made up, they hang up a sign that they will not change the schedule for a year, but all the companies are not that fair and cut the schedule whenever they get ready."

"And in some shops, whenever you make better headway on a job than they care to have you make, they tell you that you are working by the day, or if you are not making very good progress on a job, they put you on piece work."

"Right there is where I'd fight," said Buck.

"Well, perhaps you would," said Uncle Bent, "but if you had grown old in a shop and then had to submit to a piece work system or quit work, maybe you would think differently, and you know that as quick as a fellow does any scrapping in the shop he gets canned, and that means to remove your family and home to some other town, and this kind of a move puts many a workman in debt, so all things considered a great many submit without any fighting. And then, you see there are a lot of men that remind me of a street car."

"Well, now," said Heinie, "that's a rather queer comparison, Uncle Bent. I don't see anything in that at all."

"Well, you see it's like this, Heinie. A street car runs all right as long as it is on the track, but let it get off and you will see a mighty difference, and so with a lot of men, for they can do only one thing—specialists, you know. One can chip and calk, another can put in staybolts, and still another can only patch ash pans. You see, they are on a track, and when they get on another kind of a job they are off the track."

"That would not keep me down," shouted Tommy. "You could not keep me off the track. I'd go and learn something else."

"Maybe you would just now, Tommy," said Uncle Bent, "but you see you are just now full of hopes and ambitions of youth, while those fellows that can run only one track are in many cases older men who have never learned a trade, just picked up a little as helpers, and being along in years they have not the courage to make another start—in other words, they have no nerve, so they submit just as humbly as they can."

"Well, Uncle Bent," said Heinie, "what kind of prices do they have for their work; do you remember any of them?"

"Yes, indeed," said Uncle Bent, "I remember quite a few of their prices, for I have been here only about six months, and I was working piece work just before that at a big railroad shop up East. Now let's see, for staybolts they paid 25 cents apiece—that is, for staybolts anywhere in the side sheet or door sheet. In the flue sheet they paid 28 cents, and the same for one over 12 inches long. If we change a bolt an hour here, taking them anywhere they come in the firebox, we think we have done a fair job, though many times we can easily do a little better, and for any one of those hours we get 38 cents and a helper gets 20 cents. Now, at that rate we make \$3.04 per day and a helper \$1.60, which makes a total of \$4.64 for changing eight or ten staybolts complete. But if we were working piece work and wanted to earn that much we would have to put in about eighteen staybolts complete. For instance:

10 at 25 cents =	\$2.50	
4 at 28 cents =	1.12	in the flue sheet
4 at 28 cents =	1.12	over one foot long
	\$4.74	

"That would be just a dime more and a person cannot always get the bolts just as they are figured out here."

"That would keep a man and his helper going all right," said Buck. "Why, they would have to go a little better than two finished bolts an hour, and I don't believe he can do that."

"Well, you see," said Uncle Bent, "you are used to doing good, careful work and never cut up the boiler sheet, and when you finish up your staybolts you drive with a three-pound flogging hammer, but the piece worker doesn't work that way at all. He jumps on to the job with an air hammer and drill and cuts any old way to hustle the bolt out and in again, nor does he look very long for good threads, like you do, Buck. And when he drives the bolts he gets out Mr. Longstroke and plasters the bolts a few licks around the edges and lets her go. Again, when you fellows cut out staybolts you don't have the engine almost dismantled, as the piece worker does, and you see all this taking down of pipe, when a man can get the bolt out anyhow with a little extra effort, adds to the cost of the bolt upkeep. Of course some shops will do anything so that it is piece work."

"Well, I don't call that work at all," said Heinie. "Anybody could botch up a job that way, but I don't see how they could fix a price on flanging and laying out like they can on staybolts and flues."

"Well, I don't see why not," said Uncle Bent. "That is just as easy as anything else. Now I'll try and tell you about flues, since you have mentioned them. For putting in flues they get 6 cents per flue. Hand me that scrap of sheet iron there and your soapstone, Tommy. Our 500 and 600 class wide firebox engines have about 380 flues, so for putting in that set you would get $380 \times \$0.06 = \$22.80$. That means the whole job, including putting in the coppers, picking up the flues from the floor near the engine, putting them in the boiler, rolling the front end, expanding, rolling and beading the firebox and putting up a platform in the firebox if necessary—in fact, getting them ready for a test."

"But what about the busted flues?" said Buck.

"They get 18 cents a piece for changing flues that have faulty welds. For laying out a smoke-box they get one-half cent per hole. There's a 500 class smoke-box over there now and I'd guess that there are about 145 holes in it."

"A little more, Uncle Bent," said Heinie; "152 holes."

"Well, you see, Heinie, that would just pay you 152 × $0.005, or 76 cents, and I know that you were four hours on that job."

"Yes, Uncle Bent, it took me all of Monday morning to get that out. You see, the holes in the boiler shell are very poorly spaced, so I had to strip them, and that takes time."

"But if you were a piece worker it would take you just the same time," said Uncle Bent. "There would be no way to get away from the schedule unless the boss allowed you to work daywork on it, and as you would get a very low day rate, say probably 30 cents per hour, you would have then made $1.20 instead of 76 cents. This might do all right, but if the boss kept on doing this kind of work, and perhaps let some others go on day work as he let you, at the end of the month his piece work percentage would drop from the customary 85 or 90 to about 65 or 70, and then he would have to go on the green carpet and tell the master mechanic how it all happened, and if he could not explain this satisfactorily they would soon get another boss.

"Now that ring is over five feet in diameter, so you get $2 for rolling it up, or if it were less than that in diameter, $1.50.

"For punching that sheet the puncher got 25 cents per 100 holes or 38 cents, for punching out the cylinder opening he gets 3 cents per lineal foot of punching or 24 cents, and the smokestack opening would make another 5 feet or 15 cents."

"How about the liner, Uncle Bent?" said Heinie.

"I almost forgot that, Heinie. For that they pay .015 cent per hole, so you won't be making very much on that either, and they pay the same rate for laying out a dome liner. For laying out a flue sheet they pay .005 cent per hole. For example, take one of the wide firebox class flue sheets with a slant just below the flue holes. They have 380 flues and about 270 rivet, staybolt and brace holes, making 650 holes altogether at .005 cent, or $3.25, and for turning the 16 feet of flange around one of those sheets at 25 cents per lineal foot the flanging would come to $4 even."

"Oh! They flange that on a bull," said Heinie.

"Oh, no, old boy! They do it by the Armstrong process, just like you do with 16-pound hammers, and the flangers I knew only had two helpers, and you have three all the time."

"Well, Uncle Bent, I don't see how they do it. They certainly don't take as much pains as I do with the work."

"No, that's so, Heinie. You see, they flange two sheets to your one, and then make a start on the third one. They have to make a day's wages. They take long heats—say, four feet long—and they heat their sheets a great deal hotter than you do. Why, I saw them flange some sheets and the metal was so hot that it looked glassy in the fire, and when they took it out it shed big tears just because it had been mistreated so, and when it got cold it looked just like the patch did that the boomer boiler maker tried to flange last week."

"Yes, I remember that job all right," said Heinie, "for when he put that patch on it cracked, and the boss canned him and I had to make the next one."

"For flanging a door sheet they pay a little different, as they have sort of a blanket price that covers the whole sheet. Any door sheet with one door hole is $5, and for one with two door holes $7. Now that covers all the flanging, annealing and straightening of those sheets complete. For taking out a flue sheet they pay 6 cents per hole. Of course this means only rivet, staybolt and brace holes, and you have to get the old sheet out and leave everything ready for the new one to go in. Take that sheet we were talking about a while ago with its 270 holes. That would make 270 × $0.06, or $16.20. For putting it back they pay 17 cents per hole, which is 270 × $0.17, or $45.90. There are some extras on top of that, such as bringing the sheet from the fire to the engine for 20 cents, 16 feet of chipping on the sheet before it is put in place at 5 cents per foot, or 80 cents, and chipping and calking the throat sheet about 8 feet, at 15 cents per foot. Then it is customary to give a man all there is to do on such a job as this, so as to help the price out a little. There might be a flanged patch, which pays 50 cents for the first 15 patch bolts and 30 cents for all over 15, or if it is only a flat patch, 30 cents for the first 15 holes and 20 cents for all over that amount. A fire door patch is in a class by itself and paid 32 cents per hole straight. Fexible stays paid 60 cents for the first bolt and 30 cents for all others. Driving rivets with pneumatic or hydraulic riveters paid 2 cents each, and with a pneumatic hammer 5 cents each, and in either case the man doing the job must pay all the help out of that money."

"I don't see how they divide the money, Uncle Bent," said Buck.

"That is easy enough, too, Buck," said Uncle Bent. "Take that flue job we were talking about—380 tubes at 6 cents makes $22.80, and they are put in by two flue setters rated, we will say at 26 cents per hour day rate, and they need a helper at 15 cents per hour for about three hours to hand up the flues from the floor. It will take the two men about 22 hours each to work up the flues, complete. Then it will take them 1½ hours each to put in the coppers."

22 hours' work on flues.
1½ hours' work on coppers.
——
23½ hours at 26 cents, or $6.11.

"One helper at 15 cents per hour for three hours, or 45 cents.

First flue setter has earned by day rate.........	$6.11
Second flue setter has earned by day rate......	6.11
Helper has earned by day rate................	.45
	$12.67

"Now the flue setters each get 611/1267, or $22.80, and the helper gets 45/1267. Now work that out, Tommy."

"Here it is, Uncle Bent."

$10.93 for each flue setter.
10.93
.805 for the helper.
——
$22.665

"Now that don't come out just right, but it's because I did not carry my decimals one point further.

"But, Uncle Bent, I have not heard you say one word about apprentices in such shops. Do they have any? How do they learn anything?"

"Yes, Tommy, they have apprentices, too. More than that, they send their apprentices to school two or three times a week, just like you go. I'm going to tell you a lot about that some day, too, but I haven't time just now. One thing, though, you can just bet that the men don't fool away much time in trying to show an apprentice anything, for they are too busy chasing after the good American dollar."

Just then the whistle blew again and Uncle Bent walked over to his work, grumbling to himself: "Funny how men make laws to have a lot of boiler inspectors and Government officers to watch out so they don't have boilers blow up, and then let them have piece work. Looks like they never will learn anything."

Answers to Questions from Boiler Makers

BY GEORGE L. PRICE

In view of the interesting and helpful talks for apprentice boys and boiler makers published in recent issues of The Boiler Maker, the writer has kept a memorandum of questions that should be answered for their benefit, and while a number of other subjects should be mentioned, the following questions cover some of the most important points which every boiler maker should study thoroughly and be able to answer intelligently and promptly.

How Shall Boiler Inspections be Made?

There are two kinds of inspections—external and internal. The external inspections are generally made in the round house, or such places where it is impossible to gain access to the interior of the boiler. Interior firebox inspection is included in exterior inspection and also in interior inspection alike. We are compelled at present writing by our Government to make monthly, quarterly and annual inspections.

There are different modes of testing boilers used by inspectors. The applied forces used in these tests are made through the medium of steam, hot water, cold water and air. The hydrostatic test, however, is preferred on all boilers, and this should be made by using warm water with applied force or pressure. Boilers are generally tested from 25 to 50 percent above their working pressure.

The duties of a boiler inspector are not of a white shirt nature, and every Tom, Dick and Harry connected with a boiler shop is not an efficient or competent boiler inspector. By assiduous application to duties a practical boiler maker may become a competent inspector.

In railroad work, most inspectors prefer to test the interior firebox for broken staybolts void of all pressure. This mode of inspection pertains only to the fireboxes having the rigid type of staybolts. The broken staybolt is detected by the sound and vibration of the hammer test in the interior of firebox and by the telltale hole on the exterior of firebox. Should the firebox be equipped with hollow staybolts, the broken bolt may be detected from the inside of the firebox as well as from the outside, providing the telltale hole is not corroded or stopped up.

Should your firebox be equipped with flexible staybolts, and you wish to test same void of all pressure, remove all caps outside, and from the interior of the firebox strike each bolt a smart blow with a hammer, which will aid you in detecting a broken bolt, as the blow will dislodge any broken member that is held tight by dirt and scale. I have tested hundreds of flexible staybolts in this manner, but I still have to find my first broken bolt. In removing caps, care should be taken, especially when the cap starts hard, as it will often start the bushing in the sheet to turn out, which generally results in stripping the threads on same or leaving it in a loose condition so that eventually it will leak.

Some inspectors claim they can tell a fractured staybolt by the hammer test, be it ever so slightly fractured. This, however, is an empty claim. Fractured staybolts may or can be detected by interior inspection, when the point of fracture does not extend into the telltale hole. Should you wish to test flexible staybolts without removing the caps on the outside, it is advisable to test same under pressure—that is, to test same with 40 to 100 pounds steam pressure on the boiler. This pressure should hold all bolts tight on their seats if they were properly installed, and also cause the ends of broken bolts to separate, thus aiding you in detecting same. Some inspectors use this method of testing a rigid stayed firebox. (They must like the heat.) I have never found a broken flexible staybolt, and my conclusions have been formed to the extent that should I find one the cause of breakage should be charged to inferior grade of material used in the manufacture of same, or some flaw or defect that passed unobserved during course of construction of the bolt.

After a careful staybolt test the inspector should examine the plates and tubes for the following defects: Laminations, blisters, deformation of plates, buckling, thin sheets, cracks, mud burnt spots, pitting, grooving, corrosion and permanent elongation. When I say plates, I have in mind every piece of iron and steel used in the construction of the boiler. These different defects may be explained as follows:

A lamination is the parting of the sheet into layers. Pitting is the eating or wasting away of the plate in small spots. Grooving is a form of boiler deterioration, which usually occurs near seams, and bends where the plate is deeply scored with grooves of irregular edges. Corrosion is a general term to include all forms of chemical decomposition or eating away of the parts of a boiler. There are two kinds of corrosion—internal and external. The internal corrosion is the one that does the greatest damage. Permanent elongation is that part of the plate that has lost its life or its elasticity, it being stretched or pulled beyond its elastic limit and can't come back. The elastic limit of a plate is roughly one-half of its tensile strength, and when the applied forces cause the plate to expand or stretch up to a point equal to or exceeding the elastic limit, they cause permanent elongation or permanent set.

Internal inspections are generally made in back shops when the engine goes in for a general overhauling. After the flues have been removed and access to the interior of the boiler has been given to the inspector, his duties should be as above mentioned, coupled with a rigid examination of all braces, seams and rivets, taking note of all fractured, broken and loose braces with other defects, and ordering same properly repaired.

I would like to see our Federal boiler inspection law strengthened in regards to the inspection of boilers in our round houses. It is a well-known fact that our grate bars, commonly called side bars, are seldom or never removed, and oftentimes the inspector will find the sheet or plate very thin behind these bars, especially in the corners. I have found high-pressure boilers with the plate at the mud ring corners wasted away until it was less than one-sixteenth inch thick. Many boiler makers and inspectors are under the impression that the plates at this point are not subject to the same amount of pressure as carried on the steam gage and other parts of the boiler. Some advance the idea that the grates and grate bars wedged in between the firebox sheets add additional strength to the sheets. In my estimation, this is entirely wrong, as a chain is no stronger than its weakest link, and the same principle can be applied in this case. I do not wish to criticise our Federal boiler inspection laws, as I think they should have been in force years ago. Records show us that locomotive boiler explosions have been eliminated to a great extent. But I have in mind a practice that should be discontinued by some of our railroads, for the reason that it is not practical and might lead to unsatisfactory results. Our Federal law has, in my opinion, overlooked this item, but, as I am in Rome at present, I will have to do as the Romans do, hence finis with the dope. But to get back to our subject.

How Shall We Determine the Safe Working Pressure of a Boiler?

I will state there are two ways to determine same. When we do not know the factor of safety and the efficiency of the longitudinal seam, we may proceed as follows:

When TS equals tensile strength per square inch of plate, T equals thickness of plate, D equals inside diameter of boiler, and WP equals working pressure allowed, then

$$\frac{1/6\,TS \times T}{\frac{1}{2}D} = WP$$

The foregoing is expressed in algebraic symbols or letters, but let us work it out in figures so we can understand it more readily:

When TS squals 60,000 pounds per square inch tensile strength, T equals ½ inch thickness of shell, and D equals 60 inches inside diameter of shell, then the safe working pressure equals

$$\frac{1/6 \times 60{,}000 \times \frac{1}{2}}{\frac{1}{2} \times 60} = 166.66$$

```
 6)60,000
   ------
   10,000
       .5
   ------
30)5,000.0(166.66 or 167
   30
   --
   200
   180
   ---
    200
    180
    ---
```

The rule for working the above is one-sixth of the tensile strength, multiplied by the thickness, and divided by one-half of the inside diameter will give the allowed working pressure.

Apply the following rule when the factor of safety and the efficiency of the longitudinal seam are known.

What is the safe working pressure of a locomotive boiler whose tensile strength of plate is 60,000 pounds per square inch, thickness of plate ½ inch, factor of safety 5, inside diameter 60 inches and efficiency of longitudinal seam 80 percent?

When TS equals tensile strength of plate per square inch, T equals thickness of plate, F equals factor of safety, D equals inside diameter of boiler, and E equals efficiency or strength of longitudinal seam, then

$$\frac{TS \times E \times 2T}{D \times F} = WP$$

and substituting the figures for the letters and solving the problem, we have

$$\frac{60{,}000 \times .80 \times 1}{60 \times 5} = 160 \text{ pounds per square inch working pressure.}$$

```
         60,000
              1
         ------
   60    60,000
    5       .80
  ---    ------
300)48,000.00(160
    300
    ---
    1800
    1800
    ----
```

You will notice that one rule will work out 6 pounds more than the other, so in the interests of safety, when you have your choice, always use the smaller result which is practical.

Very often the above rule is hard to understand by the apprentice boy for the reason he does not comprehend the meaning of the tensile strength of plate (commonly called sheet). I have been approached by apprentice boys and boiler makers as follows: "Say, what is this tensile strength business and the factor of safety; where do they come from and what do they mean, and what's the dope about ratio and the efficiency of a seam?"

In answer to these questions I would say that the word efficiency (mechanically speaking) means the ratio of the tensile strength of the plate or joint to that of the solid material, as if the joint did not exist. Ratio is a comparison or difference between two numbers or objects of the same kind.

The tensile strength of a sheet or plate is its ultimate or extreme strength in pounds per square inch. The factor of safety is the ratio between the working pressure and bursting pressure. The factor of safety can be found as follows:

When cylindrical shells of boilers made from good material, either steel or iron, with all holes drilled in place, after which the plates or shells are taken apart and all the burrs and loose chips removed, and all longitudinal seams (commonly called running seams on the shell) fitted with double butt straps each at least five-eighths the thickness of the plates they cover, and the seams being double riveted with rivets 75 percent over single shear, and having the circumstantial seams so constructed that the percent is at least one-half that of the longitudinal seam, and providing the boiler has been inspected by Government or competent inspectors during the entire course of its construction, then we may use four for the factor of safety; but should the above conditions be altered in any way the following should be added to our factor of safety 4. (The factor of safety for railroad work is generally 5, but the Government allows 4.)

1.0 should be added when any kind of a joint in the longitudinal seam is single riveted.

1.0 should be added providing boiler has not been open for inspection during course of construction.

.15 should be added if only single butt straps are fitted to the longitudinal seams, and seams are treble riveted.

.15 should be added if the holes are not fair and good in the circumferential seams.

.15 should be added if the holes are all fair and good in the circumferential seams, but punched before bending or rolling.

.07 should be added if the holes are all fair and good in the circumferential seams, but drilled out of place after bending or rolling.

.07 should be added if double butt straps are not fitted to the longitudinal seams and said seams are lap and treble riveted.

.7 should be added when all the holes are not fair and good in longitudinal seams.

.4 should be added if the longitudinal seams are not properly crossed.

.4 should be added when workmanship or material is doubtful in any way, and the inspector is not satisfied that same is of the best quality.

.3 should be added when all holes are fair and good in longitudinal seams, but punched before bending or rolling.

.3 should be added if only single butt straps are fitted to the longitudinal seams, and said seams are double riveted.

.2 should be added when all holes are fair in longitudinal seams, but drilled before bending or rolling.

.2 should be added when all holes are fair and good in longitudinal seams, but punched before bending or rolling.

.2 should be added if double butt straps are not fitted to longitudinal seams, and seams are lap and double riveted.

.2 should be added if all holes are punched small and reamed afterwards or drilled out in place.

.1 should be added when all holes are fair and good in longitudinal seams, but drilled out of place after bending or rolling.

.1 should be added if all holes are all fair and good in the circumferential seams, but drilled before bending or rolling.

.1 should be added if the holes are all fair and good in the circumferential seams, but punched after bending or rolling.

The factor may be increased further, should the workmanship or material be of such nature as to bring the inspector's attention to defects of any kind.

Let us take, for an example, a butt joint treble riveted with holes punched to right size, and see what factor of safety it will bring us:

4.00
.30
.15

4.45 or let us say 4½ = factor of safety.

Should the Steam Pressure be Reduced as the Boiler Increases in Age and at What Percentage Per Year for Different Types of Boilers?

In the interests of safety a boiler should be given a rigid inspection as often as possible. For a locomotive boiler I would advise monthly. For a stationary boiler, from three to six to twelve months. In regards to reducing the pressure with the age of the boiler, I will say that I do not know of any set rule we could apply to any or all types of boilers that will tell us the amount or percent of pressure to be reduced according to the age of same, but I firmly believe and say that the working pressure should be reduced as the boiler grows older. The reduction should be made according to the conditions or defects found after inspection. We know that a boiler will not last forever, as it breathes by contraction and expansion, and will become feeble with age. You may not be able to find defects with the naked eye or hammer, nevertheless they are there.

For example, let us take two boilers exactly alike, one of which is brand new, the other, we will say, twenty-five years old. You wish to carry 125 pounds of steam on each, and supposing you are a competent boiler inspector and have inspected both boilers, and were unable to detect any defects with eye or hammer, still, at the same time, your mind will not be at ease if you let both boilers carry the same amount of pressure. Why? Because one boiler has seen twenty-five years of service and is considered old.

Still we are not satisfied; let us go further with the old boiler. Let us drill a hole through the shell plates at different places. Well, we find our plate wasted or eaten away as much as 1/16 or possibly ⅛ inch, or, in other words, our ½-inch shell plate is reduced to ⅜ inch by corrosion, which means we will have to reduce our working pressure accordingly.

What Factor of Safety Should be Used on Steam Boilers?

Always in the interests of safety, as before mentioned, use as large a factor of safety as possible, say 4 or 5, preferably 5.

Should Rivet Holes in Boilers be Drilled or Punched Full Size, or Punched and Reamed?

I would advise all holes drilled in place to exact size—that is, after the plates are fitted together. For instance, after the shell plates are rolled into shape and properly fitted, then drill all holes if convenient to do so. I think this is done in Government work, but I am positive it is not done by railroads nor by some boiler manufacturers. Railroads generally punch all holes full size before rolling and complete the operation by reaming or pinning, providing the holes are not fair when the sheets are in place.

Some manufacturers punch holes smaller than the desired size and ream to size after the sheets are fitted into place. It is generally conceded that a punched hole injures the plate by tearing around the hole on the bottom half of a punched plate or sheet. Therefore, should boiler manufacturers persist in punching all holes? No, they should be punched smaller than the desired size and reamed afterwards, thereby removing all injured parts, thus leaving all holes in perfect condition. They should never be punched full size and afterwards reamed or pinned, as is often the case.

I have seen punched holes ⅛ inch larger in diameter on bottom size of the plate than on top. This is caused by the carelessness of the punch man in having the female or bottom die larger by ⅛ inch than the calculated size, or, to be plain, he had the wrong die.

Should Bolt Holes be Drilled, Punched or Punched and Reamed?

As above mentioned, all holes should be drilled if possible. I do not think it is necessary to punch staybolt holes and ream them afterwards, for the reason that during the process of tapping out the hole for the staybolt the hole is reamed by the tap before the threads are cut. The staybolt tap, as we know, is a combination tool consisting of a reamer and tap which leaves the hole in a number one condition, providing it is tapped to the calculated size.

Should Staybolts be Hollow all the Way Through or Drilled From the Outside Only to Form a Telltale Hole?

The hollow staybolt, I think, has some advantages over the solid bolt. The solid bolt has, or should have, a telltale hole on the outside of the firebox 3/16 inch by 1⅛ inch deep for the purpose of detecting broken or fractured bolts. As we know, our locomotive boilers are covered with an asbestos lagging and a sheet iron jacket, and it is impossible to detect all broken and fractured staybolts without removing this jacket, and sometimes after removing the jacket and lagging it is impossible to detect them, as they become clogged with asbestos, thereby preventing the steam and water from coming out of the telltale hole. Should this have been a hollow staybolt, and the hole became stopped up on the outside, it would have leaked inside the firebox. Therefore, I favor the hollow staybolt. It is also said that the hollow staybolt helps the steaming qualities of the locomotive on account of aiding combustion in the firebox.

What is the Proper Thread for a Staybolt, and is There any Advantage of Reducing the Diameter in the Center?

I consider 12 threads to the inch the proper thread for a staybolt. There are two styles of thread used for staybolts, commonly known as the V-shape and round thread. It is said that the round thread has some advantages over the V-thread in tapping out a hole. It is claimed that the round threaded staybolt tap will not tear out the threads as readily or as often as the other.

In regards to reducing the bolt in the center, I will say there are some advantages to be gained by this operation, as follows: It will give more water space, make the bolt more flexible, more easily run in, it is quicker and better to handle, and is reduced in weight. Some railroads and boiler manufacturers have discontinued this operation, thereby saving time and expense.

Is It Good Practice to Brush Staybolt Holes on the Outside, or How Shall They be Cleaned?

I will say if the staybolt is properly drilled or counterbored, it is not necessary to brush out the telltale holes, as the dirt and asbestos lagging does not stick in the hole as readily as it does in bolts that are not counterbored. When the boiler is stripped in the back shop, a steel brush should be used to brush out the telltale holes.

What Size and Gage of Tubes and Width of Bridge Between Them Gives Best Satisfaction in Locomotive Boilers?

I think that the 2-inch eleven gage or thirteen gage tube gives the best results in locomotive boilers. It has always been the practice of some boiler designers to get as many tubes in the boiler as possible, thereby giving them more heating surface. This item, however, is a bad one for the owner. The flues being so close together in the tube sheet impairs or hinders perfect circulation, as the space is rapidly filled up with scale and mud, which is impossible to wash out without removing some flues to do so. The bridges are narrow and it does not take much to crack them, and you boiler makers know what that means. The nuisance should be eliminated, so let us have our bridges as wide as we can get them, say ⅞ inch to 1 inch.

Why do Tubes Leak More in the Center Bottom of the Flue Sheet Than Elsewhere?

To this question I will say that the principal causes are cold air coming in directly from the fire door, mud and scale becoming lodged between the flues against the sheet at the bottom, short firing while out on the road, too much blower when the door is open. Also when the feed water at a reduced temperature enters the boiler through the check in the front part of the boiler it goes down to the bottom, commonly called the belly of the boiler, and flows towards the flue sheet. The cold water will always go to the bottom, also to the lowest portion or part of the boiler, which would be the firebox and mud ring and in the vicinity of the back flue sheet. The flames and hot gases from the fire striking the flue sheet very forcibly at this point on one side, and the cool water on the other, causes expansion and contraction of the tubes and sheet, which will produce leakage. By having the feed water enter the boiler at the top of the first course of the shell, this defect can be eliminated to a great extent, as the feed water can be heated to a greater temperature before it strikes the flue sheet.

We said expansion and contraction produced the leakage. What is it that expands or contracts? The flue will contract for the reason that it is much lighter than the flue sheet, and will cool first; the sheet being four or five times greater in thickness will hold the heat longer, hence the result.

Should the Smoke-Box be Calked, or is There Another Way to Produce a Perfect Draft?

I do not think it is necessary to calk a smoke-box. Some manufacturers do, and, in my opinion, it is a waste of time. However, the box should be of a snug fit, so it will not take air, as this hinders the steaming qualities of the locomotive by forming a clinker of the front end cinders and fills up the front end, also heating the front end door and causing same to warp. The use of the blower sparingly with a tight front end and clean flues will produce a perfect draft.

Which is the Best Material for a Boiler, Iron or Steel, and What Tensile Strength Would You Recommend for Various Parts of Same?

The best of material is none too good for boiler construction, and I would use material that has the largest tensile strength, which is steel. Steel is now generally used for all parts of a boiler except the smoke-box, although wrought iron also has been used for stays and other fastenings. Steel suitable for boiler plates may have an ultimate tensile strength of 55,000 pounds to not more than 65,000 pounds per square inch, and an elastic limit of 30,000 to 31,000 pounds per square inch with an elongation of 25 percent in 8 inches and 50 percent reduction of area at the point of rupture.

The plates should be free from sulphur and phosphorus, as sulphur makes the steel brittle when hot and phosphorus makes it brittle when cold. There should not be more than four percent of either in boiler plate. When cold or heated to a bright red and quenched in water of about 75 or 80 degrees temperature, good steel will stand bending double without sign of a fracture, so use good steel for all boiler construction. However, wrought iron is freer working than steel and is less liable to injury under rough handling, and may be welded more readily. Wrought iron plates suitable for boiler plates should have a tensile strength of 45,000 pounds per square inch, and an elastic limit of 23,000 pounds per square inch.

Can Steel Flues be Welded Successfully in an Oil Burner?

Steel flues can be welded successfully in almost any kind of a fire except a dirty one.

What is the Best Flux to Use in Welding Flues?

Borax is as good a flux to use as any I know of.

How Should Flat Braces be Applied in Order to Place an Equal Shearing Stress Upon Each Rivet?

There are many different kinds of braces; some are good, others bad. Braces are generally divided into two classes, direct and indirect; in other words, straight and bent. Never use a bent brace when it is possible to use a straight one. It is sometimes impossible to use a brace where the shearing stress will be equal on all rivets. The only style I know of in this case would be one with a wide palm with two rivets side by side. In the style of brace generally used the palm is long and narrow, with the rivets placed one behind the other. It is very reasonable to believe that the rivet nearest the main body of the brace is subjected to a tension or prying off stress, as well as a shearing stress or direct pull, while the rivet directly behind it is subjected only to a shearing stress, consequently the first rivet is carrying more than its share of the stress. Therefore, braces should be so constructed as to distribute the shearing stress on all the rivets as nearly equally as possible. There are other style braces, consisting of tee irons and angle bars, that are so constructed and installed as to distribute the stress on the rivets equally. There are also some forged and pressed steel braces that answer the same purpose.

Locomotive Boiler Explosion

The boiler of a Detroit & Toledo Shore Line Railroad locomotive exploded at Detroit, Mich., Jan. 5, causing the death of one man and serious injuries to six others. According to a report in *Power* an examination of the crown sheet after the explosion showed that the plate was buckled between the stays, or forced down by the internal pressure, in many places as much as ⅛ inch. The effect of the buckling between the stays was to enlarge the threaded holes in the plate, thereby lessening their strength. All stays in the crown sheet had been repeatedly hammered up or calked to prevent leakage. The heads which the stays no doubt had originally were almost worn away. The first thread on the end was apparently destroyed by repeated hammering. In addition to the defective stay threads, 41 stays were found to have been broken at some time preceding the accident, although the broken stays would not necessarily have caused the failure. The boiler, however, bore evidence of great neglect of long standing, with stay-bolt ends and stays broken, try cocks dirty and water-gage cocks partly closed. An ordinary inspection by a competent inspector should have disclosed that this boiler was in an unsafe condition.

Tools for Boiler Makers and Their Uses—I

BY W. D. FORBES

Boiler makers' tools may be divided into two groups—those which are made of one piece, as, for instance, the chisel, and those which are made up of moving parts, such as the power punch or press. Both of these classes of tools require thought for their use to the best advantage, or to any advantage at all.

Taking up the single piece tool, attention is directed first to its main requirement, which is quality. Quality depends first upon proper material and second upon workmanship coupled with proper shape.

STAYBOLT TAPS

The staybolt tap, shown in Fig. 1, at times gives the user trouble. Such a tap is difficult to make, and when hardened it is almost sure to warp and get out of line. This defect is easy to see, consequently there is no excuse for a man to use a tap which has this defect, but a more difficult defect to detect is a twist in the tap which prevents the threads from "tracking." This defect is better explained, perhaps, by saying that in the process of hardening and drawing the body makes a partial turn in some part of its length, with the result that when used the holes tapped do not allow the staybolt to enter properly or make a snug job.

FIG. 1.—STAYBOLT TAP

In the staybolt taps made by professional manufacturers neither of these troubles is apt to be found, but all taps, wherever made, should be inspected with great care when received, so that when they are required for use no delay will occur nor any bad work result by their use. Home-made taps are pretty sure to be not only warped and twisted, but also out of size—a fault which is almost unknown in professionally made taps.

We wish to say a word right here about the making of boiler makers' tools instead of buying them from those who by long experience are in a position to produce them far more accurately, cheaply and quickly than the home-made article can be made. A concern which gives constant attention all the time to the selection of a material which experience guides them in buying, is sure to get just the quality suited for the work, and workmen who are doing every day the various operations necessary to produce the article become far more skilled than a man who only occasionally does such work, and, besides this, a manufacturer has at hand every appliance with which to test the finished article before it leaves the shop. All this must make for quality and far less cost, and it is our counsel to boiler makers to buy and not make their small tools.

A staybolt tap should not be too hard, for it will break, nor too soft, for it will not cut. A tap too hard can with care be used without breaking, but it must not be "yanked" around with a single-handled wrench when it is possible to use a double-handled one, and even then the turning must be done evenly.

It is safe to say that in handling all taps in boiler work they are not turned at a proper speed. Of course it is not possible in many cases to get at a tap so that it can be handled to advantage, as in most places where a hole is tapped by hand the operator is cramped for room, but, nevertheless, "sawing a tap back and forth, as is often done, is bad practice and generally shows that the drilled hole is too small for the size of tap used or its user was not up in his trade.

In using a staybolt tap, there is less chance of tapping a hole crooked, as the support of the tap is double—that is, the tap is entered through one plate into a second plate. This, of course, steadies the tap and guides it. In all tapping oil should be used freely; lard oil is the best for this purpose.

A special staybolt tap is shown in Fig. 2. The unthreaded part acts as a guide to keep the tap straight where the usual long taper tap cannot be used. Fig. 3 shows a set of standard taps.

The taper tap is used to start the thread and even to complete it, where the hole is so placed the tap can pass through the plate. It is often followed by either the plug or bottoming tap. The plug tap is used to start the thread in a hole, which is not drilled through the sheet. The bottoming tap threads the hole to its full depth. It will be noticed that in using a taper tap more effort is required to work it than the bottoming tap. This is generally attributed to the fact that the taper tap has cut most of the metal away, thus leaving less metal to be removed. While this is true to a certain extent, it must be remembered that in the taper type the teeth, as they are called, are all doing more or less cutting, thus they have a very considerable grip; while in a plug, and especially in a bottoming tap, only the leading threads are doing any work, therefore less effort is required to drive them.

FIG. 2.—SPECIAL STAYBOLT TAP

Considerable skill is required to tap a blind hole—that is, one which does not go through the plate, and the plug tap should be used first if possible in order to catch the thread. Care should be taken to prevent the tap from starting crooked, whichever tap is used. Taps can be ground on the face of the flute if a proper emery wheel is at hand, and before trying to tap a blind hole the taps should be ground, as then the thread catches more easily.

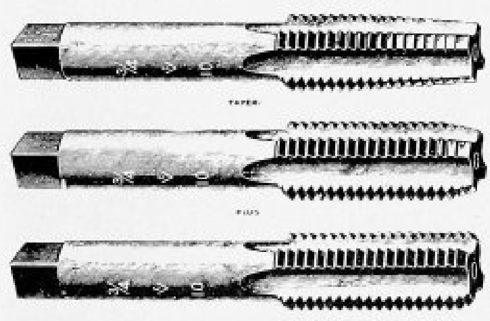


FIG. 3.—SET OF STANDARD TAPS

PIPE TAPS

What are known as pipe taps (Fig. 4) give the apprentice a good deal of trouble at first, as there is no place on these taps where the measurement of the normal size of the tap can be found, so an apprentice who goes after a one-inch pipe tap (if the size stamped on the shank is obliterated) is at a loss as to how to pick it out. After a time the eye becomes so accustomed to sizes that this trouble is not experienced.

Table 1 gives some information which is very useful, as it gives the various sizes of drills to be used when a given size of pipe tap is to be used. Table 2 is a table of drill sizes which is recommended for holes in boiler plates. It will be noticed by some that these sizes are not always those generally recommended, but it is believed that it is better to get a hole tapped with a thread which is not "chewed up," even if it is not a full thread, than to have the metal torn away at the mouth of the hole.

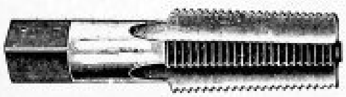


FIG. 4.—PIPE TAP

TABLE 1

Size of Pipe.	Size of Tapping.	Size of Pipe.	Size of Tapping.
1/8	21/64	1	1 3/16
1/4	29/64	1 1/4	1 15/32
3/8	19/32	1 1/2	1 23/32
1/2	23/32	2	2 3/16
3/4	15/16		

TABLE 2.

1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4
3/8	15/32	5/8	3/4	1	1 1/8	1 9/16	1 25/32	2 5/16	2 11/16	3 5/16	3 13/16	4 5/16

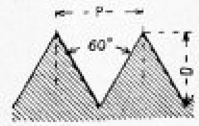
TABLE 3.—TABLE OF DIAMETERS WITH CORRESPONDING PITCHES.

Diam.	No. of Threads per Inch.				Diam.	No. of Threads per Inch.		
	U. S. Standard	A. L. A. M.	"V."	Whitworth		U. S. Standard	"V."	Whitworth
Inch.					Inch.			
1/4	20	28	20	20	1 7/8	5	4 1/2	4 1/2
5/16	18	24	18	18	2	4 1/2	4 1/2	4 1/2
3/8	16	24	16	16	2 1/8	4 1/2	4 1/2	4 1/2
7/16	14	20	14	14	2 1/4	4 1/2	4 1/2	4
1/2	13	20	12	12	2 3/8	4	4 1/2	4
9/16	12	18	12	12	2 1/2	4	4	4
5/8	11	18	11	11	2 5/8	4	4	4
11/16	..	16	11	11	2 3/4	4	4	3 1/2
3/4	10	16	10	10	2 7/8	3 1/2	4	3 1/2
13/16	..	..	10	10	3	3 1/2	3 1/2	3 1/2
7/8	9	14	9	9	3 1/8	3 1/2	3 1/2	3 1/2
15/16	..	..	9	9	3 1/4	3 1/2	3 1/2	3 1/4
1	8	14	8	8	3 3/8	3 1/4	3 1/4	3 1/4
1 1/8	7	..	7	7	3 1/2	3 1/4	3 1/4	3 1/4
1 1/4	7	..	7	7	3 5/8	3 1/4	3 1/4	3 1/4
1 3/8	6	..	6	6	3 3/4	3	3	3
1 1/2	6	..	6	6	3 7/8	3	3	3
1 5/8	5 1/2	..	5	5	4	3	3	3
1 3/4	5	..	5	5				

TABLE 4.—BRIGGS' STANDARD PIPE THREADS.

Diam. of Tube in Ins. Nominal Inside.	Actual Inside. B.	Actual Outside. A.	Nominal Weight per Foot, Lbs.	Internal Area, Square Inches.	Pipe Thread Dimensions. C.	D.	E.	F.	N.	Size of Tap Drill.
1/8	0.270	0.405	.24	.057	.334	.393	.19	.41	27	11/32
1/4	0.364	0.540	.42	.104	.433	.522	.29	.62	18	29/64
3/8	0.494	0.675	.55	.192	.567	.656	.30	.63	18	19/32
1/2	0.623	0.840	.83	.305	.702	.816	.39	.82	14	47/64
3/4	0.824	1.050	1.11	.533	.911	1.025	.40	.83	14	15/16
1	1.048	1.315	1.66	.863	1.144	1.283	.51	1.03	11 1/2	1 3/16
1 1/4	1.380	1.660	2.24	1.496	1.488	1.627	.54	1.06	11 1/2	1 15/32
1 1/2	1.610	1.900	2.67	2.038	1.727	1.866	.55	1.07	11 1/2	1 49/64
2	2.067	2.375	3.60	3.355	2.200	2.339	.58	1.10	11 1/2	2 1/4
2 1/2	2.468	2.875	5.73	4.783	2.618	2.818	.89	1.64	8	2 21/32
3	3.067	3.500	7.53	7.388	3.243	3.443	.95	1.70	8	3 19/64
3 1/2	3.548	4.000	9.00	9.887	3.738	3.938	1.00	1.75	8	3 25/32
4	4.026	4.500	10.66	12.73	4.233	4.443	1.05	1.80	8	4 9/32
4 1/2	4.508	5.000	12.34	15.93	4.733	4.933	1.10	1.85	8	4 25/32
5	5.045	5.563	14.50	19.99	5.289	5.489	1.16	1.91	8	5 11/32
6	6.065	6.625	18.76	28.88	6.347	6.547	1.26	2.01	8	6 25/64
7	7.023	7.625	23.27	38.73	7.340	7.540	1.36	2.11	8	....
8	7.982	8.625	28.17	50.03	8.332	8.532	1.46	2.21	8	....
9	9.000	9.625	33.70	63.63	9.324	9.524	1.56	2.31	8	....
10	10.019	10.750	40.06	78.83	10.44	10.64	1.67	2.42	8	....

In the United States taps are made to standards. Two forms are used. First, the sharp V thread (Fig. 5), and second the U. S. thread (Fig. 6), which has a flat top and bottom. In both of these types the angle is 60 degrees. In England the form of the thread is as shown in Fig. 7. Here

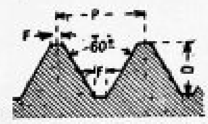


P – Pitch $= \frac{1}{\text{No. of threads per inch}}$

D – Depth – P x .8660

FIG. 5.—V THREAD

the angle is 55 degrees, and the top and bottom of the thread are rounded. This English form is usually known as the Whitworth thread, as it was developed by Sir Joseph Whitworth. It must be noticed that the rounded top and bottom of the Whitworth thread are difficult to produce, as the amount of round is very small. The idea of the round is that the top of the tap's tooth very soon becomes rounded or blunted in use, and it is therefore better to start with it so. The angle



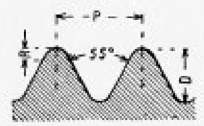
P – Pitch $= \frac{1}{\text{No. of threads per inch}}$

D – Depth – P x .6495

F – Flat $- \frac{P}{8}$

FIG. 6.—THE U. S. STANDARD THREAD

of 55 degrees is supposed to be an advantage in not throwing so great a strain on the metal, since it approaches more nearly the effect of a right angle surface to the line of effort. The angle of 55 degrees, however, is difficult to lay out, while 60 degrees is very easy to lay out, being one-sixth of a circle or



P = Pitch $- \frac{1}{\text{No. of threads per inch}}$

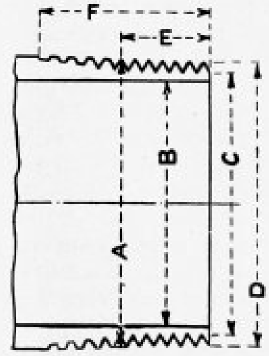
D = Depth – P x .64033

R = Radius – P x .1373

FIG. 7.—WHITWORTH THREAD

its radius. Table 3 gives the diameters and pitches of these standard threads.

The form of a Briggs standard pipe tap (Fig. 8) is slightly rounded at the top and bottom and the angle is 60 degrees. The taper of the tap is 3/4 inch to the foot, or, to make it



A—Outside diameter of perfect thread or actual outside diameter of pipe.

B—Inside diameter of pipe.

C—Root diameter of thread at end.

D—Outside diameter of thread at end.

E—Length of perfect thread = P(4.8+0.8A)

F—Total length of thread or length of taper at top.

N—Number of threads per inch.

P—Pitch of thread $= \frac{1}{N}$

Taper of thread, 3/4" per foot or 1 in 32 to axis of pipe.

FIG. 8.—BRIGGS STANDARD PIPE THREAD

clearer, the taper is 3/8 inch to the foot on each side of a line drawn through the center of the tap. It is found in practice that the pipe tap threads are not made to the standard form, but are V-shaped. The standard pipe sizes were originated, or at least were established, into exact form by a Mr. Briggs, and his name is used very properly in connection with the table of pipe tap dimensions. Table 4 gives his formula as to form and sizes.

While to-day studs and bolts are usually handed to a boiler

maker ready for use, it is often the case that he has to cut the threads with a die. With the exception of pipe dies of the cheaper variety all screw cutting dies are adjustable, and to use them attention is called to the following. First, brush the scale off the rod or forged bolt with a file, as the scale is hard on the dies. Open out the die and slip it over the screw. Set up the die until it gets a fair grip on the screw, the end of the bolt being flush with the face of the die. Be sure to oil the die well and then turn it about two turns. Run the die back and set up on it a little, then run it right down to the length of thread required, after which run the die back and set up again. It should not take more than three cuts to produce a good thread with a good die. Never "seesaw" the die back and forth or try to produce a full thread at one cut, as the result will be a torn and very likely badly distorted thread which will not fit the tapped hole, or make a tight joint or give proper holding power.

The Hammer

No single tool in any trade is as useful as the hammer, yet it is absolutely impossible to give any practical directions for its use. This is equally true of a cold chisel, as it is usually called. To chip a seam true and to do the work quickly is an art, and only practice will enable a man to become accomplished in it. Therefore, we will not go into the subject of these two hand tools further, but simply advise the apprentice to try and handle a hammer in either hand, as at times it is most convenient to be able to chip left-handed. As a matter of fact, there are very few who can do it, although it is the faker's usual boast that he can chip equally well with either hand.

(To be continued)

Work in a Mexican Railroad Boiler Shop

A type of locomotive boiler not usually found on the railroads in the United States is used by the Compagnie del Ferrocarril Mexicano (Mexican Railway). In the pictures shown on this page, which were taken in the Mexican Railway shops at Orizaba, Ver, Mex., is seen the fire-box of a Fairlie double-ended locomotive boiler. A copper fire-box is used in the main boilers, and the copper fire-boxes run from three to four years, when they usually give trouble by cracking in the flanges, then the copper fire-boxes are cut out and carbon steel is used. Brass tubes are used with the copper fire-boxes, and they usually run on an average of about nine months. Since oil is used on this road for fuel it burns off the beads of the brass flues. The fire-doors, as will be seen from the photographs, are on the side of the fire-boxes. It is found that the carbon steel fire-boxes run from four to five years before they have to be changed, while steel or iron flues, which are used with the steel boxes, run on an average of about fourteen months.

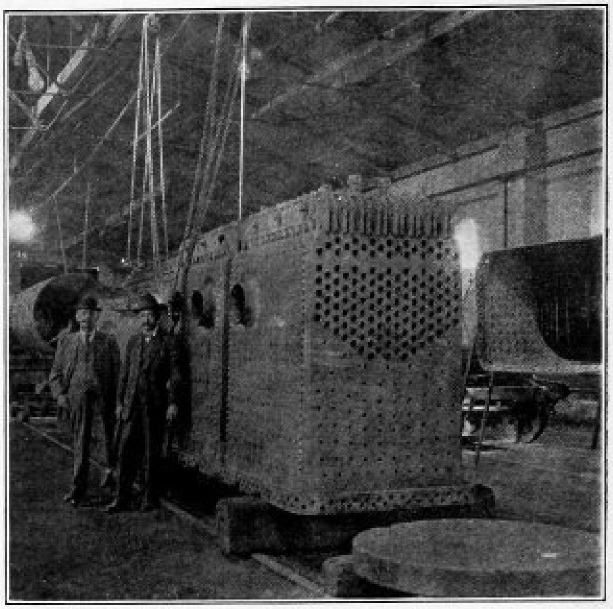


FIG. 2.—STEEL DOUBLE FIRE-BOX

Fig. 1 shows the inside of the boiler after taking out a double-copper fire-box. Fig. 2 shows a double fire-box made of carbon steel ready to be put into the boiler, and Fig. 3 shows the finished boiler. The gentlemen in the foreground of Fig. 3 are Mr. E. E. Stillwell, general foreman boiler maker of the Mexican Railway, to whom we are indebted for this information, and Mr. Rafael Arroyo, assistant foreman at the Orizaba shops.

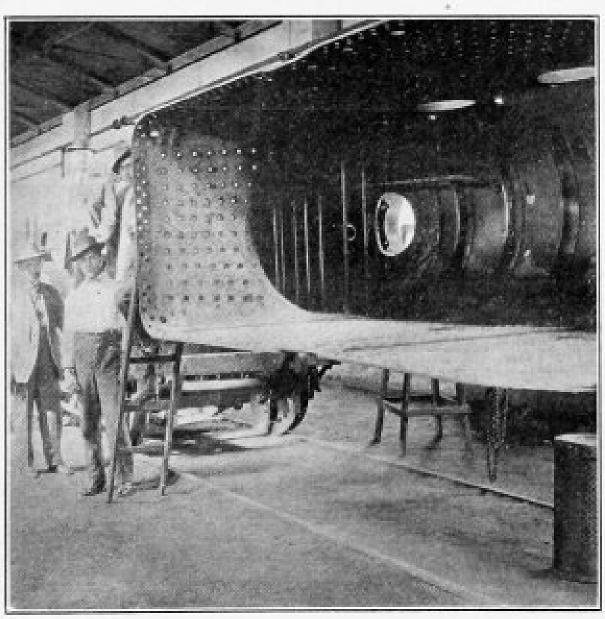


FIG. 1.—INSIDE OF BOILER (FIRE-BOX REMOVED)

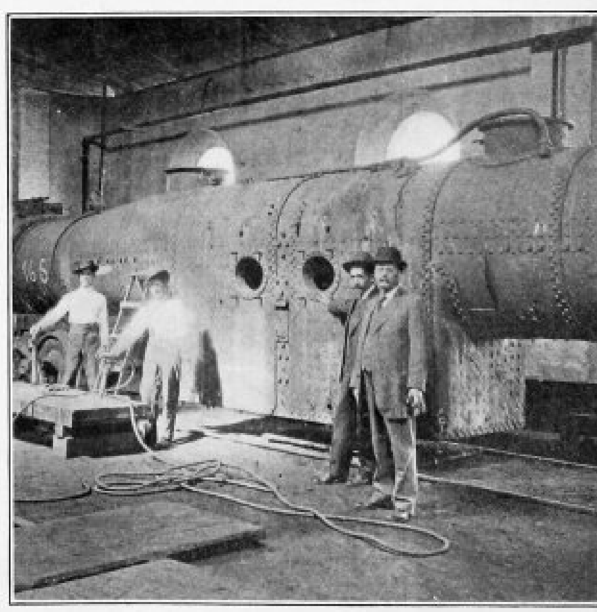


FIG. 3.—FAIRLIE DOUBLE FIRE-BOX LOCOMOTIVE BOILER

Jacobs-Shupert versus Radial Stay Boiler

The complete report of the series of tests carried out last year at Coatesville, Pa., on a Jacobs-Shupert boiler in comparison with a radial stay boiler, has just been published by the Jacobs-Shupert United States Firebox Company, in the form of an 8½ by 11-inch book containing 171 pages, profusely illustrated. The report is submitted by W. F. M. Goss, D. Eng., dean of the College of Engineering, University of Illinois, Champaign-Urbana, Ill., who approved the design and superintended the construction of the two boilers and conducted the tests. Brief notices of the different tests as they were carried out were published in the February, June and July, 1912, issues of The Boiler Maker, and following is a summary of the complete report:

A brief story of the development of the locomotive boiler emphasizes two facts: (1) That the design of such boilers has from the beginning been subject to frequent change, and (2) that the difficulties in the construction and maintenance of such boilers have always centered in the firebox.

The radial-stay boiler is recognized as the most important detail of the modern high-power locomotive. Many embellishments in its construction have from time to time been introduced, and present-day designs represent a highly developed practice. But forces are always present within the structure of the radial-stay boiler which make its maintenance difficult and which ultimately bring about its ruin. Like all its predecessors, the radial-stay boiler is weak under low-water conditions and failures, sometimes disastrous, are not uncommon. No one who considers the progress of the past can assume for a moment that our present-day practice is final. The radial-stay boiler has had its predecessors and they have disappeared, and no one can doubt that the radial-stay boiler itself is but an embryo predecessor of a type which will soon be revealed.

The Jacobs-Shupert boiler seeks to overcome some of the defects of the radial-stay type. Its firebox construction is more than a modification of pre-existing forms; it is new in its contour, in the means employed for its support, and in the fact that it is made up of a considerable number of comparatively small plates. The contour of the Jacobs-Shupert firebox is not dissimilar to that of the corrugated furnaces so long and so generally used in marine service. It has no radial stays and there are no stay-bolts except in the tube sheet and door sheet. There are no rivets or stay-heads on the fire side of the crown sheet or side sheets. The rivets joining the several sections making up the firebox structure are not inside of the firebox. They cannot be seen from the firebox and they cannot be affected by the direct action of the heat from the firebox. They are above the crown in the water space of the boiler at a distance sufficiently far from the heating surface of the firebox to be undisturbed by any condition that may arise within the firebox. These features place the design of the Jacobs-Shupert boiler upon a plane which, from a purely mechanical point of view, is essentially higher than that which is occupied by the normal radial-stay boiler. The fact also that in the manufacture of these boilers the principle of interchangeability is employed, establishes a high standard of warkmanship. Interchangeability in construction operates to improve quality and to reduce costs. In the manufacture of the Jacobs-Shupert firebox, machinery is used instead of men. Each operation is simple and yet the result is precise. There is no drifting of holes and no local heating of plates which have been set in place in the boiler. The result of the new process is a boiler accurately made, substantially put together, and comparatively free from initial strains. The design and the methods of manufacture combined permit repair parts to be carried, and provide an inexpensive procedure in maintenance.

The Jacobs-Shupert boiler in service was made the subject of an inspection at several division points, and on the road along the line of the Santa Fe, where at the time of the inspection (November, 1911) 169 locomotives were in service. As a result of five days' inspection, conclusions were reached as follows:

1. The construction of the Jacobs-Shupert firebox admits of easy and thorough inspection.

2. The Jacobs-Shupert firebox gives no trouble by leaking at the mud-ring. Not a single case of a leaky mud-ring could be found.

3. The fireboxes give no trouble by leaking between sections.

4. No indication could be found of grooving or cracking at the fillet or in any other part of the sections making up the firebox.

5. The fireboxes examined, while very large, appear to resist perfectly the pressure imposed, which in all cases was above 200 pounds.

6. The firebox structure of a Jacobs-Shupert boiler after a year of service in a district of alkali water, appeared as though new, while that of a radial-stay boiler in the same service for the same or a lesser length of time presented unmistakable evidences of degeneration.

7. Evidence was not lacking to prove that minor defects, such as those which may arise in a Jacobs-Shupert boiler from accumulation of scale or because of low water, are easily repaired.

Some months after this inspection, it was reported that defects had appeared in the outside wrapper-sheets of some of the older boilers. The cause was easily seen to be in a defective arrangement of some of the longitudinal stays, and the remedy was simple. The occasion for the occurrence of such defects is avoided in more recent designs.

Programme of Tests

A programme of tests designed to disclose the performance of the Jacobs-Shupert boiler in comparison with that of a radial-stay boiler was outlined as follows:

The boilers to be tested were to be designed for locomotive service and to be identical in their general dimensions. They were to differ from each other only in the construction of the firebox and in the means employed for supporting it. One boiler was to be equipped with a Jacobs-Shupert firebox and the other with a radial-stay firebox conforming to the best present-day practice.

A laboratory was to be provided in which the two boilers could be erected and equipped with all apparatus necessary for testing. The tests specified were to be grouped into three series designated as Series A, B and C, respectively.

Series A was planned to disclose the relative amount of heat absorbed by the fireboxes and by the tubes of the two boilers under similar conditions of operation. To facilitate these tests, it was proposed to have the boilers constructed with a partition separating the water space into two compartments, one of which was to include the firebox surface and the other the tube surface. In carrying out the tests, these compartments were to be separately fed with weighed water. Not less than three tests, one at low power, one at medium power, and one at high power, were to be made upon each boiler. It was believed that the results would serve to establish the relative value of a unit area of firebox heating surface as compared with that of a unit area of tube heating surface—facts which American engineers have long desired to know—and that they would disclose the difference, if any, in the heat-absorbing capacity of the two fireboxes tested.

Series B was to be made up of tests of normal boilers. The boilers which had served in the tests of Series A were to undergo such reconstruction as might be found necessary to the removal of the partitions. This accomplished, there would be available for the further work a normal Jacobs-Shupert boiler and a normal radial-stay boiler. Each boiler was then to be subjected to a series of evaporative tests for the purpose of establishing its evaporative efficiency and capacity under different rates of power. In addition to data usually secured in boiler testing, it was proposed to make of record such information as might be possible concerning the circulation of water within the two boilers. The purpose of this series was to secure an accurate measure of the evaporative performance of the Jacobs-Shupert boiler and of a normal radial-stay boiler.

Series C was planned to disclose the relative strength of the two boilers under low-water conditions. In preparation for the tests of this series the boilers were to be removed from the testing laboratory and set up with everything necessary to their operation in a location where their explosion would result in no harm to surrounding property. Adequate provisions were to be made for the safety of observers. The boilers were to be operated, the supply of feed-water was to be cut off or so controlled that the firebox would be uncovered, and the low-water conditions were to be continued until failure occurred.

The general dimensions of the boilers tested were as follows:

	Jacobs-Shupert	Radial-Stay
Type of boiler	Ext'd Wagon Top	Ext'd Wagon Top
Diameter of shell	70 in.	70 in.
Number of 2¼ in. tubes	290	290
Length of tubes	18 ft. 2 in.	18 ft. 2 in.
Length of firebox	9 ft. 1⅝ in.	9 ft. 1 11-16 in.
Width of firebox	6 ft. 4⅛ in.	6 ft. 4¼ in.
Total heating surface	3008.4	2989.3

Firebox vs. Tube Heating Surface

The percentage of the total heat absorbed by the boiler which is taken up by the firebox varies with the rate of power at which the boiler is worked. It is affected also by the character of the fuel used.

When oil fuel was fired at the rate of 2,200 pounds an hour:

(*a*) The Jacobs-Shupert boiler evaporated 40,000 pounds of water per hour. Of this amount, 16,000 pounds were evaporated by the firebox and 24,000 pounds by the tubes.

(*b*) The whole boiler developed 1,200 horsepower, of which amount nearly 500 horsepower was developed by the firebox.

(*c*) The average rate of evaporation per foot of heating surface per hour for the whole boiler was 9.78 pounds.

(*a*) The average rate of evaporation per foot of heating surface per hour for the firebox was 49.59 pounds, and for the tubes 6.47 pounds.

(*c*) The ratio of heat absorbed per foot of heating surface by the firebox to that absorbed per foot of tube heating surface was as 7.6 to 1.

When oil is used as fuel, the percentage of the total heat absorbed that is taken up by the firebox can be found by dividing the pounds of oil fired per hour by 100 and subtracting the quotient from 62. Strictly speaking, the application of this statement should be limited to those rates of firing which were covered by the experiments—that is, to rates between the limits of 700 pounds and 2,200 pounds of oil per hour.

When a long-flamed bituminous (Dundon) coal was fired at the rate of 4,340 pounds per hour:

(*a*) The Jacobs-Shupert boiler evaporated 35,405 pounds of water per hour, of which amount 11,982 pounds were evaporated by the firebox and 23,423 pounds by the tubes.

(*b*) The whole boiler developed 1,026 horsepower, of which amount 304 horsepower were developed by the firebox.

(*c*) The average rate of evaporation per square foot of heating surface per hour for the whole boiler was 11.77 pounds.

(*d*) The average rate of evaporation per foot of firebox heating surface was 51.92, and for the tube heating surface 8.43.

(*e*) The ratio of heat absorbed per foot of firebox heating surface to that absorbed per foot of tube heating surface was as 6.15 to 1.

When long-flamed bituminous coal is used as fuel, the percentage of total heat absorbed that is taken up by the firebox can be found by dividing the pounds of coal fired per hour by 190 and subtracting the quotient from 56. Strictly speaking, the application of this statement should be limited to those rates of firing which were embraced by the experiments—that is, to rates ranging from 1,400 pounds to 4,500 pounds of coal per hour.

Different fuels produce different results in the distribution of heat. For example, assuming the Jacobs-Shupert boiler to be evaporating 20,000 pounds of water per hour, the percentage of the whole quantity of heat absorbed, which is taken up by the firebox, is as follows:

(*a*) When oil is used as fuel	42 percent
(*b*) When long-flame bituminous coal is used as fuel	42 percent
(*c*) When short-flame bituminous coal is used as fuel	35 percent

Comparative Evaporation Tests

Results of evaporative tests of a normal Jacobs-Shupert boiler and a normal radial-stay boiler disclose the evaporative efficiency and the capacity of the two boilers tested.

The high efficiency of the Jacobs-Shupert boiler, unaided by the presence of a brick arch, is to be seen in the fact that when fired with 1,315 pounds of Dundon coal per hour it

(*a*) Evaporated 15,293 pounds of water per hour.

(*b*) Evaporated 5.08 pounds of water per square foot of heating surface per hour.

(*c*) Evaporated 11.01 pounds of water per pound of coal.

(*d*) Developed 443 horsepower.

(*e*) Developed an overall efficiency of 71.86 percent.

(*f*) Developed an efficiency, excluding the grate, of 79.75 percent.

The various effects resulting from operation at higher rates of power may be set forth as follows:

Pounds of coal fired per hour	1,389	3,419	5,930	6,314
Thermal units for each pound of coal:				
(*a*) Absorbed by water in boiler	10,687	9,327	7,532	7,388
(*b*) Lost by moisture in coal	48	34	37	33
(*c*) Lost by moisture in air	49	53	114	54
(*d*) Lost by hydrogen in coal	486	497	500	514
(*e*) Lost by smoke-box gases	1,979	2,731	3,992	4,675
(*f*) Lost by incomplete combustion	78			
(*g*) Lost by cinders passing up stack	153	851	1,078	1,012
(*h*) Lost by combustion in ash	1,187	679	291	185
(*i*) Lost by radiation and unaccounted for	205	547	881	783
Total B. T. U. per pound of coal	14,872	14,719	14,425	14,654

The evaporative efficiencies of the Jacobs-Shupert boiler and of the radial-stay boiler were found to be practically identical.

In the matter of capacity the data show the Jacobs-Shupert boiler to possess some advantages over the radial-stay boiler. The Jacobs-Shupert boiler was forced without the least sign of distress to an unprecedented rate of power. It was fired at the rate of 6,553 pounds of coal per hour, resulting in:

A rate of combustion equaling 119.38 pounds of coal per foot of grate per hour.

An evaporation of 57,564 pounds of water per hour, or the equivalent of 19.13 pounds of water per foot of heating surface per hour.

The development of 1,669 boiler horsepower, or the equivalent of one boiler horsepower for each 1.8 foot of heating surface.

An evaporation per pound of coal, notwithstanding the high rate of power developed, of 8.78 pounds of water.

The maintenance of an overall boiler efficiency of 65.34

percent, and of the boiler, exclusive of the grate, of 67 percent.

The published records of boiler performance disclose no results of equal significance.

Benefits of the Brick Arch

The brick arch as a factor in boiler performance is always beneficial. Its effect depends upon the characteristics of the fuel. When a short-flamed bituminous (Scalp-Level) coal was used, the addition of an arch to either boiler tested increased the amount of water evaporated per pound of coal 0.6 pound—that is, assuming either boiler to be fired with 6,500 pounds of Scalp-Level coal per hour, they will evaporate 7.35 pounds of water per pound of coal without the arch, and 7.95 pounds with the arch, a gain resulting from the introduction of the arch of 8 percent. The substitution of a long-flamed bituminous (Dundon) coal will, under similar conditions, result in the evaporation of 7.7 pounds of water per pound of coal without the arch, and 8.7 pounds with the arch, a gain resulting from the introduction of the arch of 12 percent.

Circulation of Water

Some facts of interest with reference to the circulation of water within a locomotive boiler have been developed. The motion of the water within a locomotive boiler in response to the energy transmitted to it in the form of heat is known to have an important bearing on the upkeep and life of the boiler, and there has been much speculation concerning the direction and strength of the circulating currents. It has been urged, for example, that the presence of the stay sheets which enter into the construction of the Jacobs-Shupert boiler retard the fore-and-aft movement of water and that they are, therefore, objectionable. As the stay sheets are provided with widely distributed openings of large area, such criticisms necessarily assume fore-and-aft currents which are tremendously vigorous. The presence of such vigorous currents has been questioned. An experimental inquiry conducted by Mr. George Fowler sustains the very rational contention that only enough water passes back from the barrel of the boiler to the water legs of the firebox to make good that which the firebox evaporates. Since the firebox evaporates from 30 to 50 percent of the water handled by the boiler, a similar percentage of the total feed must, in the case of the Jacobs-Shupert boiler, find its way through the ports in the forward stay sheet. Some of this water is evaporated before the second stay sheet is reached. With the passage of each section, the backward flow diminishes until at the last stay sheet only enough passes to supply that which the last section evaporates.

As the stay sheets have an aggregate port area below the waterline of 1½ square feet, and as only 30 to 50 percent of the total water delivered by the injectors must pass by them, it is inconceivable that their presence can affect the circulation unfavorably.

The strongest currents which are set up in a locomotive boiler are those which sweep over the heating surface in a direction which in its general tendency is vertical. These are the most important of the circulating currents, and with respect to them, the Jacobs-Shupert boiler presents superior advantages, for the water space about a Jacobs-Shupert firebox presents broad, unobstructed vertical channels which in the matter of form and dimensions have no counterpart in the radial-stay boiler.

The conclusion as drawn from analysis and experiment, is to the effect that with reference to circulation the Jacobs-Shupert boiler is at no disadvantage as compared with the radial-stay type, but, on the contrary, possesses elements of distinct superiority to that type.

Low Water Tests

The superior strength of the Jacobs-Shupert boiler under low water conditions has been abundantly demonstrated by experiment. In the progress of the tests each boiler in turn was put under steam. Its draft was adjusted to give an evaporation of approximately 10 pounds of water per foot of heating surface per hour. Upon signal, the injectors were shut off and the delivery of feed-water ceased. Thereafter the water level steadily declined, but the fire was not checked. The purpose was to maintain all the general conditions the same for both boilers, and the data show that this purpose was satisfactorily achieved.

In the test of the Jacobs-Shupert boiler, the water level receded to the bottom of a special water glass 25½ inches below the level of the crown sheet in 34 minutes after it had passed the level of the crown sheet, but there was no failure or serious leak. The extent of the submerged heating surface continued steadily to diminish and the steam jet from the exhaust pipe, which made heavy demands upon the boiler, began to reduce the steam pressure, until finally when the water had fallen nearly 40 inches below the crown sheet and the pressure had been reduced to 50 pounds, 53 minutes after the water had fallen to the level of the crown sheet, the test was ended. The Jacobs-Shupert boiler had been boiled nearly dry and no failure had occurred. An inspection of the boiler after the test showed all the usual effects of overheating except that the firebox was intact. Three-quarters of the tubes were out of water and were sagged from effects of the heat. Several tubes had collapsed. The crown and sides of the firebox for half their height presented the scale and color of newly-heated metal. There was some change in the curvature of sections, but there were no local pocketing and no leaks between sections. The integrity of the firebox was complete, and so far as its condition was concerned, the boiler at the conclusion of the test might have been refilled and operated. Probably no other type of locomotive boiler now in common use could have withstood such a test.

The radial-stay boiler was subjected to a similar test. The conditions of operation imposed were identical with those which had prevailed during the test of the Jacobs-Shupert boiler. Seventeen and three-quarter minutes after the water in glass had fallen to the level of the crown sheet, when its level was 14½ inches below the crown, the boiler failed. One-half the crown sheet came down. The rear end of the boiler was lifted from its foundation and the brickwork making up the furnace construction was scattered in all directions over a radius of 150 feet. An examination of the boiler showed only the upper row of tubes to have been out of water, and these had not been heated sufficiently to make them sag. The lowering of the water level had not been sufficient to allow the side sheets or the back sheet or the tube sheet to take on evidences of overheating, facts which suggest the brevity of the interval during which the crown was actually exposed, and yet in the interval the crown of a new boiler came down with explosive effect. The failure was complete; the boiler had broken away from all its fastenings, property in its vicinity was disturbed, and the boiler itself left incapable of rendering further immediate service.

A comparison of these statements shows conclusively the superior strength and safety under low water conditions of the Jacobs-Shupert boiler.

General Conclusions

The general conclusions justified by the work are to the effect that the design of the Jacobs-Shupert boiler is the result of a carefully studied development of pre-existing practice; that the design easily admits of a grade of workmanship difficult to attain in the construction of pre-existing types of locomotive boilers; that those features which are peculiar to the new construction are such as tend to reduce cost in maintenance; that the evaporative efficiency of the Jacobs-Shupert boiler is the same as that of a radial-stay boiler of the same dimensions; that the steaming capacity of the Jacobs-Shupert boiler is, in general, the same as that of a radial-stay boiler, but that it may be forced without danger of injury to higher power; that the Jacobs-Shupert boiler presents nothing in its internal construction which can interfere with the usual movement of water over the heating surfaces, and that in the matter of circulation it possesses some advantage when compared with other types of locomotive boilers; that the superior strength of the Jacobs-Shupert boiler under low water conditions permits it to endure overheating without failure for long periods of time, where the normal radial-stay boiler quickly fails; and that where the overheating is so severe that it cannot be resisted, the result will be a blow-out and not a disastrous explosion.

Welding Firebox Half Side Sheets

BY A. R. HODGES*

The following is an account of how the half side sheets are welded in by the autogenous process in the high-pressure Atlantic type, wide firebox boilers of the A. T. & S. F. Railway. impossible to weld it any farther than the calking edge of each sheet.

At the flue sheet, where the side sheets come together, a space is left open of about 1/8 to 3/16 inch, but at the other end at the door sheet an opening is left of 1½ inches. This is very important, as it will draw up to its proper place before the welding is completed, and even then to keep it from drawing too much it is necessary to clamp the sheet to the mud ring with about three good horseshoe clamps. Bolts are also inserted along the line of welding with pieces of flat bar iron as washers or clamps to keep the sheets uniformly flush along the route of welding.

The operator must always commence welding from left to right. Fig. 2 shows the proper application of the sheet before welding. After welding a great deal of metal has been piled up on the welded part until the sheet at this place is nearly twice as thick as the original sheet. This produces good, strong, substantial work. Experience has proved that by observing this order you will secure a good job. It should be remembered that, having commenced welding the sheets, the job must be continued without any remittance or stop, even

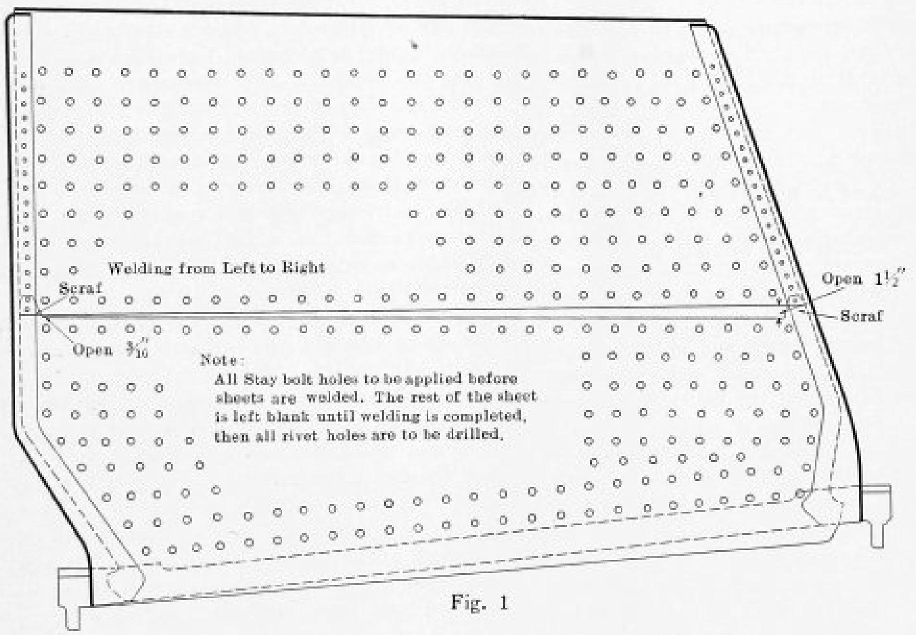


Fig. 1

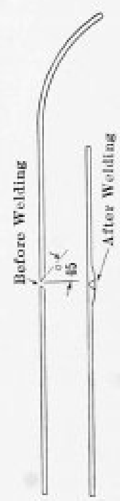


Fig. 2

FIREBOX ARRANGED FOR WELDING HALF SIDE SHEET

By referring to the sketches, Figs. 1 and 2, the general method of procedure will be quite intelligible and self-explanatory. It will be noted that in Fig. 1 the old sheet is cut out between the ninth and tenth rows of staybolts, very much as a sheet would be cut out which was to be applied with patch bolts or rivets, except that in that instance the sheet would be cut out directly above the staybolt holes. In this instance it will be noted the sheet is cut out between the two rows of staybolts.

The old sheet is beveled to about 45 degrees, and care should be taken that it is cut down to a feather edge all along. The new sheet is then gotten out in the same manner as any other half side sheet, with the exception of all rivet holes. They should be left out until the sheet has been welded, otherwise there are liable to be bad holes. The top edge of the new sheet which is to be welded should be beveled to about 45 degrees, either by chipping or planing. Of course this is done in the Topeka shops on the planer. At the laps of the door sheet and flue sheet the half side sheet has been scarfed in the same way as any other sheet. This is done because it is

* General foreman boiler department, A. T. & S. F. Ry., Topeka, Kan.

if it is necessary to use two welders on the job, although the writer would not and does not advise using two men welding on the job unless it is known absolutely that both understand equally well how to weld boiler patches.

After the sheet has been welded, remove all clamps at the mud ring and all bolts, and let everything get perfectly cool before hammering it or doing any more work on it. Then drill all holes in the door sheet and flue sheet flanges, as well as in the mud ring. Drive the rivets, chip, calk, tap out the staybolt holes and apply the staybolts complete. You can drive the staybolts with an air gun or by hand, whichever you choose, for it makes no difference as far as the weld is concerned.

This is the method we use in welding in half side sheets, and we follow the same process as nearly as possible in welding in half door sheets of the same class engines, with the exception that all holes are applied in the door sheet, both staybolt and rivet, before the welding is begun, the lower right hand corner being dropped as low as the fire door hole will admit.

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NOTICE TO ADVERTISERS.

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

Elsewhere in this issue is published a summary of the complete report of the series of comparative tests on a Jacobs-Shupert and a radial stay boiler carried out last year by Dr. Goss. Much that is of interest and of great value was brought out in this work, and in a later issue we hope to publish more fully some of the details of these tests. The most striking advantage of the Jacobs-Shupert firebox seems to lie in its superior strength under low-water conditions, whereas the firebox of a normal radial stay boiler commonly fails shortly after the crown sheet becomes overheated. The low-water tests showed that the sectional firebox could withstand overheating without failure for a long period of time, and that nothing more serious than a blow-out would result from this cause. There does not seem to be much to choose between the evaporative efficiencies and steaming capacities of the two types of boilers, except that the Jacobs-Shupert boiler may be forced to a higher power without danger of injury, as this type of construction possesses some advantages conducive to freer circulation of water in the boiler.

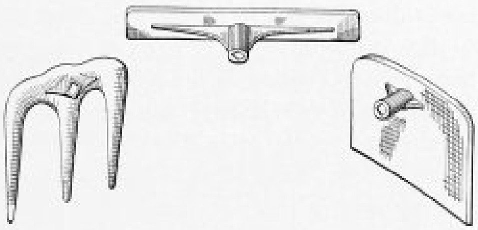
No man who has made an earnest effort to master the trade of boiler making with the intention of becoming a first-class boiler maker can fail to recognize the importance of keeping posted on up-to-date methods and practices in boiler making, wherever employed. The matter of learning his trade, and learning it well, is, of course, the first requirement for a successful boiler maker; but the wider the range of knowledge which he gains from his practical every-day experience, the greater will be his opportunities for advancement to a higher position and better pay. Furthermore, after the trade has been thoroughly mastered, the field of opportunity opens up wonderfully, because the science of boiler making itself is always advancing, and in the short space of only a very few years new tools, new methods and improved materials are continually being introduced, thereby raising the standards of boiler making to a higher level. In view of this, it certainly does not pay to neglect any opportunity to get up-to-date information as to what is going on in different boiler shops, nor is it in keeping with the tendency of the times to withhold information which will tend to better the trade. For this reason, if for no other, we strongly urge our readers to take notes of the many interesting and instructive things that come to their notice, and, by taking advantage of a spare moment now and then, to send these notes to us for publication. Both the contributor and the reader will benefit by this service.

According to the Federal locomotive boiler inspection rules, all staybolts must be tested at least once each month, and also after every hydrostatic test. The inspector must tap each bolt and determine the broken bolts from the sound or the vibration of the sheet. If staybolt tests are made when the boiler is filled with water, there must be not less than 50 pounds pressure on the boiler. Should the boiler not be under pressure the test may be made after draining all water from the boiler, in which case the vibration of the sheet will indicate any defect. The latter case is considered preferable. It is further specified that no boiler shall be allowed to remain in service when there are two adjacent staybolts broken or plugged in any part of the firebox or combustion chamber, or when three or more are broken or plugged in a circle four feet in diameter, or when five or more are broken or plugged in the entire boiler. It is required that all staybolts shorter than 8 inches, except flexible bolts, must have telltale holes 3/16 inch in diameter and not less than 1¼ inches deep in the outer end, and that these holes must be kept open at all times. Now the important point to be determined by the inspector in these staybolt tests is whether or not the staybolt is broken, and herein there is a chance for a difference of opinion. Some inspectors hold that when a staybolt is cracked part way through it is a broken staybolt and should be removed, while others claim that the bolt is not broken unless it is fractured at least half way through or up to a point where the failure is indicated by the telltale hole. There is certainly some latitude for decision on this point, but there should be a well defined rule to cover the case, so that no dispute can arise as to whether a bolt is or is not broken.

Engineering Specialties for Boiler Making

Indestructo Fire Tools

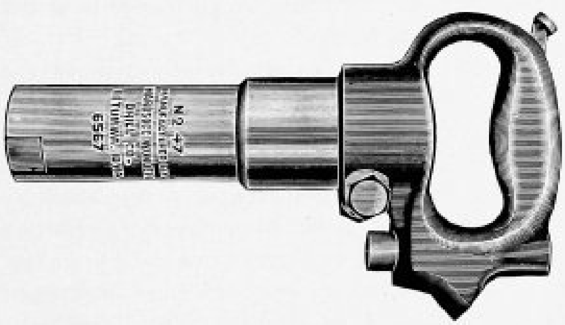
It is a common complaint from the boiler room that the ordinary fire tools are unsatisfactory, in so far as their durability and wearing quality is concerned. In order to overcome this difficulty the Indestructo Fire Tool Company, Philadelphia, Pa., has brought out a set of fire tools of standard pattern but made of a new composition metal especially de-



signed to withstand the hard use to which such tools are subjected under particularly high temperature. Practically no change is made in the shape of the tools except that they are strengthened at the points most subject to wear, but the chief advantage claimed for them lies in the composition of the metal, which is a special high heat-resisting alloy capable of withstanding the hard usage to which such tools are put.

"Wonder" Chipping, Beading and Calking Hammer

The Hardsocg Wonder Drill Company, Ottumwa, Ia., manufacturers of "Wonder" rock drills, have placed on the market recently a chipping hammer which is made after the pattern of their air hammer rock drills. The hammer has only

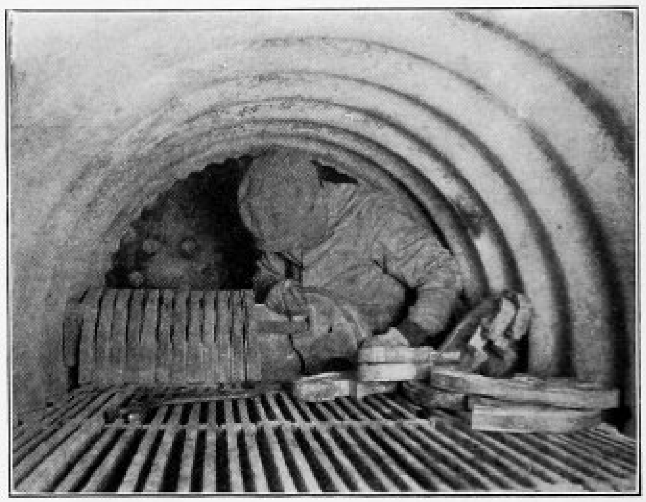


one movable part; that is, a combined piston, valve and hammer. The particular advantage claimed for this hammer is that there is no live air used in returning the piston on the return stroke, and consequently there is a great saving in the air consumed over the old-style valve hammer. The hammers are made in three sizes, of 8, 10 and 12 pounds, respectively. The 8-pound hammer is suitable for calking 3/16-material, while the 10 and 12-pound hammers are for heavier work in proportion. They are made with either outside or inside latch.

Wager Patent Improved Furnace Bridge Wall

An improved furnace bridge wall, which has been installed with satisfactory results on ocean-going and harbor tugs, ferryboats and by many of the large railroads and steamship companies, is made by Robert H. Wager, 100 William street, New York. This device was designed to provide at a very moderate cost a bridge wall which can be easily removed and replaced without sacrificing material. It is composed of gray cast iron bars with suitable air openings between. The back bridge wall casting is provided with suitable air openings to admit air freely from the ash pit to and around the bridge wall castings, and through openings in the bridge wall bars to the fire, in order to do away with the usual pile of dead fire against the bridge wall. The intermediate sections have formed at the crest of the bridge a series of openings by which air is admitted to mingle with the gases from the furnace as they pass into the combustion chamber, thus effecting their complete combustion and preventing gasing and excessive smoking. When in use the bars of the bridge are securely locked in place, but they are provided with means for readily removing them when necessary.

The illustration shows how easily the Wager improved bridge wall may be attached or detached to the bridge wall casting, whereby a single bar may be removed from any part

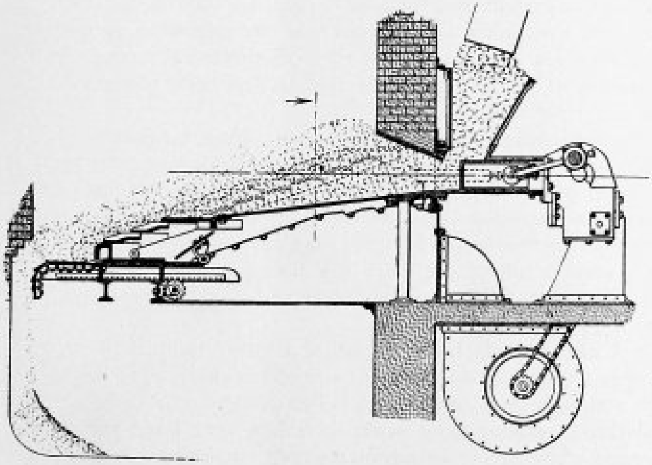


of the bridge wall without disturbing the general assembly. The whole bridge wall can be removed to permit examination of all parts of the furnace and be easily replaced without destroying any part of the bridge wall, thus effecting a saving in comparison with bridge walls of brick and fireclay. It is claimed that this bridge wall assists in the perfect combustion of fuel in the furnace and also acts as a smoke consumer.

A New Mechanical Stoker

The Sanford Riley Stoker Company, Ltd., Worcester, Mass., is now placing on the market a new automatic stoker which is of the underfeed type, with self-dumping features. It is said to be the only underfeed stoker that has a mechanical movement of the fuel-bearing surfaces, so that the continuous movement of fuel and ash down the slight incline results in a continuous rather than a periodic cleaning.

The most conspicuous difference between the new Riley self-dumping underfeed stoker and all other underfeed stokers is that the Riley has moving fuel-bearing grates extending across the entire width of the furnace. These moving grates carry the fuel down an incline of about 20 degrees. The positively forced feed, made up of the combined motion of a plunger in the retort and the moving grates, distributes the coal evenly. The nearly uniform thickness of fuel, it is claimed, insures active combustion over the whole fire surface by providing a much freer and more uniform passage of air through the coal than is possible when the coal heaps in large masses with adjacent thin spots, The discharge of refuse is continual and automatic, not periodic, which brings down large masses of fuel with the refuse. At the lower end of the overfeed grates are pusher noses, which force the refuse slowly but continuously toward the bridge, then on and over the ash-supporting plates, which are hinged together in the form of an apron. The plates of this apron hang down over the ends of a rack which controls the size of the opening and is adjustable by hand power. The discharge capacity can be regulated by the amount of travel



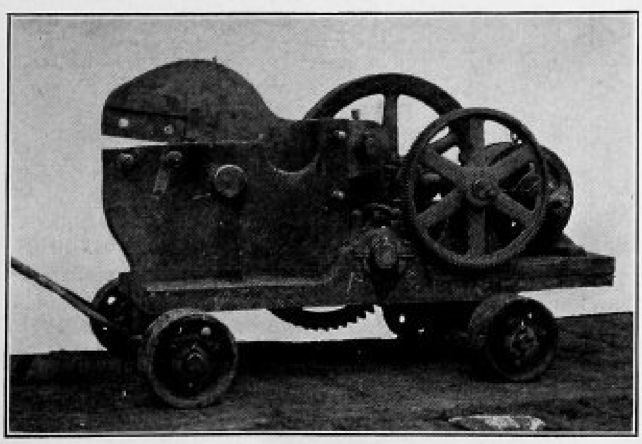
given to the pusher noses. The discharge of refuse is at such a rate that the fuel is thoroughly burned out and practically cold before discharge.

For a year a Riley stoker has been tested out in a large electric light plant with conspicuous success. It has been operated under the severest conditions of actual service, and has been subjected to numerous tests to determine its efficiency and capacity. As a result of these tests final improvements have been introduced and parts standardized.

Like all other underfeed stokers the Riley is smokeless, even when forced to far beyond the normal capacity of the boiler. Unlike other types, however, it is without dead plates, the entire surface within the furnace being live fire surface. The makers claim that this stoker takes up less space than any other of equal capacity, and also requires less head room than other types. It has been made thoroughly rugged in every part, but at the same time protected by shearing pins so that serious obstruction in the fuel can cause no damage to the mechanism.

Little Giant Portable Sheer

The Danville Foundry & Machine Company, Danville, Pa., manufactures an electrically-driven portable shear with a



capacity for shearing 1½-inch rounds and 1¼-inch squares. The machine is designed with the purpose of securing the greatest power in compact space for meeting the requirements of all iron working establishments of every character and to meet the uses of scrap yards and metal dealers. It is made in a most substantial and workmanlike manner, having all cut gears, excepting the large gear wheel on the crankshaft. The crankshaft is steel, having a 6-inch stroke. The two small pinions are also steel. The crank-pin is 3½ inches in diameter, and the blade is driven by a pitman connection, making positive opening. It can be driven either by belt or by a 5-horsepower Westinghouse 2 or 3-phase electric motor.

Personal

F. J. PEACOCK has resigned his position as boiler maker at the Philadelphia & Reading engine house and accepted the position of foreman boiler maker for W. T. Bate & Son, Conshohocken, Pa.

JAMES BEALE and WILLIAM FRAZER have established a new boiler shop, known as the Hamilton Boiler Works Company, at Hamilton, Ontario, Can. The new company is engaged in the manufacture of all types and sizes of boilers, stacks, tanks and retorts, and the shop has been especially equipped for handling repair work, both marine and stationary.

FRED. GARDNER, for many years connected with Joseph T. Ryerson & Son, Chicago, Ill., resigned Jan. 1 to open an office for railway supplies in the Railway Exchange building, Chicago. Mr. Gardner is now handling Burden stay and engine bolt iron, Burden rivets, expanders and high-speed drills, and also the accounts of the Oxweld Railroad Service Company and the Jacobs-Shupert United States Firebox Company.

GILBERT H. PEARSALL, formerly secretary of Joseph T. Ryerson & Son, in charge of railroad sales, with headquarters in New York City, resigned Jan. 1 to become president of the Burden Sales Company, which has been organized as a distributor of the products, exclusive of horseshoes, of the Burden Iron Company, Troy, N. Y. The other officers of the company are H. H. Linton, vice-president, and Craig Graves, secretary and treasurer. The general offices of the newly-organized company are at 30 Church street, New York, with sales offices in Chicago, Atlanta and St. Paul. The general offices of this company will also be the Eastern sales office of the Jacobs-Shupert United States Firebox Company and the Oxweld Railroad Service Company. Notice of Mr. Pearsall's election to the vice-presidency of both of these companies appeared in this publication several months ago.

NATHAN B. PAYNE, formerly connected with Manning Maxwell & Moore, of New York, has been appointed manager of sales for the Davis-Bournonville Company, 90 West street, New York.

SOUTH BEND BOILER WORKS.—A change has been made in the location of the South Bend Boiler Works, South Bend, Ind. The company has purchased all of the buildings, machinery and tools of the Matthews Steam Boiler Works of the same city, and will hereafter carry on their business in these shops. The company makes a specialty of boiler and repair work, sheet iron work and tanks of all kinds.

A BOILER SHOP WITH A RECORD.—The D. M. Nichols Iron Works, Inc., Gouverneur Slip, are apparently doing their share of the marine boiler building and repair business of the port of New York. The works were established sixty-three years ago, and have never been known to turn out a boiler that was not in every way successful. They have built and repaired thousands of tug and steamboat boilers, and some of their boilers built twenty-five years ago are still performing duty.

Letters from Practical Boiler Makers

Testing Welded Joints

Welding joints and heads by the oxyacetylene process for boilers, tanks and jacket kettles for pressure has not yet come into universal use, and consequently the inspection of same is somewhat vague.

The writer was called on to make an examination of a number of jacket kettles which had been constructed in this manner, and as we had no way of determining the efficiency of the joint, we simply placed a hydrostatic pressure on the kettles and followed along the line of the weld by sharp blows of a hammer in an endeavor to discover some place where the metal had not fused. The pressure was 200 pounds and the working pressure 120 pounds.

One defect disclosed, which was not serious, was that the sheets did not match up fair for welding, which left a slight offset after the weld was finished and which I attribute to the rolls springing, the metal being five-eighths inch thick.

Some of these kettles have been in service for some time and show no weakness, and are worked under severe conditions, such as being kept under 100 pounds steam pressure for a time, after which steam is shut off, the relief valve opened and cold water circulated through.

Chicago, Ill. E. C. PACHALY.

Piece Work

I have followed with much interest the communications with reference to the above subject which have appeared in recent issues of your valuable paper, and I would like to say a few words with regard to this subject from an English point of view.

In my opinion, piece work is a good thing, both for employer and employee, for with a price properly and fairly fixed it acts as an incentive and reward to the industrious workman, a whip for the idler, and a safeguard to the employer, because it enables him to ascertain the exact amount of work he is getting for a given amount of money. To make piece work a success the price should be carefully and accurately fixed at the outset, and unless the method of manufacturing the article is modified, the price should not be altered—there must be no price cutting.

The fixing of a price for a given job is not always easy, and often means a lot of unpleasantness for everybody concerned before it is finally adjusted. Unless the rate fixer has had considerable experience, the only way of arriving at a fair price is to make a time study on the job, and thus arrive at the actual time taken. After making suitable allowances the equivalent money value for this time can easily be calculated.

In a shop where piece work is in operation, all work should be subject to rigid inspection before being passed out if bad work is to be avoided. I fail to see why piece work of necessity leads to bad workmanship, because if a man knows that his work has to pass a certain standard or it will be returned to him for correction, he will make sure that it is done properly the first time. I agree with your correspondents that if a man is working at a good hard pace and is turning out good work, it is useless to offer him a price for it which would make it impossible for him to earn his wage at it.

I remember some time ago I was assisting to fix up a set of basic prices for manufacturing standard types of boilers, and it became necessary to make a time study of the job. The men were paid time and a half wage while on the test and had to keep at it at a good hot pace. All work done had to pass inspection by the foreman. Two independent sets of men were timed, the average time taken being afterwards reduced to the equivalent money value at the standing wage of the men employed. The price so found was increased 50 percent, so that the men could earn time and a half if they worked at the same pace as they did during the tests.

With this system, and the men earning time and a half each week, the boss could rest assured that the men were *earning* what they got over and above their standing wage, and the inspection of the work insured that it was being done in a satisfactory manner.

Another advantage was that as every little item of work on the boiler, for example, such as calking inside (13 cents for 10 feet), calking outside (15 cents for 10 feet), chipping 10 by 13-inch manholes (12 cents each), it was possible to fix a price for another boiler by simply taking the quantities from the drawing, which was quite a simple job, and one could rest assured that the price was right and that the men could earn a good bonus at it.

As I have already taken up rather a lot of space, it is impossible to describe this system further, but there is no doubt that although on some special boiler-making jobs it is not advisable to employ piece work, there is a very large variety of work where it can be advantageously employed. A proof of this lies in the fact that there are boiler ships to the writer's knowledge where the amount of piece work averages 80 percent of the total output, and the workmanship is as good as any that can be found in shops where no piece price system is in operation.

Lincoln, England. DIFFERENTIAL.

Layout of 90-Degree Compound Elbow

If there is any one thing that goes to show the value of THE BOILER MAKER and the interest that is taken in its columns, it is the increasing number of contributors to its columns from other lands. Our English subscribers are well represented in the January number, and as the writer hails from Staffordshire, it gives one a kind of "family" feeling to be numbered among the subscribers and workers for THE BOILER MAKER.

The query of C. G. Reem in regards to the development of patterns for a 90-degree elbow prompts me to send in a method which was explained to me by the layer-out, or in English parlance "the plater," in a boiler works in England. Fig. 1 represents the elevation of a 90-degree compound elbow, which was laid out and built by the writer. The elbow was 21 inches diameter, made of 3/16-inch material, and laid out by the following method:

Erect a right angle as *B A C* in Fig. 2 and set off from point *A* the diameter of the elbow as *A D*. Erect the perpendicular *D* 9. From point *B* set your protractor and mark off an angle of 11 degrees 2 minutes, which will be close enough for all practical purposes in a five-piece 90-degree elbow. Set out the diameter of the elbow as shown and divide it into equal spaces. Connect the various points with lines drawn as shown, and you are ready to set out the pattern.

Mark off the line 9-9 in Fig. 3, making it equal in length to the circumference of the large end. Divide 9-9 into halves at point 1 and square off the line 1-1, which should be equal in length to twice the height of line *A C* in Fig. 2. This will give the width of the plate for one whole section of the elbow. Set off on each side of line 1-1 at the bottom of the half circumference for the small end, making this four thicknesses of material less than the circumference of the large end. Now divide the top line into the same number of spaces as found in the plan and drop lines to the bottom line. Bisect line 1-1 at point *O*, and with the square set to line 1-1 and touching point *O*, mark off the point on line 2 where the square touches line 2. Set the square to line 2 at the point found and mark line 3. Continue until all points are found. This should give us the proper camber from which to set off the distances found

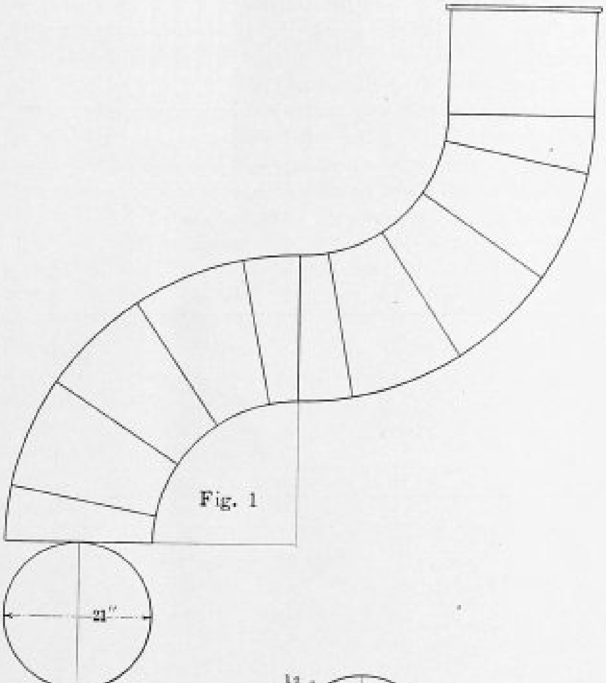


Fig. 1

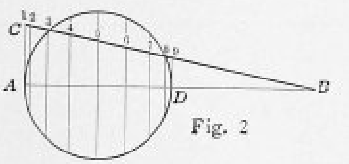


Fig. 2

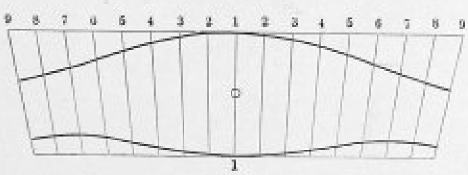


Fig. 3

DEVELOPMENT OF ELBOW PATTERN

in the plan. From the points found on Fig. 3 set off on each side the distances from line *A D* to the points where they touch line *C B* in Fig. 2. This will give us the pattern to the rivet line, beyond which laps must be allowed. The elevation and plan should be drawn to the neutral diameter of the elbow required.

Lorain, Ohio. Joseph Smith.

Drilling Telltale Holes in Staybolts

Pneumatic Feed Attachment

Fig. 1 is a sketch showing a pneumatic feed attachment applicable to any breast motor for the purpose of drilling telltale holes in the outer end of staybolts. The invention is an attachment for automatically feeding the tool to its work. While of varied application, it is designed with especial reference to portable pneumatic tools. Its special usefulness is found in drilling sheet metal, such as boiler plates, telltale holes, etc., where large numbers of holes are to be drilled and where high speed drills are used. Its object is to feed the tool to the work uniformly and positively so as to keep the tool at its work under uniform pressure at all times. It is exceedingly simple in construction and easily maintained. A further object is to provide for simple and efficient operation so that the workman may perform the work of drilling at the utmost speed without finding it irksome or tiresome.

In the A. T. & S. F. shops at Topeka, Kan., this pneumatic

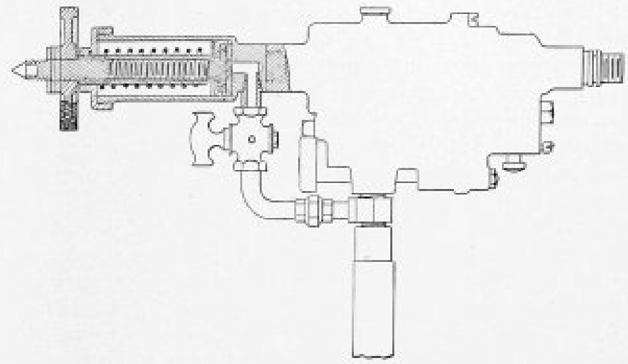


FIG. 1.—PNEUMATIC FEED ATTACHMENT FOR DRILLING TELLTALE HOLES

feed is attached also to a Thor motor No. 2 for drilling staybolts and staybolt burrs out of the firebox shell. The efficiency of the driller with one of these pneumatic feed attachments has been increased one hundred percent. As far as the telltale hole is concerned, for which this feed was primarily designed, it is exceeding our expectations. We have a number of these equipped and in constant use.

Air Motor Support

Fig. 2 shows an "old-man" attachment which was designed here and is being used in drilling telltale holes, as well as drilling out staybolt burrs. We can drill telltale holes 3/16-

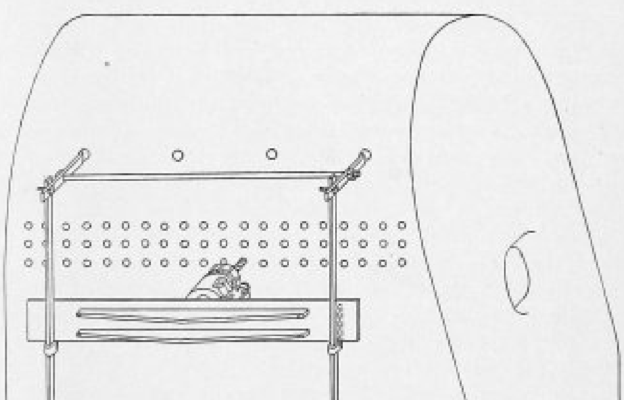


FIG. 2.—AIR MOTOR SUPPORT FOR DRILLING TELLTALE HOLES

inch diameter and 1¼ inches deep, including all changes, every thirty seconds, which is the average of every hole. The drawings are self-explanatory, but if anyone would like to have a detailed sketch we will be glad to furnish it with any other information. The pneumatic feed device is covered by a patent. A. R. Hodges

General Foreman Boiler Department, A. T. & S. F. Ry.
Topeka, Kan.

Camber in Plates of Ninety-Degree Elbow

In reply to the comments made by Mr. Reem in the January issue, I wish to say that the solution given for the lay-out of the 90 percent elbow is not mathematically correct. This is mentioned in the explanation concerning its development. In all tapering objects where the taper is sufficient to warrant its consideration, the camber must be determined in the pattern of the object, in order that when same is rolled it will form the correct shape of the object. In this case, however, where the taper is slight, and the diameter of the respective sections at the small and large ends large, the patterns produced by using the approximate method as explained is sufficient for determining a pattern close enough for all practical purposes. As the error is the same in all sections, the riveted holes will match fairly well, provided care is exercised in laying off the required patterns.

The relationship between the plate thickness and diameters of the sections in Fig. 1 was purposely distorted on the drawing—that is, the plate thickness was made much greater in proportion to the diameters at the respective ends. This causes a taper greater than would be found according to actual conditions. The plate was made thicker in cross section in order to show the construction better. In all cases where the taper is a factor and must be considered, the system of development by triangulation can be readily employed, but there are also a number of approximate methods which can be used satisfactorily, producing a pattern which is approximately correct.

Scranton, Pa. C. B. LINSTROM.

The Shop Toters

This is a story of an incident that happened in one of ye olden style boiler shops where men and boys did the work that cranes are now made to do, and especially where the apprentices were made to waste years of valuable time that could have been put to better use both for themselves and for the company. Besides wasting their time trying to do impossible work, in many cases the apprentices were also derided and abused, and, of course, always laughed at by the older time wasters in the shop. To-day things are different, for boiler shops are now operated for the purpose of making money for the stockholders. There is no place for the shop rowdy, and the apprentice is treated as an asset. Incidentally, the management of some of the boiler shops have found that cultivating the welfare of their employees is an asset, too. Anyway, the greatest need of shops, both past and present, is brains and not muscle, and that these brains be utilized for the company's business instead of being dissipated as of old in hazing operations and by the employees in devising ways and means for their own self-protection.

So it happened, as our story goes, that Jimmy, the apprentice, who was light of frame, was assigned to yard duty with three men who were brawny newcomers to our shores. A train load of rails and bars and plates had to be toted to the storage racks. Have you ever seen a calf yoked to a plow with a mule, or a burro hitched to a wagon with a Norman stallion? Well, such teams were no greater anomalies than was Jimmy with his co-workers, except that the calf and the burro lacked one great thing which Jimmy didn't—brains.

The first step in the use of his brains was to get the good will of Dan, his working partner. They were toting 30-foot rails, the three men and the boy, by working in pairs and using two pick handles for slings. The team of two men, Yale and Valle, always slid their pick handle under the rail at a considerable distance from the end, sometimes as much as five feet or more in. Probably they did this because it saved some steps, or maybe because it was easier to get under the rails at this point. More likely, however, it was just because it just happened so and they knew no better, as will be noted later on in the story. On the other hand, Jimmy located the handle as close to the end as could be done with safety. Fig. 1 shows the arrangement with Jimmy and Dan standing close to the end of the rail. In case the rail were 30 feet long and weighed 60 pounds per yard, or 600 pounds in all, and the leaders set 5 feet back from the end, as shown in Fig. 1, how much lighter would the load be for Jimmy and his partner? Let us see. The figures are in common arithmetic and are applied to Fig. 2 as follows:

The two teams are 25 feet apart, and hence each must carry one-half, or 12½ feet, of the rail between them. In addition to this, the team of men must carry the five feet projecting beyond them, or 17½ feet in all. Also, the five feet overhang-

Fig. 1

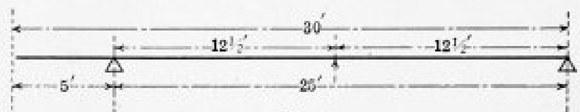


Fig. 2

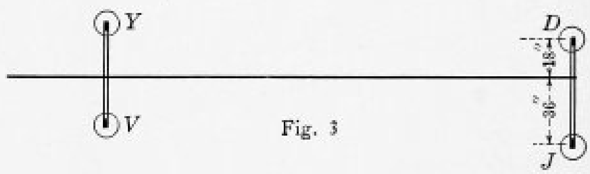


Fig. 3

ing will act as a lever or weight of $5 \times 20 = 100$ pounds that tends to lift up on the load of $12\frac{1}{2} \times 20 = 250$ pounds at Jimmy's end. The amount this five feet will lift up is

$$\frac{100 \times 2\frac{1}{2}}{25} = 10 \text{ pounds.}$$

That is, it is equal to the weight of the five feet multiplied by half its length, and this divided by the distance between the two teams, or 25 feet. Hence, Jimmy and Dan will carry $250 - 10 = 240$ pounds, while the other team carries $600 - 240 = 360$ pounds. So Jimmy makes saving number one. The reason that the five feet of overhang has a lever arm of half its length is because with any bar of equal section throughout, the bar will balance at its middle. Therefore, its weight will act as if concentrated at the middle, which is in this case a distance of 2½ feet from the pick handle. Its tendency to turn is its weight multiplied by its lever arm, or $100 \times 2\frac{1}{2} = 250$. On the other hand, the lever arm between the teams is 25 feet, and hence the effect where Jimmy and Dan are located is $250 \div 25 = 10$ pounds, as given above. But there is more to come, for while a little saving is good the limit is much better.

Suppose now that where Jimmy slips the pick handle under the rail he locates it so that his end is twice as long as that for Dan, as shown in Fig. 3. Then what? Here the 240 pounds which the two carry will be carried between them in the proportion of one to two, or 1/3 of $240 = 80$ pounds for Jimmy and 2/3, or 160, for Dan. Now the load is carried so that Yale and Valle each have 180 pounds, Dan has 160 and Jimmy carries 80 pounds. The sum of these loads, of course, makes 600 as follows: $180 + 180 + 80 + 160 = 600$.

This was a fair proportion for Jimmy under the circumstances, anyway, but do you know that these three men went home at night tired out, and that not one of them could understand why it was that Jimmy was not used up like they were by such a hard job! Yea, verily, knowledge is power!

Scranton, Pa. F. WEBSTER.

Advancement of the Skilled Boiler Maker

I have read with much satisfaction Mr. W. D. Forbes' "Talks to Young Boiler Makers," in the January issue of THE BOILER MAKER. Especially interesting is that part of it relating to his young friend's Dad, and I agree with him that this is a subject that can be discussed with advantage in the pages of THE BOILER MAKER. There is no doubt in my mind that Mr. Forbes' young friend has struck a chord that will vibrate in the hearts of thousands of boiler makers throughout this great country, including not only those who, like the young man's Dad, came from the Old Country, but also those who have learned their trade thoroughly on this side, only to find that they are handicapped by the workmen alongside of whom they are working, and in many cases being compelled to help their fellow workmen along if they want to make any showing themselves.

One of the greatest evils that tends to bring about these conditions is, in my way of thinking, the division of labor so much in vogue in our large locomotive and other boiler works. That is, when a foreman finds a man handy at one thing, he generally keeps him at it. The man becomes expert at that one job, and, as a matter of course, his wages are advanced from time to time until he is getting almost as much as the first-class all around man, for whom he would scarcely make a good helper. Again, it sometimes happens that there is a rush of work and the right kind of men are hard to procure; the firm must start shipping by a certain time, and it is up to the foreman to show results. There is nothing left for him but to split up his old gangs of men, slip in an old helper that has a good idea of the work required of him, and so tide over the busy time, but the foreman cannot expect to promote a man without advancing his wages at the same time, and here is where the thin edge of the wedge enters for this man's advancement if he makes good and he remains in the shop as a menace to the man that has spent years to learn the trade.

Another source of the same trouble is limiting the power of the shop foreman—that is to say, the shop manager or superintendent reserves to himself the right to establish a certain rate of wages, beyond which he will not go, regardless of the ability of the man employed. On the other hand, a lot of the fault lies with the foreman himself in not insisting upon having his rights, which are to hire, set the wages, and discharge a man not capable of doing his work.

There are foremen who wilfully discriminate against some good men for reasons best known to themselves. To illustrate this point, I will cite one case which came directly under my observation some little time ago. The parties are still alive, so I will use fictitious names, calling them Pat and Mike.

Pat is an all-round boiler maker of the very best quality, can do anything but lay out, but can take the plates from the layer-out and take them through all of the various fabrications of making a locomotive boiler, and there would be no occasion to look after him, so thoroughly does he have the work in hand, having worked for the company, boy and man, over forty-five years. His only failing is that he can hardly write his own name.

Mike came to the company at one of the busy times as tank riveter and calker, having spent the greatest part of his time on oil tanks and hot blast stoves, etc. When the rush was over he was retained to chip flanges and other work not requiring much skill. Eventually he was put on to chip and calk boilers. Of this he certainly could do a large amount, but of a very rough quality, and by a plentiful use of hot air. His wages kept pace with him, until he actually drew about 4½ cents per hour more than Pat, with his years of service and greater ability.

While going around the shop one evening I chanced to hear Mike calling Pat down in the worst kind of way. Poor Pat stood there taking it all without saying a word. When I questioned Pat as to the trouble, he would not say anything, but put his coat on as if to go home. I told him not to do that, that I had a say in that. The next day I made it my business to see one of the officials higher up and ask him if that was the way to treat a man who had given the company his best days, and at the age of sixty-two years could not go out into the world and hunt another job, but who had to submit to insult from a man that would scarcely make him (Pat) a good helper. His place, I said, should be walking around that shop seeing that the men were well employed. The result was that Pat came into his own the next day, being made assistant foreman with a substantial advance in wages.

As a foreman, I made it a point to watch closely the work of a new man during the first week, and usually tried them at various jobs without letting them feel that they were being tried, and on hiring them gave them to understand that if they filled the bill they got the shop rate. If not, they were told so, and were told what they were worth, and it was up to them to stay or leave. If they stayed and showed improvement in their work during the next six months, their wages were advanced without their asking for it, and I may say here that I have procured a special rate for men whose ability demanded it.

It has always been objectionable to me to put anyone except a boiler maker to do boiler maker's work, for I do not like to see every Tom, Dick and Harry who chance to get a job in a boiler shop usurp the places of men who have spent years to learn the trade, and that at small wages. FLEX IBLE.

Locomotive Boiler Efficiency

BY W. L. FRENCH

Boilers are built for locomotives, at the present time, to meet the demands and requirements of service efficiency, whether the boiler pressure be 220 or 165 pounds per square inch.

From a maximum boiler pressure of 125 pounds per square inch of surface in the late '70s, the pressure was steadily increased to meet the demands for increased tonnage hauling power in freight service and higher speed in passenger service, until it went as high as 220 pounds per square inch, but with the high-pressure new and frequent boiler troubles made their appearance. More frequent leaks about the firebox, more broken stay bolts, cracked side sheets and broken crown braces resulted.

Much of the water used in locomotive boilers is bad; that is, contains foreign matter injurious to boilers, and this seemed to make more trouble with the large high-pressure engines than with those with lower pressure.

When the large locomotives with high-pressure got to leaking it became necessary to set out the trains and go in light, else they would die on a side track, while a smaller engine with low-pressure would peg along with a pressure under the maximum and then do very well. It became plainly evident that the effective working pressure for both economy and good service had been exceeded unless these difficulties could be overcome.

The superheater and the blowoff cocks, with treated water, or soda ash placed in engine tenders direct, have overcome these troubles to a large extent. With the use of the superheater a much lower boiler pressure can be used, with less strain on the boiler, less cost of repairs and with an equal or greater service efficiency as to tonnage handled.

The boiler is more dependable from day to day, leaking less often, as it does, and this adds to its value from an economical point of view over one that is out of service every few days for repairs, and possibly failing on the road and often delaying other trains besides its own. In districts where good, pure water is used, a boiler with fair care and ordinary repairs may last twelve or fifteen years; in bad water districts, under the same conditions, its life will be considerably lessened.

Wide fireboxes call for more crown stays, and this adds to the difficulty of keeping the crown sheet free from mud and scale, which means more and thorough washings out.

Rapid change in temperature and pressure is very injurious to a boiler, and this is particularly true from the maximum of both down to the minimum. Where power is plentiful to handle the road traffic, and this is the exception and not the rule, time can be taken to reduce the pressure and temperature at a moderate rate and thus avoid the rapid contraction of the flues and boiler sheets that comes with a sudden cooling and which, later, when they start on a trip, causes them to leak and make a failure.

Generally a shortage of power requires that the engine be made ready for service as soon as possible, so that the cooling, washing out, filling up and firing up are hurried along and the boiler suffers. Later, if the engine starts out and makes a failure, the blame is usually placed on the shop, when it should properly be placed on the traffic needs and shortage of power, which are pretty much the same thing. Expansion and contraction of a boiler should both be gradual, and when a locomotive is out in service as little variation of pressure and temperature as possible should be permitted. A fairly wide water space in the water legs of a boiler is a good help to prevent staybolt breakages and leaks, as it gives more room for water circulation and longer staybolts for expansion and contraction; it is easier to keep the water legs free of mud and the sheets will not burn out so quickly as with narrow spaced water legs and a small amount of water between inner and outer sheets.

Records show that fully half the engine failures made are boiler failures, so the proper care of boilers is an evident necessity.

The longer a boiler will go between washings the better, provided it can be kept free from scale and mud, and with the free use of the blow-off cocks much can be done along that line. A boiler had better go a trip longer than common if plenty of time could be thus secured to wash the boiler out properly on its return. Cold water should not be run on a warm crown sheet at any time.

Pumping an engine when the pressure is low, or from a high to a low-pressure, is hurtful to the boiler and should not be done when it can be avoided.

So it resolves itself into a gradual heating or cooling of a boiler for the best results. The more rapid cooling of one sheet than another at a seam is likely to cause a seam leak, as the one cooling the more rapidly will shrink away from the other one. Rapid changes of temperature so far as possible should be eliminated.

A boiler must at all times furnish the maximum steam pressure required in order to handle a full train at schedule speed, and in order to do this in a satisfactory manner it must furnish more steam than is demanded from it at any one time. The locomotive with such a boiler is classed as a good steamer.

Tight cylinder, valve rod and piston rod packing and valves free from blows are important aids in making a good steaming engine.

With the method of water feed used in locomotive practice—that is, the injector throwing a solid stream of cold water into the front of the boiler shell—the necessity of keeping the fire burning brightly and the temperature of the boiler as nearly normal as possible is plainly apparent to anyone who gives the matter consideration.

The locomotive boiler is wasteful of fuel as compared with a stationary boiler, but the service demands made upon each are so different that a fair comparison cannot be made.

As noted before, good and bad water are important factors in the life of a boiler. Good feed water is that which is practically free from impurities, both organic and mineral, and the endeavor is to make poor feed water containing these substances as free from them as possible. The organic material may be removed by filtering, but too often this is not done. Some roads have water-softening plants, where the water is first treated and then stored in tanks and allowed to settle before being placed in locomotive tenders. In certain softening plants one part soda ash is mixed with two parts water in a wire scoop divided into two compartments. The scoop stands on the edge of an angle of 45 degrees. One end of the scoop fills while the other end empties, this alternate filling and emptying occurring automatically by reason of the weight of the water tipping the filled end down and bringing the empty end of the scoop under the filling jet. The pulling of the ratchet chain that works the vacuum pump supplying the solution is done also by the weight of the water. By this method the solution is thoroughly mixed with the impure water and it is purified more thoroughly than where chemicals are thrown into the water in the tender and allowed to mix at will, while in service, because the mixing is certain to be more or less incomplete.

It requires a considerable quantity of any chemical to soften the large amount of water used in engine practice, but it can be used successfully if blow-off cocks are made use of freely and the water level is not carried too high in the boiler, and this latter is more necessary when pulling out from a station, but where the opposite is more liable to be the rule.

Scale on boiler sheets is a detriment to the free passage of heat from the fire to the water; and while it may not be so great as often claimed, yet it is sufficient to deserve attention. The damage to the sheet itself is of more importance. Heavy scale or mud banks cause bulged side and crown sheets and collapsed flues, owing to their becoming overheated on account of the water being held away from direct contact therewith.

Becoming excessively heated, the sheet moves away from the pressure within the boiler toward the point of least resistance, and a bulge shows in the firebox. If this movement is sufficient a small amount of water might pass between the sheet and the mud bank, but such opening will soon close and this portion of the sheet becomes mud burned. Flues have been known to so collapse under pressure as to close their opening. For the same reason scale will cause crown and staybolts to leak, and, while for a time calking will stop the leaking, such bolts will eventually have to be renewed, as there will be nothing left to calk in the firebox.

Cracked sheets require patch bolts, and mud-burned spots call for patches, and as they can seldom be kept from leaking for any great length of time the efficiency of the locomotive is lessened by these boiler defects. Therefore, the need of keeping the boiler free from scale and other evils that cause leaks is evident. The elasticity of the steel must be conserved if its tensile strength is to be maintained at its full value so long as possible.

Any boiler may leak from the material becoming old or worn, by the vibration of long tubes, or from service causes that could not be overcome, but a large percent of firebox leaks can be overcome by proper handling on and off the road. The cleaner the firebox sheets are the freer will be the passage of heat through them, but the claim which has been made that where scale on the inside of a sheet is from ⅛-inch to ¼-inch thick there will be a heat loss of from 15 to 40 percent is hardly borne out by the performance of engines that have scale—that is, as to steam making when in service. They can, as a rule, be kept hot if leaking can be avoided, but will not steam as freely as they would if free from scale and mud. With deep wells for obtaining water little organic matter will be found, but with the use of surface or river water much impurities of this kind are liable to be held in suspension, and filtration should be used.

One of the great difficulties that had to be overcome with the use of soda ash and lime at softening plants, or soda ash alone on the road, was the tendency of the water to foam or raise and pass over into the valves and cylinders, causing the engine to work water. This is partly caused by the water being lighter, and partly by the water being under pressure and inclined to be turbulent when undergoing a change, and it rushes with the steam to any opening afforded, whether it be the throttle or pops above, or the blow-off cocks below. If the engine is working water, frequent opening and closing of the blow-off cocks will help to settle it quickly. This method is a good way to handle the blow-off cock at any time.

Superheated steam is more elastic and lighter than saturated steam, and is much more effective when working than saturated steam at the same pressure. A lower boiler pressure, a better boiler and equal or greater effectiveness can be secured with a superheater equipped locomotive than one not so equipped.

The cylinders are heated much hotter by superheated steam and initial condensation amounts to practically nothing, and with a good high-pressure valve oil for lubricating the cylinders the superheater is a decided improvement and is doing in the line of economy and effectiveness what it was hoped at one time the compound locomotive would do, but which, owing to several objectionable features, it failed to do, and its early popularity soon waned.

Efficiency of boiler service is, therefore, dependent upon material, construction, care in the roundhouse and on the road, skilled workmen for repair work, and proper, careful handling by enginemen.—*Locomotive Firemen and Enginemen's Magazine.*

Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

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

1,040,020. DUPLEX WATER GAGE. JOHN J. RYAN, OF HOUSTON, TEX.

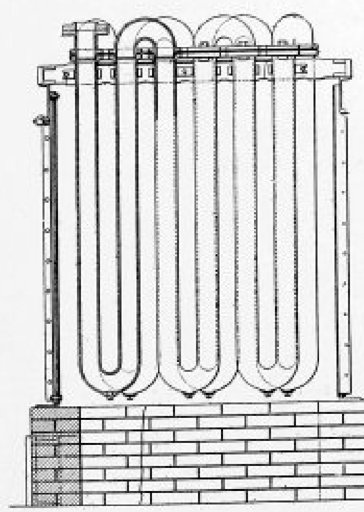
Claim.—The herein described duplex water gage, comprising gages arranged side by side and each having a tubular extension at its upper end and a tubular extension at its lower end; an upper coupling body having a valve casing containing a seat and also having a threaded projection extending from the inner end of the casing and further having lateral arms at opposite sides of and in communication with the casing and made up of portions disposed at right angles to said threaded projection, and depending portions in the upper ends of which are vertically disposed apertures; a lower coupling body having a valve casing containing a seat and also having a threaded projection extending from the inner end of the casing and further having lateral arms at opposite sides of and in communication with the casing and made up of portions disposed at right angles to said threaded projection, and upwardly extending portions in the lower ends of which are vertically disposed apertures, the interiors of the said upwardly extending portions being reduced at an intermediate point to afford supports for the lower tubular extensions of the gages; the interiors of the vertical arm portions of both coupling bodies being unobstructed throughout their length; removable means normally closing the said vertically disposed apertures of the coupling bodies; a tubular projection depending from the valve casing of the lower coupling body; and valves arranged in the valve casings of the coupling bodies and having handles disposed in front of said casings. One claim.

1,043,298. LEAK-STOPPER FOR BOILER TUBES. CORNELIUS S. CLARK, OF NORFOLK, VA.

Claim 1.—In a leak stopper for boiler tubes, a rotatable body member, a pair of compression rings and a packing ring therebetween on said member, non-rotatable means on said body member adapted to be drawn longitudinally thereof, and an anchor ring having peripheral projections adapted to be expanded and drawn longitudinally by said means to force said projections into the body of a tube. Sixteen claims.

1,043,312. FUEL ECONOMIZER. ERNEST B. FREEMAN, OF DEDHAM, MASS., ASSIGNOR TO B. F. STURTEVANT COMPANY, OF BOSTON, MASS., A CORPORATION OF MASSACHUSETTS.

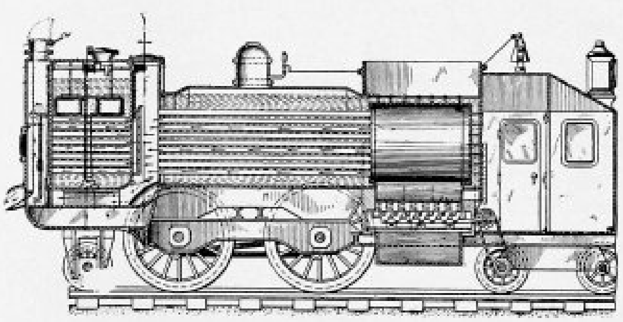
Claim 2.—A fuel economizer having, in combination, a plurality of series of vertical circulation tubes, a plurality of tube supporters sup-



porting the series of tubes and coupling pipes connecting the tubes. Six claims.

1,043,848. LOCOMOTIVE FEED-WATER HEATER. THOMAS FRANCIS FITZHUGH LEE, OF NEW YORK, N. Y.

Claim 3.—In a locomotive, the combination of a boiler, a storage tank provided with flues adapted to carry combustion gases from the boiler



to the outlet, a float within said tank and means actuated by said float for closing and opening said flues. Nine claims.

1,044,259. LOWB-OFF VALVE FOR STEAM-BOILERS. JOSEPH F. SCHILLER, OF PHILADELPHIA, PA.

Claim 5.—A valve, comprising a casing, a piston valve therein, and said casing constructed to admit water to both sides of said valve, whereby a balance of pressure is had during the opening and closing movements of the valve, packing rings around said piston valve, a shield around the piston valve bearing against the packing ring, a spring bearing against the shield, and a nut on the piston bearing against the spring. Fourteen claims.

1,042,059. FURNACE. CALVIN R. WAID, OF BIRMINGHAM, ALA.

Claim.—The combination with a fire-box and a smoke chamber, of a bridge wall interposed between the fire-box and the smoke chamber and having its upper face inclined upwardly to the smoke chamber from the fire-box and to a point close to the boiler, the upper face of the wall being concaved transversely throughout the length thereof, and a boiler supported above the fire-box and the bridge wall and having one end portion thereof projecting into the smoke chamber and abutting against the top of said chamber, the top of said smoke chamber being arched to form a pocket above the plane of the uppermost flues in the boiler. One claim.

1,040,481. STEAM GENERATOR. CHARLES C. WORTHINGTON, OF DUNNFIELD, N. J.

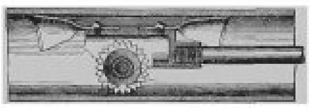
Claim 1.—In a horizontal generator, the combination with a continuous tube formed in a series of vertical coils, of a heater for heating the coils, said heater being arranged below the coils at one end of the series, and means for directing the products of combustion from the heater vertically against the adjacent coils and for deflecting the said products horizontally through the remaining coils of the series. Eleven claims.

1,040,800. SAFETY ATTACHMENT FOR BOILERS. WILLIAM P. SMITH, OF LOCUST GROVE, VA.

Claim 2.—A float attachment for boilers comprising the combination with a gage of a pair of contact points extending through the wall of the gage and spaced longitudinally thereof, the inner ends of said contact points being rounded and a cylindrical metallic float having rounded edges adapted to contact with the rounded ends of the points and complete the circuit between the contact points. Two claims.

1,042,841. TUBE-SCRAPER. MARTIN J. THORSEN, OF WEEHAWKEN, N. J.

Claim 1.—A tube scraper comprising a body portion, a blade secured thereto, the edge portion of one end of the blade being curved whereby it may engage the inside of a pipe or similar body, the other end of the blade being adapted for engagement with the inside of the pipe at a



distance from the portion engaged by the said edge portion, together with a plurality of removable serrated wheels carried by the body member and positioned intermediate the said blade and bearing member and on the opposite side of the body portion whereby, when the device is inserted in a pipe or tube, the deposits therein may be removed and crushed. Three claims.

1,040,994. STEAM-BOILER WORKING AS AN ELECTRIC TRANSFORMER. JEAN BALLY, OF GRENOBLE, FRANCE.

Claim 1.—In an electric boiler, in combination, an upper cylinder, a lower cylinder, pipes connecting said cylinders directly together, annular pipes connecting said cylinders together, a magnetic frame engaging through the central space in the annular pipes, a primary wire coil through which the magnetic frame is engaged, means for supplying electric current to said primary coil and a heat insulating brickwork inclosing the upper and lower cylinders and the pipe system. Four claims.

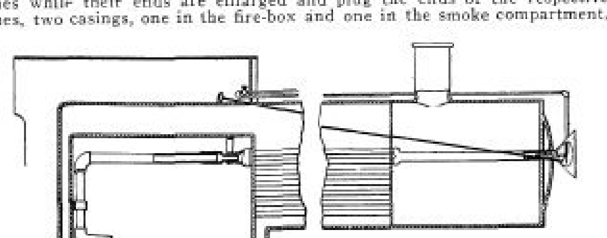
1,042,121. BOILER-TUBE CRIMPER. JOHN J. KERRIGAN, OF PHILADELPHIA, PA.

Claim 1.—A device of the character described, comprising a handle, and a head thereon, said head having a curved groove therein, dividing

the said head into an inner and an outer jaw, said inner jaw longer than the outer jaw and beveled from its end to a point directly below the end of the outer jaw. Two claims.

1,041,899. SMOKE-CONSUMER. JOSEPH H. TATE, OF RICHMOND, VA.

The combination with a horizontal tube boiler having a central flue compartment, a rear fire-box, and a forward smoke compartment, of a smoke consumer, comprising a plurality of tubes disposed within the upper flues of the flue compartment with their ends projecting beyond the ends of the flues into the respective fire-box and smoke compartment, the body portions of said tubes being reduced and out of contact with the flues while their ends are enlarged and plug the ends of the respective flues, two casings, one in the fire-box and one in the smoke compartment,



each of said casings having an apertured base to fit upon the projecting ends of the tubes and having a tapered mouth projecting into its respective fire-box, or smoke compartment, a conduit having a flaring mouth exteriorly of the smoke compartment and having its inner end connected to the casing within the smoke compartment, an air conducting nozzle disposed in the fire-box, and an expansible conduit connected to the nozzle and to the casing within the fire-box. One claim.

1,042,797. OIL-BURNING APPARATUS FOR LOCOMOTIVES. ARTHUR J. JONES, OF WASHINGTON, D. C., ASSIGNOR OF ONE-HALF TO FREDERICK W. PRATT, OF WASHINGTON, D. C.

1. An oil burner for locomotives comprising a series of V-shaped troughs with their outer ends closed and their inner ends adapted to slide one within the other, injector nozzles extending through holes in the end of the furnace and adapted to introduce oil and steam into the troughs, the latter adapted to direct the atomized oil the entire length of the fire-box. Two claims.

1,041,761. MEANS FOR FEEDING AIR TO FURNACES. WILLIAM W. EVANS, OF SALT LAKE CITY, UTAH.

Claim 3.—In means for feeding air to furnaces, the combination with the fire-box of a furnace, of an air chamber arranged in a wall of the fire-box and having apertures in its inner side, at intervals of its length, and also having an end adapted to be connected with the atmosphere, and slides adjustable independently of each other; the said slides being arranged side by side and close together and also close to the inner side of the chamber and having apertures so relatively arranged that adjustment of one slide relative to the other will jet into the portion of the fire-box adjacent the open end of the chamber, only, and adjustment of the other slide relative to the first-mentioned slide will jet air into the portion of the fire-box remote from said end, only. Three claims.

1,041,295. STEAM-BOILER. MICHAEL KELLY, OF BUFFALO N. Y.

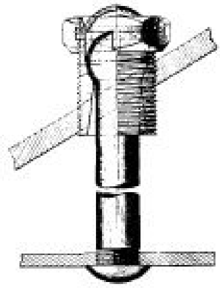
Claim 1.—A boiler comprising a section having upright hollow columns at its opposite sides, a hollow arch connecting the upper ends of the columns, and a hollow horizontal pipe connecting the columns below said arch and having its upright sides corrugated horizontally so that the base between two adjacent corrugations of one of these sides is arranged opposite to the space between two bases of adjacent corrugations of the other wall. Two claims.

1,041,080. BOILER-FLUE-CLEANER SYSTEM. DE LOS E. HIBNER AND FREDERICK W. LINAKER, OF DUBOIS, PA., ASSIGNORS TO THE VULCAN SOOT CLEANER COMPANY OF PITTSBURG, PA., OF DUBOIS, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—In a flue cleaner system, a distributing pipe mounted for rotation in proximity to the water tubes of a boiler, means for supplying said pipe with steam, projecting nozzles carried by said pipe, and means whereby the discharge ends of said nozzles are maintained at an oblique angle to the axis of the distributing pipe while the inlet ends of the nozzles describe an arc of a circle on lines at right angles to the axis of said pipe while the latter is being rotated. Eleven claims.

1,042,831. FLEXIBLE STAY-BOLT FOR BOILERS. BENJAMIN E. D. STAFFORD, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

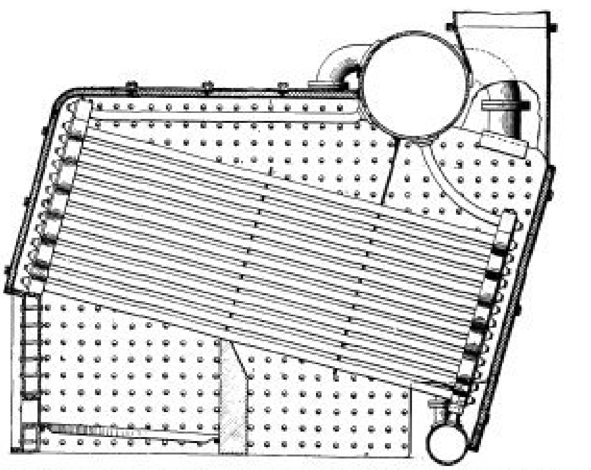
Claim 1.—A stay-bolt structure comprising a bolt having a head, a sleeve or bushing having an internal seat for the head of the bolt, a



soft metal cap forming a closure for the sleeve or bushing, and a nut for locking the cap to the bushing. Six claims.

1,042,709. WATER-TUBE BOILER. JOHN J. MOONEY, OF NEW YORK, N. Y.

Claim 1.—In a water-tube boiler, an inclosing casing whose sides are of separated plates connected by stay-bolts and form within them adequate water-chambers, a steam-drum, pipe-sections at opposite sides of each end of said drum connecting the same with the chambers formed between the plates of said sides, a mud-drum connected at its ends with



said chambers in said sides, a bank of water-tubes in individual vertical sections having headers at their front and rear ends, individual pipes connecting the upper ends of the respective headers with said steam-drum and pipes connecting the lower ends of the rear headers with said mud-drum. Three claims.

1,042,573. BOILER-FURNACE. WILLIAM LEMB, OF NEW YORK, N. Y., ASSIGNOR TO JOHN LEMB & SON, INCORPORATED, OF BROOKLYN, N. Y., A CORPORATION OF NEW YORK.

Claim 2.—A combustion chamber arch including in combination, a pair of opposite side walls, a pair of ventilated cross supports supported from said side walls, a rear fire-brick having a groove therein adapted to span said rear cross support and be supported thereby, said groove having an undercut portion to interlock with said support and an upper fire-brick adapted at its forward end to span said front cross support and to be supported thereby and at its rearward end to rest upon said rear fire-brick. Three claims.

THE BOILER MAKER

MARCH, 1913

Electric Welding in the Jersey Central Shops

Some noteworthy applications of electric welding to locomotive boiler repairs are shown in the accompanying photographs which were taken at the Elizabethport shops of the Central Railroad of New Jersey, through the courtesy of Mr. C. E. Chambers, superintendent of motive power, and Mr. J. J. Mansfield, chief boiler inspector of this road.

In Fig. 3 is shown an unfinished weld on the side sheet of a narrow firebox boiler. This photograph shows how the seam is prepared for welding. The welding is done by the electrode process, in which a welding pencil of a pure grade of Swedish iron is carried in a welding clamp and an arc formed between the point of the electrode and the metal to be welded. As soon

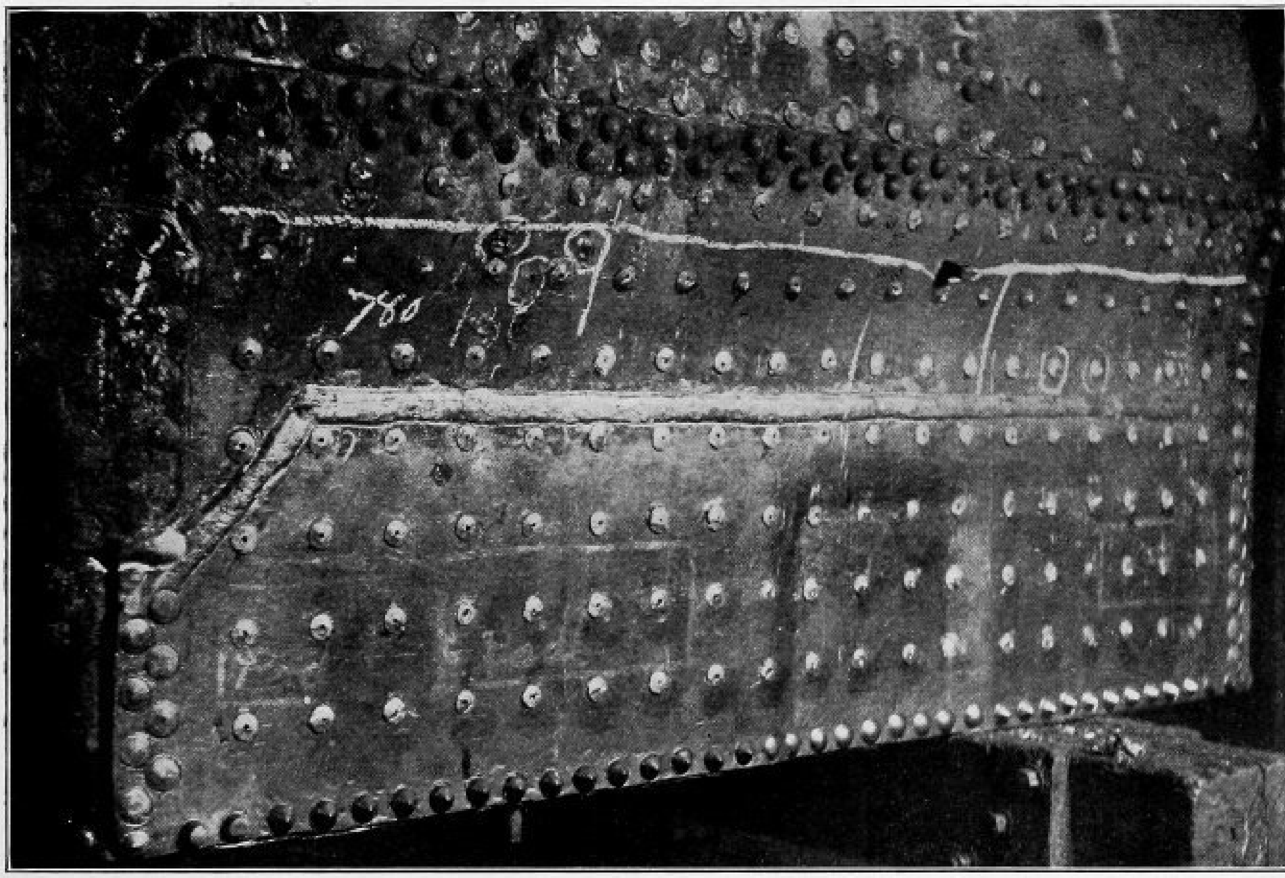


FIG. 1.—SIDE SHEET WELDED IN BY ELECTRICAL APPARATUS

The boiler shown in Figs. 1, 2 and 4 required new half side sheets, both inside and outside the firebox, and a half throat sheet. Fig. 1 shows the finished weld on one of the outside sheets, Fig. 2 a similar weld on one of the inside sheets, and Fig. 4 the welded seam on the throat sheet. A saving of about 50 percent was made in the cost of repairing this boiler by using the electric welding apparatus.

as the arc is made the metal is instantly brought to a state of incipient fusion, and minute molten particles of the electrode detach themselves progressively in a continuous rapid stream and, following the arc, attach themselves securely at the spot where the arc strikes. In this way the material from the electrode is applied until the chipped and V'd-out portion of the sheets is entirely filled up, and then an additional amount of material is applied, until the thickness of the metal at the weld is somewhat greater than that of the original plate, so that the strength of the weld will be nearly, if not quite, equal to the strength of the plate itself. The welding leaves a rough surface which is afterwards smoothed down to a uniform finish.

As was pointed out in our last issue, the range of repair work for which electric welding can be successfully applied

FIG. 2.—ELECTRICALLY WELDED FIRE-BOX SEAM

is almost universal. Successful welds are made on fractured frames, driving wheels, castings, broken tools and machinery, as well as in the various parts of the boiler itself.

The electric welding apparatus used in the Jersey Central shops was manufactured by the C & C Electric & Manufacturing Company, Garwood, N. J., and consists of a motor generator set of special construction with certain automatic switchboard regulations. The generator is wound to furnish direct current at a range of potential of from 50 to 80 volts, the amount of voltage being regulated to suit the work by varying a resistance in series with the field circuit.

Rivets and Riveting

This is a very old subject and one which by reason of the general familiarity with it should be well understood, but leading engineers still admit there are many sides to it which they do not understand, as is indicated in the following statement from the latest "Trautwine": "The subject of riveting is abstruse, and involved in much uncertainty, and experimental results are very discrepant." We do not presume to take issue with the writer of this alarming statement, for he doubtless gave the subject more theoretical consideration than opportunity will allow us, but we believe his conclusions are to too great an extent based on "experimental results" as old as many of us. The element of uncertainty in riveting is in the men doing the work, and this can be largely eliminated by the use of modern tools powerful enough to do the work attempted by hand when the tests which form the basis of most riveted joint calculations were made.

The strength of a riveted joint is gaged by its likelihood to fail—

1. By shearing of the rivets.
2. By tearing of the metal between the rivets.
3. By crushing out of the metal in front of the rivets.
4. By a combination of any of the foregoing.

The shearing strength of rivet steel is estimated at from 35,000 to 60,000 pounds per square inch, depending on the experience or information the estimator may have on the subject. Not many years ago it was not unusual to find joint calculations made on the assumption that the shearing strength of

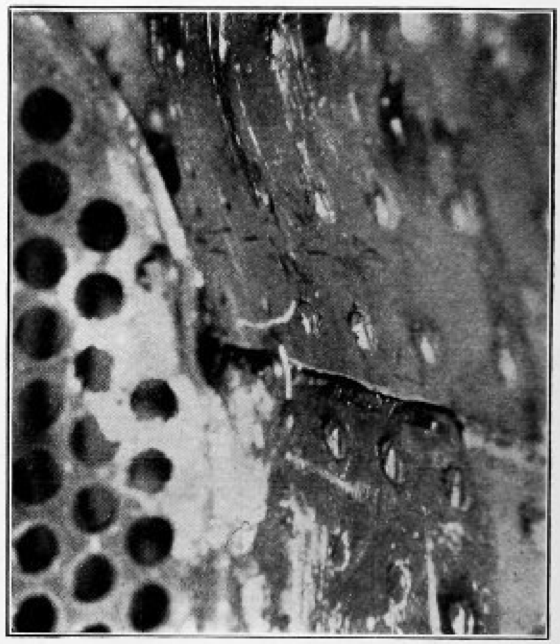


FIG. 3.—UNFINISHED WELD, SHOWING HOW THE SHEETS ARE BEVELED AND CLAMPED TOGETHER AT THE SEAM

rivet steel is equal to the tensile strength of steel plate, and tables of joint data made up on this basis are in use to-day.

The actual shearing strength of rivet steel, as determined by test between carefully alined blades in a testing machine, is a very different value from the apparent strength of a rivet tested in a riveted joint. In the latter case friction between the plates joined, and the character of the rivet holes have a varying influence which cannot be predetermined. It would appear from tests of riveted joints:

1. Shearing strength per square inch increases as the rivet diameter decreases, due to the smaller rivet bars being finished at a lower temperature than the heavier bars.

2. Rivets in drilled holes without chamfered or reamed edges have a lower shear value than in punched holes due to the sharp machined edges acting as a shear.

3. Hydraulic-driven rivets are stronger than pneumatic-driven, which in turn are stronger than hand-driven, due to the relative upsetting of the rivets in the holes as done by the several methods. The difference in value is slight for small rivets.

Hydraulic-driven rivets in drilled holes are generally given shear values per square inch of 42,000 pounds for steel and 38,000 pounds for iron. The same rivets hydraulically driven in punched holes are conservatively estimated, respectively, to be good for 45,000 and 40,000 pounds per square inch. Pneumatic-driven rivets of sizes ¾ inch and larger should be figured 1,000 pounds less per square inch and hand-driven rivets 2,000 pounds less.

The punching of full-size rivet holes in plates is generally conceded to damage the plates, but the extent of this damage varies with the character of the punches and dies used and the thickness of the plates. A point to remember in this connection is that the majority of tests which form the basis of our riveted joint formulas and unit values were made with punched holes, and these formulas and unit values are accordingly applicable to punched hole joints without modification. If the punching of the rivet holes in the test plates damaged the material and drilled holes eliminate this damage, the drilled hole joint should be allowed greater strains in proportion instead of the punched hole joint being given a reduced value.

driven hydraulically by ample pressures the shearing area should be figured as of the diameter of the rivet hole at point where the rivet is in shear. The upsetting of the rivet in the hole is dependent on the temperature of the rivet and the pressure applied on it. Steel rivets should be heated at least to a yellow heat for all forms of driving, but when hydraulic riveters are used a light red heat is considered sufficient, and on this basis the pressures in Table I have been found ample to upset the rivets in holes 1/16 inch larger than the cold rivet diameter.

Soft rivets, such as Burden iron, can be driven cold hydraulically; but in this way the rivet shrinkage, which makes tighter

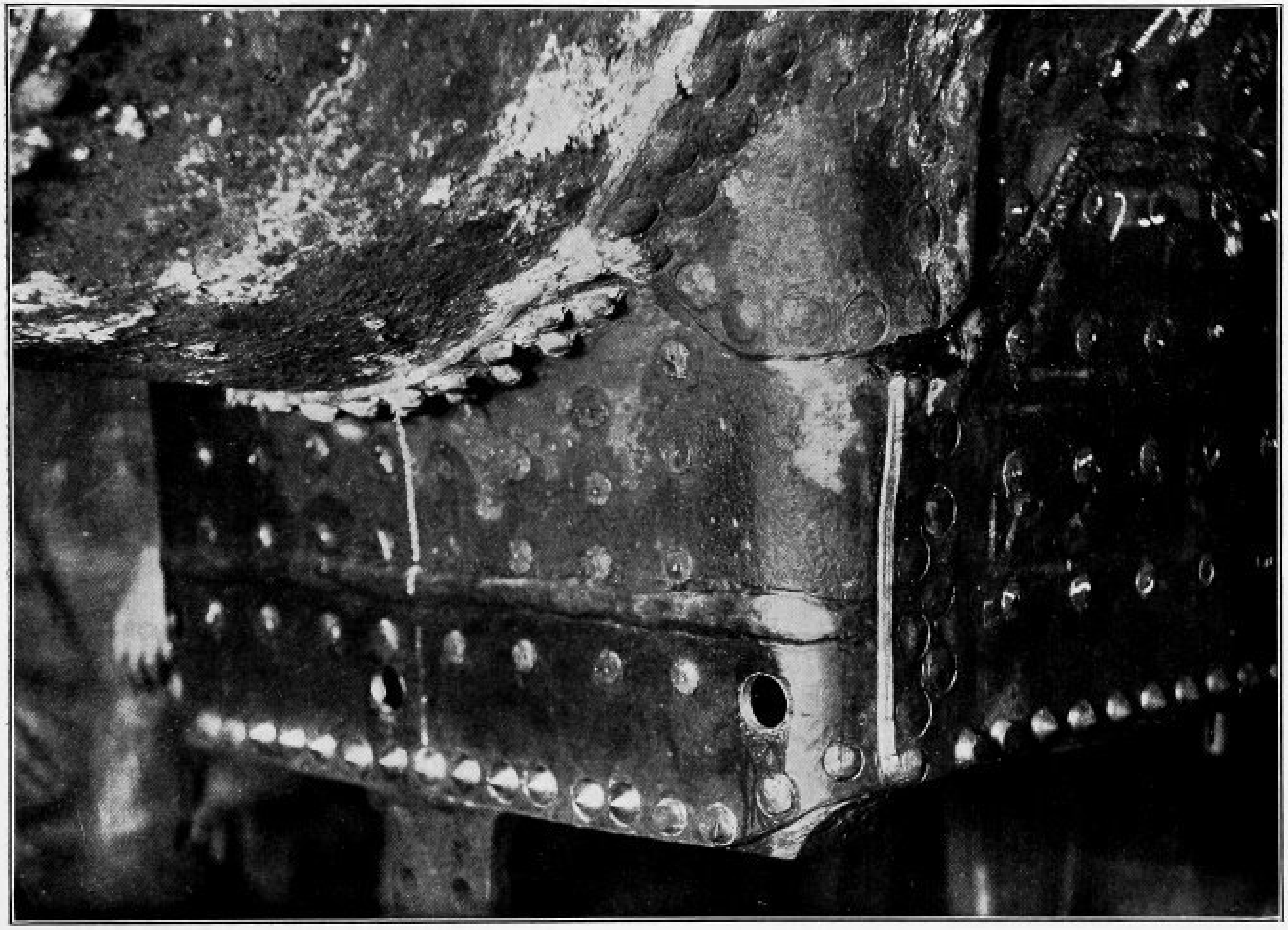


FIG. 4.—THROAT SHEET REPAIRED BY ELECTRIC WELDING

joints, is lost, consequently cold riveting cannot be recommended for high-pressure work. Hydraulic pressures for cold driving, which have given good results, are:

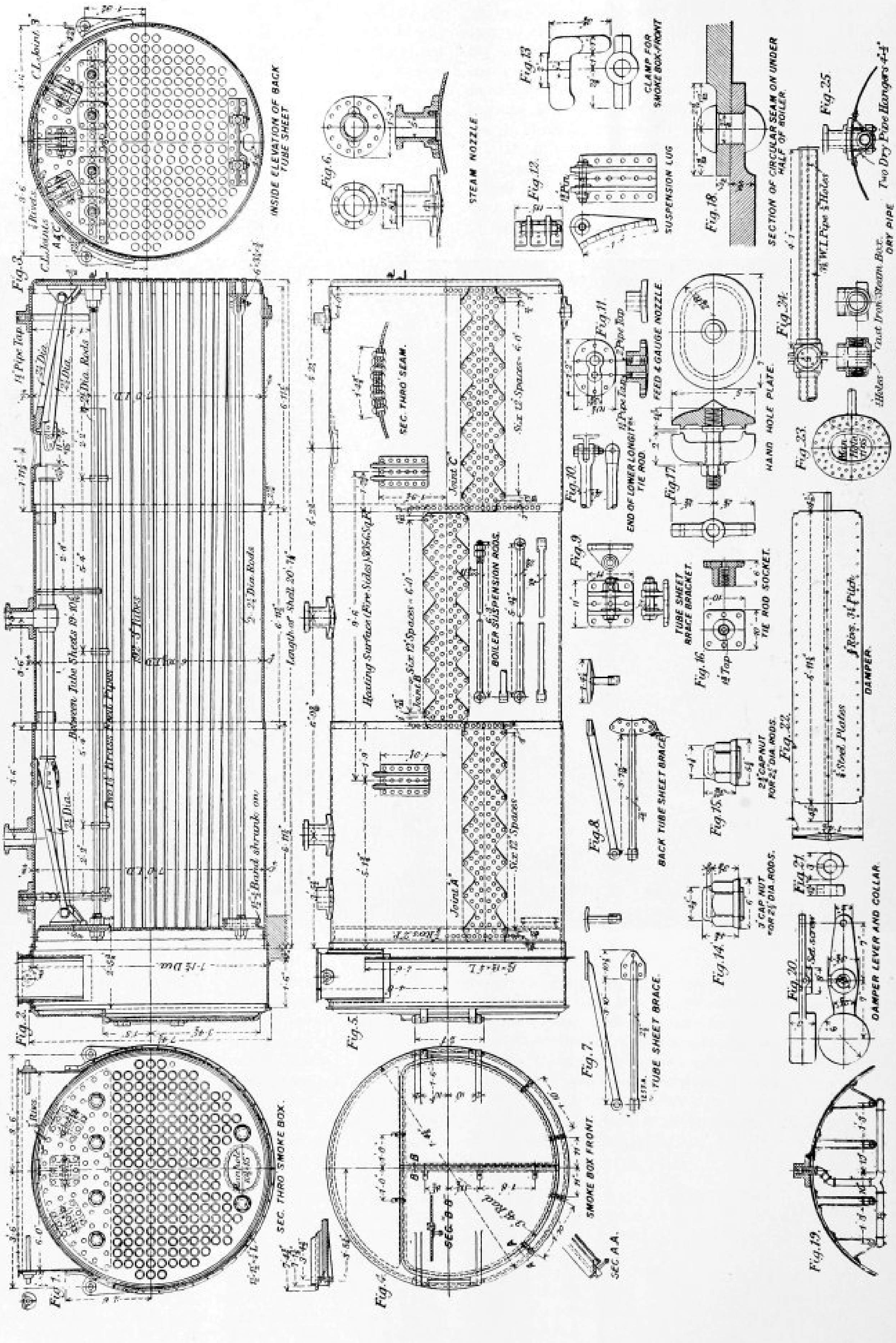
90 tons on rivet for ⅝-inch rivets.
110 tons on rivet for ¾-inch rivets.
150 tons on rivet for ⅞-inch rivets.

Many specifications require that the strength of the rivets shall be figured for the area of the cold rivet instead of the driven rivet. This is correct when it is likely that the riveting method will not upset the rivets to the full diameter of the holes, as is the case with large rivets and long grips when the driving is done by hand or pneumatic hammers, but for rivets

TABLE I.—PRESSURE IN TONS ON RIVET

Cold Diameter of Rivet	Nature of Work		
	Girder	Tank	Boiler
½	9	15	20
⅝	12	18	25
¾	15	22	33
⅞	22	30	45
1	30	45	60
1⅛	38	60	70
1¼	45	70	100
1½	60	85	125
1¾	75	100	150

For long grips or in heavy plates the rivet holes should be slightly tapered from the driving side if tight joints are desired. For example, if the hole in the outside strap of a double-butt strap joint has an outside diameter about one-twelfth of the diameter larger than the inside diameter it will be found that the wedging effect of the rivet in this tapered hole will make the contact between the shell plate and the butt strap closer than would otherwise be the case. This effect is secured in punched holes when the punching is done from the contact side. Where the grip is long and close contact between the different parts of the joint is required, the holes should taper from both sides and special tapered rivets be used.—*Ryerson's Monthly Journal.*



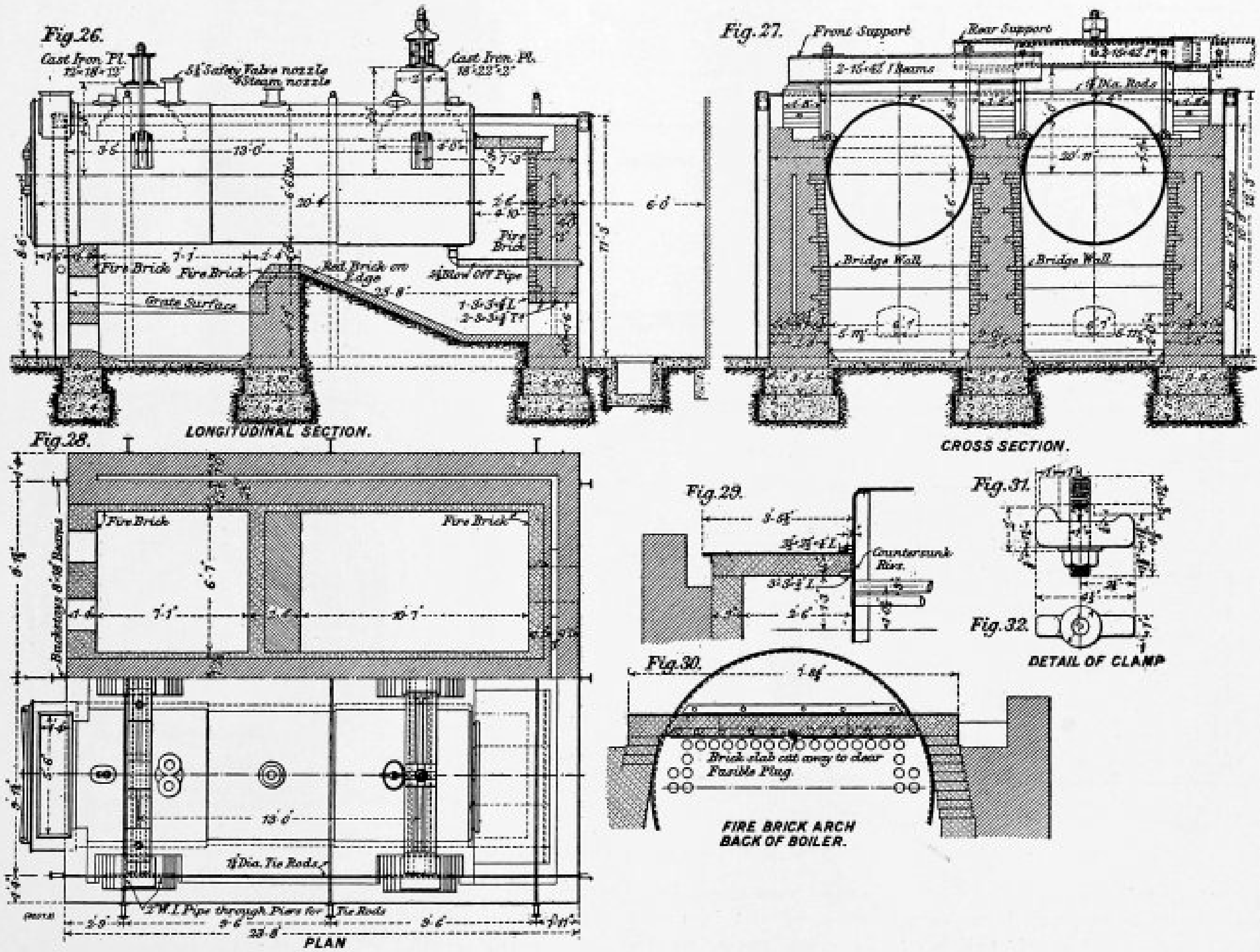
HORIZONTAL RETURN-TUBE BOILER

American Boiler Practice

An interesting letter from Mr. F. W. Dean, a widely-known American engineer, is published in a recent issue of the English journal *Engineering*, showing the advantages of the principal types of firetube or shell boilers used in America as compared with the Lancashire type of boiler which is so commonly used for similar purposes in Great Britain. In his letter Mr. Dean has the following to say:

It seems to me that the Lancashire type of boiler is open to severe criticism, for it is large for its power, is expensive per unit of heating surface or grate area, requires expensive brickwork, occupies an immense amount of floor space, and requires a large and expensive boiler house. While I have no dimensions convenient, I believe that a Lancashire boiler 8 feet in diameter and 30 feet long contains about 1,000 square feet of heating surface and 36 square feet of grate area. In addition to this the type violates a fundamental law of boiler design in not dividing the gases into small streams and compelling them to be near the heating surfaces.

Some years ago, when I was designing a boiler plant for a cotton mill in Canada, I finally persuaded the manager to allow me to substitute for Lancashire boilers some horizontal return tubular boilers, such as are so frequently used in the United States. In place of a Lancashire boiler of about the same size as that mentioned, I installed a horizontal return tubular boiler in the same width, 10 feet less length, and in the same building, having four times the heating surface and about double the grate area.



SETTING FOR RETURN-TUBE BOILER

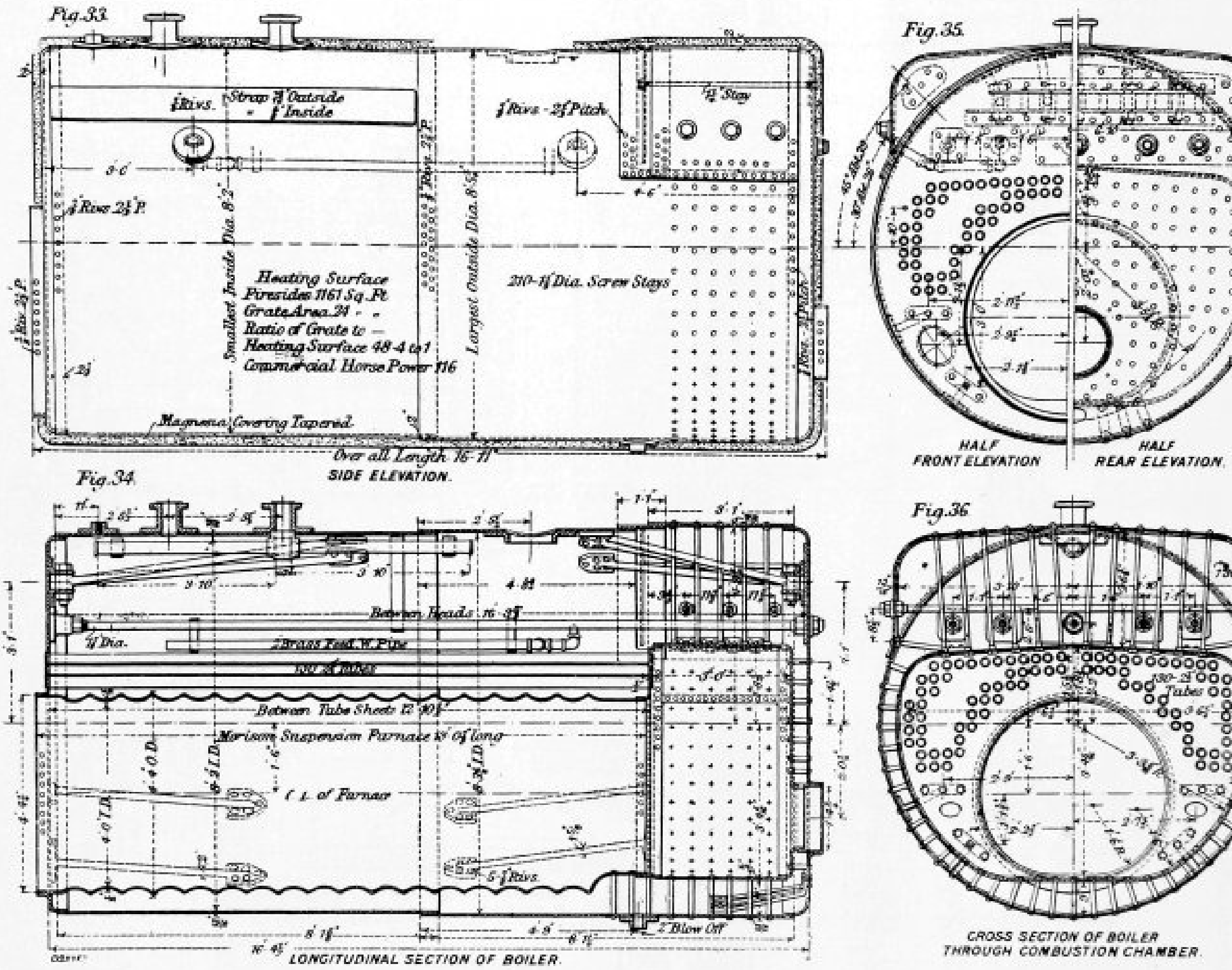
The horizontal return tubular boilers referred to have each 260 3-inch tubes 20 feet long, and have 4,027 square feet of heating surface, computed on the fire sides. They are rated each at 400 horsepower (United States commercial, equal to the evaporation of 34½ pounds of water from and at 212 degrees per hour), and cost $2,900 each.

Boilers of the same design were tested in a paper mill, and averaged 742 horsepower for 8¾ hours. Some of the principal results of these tests are given in Table 1. It will be observed that the efficiency was over 76, and with better combustion would have been higher. An efficiency of 80 percent or more is not unknown with such boilers, which is what Dr. Nicolson claims for his. He also claims an actual evaporation of 9.895 pounds per pound of coal, which is not much more than this boiler (9.41 pounds with feed water at 85.5 degrees F.), and this is not at all unusual.

I shall take this opportunity to say something about American boiler practice and illustrate it with designs of my own.

I have no doubt that English engineers look with skepticism upon the American horizontal return tubular boiler, because the fire is in contact with the shell. But this boiler when built with the longitudinal joints butted has never exploded, and thus is almost unique in boiler history. There have been many explosions of such boilers when constructed with lapped longitudinal joints, and they are still exploding. In the State of Massachusetts lap joints are now prohibited by law.

The merits of the boiler are that it is cheap, efficient, safe, easily inspected inside, can be made of any reasonable size, say up to 5,000 square feet of heating surface (rated at 500 United States boiler horsepower, or 1,000 or more compound-engine horsepower), and can carry any reasonable steam pressure. This type of boiler is constructed in various sizes, a 90-inch 400 horsepower being built for 165 pounds, and a 78-inch of 250 horsepower for 140 pounds. Figs. 1 to 25 show an 84-inch boiler of 300 horsepower to carry 185 pounds, the various details being so clearly seen as to need no description, while Figs. 26 to 32 show the method of setting this type of use them. They have the advantages of being internally fired, have no brickwork, superheat the steam 20 to 40 degrees, take up but little floor space, and about twice as much horsepower can be placed upon a given floor space as with horizontal firetube or watertube boilers. They can be made of any size that can be transported; can be made for any steam pressure, and can be forced to any extent. When the feed water is good—and most water can be made such by treatment—this type of boiler causes no trouble. With dirt on the lower tube plate the tubes may leak at the bottom, but it will be shown in



SCOTCH BOILER FOR MASSACHUSETTS

boiler. In this case the boilers are suspended from above, but the more common way is to support them by cast iron or pressed-steel brackets riveted to the sides and resting upon the brickwork. The back combustion chamber is shown covered by slabs of firebrick attached to the end of the boiler, these slabs sliding back and forth on the brickwork as the boiler expands and contracts. The brickwork on the sides should be kept ¾ inch away from the boiler and the space stuffed with long-fiber asbestos, so that the boiler can expand and contract in all directions without injuring the brickwork. When the setting is built in this way it will not crack materially. The top and back end are covered with non-conducting material.

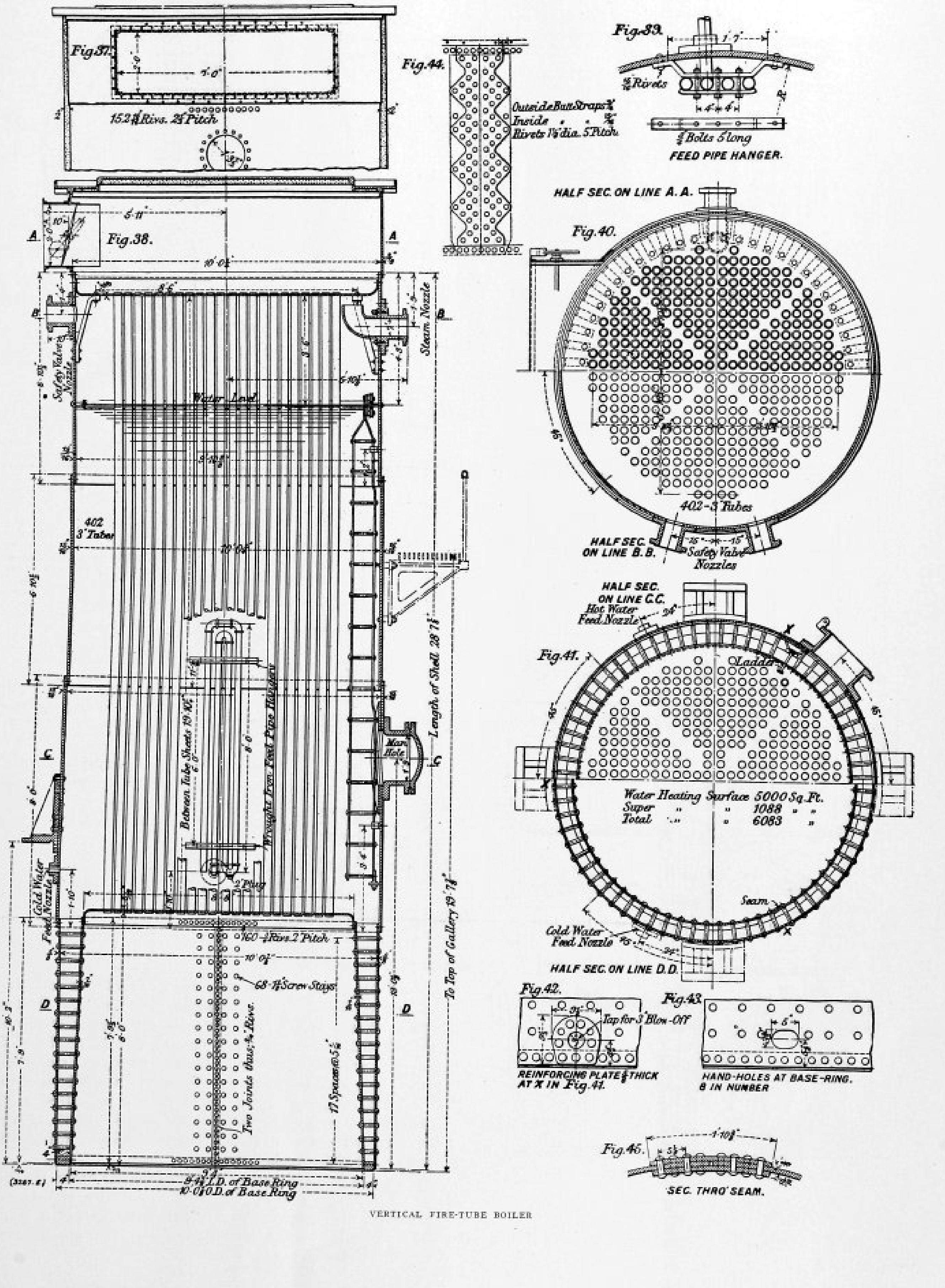
I also add Figs. 33 to 36, showing a Scotch boiler that I designed for the Metropolitan Water and Sewerage Board of Massachusetts, of which four were built. They have not yet been tested.

In the New England States vertical firetube boilers are largely used. At the Amoskeag Mills, Manchester, N. H., there are about 160 of them, and many other mills and steam plants the designs given that the interior is accessible, so that the tube plate can be cleaned.

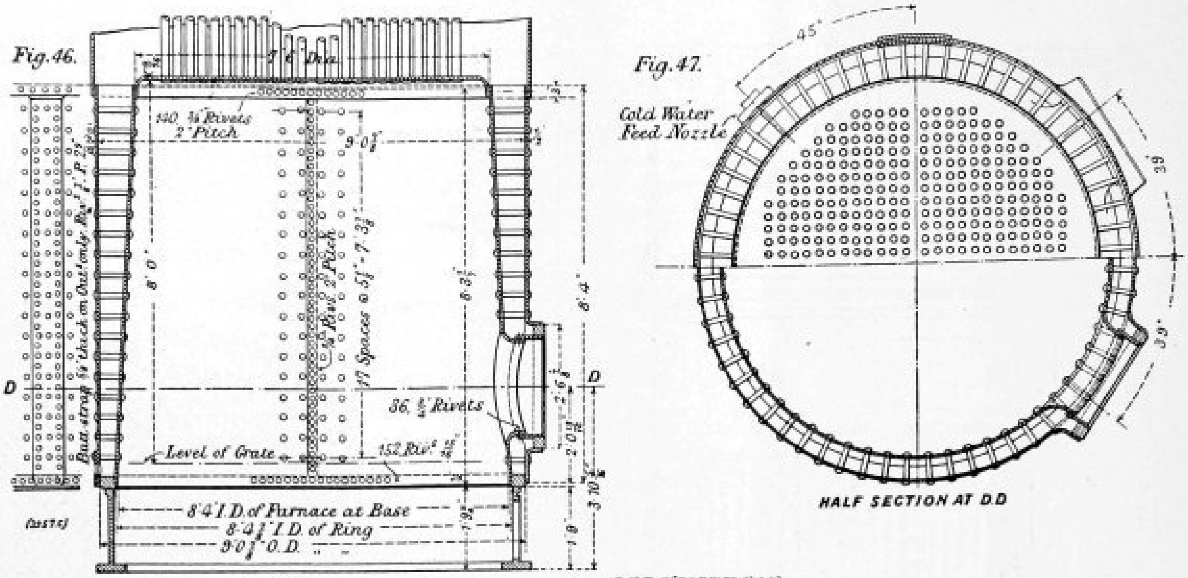
Figs. 37 to 45 show a boiler of 500 horsepower, and Figs. 48 to 50 a boiler of this type on a setting fitted with a chain-grate stoker, while Figs. 46 and 47 show the firebox of a similar type of boiler of 300 horsepower, but having a fire-door and grate and designed for firing by hand.

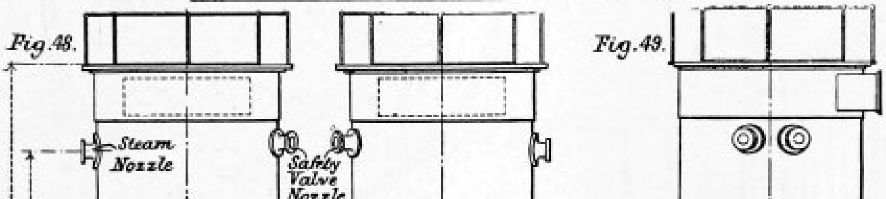
Table 1 shows some of the results of several trials of the 90-inch horizontal boilers, those of April 4 and 19 being with hand-firing and those of April 5 and 20 being with the chain-grate stoker. It will be seen that the results were good, and with better combustion they would have been still better.

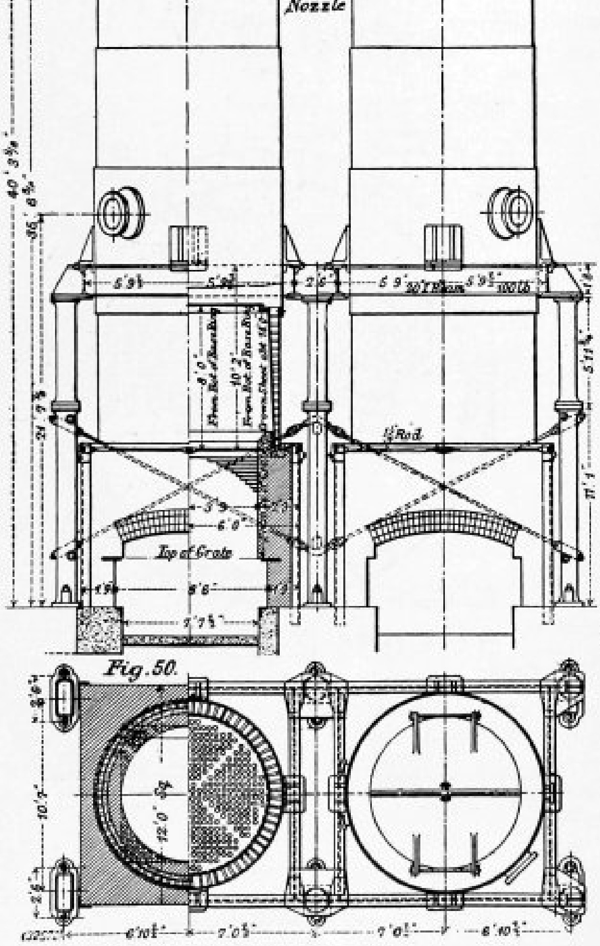
Table 2 gives data from some trials of a 500-horsepower vertical boiler, having 2½-inch tubes, 20 feet long, but otherwise like Fig. 38. The trial of April 29, 1909, was made before it was known how to fire properly, the CO_2 being low. The trials of July 8 and 9, 1910, were made after the difficulties of good gas analysis were overcome, and it will be seen that the results are among the best. In the test of April 29 it will be seen that over 39 pounds of coal were burnt per square foot



VERTICAL FIRE-TUBE BOILER







VERTICAL FIRE-TUBE BOILERS

of grate per hour, and the horsepower was more than double the rating.

In Table 3 the main results are given of two tests of a locomotive boiler which I designed for the New Bedford, Mass., Water Works. In this case the firemen were very skillful, and it is interesting to observe that the results of the two tests are almost identical, although the rate of combustion in one case was double that in the other. It will be seen that the actual evaporation per pound of coal with feed at 159 degrees to 154 degrees was over 11 pounds. In all of these trials the water was weighed. The economizer consisted of a copper coil in the smoke-box.

In the case of the horizontal return tubular boiler the thick plates in contact with the fire cause no difficulty, and this corroborates the experience of Kilvington and Taylor, as related in a paper before the North-East Coast Institution of Engineers and Shipbuilders in 1890.

Speaking generally of American boiler practice, the horizontal return tubular boiler is used more than any other all over the country. Watertube boilers are largely used in consequence of the energy of salesmen, and the use of sophistry concerning their safety, small quantity of water contained, and quick steaming qualities, oblivious of the fact that the horizontal tubular boiler surpasses them in all of these respects.

Table 1—Results of boiler trials for S. D. Warren & Company, April, 1900. Kind of boiler, 90-inch horizontal return tubular boiler; kind of fuel, G. C. Cumberland; kind of trial, fresh wood fire, April 19. Others, running start and stop.

	Hand.	Stoker.	Hand.	Stoker.
Date of trial	April 4.	April 5.	April 19.	April 20.
Duration of trial, hours	9.5	8.75	8.5	8
Number of boilers in use	1	1	1	1
Grate surface of each boiler, square feet	48.75	61.87	48.75	61.87
Water-heating surface of each boiler, square feet	4,027	4,027	4,027	4,027
Steam pressure in boiler, by gage, per sq. inch, pounds	92.1	94.0	94.5	95.0
Temperature of feed water before entering boiler, degrees	85.5	85.5	70.	78
Moisture in coal, percent	4.91	5.31	4.46	4.46
Percentage of moisture in steam, percent	0.45	0.49	0.70	0.70
Number of heat units in a pound of dry coal, by analysis, B.t.u.	13,961	13,961	13,718	13,718
Efficiency of boiler, based upon dry coal, percent	73.14	76.14	73.43	70.56
Efficiency of boiler, based upon combustible, percent	72.95	76.33	74.44	83.11
Factor of evaporation for boiler	1.17	1.17	1.186	1.178
Water actually evaporated per pound of dry coal, pounds	9.04	9.41	8.79	8.51
Equivalent per pound of dry coal from and at 212 degs. F., excluding economizer, pounds	10.57	11.06	10.43	10.02
Commercial horsepower (boiler only) on basis of 34½ pounds of water from and at 212 degrees F. per hour, horsepower	630	742	349	353
Horsepower, builders' rating, at 10 square feet per horsepower, horsepower	400	400	400	400
Percent developed above or below rating, percent	57 a	85 a	12.7 b	4 b
Dry coal actually burned per square foot of grate surface per hour, pounds	42.2	37.6	23.7	21.3
Water evaporated per square foot of heating surface per hour from and at 212 degs. F., pounds	5.39	6.35	3.00	3.28

a = above; b = below.

Table 2—Results of boiler trials for S. D. Warren & Company, at Cumberland Mills, Me., April, 1909, and July, 1910. Kind of boiler, vertical firetube; kind of fuel, New River Slack; kind of trial, running start and stop.

Date of trial	April 29, 1909.	April 30, 1909.	July 8, 1910.	July 9, 1910.
Duration of trial, hours	7	8	11	8
Number of boilers in use	1	1	1	1
Grate surface, total, square feet	76.5	76.5	76.5	76.5
Water-heating surface, total, square feet	....	....	4,900	4,900
Superheating surface, total, square feet	....	....	1,181	1,181
Total heating surface, square feet	6,081	6,081	6,081	6,081
Steam pressure in boiler, by gage, per square inch, lbs.	129.8	124.3	122.7	115.6
Temperature of feed water before entering boiler, degs.	50.6	63.6	78.6	76.6
Percentage of moisture in steam, percent	16.68	16.71	....	....
Number of degrees superheated, degrees	17	17	10.3	17.4
Number of heat units in a pound of dry coal, by oxygen calorimeter, B.t.u.	14,759	14,759	14,414	14,414
Efficiency of boiler, based upon dry coal, percent	67.1	68.3	75.4	75.5
Efficiency of boiler, based upon combustible, percent	70.0	69.3	79.1	78.2
Factor of evaporation for boiler	1.224	1.215	1.186	1.193
Water actually evaporated per pound of dry coal, pounds	8.45	8.66	9.49	9.48
Equivalent per pound of dry coal from and at 212 degs. F., excluding economizer, pounds	10.34	10.52	11.20	11.22
Commercial horsepower (boiler only), on basis of 34½ pounds of water from and at 212 degrees F. per hour, horsepower	1,005	640	757	830
Horsepower builders' rating at 10 square feet per horsepower, horsepower	500	500	500	500
Percent developed above rating	101	28	51	66
Dry coal actually burned per square foot of grate surface per hour, pounds	39.1	25.3	30.5	33.4
Dry coal burned per square foot of water-heating surface, pounds	0.61	0.39	0.475	0.521
Water evaporated per square foot of heating surface per hour from and at 212 degs. F., pounds	7.05	4.50	5.33	5.85

Table 3—Results of boiler trials for New Bedford Water Works, May, 1893. Kind of boiler, Belpaire boiler; kind of fuel, Georges Creek Cumberland Coal.

Date of trial	May 18.	May 19.
Duration of trial, hours	12.3	12.26
Number of boilers in use	1	1
Grate surface, total, square feet	30.5	30.5
Water-heating surface, total, square feet	1,883	1,883
Steam pressure in boiler, by gage, per sq. in., pounds	114.05	113.35
Temperature of feed water before entering boiler, degrees	158.7	154.0
Moisture in coal, percent	5.15	5.15
Percentage of moisture in steam, percent	0.39	0.38
Number of heat units in a pound of dry coal, by oxygen calorimeter, B.t.u.	14,092	14,092
Efficiency of boiler, based upon dry coal, percent	82.08	83.32
Efficiency of boiler based upon combustible, percent	84.28	84.28
Efficiency of boiler and economizer based upon dry coal, percent	84.64	86.01
Efficiency of boiler and economizer based upon combustible, percent	89.35	88.82
Factor of evaporation for boiler	1.098	1.103
Factor of evaporation for boiler and economizer	1.165	1.162
Water actually evaporated per pound of dry coal, pounds	11.01	11.09
Commercial horsepower (boiler only) on basis of 34½ pounds of water from and at 212 degrees F. per hour, horsepower	94.55	173.84
Dry coal actually burned per square foot of grate surface per hour, pounds	8.85	16.06
Dry coal burned per square foot of water-heating surface per hour, pounds	0.143	0.260
Water evaporated per square foot of heating surface per hour from and at 212 degrees F., pounds	1.73	3.19

OHIO BOILER INSPECTION REPORT.—The law creating the boiler inspection department in Ohio went into partial effect on Jan. 1, 1912, but did not become fully effective until July 1. The following report covers about seven months:

State inspections	1,980
Insurance inspections	11,670
Boilers registered and certified	12,150
Boilers held for repairs	302
Boilers condemned and out of service	198
"Ohio Standard" boilers built and approved since July 1	702
Boiler manufacturers registered and authorized to build "Ohio Standard" boilers	59
Applicants examined to qualify as boiler inspectors	170
Qualified	146

From the list of those who qualified, ten inspectors were commissioned to act as "general inspectors" in the State service and 104 as "special inspectors" in insurance service.

Three boiler explosions, in which three persons were killed and one injured, were reported. Four explosions, killing four persons and injuring eleven, occurred on boilers not covered by law.—*Power.*

RECENT BOILER EXPLOSIONS.—On March 3 the boiler of an engine drawing a special train over the Pennsylvania Railroad from Jersey City to Washington exploded at Rahway, N. J., killing the engineer, fatally injuring the fireman and seriously injuring several others. The bell, cab, steam dome and smokestack of the locomotive were thrown to the left of the track, and the boiler itself was hurled 60 feet in the air and thrown more than 400 feet. While the cause of the explosion is unknown, it is generally attributed to low water.

On Jan. 13, one of two horizontal return tubular boilers operating at 100 pounds pressure at the plant of the McMillan Lumber Company, Pine Barren, Fla., exploded, killing the engineer and seriously injuring several others. Low water is said to have caused the explosion.

The Development of the Locomotive Boiler*

The boiler is the locomotive's primary source of power. However efficient the details of its engine, they can be effective in the development of power only when furnished with an ample supply of steam. This must come from the boiler. The boilers of early locomotives were small and inefficient, and the problem of improving them as it has presented itself to succeeding generations of designers has been beset with difficulties.

An early form of locomotive boiler was a plain cylindrical structure containing a single flue. At one end of this flue a fire-door was attached, and inside the fire-door grate bars were arranged. At the other end an elbow was added to connect with a vertical stack. By this arrangement the stack was in front of the boiler, not on it. When the locomotive was operating, the elbow and a considerable portion of the stack were commonly red-hot. An improvement consisted in fitting the boiler with a return flue, which brought the stack and fire-door at the same end, and which provided more heating surface, a longer flameway and lower stack temperatures than were possible with the earlier design. The famous "Puffing Billy," a locomotive which did effective service for many years, was provided with a boiler thus constructed. Obviously, the power developed by such an arrangement could not be great, and the commercial success of the locomotive awaited the advent of a boiler having greater capacity. This came when George and Robert Stephenson designed and constructed the multi-tubular boiler for their famous locomotive "Rocket." This boiler had a plain cylindrical shell fitted with twenty-five 3-inch copper tubes extending from end to end of the boiler. At the front end a smoke-box was attached which discharged into the stack. At the back end a box-like fixture was added to constitute the firebox. The superior success of the "Rocket" over that of previously existing locomotives was due largely to the fact that its boiler gave an abundant supply of steam.

* From a report on tests of a Jacobs-Shupert boiler in comparison with a radial-stay boiler, by Dr. W. F. M. Goss, D. Eng.

The "Rocket's" boiler fixed the general lines to be followed in the building of locomotive boilers for many succeeding years, but it did not completely solve the problem of the firebox construction. That detail was destined to take on many forms in pioneer days, and it is one which has been the subject of much debate and change in more modern times. The first tubular boiler having a self-contained submerged firebox seems to have been that of the locomotive "Planet," built by the Stephensons for service on the Liverpool & Manchester Railway in 1830. The firebox was rectangular in plan. While the Stephensons subsequently devoted themselves to the development of this form of construction, others built fireboxes which were circular in plan, crowned by a hemispherical dome, a form well chosen to resist the stresses imposed by the internal pressure of the boiler. In the process of developing such structures, however, practice came gradually to rely for strength less upon form and more upon stays by the use of which a structure weak in form could be held in place. A firebox rectangular in plan being desirable, other forms gave way to this plan. The stability of the sides and ends of all such fireboxes was secured by the use of staybolts connecting the inside and outside sheet. The support of the crown sheet proved a more difficult matter. For many years it was provided for by the application of crown bars running over the crown sheet either longitudinally or transversely, the latter being the more common arrangement in this country. The crown bars were metal girders, of such form as to permit them to extend across and above the crown sheet, while receiving their support from feet bearing on the upper edges of the side sheets. A series of such crown bars served as lines of support for the crown sheet, which was held up by suitable rivets or bolts. The crown thus supported was in effect carried by the side sheets, and while this type of construction proved serviceable for many years, and is still used in small boilers, the time came when in the development of the American boiler it had to give way to something better. As the

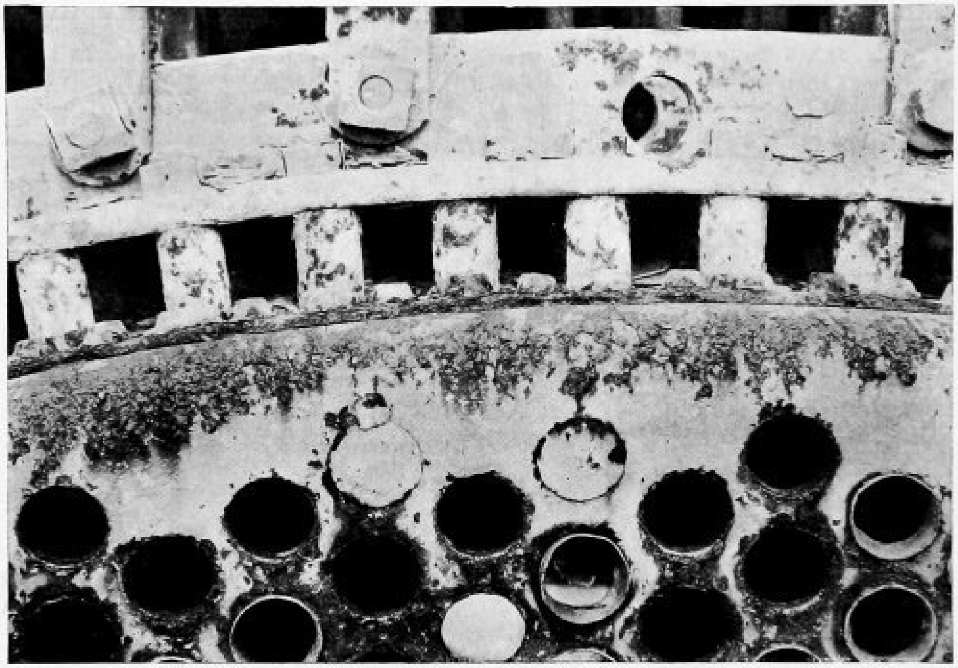


FIG. 1.—TOP OF FLUE SHEET SHOWING THE BADLY DETERIORATED TOP FLANGE

FIG. 2.—TOP OF FLUE SHEET SHOWING PATCH MADE NECESSARY BY CRIMPING ACTION OF FLUE SHEET

dimensions of fireboxes increased the crown bars became enormously heavy, and the load which they imposed upon the side sheets became so great as to complicate the problem of firebox maintenance. In this emergency a part of the load was for a time removed from the side sheets by carrying heavy sling stays from the crown bars to the outside shell of the boiler, but the relief thus obtained was only partial, and the size of boilers continued to increase. For a time, and to a very limited extent in this country, the crown-bar boiler was followed by the Belpaire boiler, a design in which all portions of the firebox are stayed, and in which the outside of the boiler is so formed as to permit all stays to connect sheets which are parallel. But the real successor of the crown-bar boiler has been the radial-stay boiler, in which the crown of the firebox is curved to a form which will permit its being held up by stays extending to the outside shell or wrapper sheet. The lines of the stays extended do not necessarily radiate from any single point, but their arrangement suggests such a possibility, hence the term "radial stays." As compared with the Belpaire, the radial-stay type presents greater difficulty to be overcome in making an analysis of the stresses which are set up in its several parts by the presence of internal pressure, but it is lighter and probably on the whole equally satisfactory. The radial-stay firebox of the present day may have either one of two forms. It may be "wide," in which case the side sheets extend in a straight line from the mud ring to the curved portion of the crown sheet, or it may be "narrow," in which case the side sheets extend vertically for a short

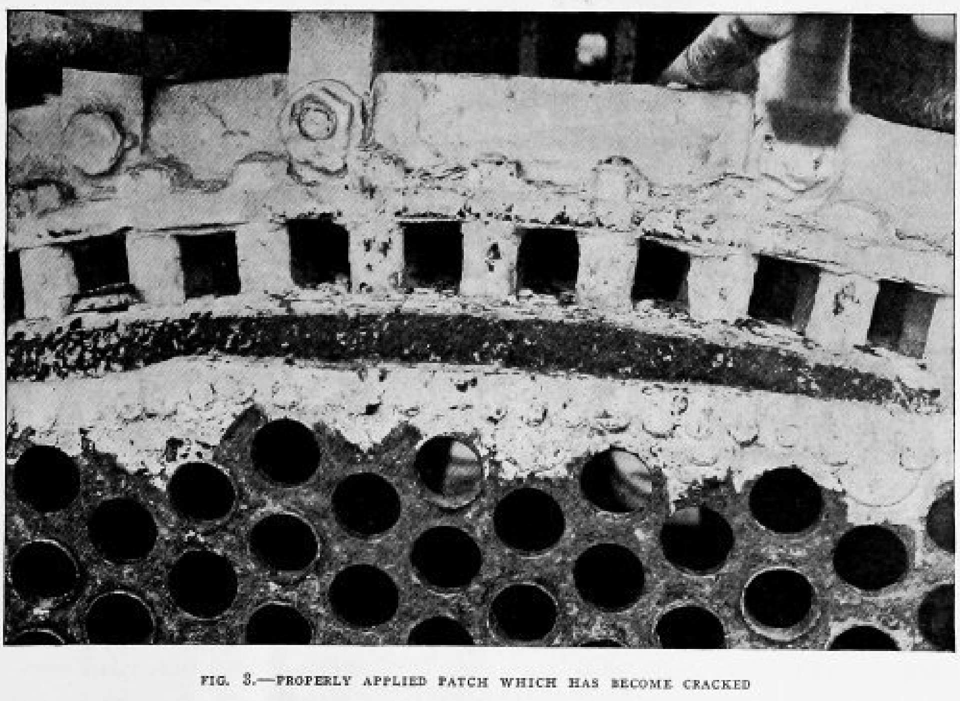


FIG. 3.—PROPERLY APPLIED PATCH WHICH HAS BECOME CRACKED

distance above the mud ring, then curve outward and finally back again to meet the curvature of the crown sheet. In either case, staybolts closely spaced connect the side sheet with the outside sheet of the boiler.

Practice has developed many embellishments in the construction of this form of firebox. First, it has found that longitudinal stresses imposed upon the tube sheet make it desirable to have a certain element of flexibility locally about the tube sheet, and hence, instead of inserting rigid radial stays at this point, two or more rows of sling stays are used. The design of these is such that while giving adequate support to the crown

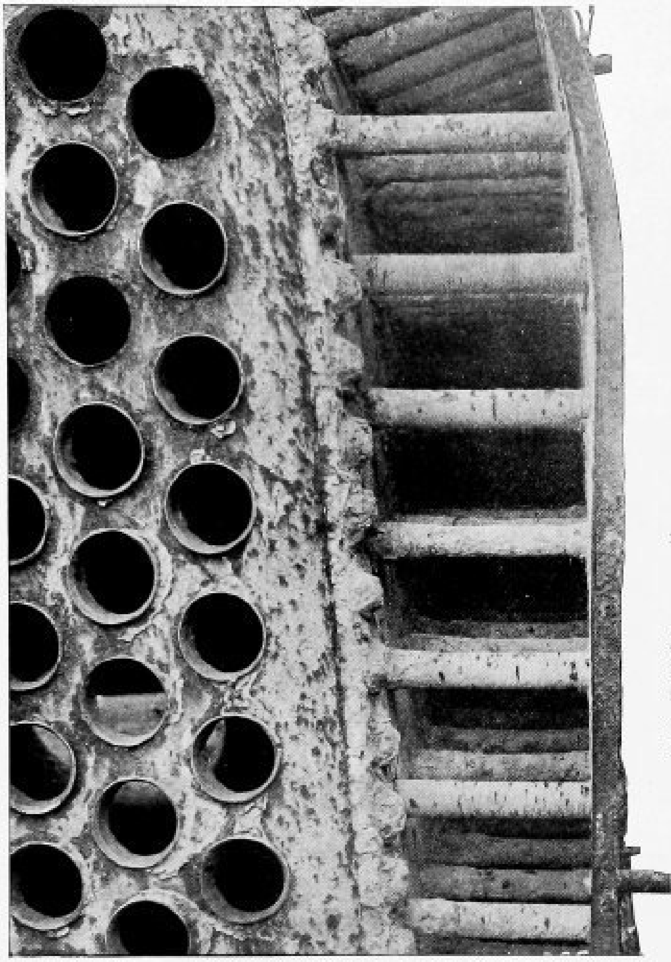


FIG. 4.—CONDITIONS FOUND IN MOST LOCOMOTIVE BOILERS WORKING UNDER AVERAGE WATER CONDITIONS

sheet they offer no resistance to the movement referred to. A second embellishment is to be found in the use of button heads on the firebox end of some or all radial stays. The design of these heads is such as to provide a broad bearing for the plate upon the head of the stay, a connection which is altogether stronger than is obtained by merely screwing in the straight stay and heading it. Practice has also developed certain forms of flexible stays for use in the water leg and higher up in the boiler. These devices are such as to permit some change in the angular position of the stay without imposing transverse stresses upon it at points near the outside sheet. These and many other embellishments in its design have permitted the radial-stay boiler to perform a service which, as measured in power output per unit weight, is superior to that of any type previously employed in locomotive service, and it is this fact which chiefly has resulted in the wide use of the type. But the necessity for certain of these embellishments and the practical difficulties which are experienced in maintaining the modern radial-stay boiler suggest deficiencies in the fundamental principles underlying its design, and the time will doubtless come when the large-sized radial-stay boiler will entirely give way to something that is scientifically more sound. The promise of such a consummation is to be seen in the recently-developed Jacobs-Shupert boiler, which was first put in service in 1909. This type of boiler has in the past three years been subjected to extensive use and to elaborate laboratory tests, with results which as to maintenance cost and strength are entirely complimentary to the new design.

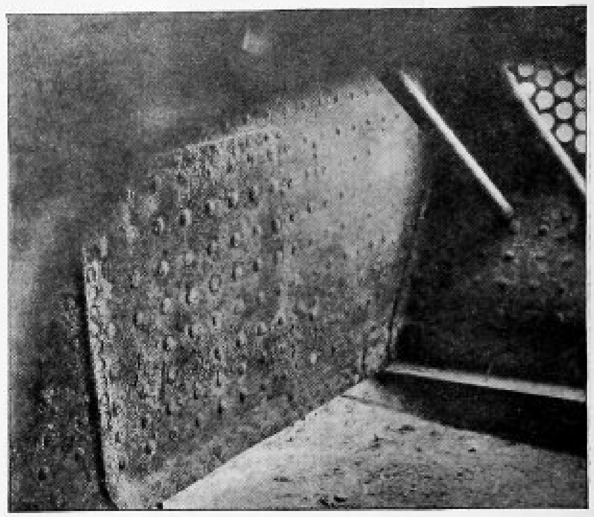


FIG. 5.—BOLTS AT REAR END OF PATCH WORKING DOWN, AND INDICATIONS OF CRACKS NEAR CALKING EDGE

The Jacobs-Shupert boiler in its external form follows the general lines of the radial-stay boiler, of which it is to be regarded as a logical development. It differs radically from its predecessor in the structural characteristics of its firebox and in the means employed for supporting it. The Jacobs-Shupert firebox provides an element of longitudinal flexibility

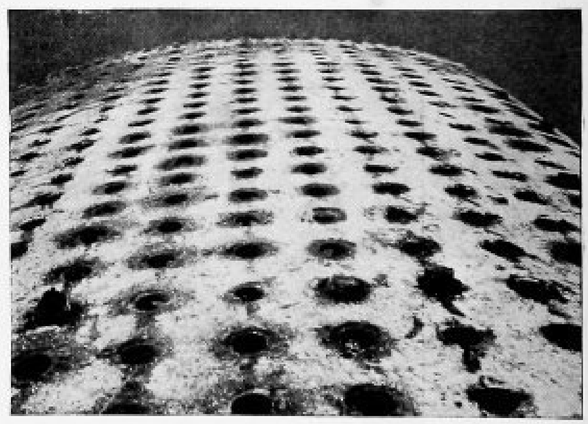


FIG. 6.—CROWN SHEET SHOWING PITTING AND CORROSION FROM SCALE

which the firebox of the radial-stay boiler does not possess, and thereby eliminates strains due to expansion which must be met by the rigid sheet of the radial-stay boiler. It makes no use of stays in side sheets or crown, and hence abolishes completely a fruitful source of trouble which is always present in the radial-stay type of boiler. The support of the side sheets and crown is secured by means of rivets submerged in the water space of the boiler, no one of which can be exposed to the direct heat of the furnace. As a consequence, the strength of the Jacobs-Shupert boiler under low water conditions as compared with that of the radial-stay boiler is vastly augmented.

THE MODERN RADIAL-STAY BOILER

The radial-stay boiler has constituted an important factor in the development of the modern high-powered American locomotive. For a score of years the locomotive designer has endeavored to secure larger boilers. In working out this purpose the machinery of the locomotive has been lightened, steel has been substituted for cast iron, and to insure the exclusion of unnecessary weight, the design of every detail of mechanism has been subject to the closest scrutiny. All that has been gained through the better design of machine parts has been utilized by giving increased weight to the boiler; but here, again, no unnecessary material has been allowed. In the design of the boiler the effort has been to secure maximum heating surface for minimum weight. It is in the development of this general conception that the radial-stay boiler has been brought forward to its present-day standard. It has given the American locomotive greater steaming capacity and power than have been possessed by the locomotives of any other country. Whatever may be the future of the steam locomotive, the history of the art will not fail to give an important place to the radial-stay boiler.

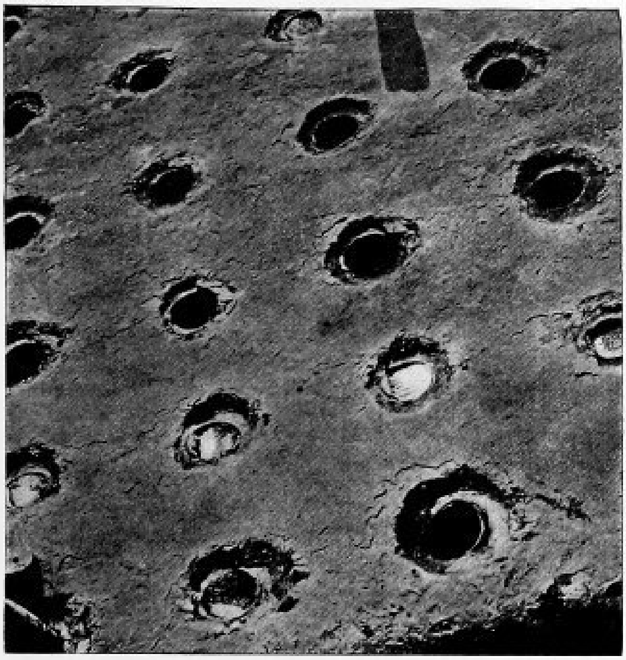


FIG. 7.—CORROSION OF CROWN SHEET AROUND BOLTS

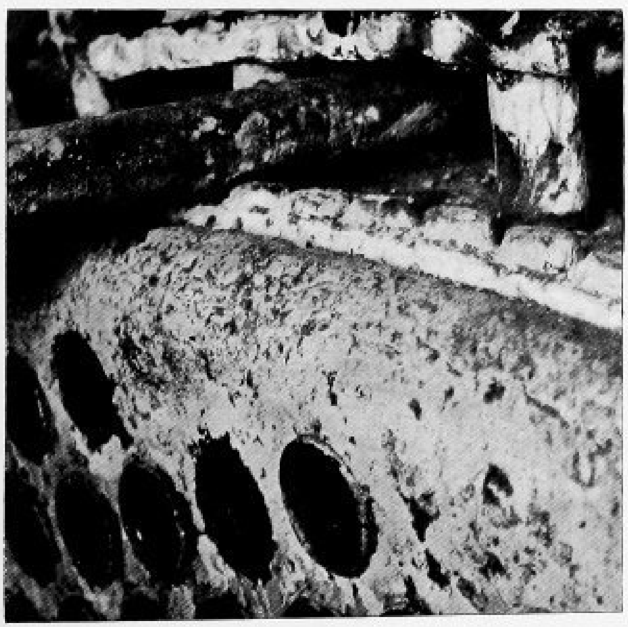


FIG. 8.—CRACKS IN BACK FLUE SHEET DUE TO CRIMPING ACTION OF SHEET

However great the success of the modern radial-stay boiler, it must be admitted that under present-day conditions, involving high steam pressures and large firebox areas, it is a structure which is exceedingly susceptible to deteriorating influences. The difficulties appear chiefly in the firebox, which, as usually constructed, is made up of five plates of steel; namely, two side sheets, the tube sheets, the door sheet and the crown sheet. The side sheets are usually flat plates of steel, which are in the neighborhood of 5 feet wide, and which may be 9 or 10 feet in length. As these plates must transmit heat from the furnace to the water of the boiler, they cannot be heavy, and they are usually 3/8 inch thick. Under modern conditions of operation, however, they must be so supported that they will resist a pressure of 14 or 15 tons per square foot. This is accomplished by the introduction of staybolts, which tie the side sheet to the outside sheet of the boiler. The construction is well shown by Fig. 4, which is a view of the water leg of a firebox from which the barrel and throat sheet have been removed. Obviously, there is no provision in the design of such a side sheet for taking care of local expansion, and as a consequence the effect of such expansion can only find expression in bringing about a change of stress within the sheet itself. The result is that different portions of the side sheet behave in different ways. They change their position with

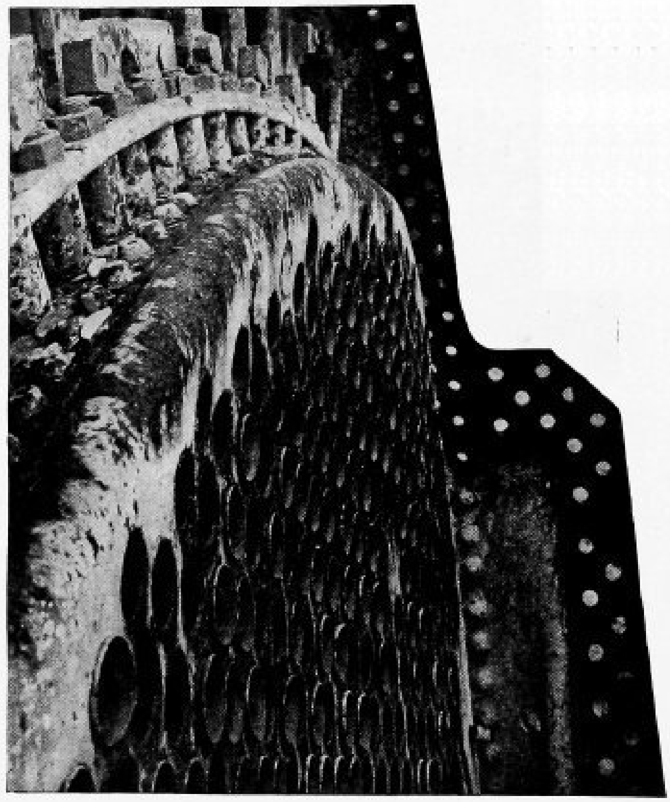


FIG. 9.—BACK FLUE SHEET SHOWING DETERIORATED CONDITION OF FLANGE

reference to the outside sheet of the boiler, causing staybolts to loosen, to become leaky, and, in the zone of greatest movement, finally to break. This fact was recently emphasized by Mr. F. A. Delano, president and receiver of the Wabash Railroad, a high authority in railway mechanical matters, who, in the course of a recent address,* said:

"A modern locomotive boiler has from 1,200 to 1,500 staybolts, between 4 and 5 inches apart, on all sides of the firebox.

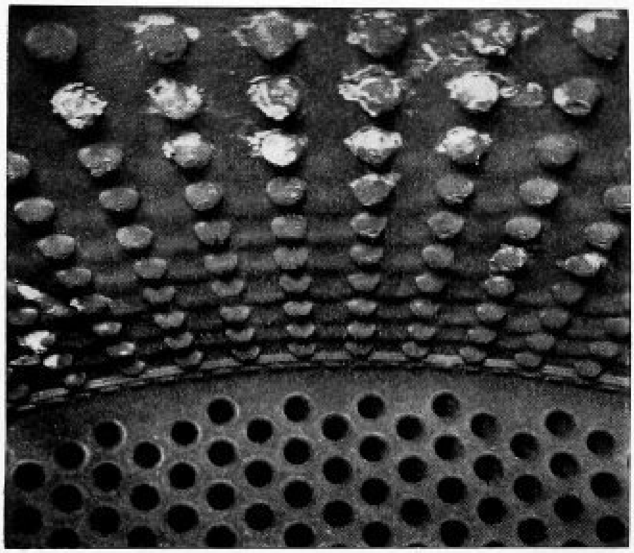


FIG. 10.—BULGING OF CROWN SHEET BETWEEN STAYBOLTS

Under the law five broken staybolts are sufficient to condemn an engine. This means that a locomotive boiler must be more than 99 percent perfect to meet approval; and yet it is safe to say that no high-pressure boiler can be cooled down and reheated again (as it must be for each washing out) without breaking at least this number of staybolts."

Not only does trouble arise from the presence of staybolts, but the sheets themselves gradually bulge between the staybolts, and under unfavorable conditions of service they deteriorate rapidly. Fig. 5 shows a patch which in the process of making repairs has been applied to a bulged side sheet. The appearance of this patch itself, and especially of the patch bolts which hold it in place, suggests the difficulties that must be met in maintaining any flat sheet under the conditions of service to which a side sheet is exposed.

The crown sheet in the radial-stay type of boiler is usually curved. It must be thin, and in common with the side sheets it must stand up under a pressure of approximately 15 tons per square foot, or a total load for a modern crown sheet of 1,000 tons or more. Support is given the crown sheet by the radial stays which tie it to the outside shell of the boiler, and which having considerable length permit some freedom of movement in the sheet under them. Consequently, the crown sheet is more durable than the side sheets, but it nevertheless suffers deterioration as an indirect cause from expansion and contraction stresses. Fig. 6 shows a crown taken from service, in which the plate is more or less bulged between stays, and in which the dark spots indicate pitting or local corrosion of the plate. Fig. 7 is a view into the water space over the crown sheet of a boiler from which the barrel has been removed. It indicates the size and the spacing of the stays. Four front rows were sling stays, and these had been removed prior to taking the pictures. Figs. 8 and 9 show a similar view of a boiler with all the stays still in position. The illustrations well show the obstructions which are presented to the free movement of water over the crown sheet, and the ease with which sediment or scale may collect upon certain portions thereof in this type of boiler. Fig. 10 shows a bulged and leaky crown sheet from the fire side.

The back tube sheet is one difficult to maintain in the radial-stay boiler. If its tubes leak they must be rolled, and the gradual process of rolling extends the tube sheet upward, with

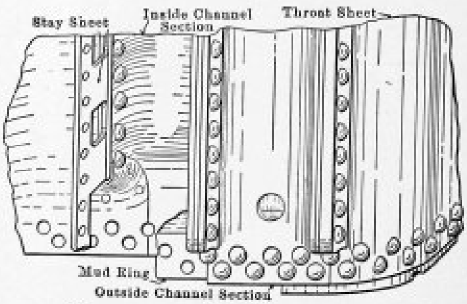


FIG. 11.—LAP-JOINT CONNECTION AT MUD RING

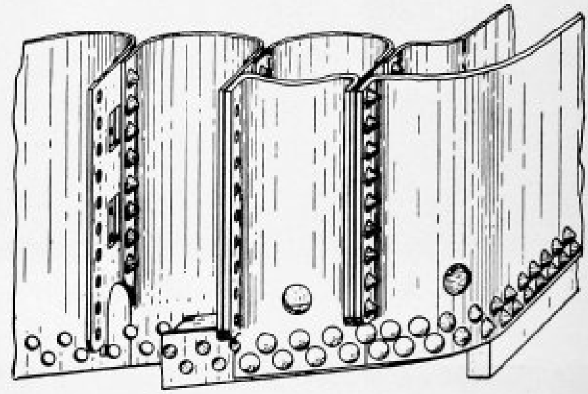


FIG. 12.—BUTT-WELDED JOINT AT MUD RING

the result that the forward end of the crown sheet gradually becomes bent upward and the fillet of the tube sheet itself not infrequently expands above the level of the crown sheet. Fig. 9 shows this rise in the fillet of the tube sheet. One result of this extension is a gradual degeneration of the upper portion of the tube sheet itself. Thus in Fig. 8 is to be seen a series of irregular cracks extending all around the top not far from the point of its connections with the crown sheet. Figs. 1, 2, and 3 show the degeneration of the tube sheet resulting from stresses induced by the distortions already referred to. These illustrations are in nowise peculiar, but on the contrary may be taken as entirely typical of the difficulties to be met in the maintenance of all large radial-stay fireboxes.

The forces at work within the structure of the radial-stay firebox, which ultimately bring about its ruin, are, under service conditions, always present, but the careless handling of the locomotive or the necessity for using a muddy, foaming or scale-producing water hastens its deterioration. Careless handling may expose the firebox to sudden changes of temperature which may result in leaks; the use of muddy or scale-producing waters may result in the deposit of solids on the sheets and lead to local overheating; and the use of foaming waters may operate in various ways to deprive the plates of the protection against overheating which they are designed to have. In other words, where the conditions are all favorable to longevity, the radial-stay boiler must be tenderly handled, and under conditions which are normal through large sections of our country it is kept in service only as a result of constant attention. The radial-stay boiler is everywhere expensive to maintain, and its need of attention requires the locomotives to

* An address given before the Commercial Association of the State of Michigan, Detroit, April 17, 1912.

spend much time in the roundhouse, which might otherwise be given in service at the head of a train. It is customary on most roads to have a boiler maker go over the boilers after each trip, and on many roads the conditions are such that he must always do some work on them. Now a boiler that must be fixed after each brief period of service is to be compared with a highway bridge which must be mended after each passing vehicle—it serves an immediate purpose, but it leaves much to be wished for.

Finally, the radial-stay boiler is weak, as have been all its predecessors, under low-water conditions, and when failure occurs the results are likely to be disastrous. A study of the radial-stay construction will suffice to reveal the explanation. The support of the crown sheet is such that any local yielding imposes additional stress upon adjacent parts, and as these fail the affected zone is extended, the process proceeding with such rapidity that the pent-up water and steam in the boiler is released with explosive effect. This is well illustrated by the fact that almost the whole crown frequently comes down together with a considerable portion of one side sheet. The explosive effect of such a failure is apparent. A committee of the American Railway Master Mechanics' Association, reporting at the convention of the association in 1910, gives results of an inquiry concerning the number of boiler explosions, failures and casualties to employees and others. The report was based on responses received from 157 railroads owning and operating 43,787 locomotives. The committee reports that during the period from June 1, 1905, to Nov. 1, 1909, there were 246 firebox explosions, resulting in the loss of 127 lives, and 2,499 fireboxes damaged by overheating, resulting in 142 deaths. More than 98 percent of these failures are said to have been due to low water. This statement makes it evident that low-water conditions are matters to be reckoned with, and that a boiler which is inherently weak when the water is low is at a disadvantage as compared with one which is less affected by overheating.

The explosion of locomotive No. 2,538, which occurred 4 miles south of Yoncalla, Ore., on April 4, 1912, may be accepted as typical of recent disasters. The accident in question occurred on the Oregon & California Railroad, which is operated by the Southern Pacific Company. A report of the accident, as formulated by the chief inspector of locomotive boilers of the Inter-State Commerce Commission, presents the following facts:

The locomotive was of the consolidation type, and at the time that it exploded was engaged in helper service on a southbound train of forty cars, weighing altogether 1,605 tons. Three freight engines were coupled to the train, the road engine No. 3,203 at the head and two others, No. 2,538 and No. 2,194, between the caboose and the train. It was the boiler of 2,538 that failed. The exploding boiler was blown clear off the frames of the locomotive, breaking or pulling out the expansion plates attached to the firebox, shearing cylinder saddle bolts and breaking the saddle. It passed over three box-cars, apparently lighting on an oil-tank car, from which it rolled off to the right side and landed on the bank of an 8-foot cut at a distance of approximately 218 feet from the point where the explosion occurred. The engineer and fireman were both killed. The report continues: "At the time of the accident the train was ascending a grade of 84.48 feet per mile at a speed of 10 to 12 miles per hour. The accident occurred on a tangent 627 feet south of a left-hand 8-degree curve. The elevation of the right-hand rail of this curve was 3½ to 3¾ inches for a distance of 198 feet in the center of the curve. Our inspection disclosed the fact that almost the entire crown sheet, with the exception of a portion of the left back corner, was overheated. The overheated portions of the sheet extended 4 inches below the highest part of the crown sheet at the right front corner and 1 inch below at the left front corner. At the right back corner it was about on a line with the crown sheet, while there had apparently been water on the left back corner. So far as could be ascertained by our in-

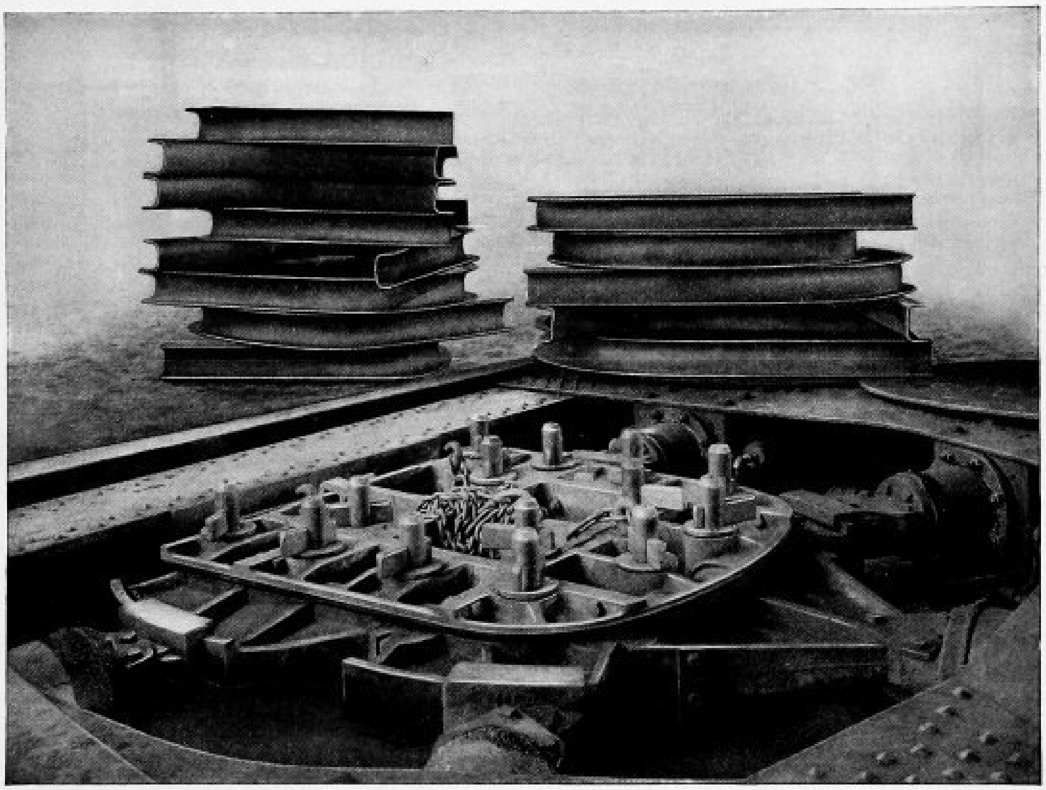


FIG. 13.—HORIZONTAL HYDRAULIC PRESS FOR FLANGING CHANNEL SECTIONS AT WORKS OF JACOBS-SHUPERT U. S. FIREBOX CO.

spection, the injectors, safety valves and steam gage were in good condition."

The report concludes with the opinion that the accident in question was the result of overheating the crown sheet, due to low water. With the efforts of the inspector to fix the responsibility for the low water the undersigned is at present not concerned, but he wishes especially to call attention to the fact that the crown sheet came down as soon as any considerable portion of it was bare and before it was entirely uncovered. The modern firebox has so little power of resistance in the presence of low water that the fact that any part of the crown sheet is bare is commonly accepted as a cause sufficient to explain a firebox failure.

It is obvious that any boiler, however satisfactory when properly handled, which possesses such enormous power of destruction when carelessly or imperfectly managed, always presents a certain element of danger. In stationary practice, progress in the art has produced certain types of boilers which in case of failure do not act with an explosive effect. In these so-called "safety boilers" the heating surface is subdivided, so

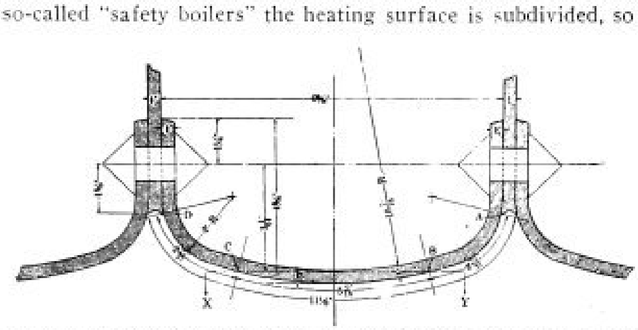


FIG. 14.—JOINT OF JACOBS-SHUPERT FIREBOX BETWEEN FIREBOX SECTIONS AND STAY SHEETS

that a failure, if one occurs, is limited to a comparatively small detail; a breakdown cannot easily become progressive. A failure is merely a blow-out. There is no explosion, and no damage is done beyond that of the affected part. There is no wreckage, and there are ordinarily no casualties. In this respect the design of the stationary boiler occupies a much higher plane than that occupied by the locomotive boiler. The locomotive service is in need of a boiler possessing the elements of safety which are to be found in existing types of stationary boilers.

These well-known deficiencies of the radial-stay boiler are not rehearsed for the purpose of obscuring its merits, but that our devotion in fostering it may not be permitted to blind our eyes to its frailties. No one who considers the progress of the past can assume for a moment that our present-day practice is final. The radial-stay boiler has had its predecessors and they have disappeared, and no one can doubt that the radial-stay boiler itself is but an embryo predecessor of a type which must soon be revealed.

The Jacobs-Shupert Boiler and Some of the Advantages

The Jacobs-Shupert firebox is more than a mere modification of pre-existing forms; it is entirely new in its contour, in the means which are employed for its support, and in the fact that it is made up of a considerable number of comparatively small plates. A Jacobs-Shupert firebox may have the same over-all dimensions as a radial-stay or a crown-bar firebox; that is, it may be designed to respond to all of the limitations which must be observed where other types of fireboxes are used. On the other hand, indications are not lacking to show that the dimensions of the Jacobs-Shupert boiler may be extended to limits which are hardly possible in the case of the radial-stay type.

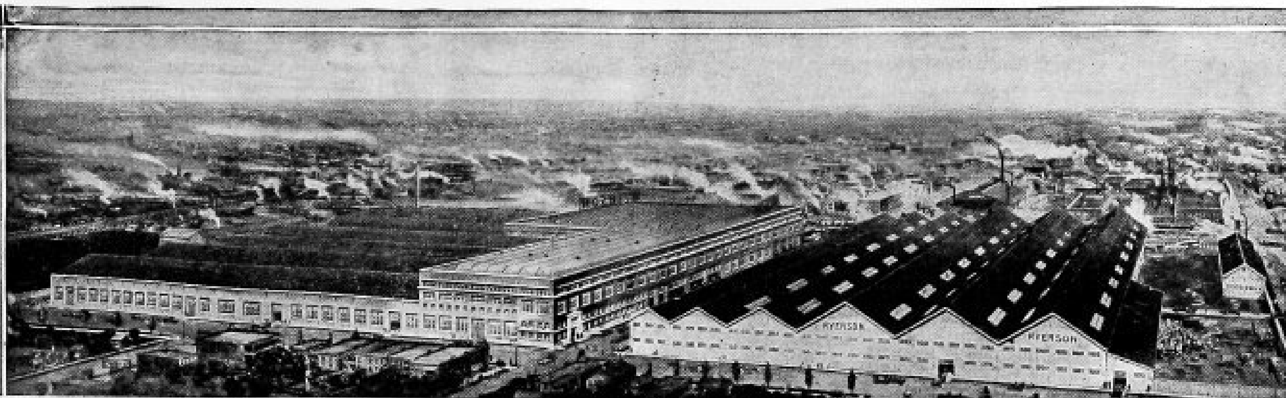
The contour of the Jacobs-Shupert firebox, as shown by any longitudinal section, is not dissimilar to that of the corrugated furnaces so long and so generally used in marine service. It is shown in Fig. 13. The firebox is supported in part from the shape which is given the several elements entering into its construction, and in part by stay sheets extending between the sections and the outside shell of the boiler. There are no sling stays in the boiler, and staybolts are used only in the door sheet and tube sheet.

The sides and crown of the Jacobs-Shupert firebox are composed of a series of channel sections made up from long, narrow, flat sheets, which, having been heated, are pressed into a shape by a special hydraulic flanging machine (Fig. 13). Stay sheets are fitted between every two adjacent sections and find their support in the sections of the outside wrapper of the boiler. The two adjacent sections of the firebox and their stay sheet are fastened by through rivets. A firebox with all the inside sections in place is shown by Fig. 15. The sections have a uniform width of 9⅝ inches over flanges, and the stay sheets are ⅜ inch thick, so that each stay sheet and its accompanying section cover the construction of a 10-inch length of firebox. A firebox having ten sections is, therefore, 100 inches in length, and one having thirteen sections is 130 inches in length. The stay sheets connect the sections of the firebox with similar sections, which form the outside wrapper of the boiler, the construction of which is well shown by Fig. 16. To provide for circulation in a horizontal direction, the stay sheets are pierced with openings of liberal size, and as all stay sheets of a given boiler are made from the same templet these holes line one with another. The door and the back sheet of the firebox are stayed to each other in the usual way. There are stays also in that portion of the tube sheet which is below the tubes. A throat sheet connects the special construction of the Jacobs-Shupert boiler with the barrel, which in all respects is normal.

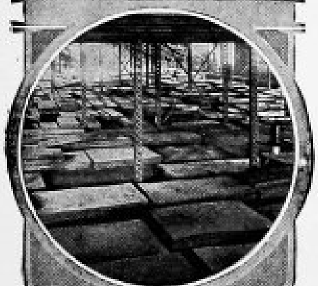
In fitting up the stay sheets and the inside and outside sections of the Jacobs-Shupert boiler, all rivet holes are drilled from standard templets, so that the process of assembling parts is more like that of assembling a machine than that of putting together the several parts of the boiler. This impression is heightened by the fact that in the mill a long reamer is run through half the flanges of a completely assembled firebox, and then, working from the opposite end, through the other half. All rivets are driven in reamed holes, and rivets in the same horizontal course line with each other perfectly. The mud ring is in nowise different from that employed in a normal boiler. The method of connecting the sections with the mud ring is shown by Fig. 11.

The latest fireboxes of the Jacobs-Shupert design have what is claimed to be an improved joint between the inside sections at the mud ring. In this new joint the lapping of the sections over each other at the mud ring and around the bottom of the stay sheet is eliminated. This new style joint is shown by Fig. 12. Adjacent inside sections are butt-jointed from the point where the stay sheet ends to the bottom of the mud ring, and this butt-joint is welded by means of the oxy-acetylene method.

It has been said that objections have been made to the Jacobs-Shupert boiler because of the number of rivets it contains, but before urging such an objection one should consider that a rivet which is well placed and well driven is a very reliable fastening, and that there are no rivets in the side sheets or the crown of the Jacobs-Shupert firebox where the presence of such fastenings would be most objectionable. The fact that there are no seam rivets in the firebox, and that all the rivets made necessary by the special construction of the Jacobs-Shupert boiler are either entirely in the water space or on the outside of the boiler, suggests that the service to be met by them is similar to that imposed upon the normal shell rivet. Shell rivets commonly give no trouble. Moreover, the number of rivets in the Jacobs-Shupert boiler is not greatly in



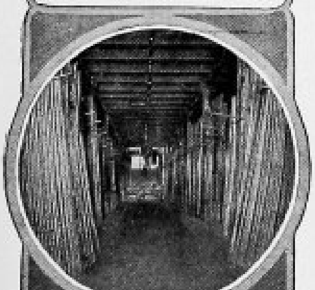
EVERYTHING IN IRON AND STEEL



Plates

Rivets

Boiler Lugs and Hangers



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The Advantages to Boiler Makers of having immediate access to complete supplies of material and equipment for their requirements are constantly becoming more generally appreciated; and, as a result, we are carrying larger lines than ever before.

All of the Staples and more than 1100 carefully SELECTED SPECIALTIES are constantly carried on hand. Whatever your requirements, standard, extreme, or unusual sizes, any quantity at any time, will receive careful and intelligent attention immediately upon receipt of your order.

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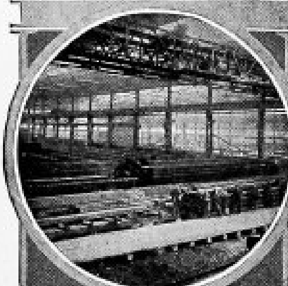
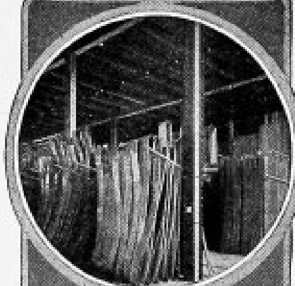
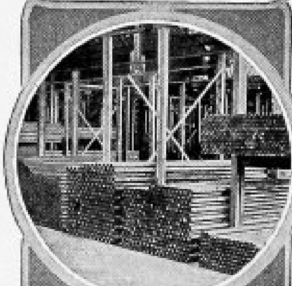


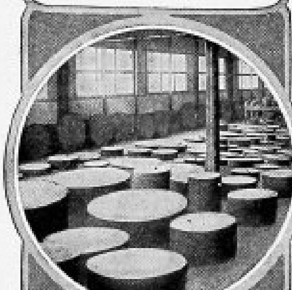
Structural Shapes



Bands



Boiler Tubes



Boiler Heads

THE LARGEST IRON AND STEEL SUPPLY HOUSE IN THE WORLD

excess of the combined number of rivets and stays in older types of boilers.

Many rivets may be driven in the time that is required to set one staybolt, and a rivet in a reamed hole once driven requires no attention, while a staybolt must be constantly inspected and frequently worked upon. The elimination, therefore, of 1,374 firebox stays in return for the addition of 793 through rivets, is a matter which, from the standpoint of construction and maintenance, has much to recommend it. Obviously, while the Jacobs-Shupert construction does increase the number of rivets, there is no corresponding increase in maintenance cost or hazard; the change amounts to the displacement of a troublesome device by one of the oldest and most reliable fastenings employed in the arts.

A number of advantages possessed by the new form of fire-

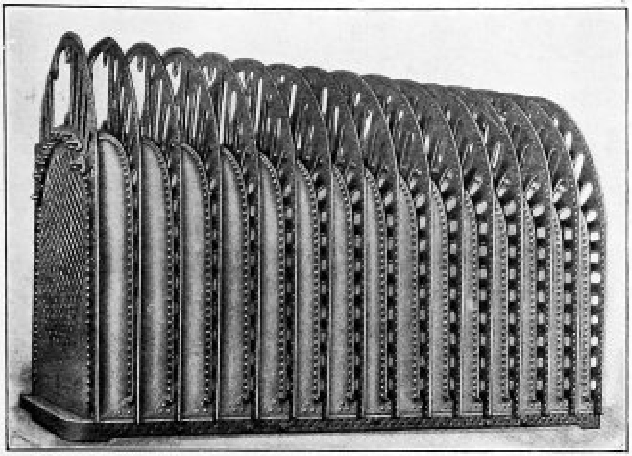


FIG. 15.—JACOBS-SHUPERT FIREBOX READY FOR APPLICATION OF OUTSIDE SECTIONS

box are at once apparent. Most obvious, perhaps, is the presence of an element of flexibility which is introduced by the combination of curved sections. In this respect the Jacobs-Shupert firebox is comparable with the corrugated furnace to which reference has already been made. Any strain due to longitudinal expansion is taken care of with the least chance of injury to the structure. The effect of this provision must be beneficial in reducing the cost of repairs and in increasing the life of the boiler.

The presence of the corrugated surface within the firebox adds somewhat to the extent of the firebox heating surface, as compared with the surface presented by a normal firebox of the same over-all dimensions. The extent of this increase in the case of the boilers tested was 11 percent.

The fact that the Jacobs-Shupert firebox has no staybolts in the sides and crown removes an important source of difficulty. With no staybolts there can be, of course, no leaky bolts to calk, no broken bolts to replace, and no spots inherently weak when the water drops a little low. The rivets joining the several sections making up the firebox structure are not inside of the firebox. They cannot be seen from the firebox, and they cannot be affected by the direct action of the heat from the firebox. They are above the crown in the water space of the boiler at a distance sufficiently far from the heating surface of the firebox to be undisturbed by any condition that may arise within the firebox. These features place the design of the Jacobs-Shupert boiler upon a plane which, from a purely mechanical point of view, is essentially higher than that which is occupied by the normal radial-stay boiler. The fact, also, that in the manufacture of these boilers the principle of interchangeability is employed establishes a standard of workmanship which has never before been reached in the construction of large boilers. This superior workmanship will not, in the long run, increase the cost. Interchangeability in machine construction has operated to improve the quality of the machine and also to reduce its cost. Similar results will ultimately follow the adoption of interchangeability in boiler construction. In the manufacture of the Jacobs-Shupert firebox, machinery is used instead of men. Each operation is simple and yet the result is precise. There is no drifting of holes and no local heating of plates which have been set in their places in the boiler. The result of the new process is a boiler accurately made, substantially put together, and comparatively free from initial strains. The design and the methods of manufacture combined permit repair parts to be carried, and provide an inexpensive procedure in maintenance.

The Jacobs-Shupert boiler, judged by the standards of good design, is obviously less susceptible to the weakening influences of low-water conditions than the radial-stay boiler. In the Jacobs-Shupert boiler the fastenings which must be depended upon to hold up the crown are so far removed from the heat as to be comparatively unaffected; whereas, in the radial-stay boiler they are actually in the fire. Its superiority in this respect, while apparent as a matter of design, has now been

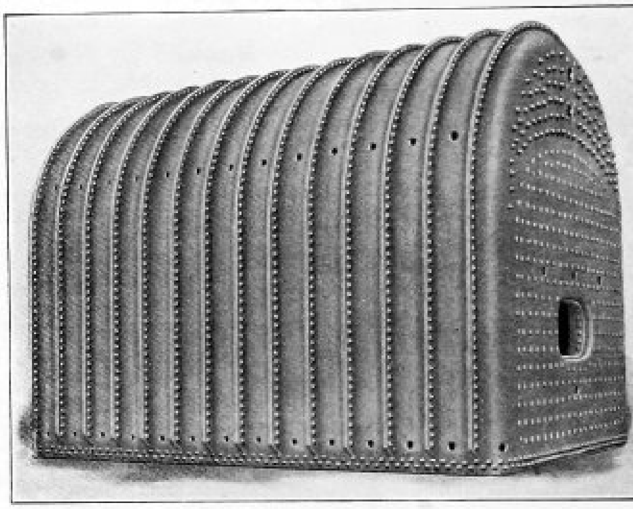


FIG. 16.—JACOBS-SHUPERT FIREBOX COMPLETED

abundantly demonstrated by the results of tests under low-water conditions.

As a safety device, the Jacobs-Shupert firebox derives from its sectional form the same advantage which the watertube boiler derives from the subdivision of its heating surface into tubes of moderate size. If for any reason, such as the occurrence of low water or the accumulation of scale, the firebox fails, the worst thing which can happen is the blowing out of a single section. In this case the plate will "pocket," and the rent will be small. The result will not be an explosion, but merely a discharge of steam and water into the firebox, which extinguishes the fire and relieves the boiler from pressure without doing serious injury to life or surrounding property. The Jacobs-Shupert boiler may, in fact, properly be characterized as a "safety boiler."

NEW YORK SECTION OF THE AMERICAN INSTITUTE OF STEAM BOILER INSPECTORS.—The annual dinner of the New York Section of the American Institute of Steam Boiler Inspectors was held on Friday, Feb. 21. The speakers included representatives from Boston, Mass.; Mr. Lukens, chief inspector of boilers of Philadelphia, Pa.; and also representatives of the Government service and boiler manufacturers. The officers of this society for the coming year are F. G. Shaw, president, and R. A. Thompson, secretary.

The Boiler-Shop Boy and Geometry

BY JAMES F. HOBART, M. E.

"Mr. Hobart," sang out John, the Boiler-Shop Boy, as he came running up to the laying-out bench, "is there any geometry short-cut which will tell me quickly how to find the diameter of a head which will fit a boiler whose diameter is not known? That is, a boiler comes into the shop to be fitted with new tube sheets or heads. The nominal diameter of the shell is 72 inches, but as one course is an inside one and the other course an outside one where the heads fit, I surely don't know the exact diameter of that shell—at least, not closely enough to lay out a head which will fit closely enough. Is there any short-cut or 'geometry stunt' which will help things out?"

"Yes, John. There is a method, one which is used by about every barrel maker who desires to fit a new head into an old barrel, and you can use the same method for finding the radius of a head which will fit a given boiler, and the best of it is, you can lay out the head to exact size without making a single figure or doing any mental calculation. Here is the scheme all drawn out in Fig. 1. The inside of circle *A A* represents the inside of the boiler and you want to find the radius *D J*, or *J G*?"

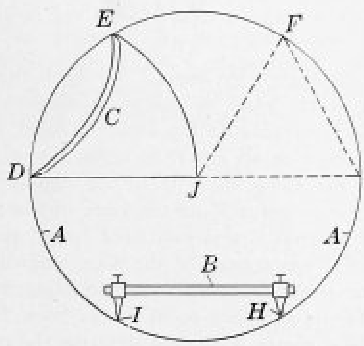


FIG. 1.—FINDING RADIUS OF A BOILER

"Yes, sir. That is what's wanted. When I get that dimension it's easy to lay out the new tube sheet."

"Well, then, first get a tram, *B*, or if you can't find one long enough, then just bend up a small rod, *C*, point each end and make the distance *D E*, between the points, as nearly one-half the diameter of *A A* as can be judged by the eye. Then, with a center-punch mark at *D*, start around the inside of the boiler circumference with tram *B* or rod *C* and space off six steps, *D E, E F, F G*, etc., taking care to space square with the shell at every step. If the last step brings the spacing tool squarely into mark *D* again, then the operation is finished, but if space *I D* falls short or overruns mark *D*, then the distance *D E* must be changed accordingly and the spacing repeated until at last the tool *B* or *C* comes around squarely into mark *D* again, and the distance *D E* will be the required radius of circle, or boiler *A A*."

"Say! But that's a slick stunt, only I wish you would tell how I am to know that half the diameter of a circle is just one-sixth of its circumference. I should think there would be a nasty fraction there, for we found that a circumference was 3.1416 times the diameter, and that would make a 4-foot circle or boiler have a circumference of 12.5664 feet. Dividing by 6 gives 2.0944 as the radius of the circle, which we know to be exactly 2. Now, Mr. Hobart, that don't seem to come out right, does it?"

"John, you are up against what happens to a whole lot of mechanics when they try to do something without first figuring out all the conditions. If you measure along the arc of the circle, from *D* to *E*, following the curve, then your figures will be right. But we didn't do that. The tram straddled right straight across from one point to another, as shown by the dotted line *F G*, and the difference between the lengths of lines *F G* and *D E* will exactly equal the 'nasty fraction' of which you complain. That is, the difference between the lengths of the two lines in question will be 0.0944 foot."

"Oh, Mr. Hobart! I bet I know now! Doesn't the difference in the lengths of the straight and curved lines have something to do with .7854?"

"Not directly, John, but you have got the right idea. The portion of area cut off in squaring up the circle made the difference between 1 and .7854, and likewise, the cutting across lots in Fig. 1 makes the difference between 2.0944 and 2. Just draw another circle, Fig. 2, and space it off as described for Fig. 1; then connect all the points and you have six little triangles inside a circle. Each side of each triangle is equal to each other side—you remember the study we had about the things which are equal to the same thing being equal to each other? Well, here is a case of that kind. All the sides are equal, and as two sides joined together form a diameter, then one of the sides must be a radius of the circle inside of which they are drawn. Have you got that, John?"

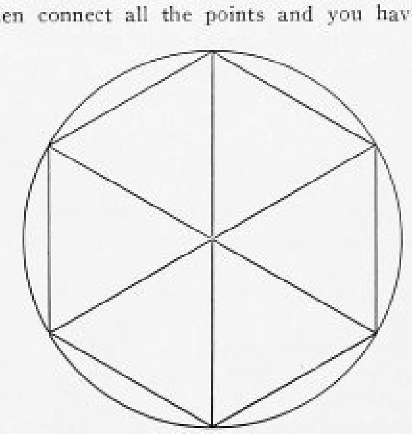


FIG. 2.— PROVING THE RADIUS

"You bet I have. That argument is sure 'Hoss high, hog tight and bull strong.' It's all right, and I'm going to use it right now."

"Go after it, John, but sure be mighty careful with the spacing. A very small mistake there will make you get out a head too large or too small, and you know what that would mean between you and the boss?"

"Crackee! You bet I do. I heard him bawling out a man this morning for cutting some braces too short. I don't want any of that in mine! But, Mr. Hobart, isn't the method we have been talking about a pretty good way for laying out a six-sided figure—a 'hexagon' they call it, don't they?"

"Yes, Fig. 2 shows the correct method of laying out a 'hex.' Just lay down a circle of the same diameter as the 'hex' across its diagonal, then space around the circumference with the radius, and there you are; and, John, if you put in only three of the radii shown in Fig. 2, putting the main radii vertical instead of horizontal, as shown by Fig. 3, then you can show the perspective of a cube by leaving out alternate radii, those indicated by the dotted lines in Fig. 3 being omitted. The full diagonal lines, together with the lines forming the 'hex,' forming the picture of a cube in what is called 'bastard or isometrical perspective.' If the cube had been drawn in true perspective, the far sides would be shorter than the near ones, just the same as it appears when we look at the real article. But the perspective shown by Fig. 3, while not correct actually, forms a very convenient way of showing three sides of any object in the same drawing, and it is a mighty handy way in which to make sketches which are to be dimensioned and worked to, in place of regular drawings which show two or three sides in as many different views."

"Oh, Mr. Hobart! Isn't there some way of laying out an octagon which I can use in somewhat the same manner that we lay out a hexagon in Fig. 1?"

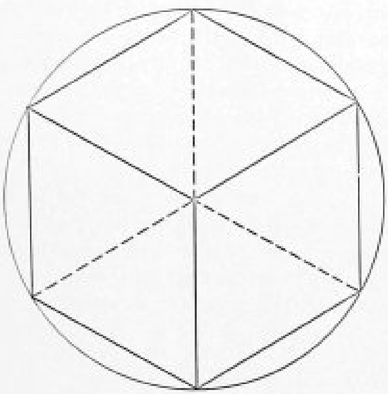


FIG. 3.—DRAWING A CUBE

"Yes, John; geometry shows a man several ways of laying out an octagon, and there are a couple of the simplest methods illustrated by Figs. 4 and 5 herewith. Fig. 4 shows a bit of plate, *A*, which is to be made eight-sided and to lay it off draw two parellel lines, *B C* and *D E*, making the distance between them equal to the width of plate *A*. Then take a steel square or a 24-inch rule and lay it across from line to line as at *B E*, and mark at the 7 and 17-inch points—'pricking the 7's,' the old-school mechanics used to call it. Lines *F* 7 and *G* 17 are then drawn parallel with lines *B C* and *D E*, and where these lines touch the edges of plate *A*, there will be the points where the diagonal lines start which form the octagonal cuts desired. Two of these lines are shown, *F H* and *G I*. The points at *H* and *I* may be obtained in the same manner that *F* and *G* were obtained, by laying off a couple more parallel lines on the sides of plate *A*, or, the laying-off having been done on a large plate, simply turn plate *A* one-quarter around and mark at *I* while the plate is in that position."

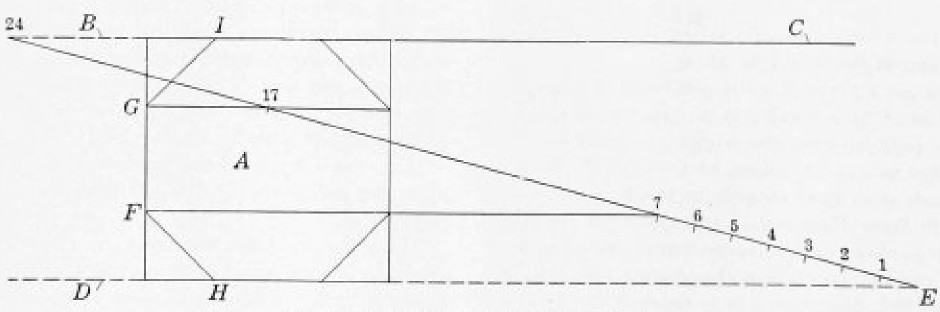


FIG. 4.—METHOD OF DRAWING AN OCTAGON

"Mr. Hobart, how does geometry have any chance in this inning? It looks to me like a 'kink' or a 'wrinkle' more than it does like a stunt in geometry."

"It does have a 'kinky' look, John; but it is straight geometry, nevertheless, and when it was figured out geometry and trigonometry (a first cousin to geometry) doped out the fact that the width to be gaged off for an octagon cut was nearly 7/24 the width of the article. We have already found out that we use geometry when we divide any given distance or width into a number of equal parts or spaces, by means of the diagonal, as in Fig. 4, and the taking 7 and 17 of these parts, is merely for the purpose of obtaining 7/24 of the width of plate *A*, Fig. 4. If desired, after the first points are found, *F* and *G*, the remaining part of the work may be done with a 45-degree bevel square, just marking lines *F H* and *G I* alongside that tool and then repeat the operation on the other edge of the plate.

"There is another way, John, which is perhaps an easier one, and which is shown by Fig. 5. To work this stunt, first find the center of the plate by means of diagonal lines, then with one leg of the trams on the center *K*, and the other leg or point on *J*, describe an arc *K L*, right out to the edge of the plate. Do the same thing from the opposite corner *N*, describing the arc to point *M* on the edge of the plate. Draw a line through *M* and *N* and you have found the cut which should be made at one corner of the plate. Similar arcs may be drawn at the remaining corners of the plate, but it will be found more convenient, once point *L* has been found, to set the trams to the distance *K L*, then describe the circle *N O P*, with the assurance that wherever this circle touches the edge of the plate there will be a point from which to start one of the octagon cuts. To do so the plate must be square and of the exact dimensions called for when line *M L* is established. In fact, the circle *N O P* transforms conditions in Fig. 5 to almost exactly the same ones that exist in Fig. 2, with the difference that one figure (2) develops a hexagon or six-sided figure, while the other figure (5) forms an eight-sided one, an octagon."

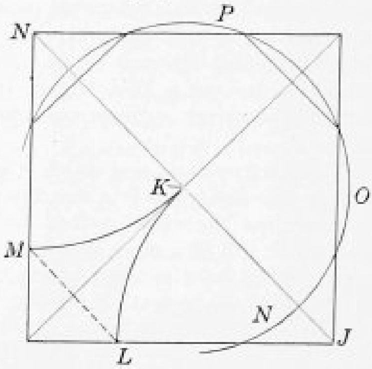


FIG. 5.—LAYING OUT AN OCTAGON WITH THE TRAMS

"Mr. Hobart, can the reasons for all these things be figured out by geometry?"

"Yes, they can. Do you remember how we figured out the connection between the diameter of a circle and its area in the January BOILER MAKER (page 11)?"

"Yep! You bet I do. I studied that thing a whole lot and it ain't going to get away from me, not by a long shot."

"Well, John, it is possible to show, in a manner somewhat similar, the connection between the square and its octagon and hexagon as described in the preceding paragraphs, but we will not fill the BOILER MAKER columns with too much of that stuff. Now that you have an idea of the matter, you can dig into some book on geometry and trigonometry and work out the stunt for yourself. And, John, you and Bill haven't sent in but just one question since we started these talks! Now, then, that won't do, and if you don't want me to go to telling you how to work out the proofs by geometry, of the things I have shown you to-day, then you boys just get busy with the questions and send them in P. D. Q.!"

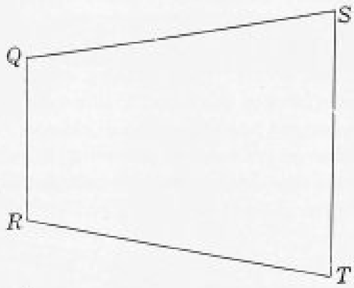


FIG. 6.—TAPER SHEET INCORRECTLY LAID OUT

"All right, Mr. Hobart. I have one question which has bothered me a good deal, and Tom and Bob asked the head layer-out about it, but we didn't find out what we wanted to know, which is this: When we lay out taper sheets for inside at one end and outside at the other end, why is it that, while the holes at and near the longitudinal seam come fair with each other in the girth seam, that there is always more trouble in getting the holes fair which come in the middle of the sheet? And when we made some very tapering pipe there was so much trouble that the 'old man' had us ream all the holes and put in rivets one size larger. What caused that trouble?"

"I'll tell you, John. When the layer-out lays out a sheet which is taper and straight on sides and ends, he has passed along work which is not correctly laid out. To be sure, on a sheet 20 feet long and 6 feet wide the error is very slight, especially when the plate is thin, but when the taper is considerable the error is greater and becomes troublesome. A taper sheet should always be laid out with the sides radial to a common center and the ends of the sheet should be segments of circles drawn from the same center. Fig. 6 illustrates this matter, but the taper has been greatly exaggerated in order to show matters better."

"Why isn't that sheet right, Mr. Hobart? The length is all right, and the width at one end is three times the thickness of metal wider than the other end of the plate. What is the matter, anyway?"

"The matter is, John, that the ends of the sheet have been cut straight across when they should be circular. Fig. 7 shows up this matter. In that engraving, sides *Q S* and *R T* radiate from the common center *U*, while the ends of the sheet, *Q R* and *S T*, are portions of circles—segments—struck from the same center, *U*. And now you see the difference between the ends of the sheet in Figs. 6 and 7."

"Oh, yes, I see it now. And, say, isn't that what Mr. C. G. Reem means in his letter about 'camber in plates,' on page 27 of the January BOILER MAKER?"

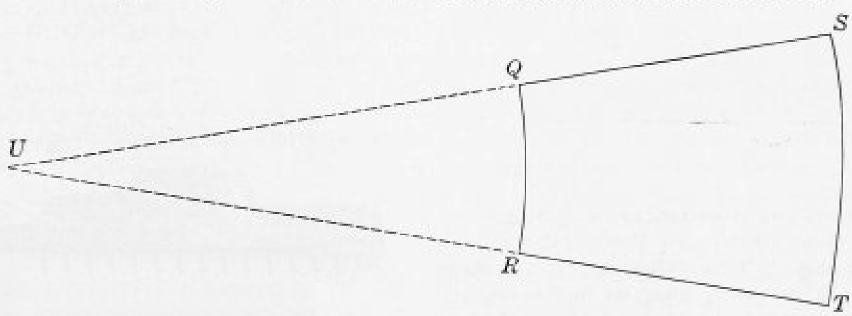
"Yes, John. That is just the point Mr. Reem desired to make, and he calls the rounding up of the plate 'camber'—well, it really is 'camber,' but one thinks of bridge stringers rather than boiler plate when that term is used. And, John, Mr. Reem said to 'use a certain amount of camber,' but he didn't say how much to use, or how to lay it out. Fig. 7 shows how to do this, and if you want to know the arithmetic of the job, then just look at the letter on the same page, from Mr. John Cook. That letter will tell you how to find the distance from *U* to *Q* when the direct distances between *Q R*, *Q S* and *S T* are known."

"That's all to the good, Mr. Hobart. I have got the matter now, right where I can work it when I want to, and I'm much obliged for the tip."

"All right, John, only just bear in mind how easy it is to get such information when you want it. It can be had for the asking, you know?"

"Sure, and I'm going to ask you a whole raft of questions pretty soon. There are some things in the shop, and some ways some people do those things, which don't look good to me, and I'm going to put them up to you as soon as I get to understand those things a bit better!"

"Go to it, John! You are getting ahead pretty fast just now. Keep it up, and you'll always find Hobart at the Old Stand, right behind the Question Box!"



-TAPER SHEET CORRECTLY LAID OUT

Opinions Wanted

A boiler inspector has sent us the following communication asking readers of THE BOILER MAKER to express their opinions regarding the subject which he has brought up. We hope that our readers will discuss this subject fully in our next issue. The communication is as follows:

"I have noticed on several different occasions, while making an interior inspection of several locomotive boilers, that where a plug extended through the barrel sheet into the boiler it very often showed a decided blue color. Also I have noticed the same thing in the boiler check casing, and in one or two barrels I have seen several small spots which were very smooth and blue in color. Now we all know that when iron or steel is heated very hot it will show a blue color, an indication of its having been hot; in fact, when the water is allowed to get low in the boiler with a fire in the firebox, the uncovered, or exposed portion of the crown sheet and side sheets, as well as the back flue sheet and the door sheet, will be blue in color in proportion to the degree of heat and the length of time that they are subjected to heat without water on them. The gray line, or water line, as it is called, extending around the box will show us just how low the water has been; but these plugs and blue spots in question are usually in the top part of the barrel away from the fire, and the box shows no indications of having been overheated. J. M. H."

Tools for Boiler Makers and Their Uses—II

BY W. D. FORBES

Calking Tools

We will, however, direct attention to the use of a hammer and calking tool. The latter is nothing more or less than a blunt chisel. If a round-nosed tool, as is shown in Fig. 9, is used, the result will be that shown in Fig. 10. Here it will be noticed the top plate is forced away from the bottom plate and a thin edge is forced down tight to the bottom plate. Such work is not as satisfactory as the method shown in Fig.

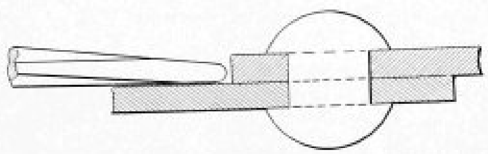


FIG. 9

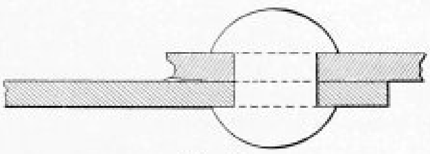


FIG. 10

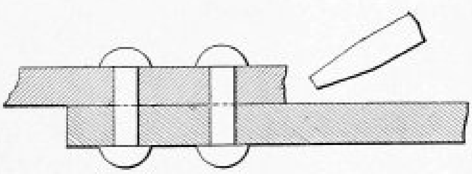


FIG. 11

11. Here the form of the tool is square, and it is used so as to set the upper plate down tight to the lower. This should not be done with too heavy a blow, otherwise the top plate will be lifted away from the lower plate, as in the case of the round tool. It must be remembered that a blow stretches the metal which is struck, and great care should be observed not to hammer a plate until it buckles, as besides becoming distorted it also becomes brittle.

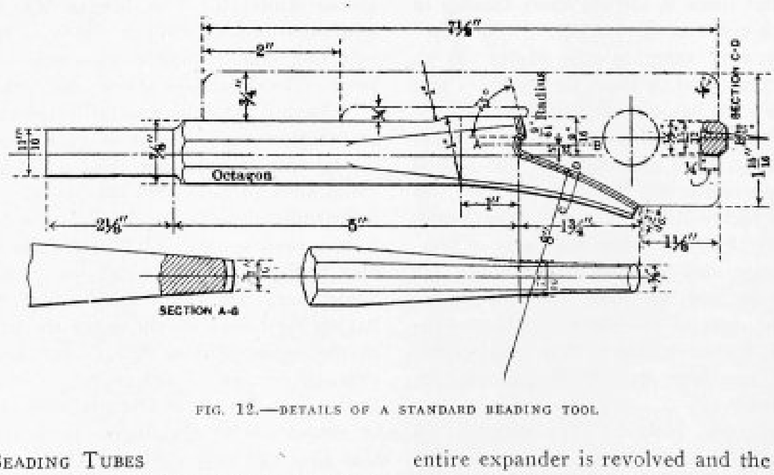


FIG. 12.—DETAILS OF A STANDARD BEADING TOOL

Beading Tubes

In well-equipped boiler shops compressed air is generally used in beading boiler tubes. Fig. 12 shows a detailed drawing of a beading tool which is designed for use with an air hammer, while Fig. 13 shows the application of beading tools and the method of using the ball end of a hammer to start beading. In this operation it should be remembered that heavy blows must be avoided, and care should be taken not to strike the tube too often in the same spot, as it will make the end of the tube hard and brittle. The peening effect of the ball face of the hammer stretches the metal in the tube and lays it over so that the use of the beading tools, *P*, *N* and *W*, Fig. 13, can be used to fold over the tube, as shown at *G*, which represents the finished beading. The manner in which the tube was first

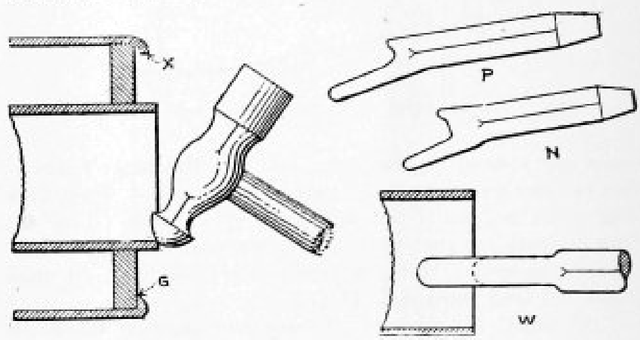


FIG. 13.—BEADING BOILER TUBES

laid over by blows with the hammer is shown at *X*. Skill is required to bead a tube well, and it must be borne in mind that the beading is done only after the expanding of the tube is completed.

Tube Expanders

A tube expander is a tool which is designed to expand the walls of a tube by means of a rolling action coupled with a

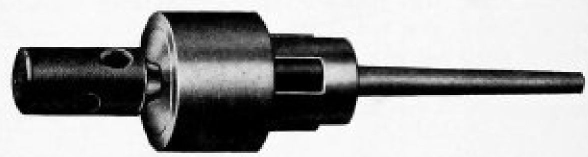


FIG. 14.—ROLLER EXPANDER

direct rotary pressure, or, in other words, small rollers are forced against the tube by means of a tapered pin, and then the entire expander is revolved and the action of the small rollers, coupled with the pressure of the tapered mandrel, spreads the metal against the tube sheet, thereby making a tight joint.

Expanders are divided into two classes—self-feeding and those which have to be fed by light blows with a hammer.

The self-feeding expander is most frequently used on tubes of small diameter. Fig. 14 shows an expander of the self-feeding type. Here it will be noticed the rollers are set at an angle. This results in obtaining a screw-like motion which feeds the rollers automatically. The angle is important in this class of tools, since if it is too great the feed will be too quick,

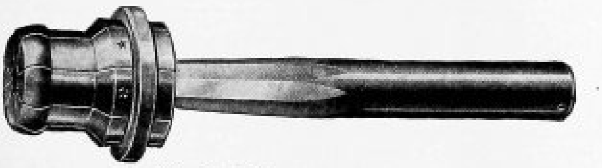


FIG. 15.—SECTIONAL EXPANDER

resulting in difficult and unsatisfactory work. On the other hand, if the angle is too slight the feeding action will be uncertain.

It is far from wise for a shop to try to make its own expanders, as the quality of the steel as well as the design has much to do with the satisfactory working of the expander, and, of course, with its lasting qualities. One thing must be remembered in the use of a tube expander, and that is that the metal must be allowed sufficient time to flow in front of the

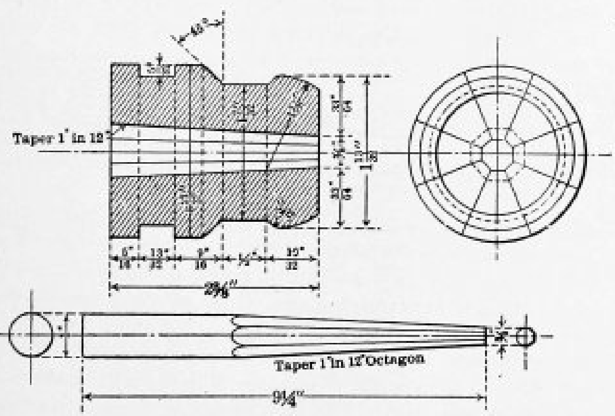


FIG. 16.—GENERAL CONSTRUCTION OF SECTIONAL EXPANDER

roller. It is evident that as the small rollers are forced out they imbed themselves to a certain extent in the metal of the tube, and as the rotary action takes place a wall or wave of metal rises in front of the rollers. If the rotary action is too quick this wall will be mounted by the rollers and the metal will not be spread as it should be in order to make a tight

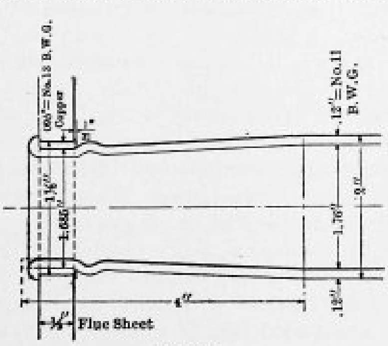


FIG. 17

joint. Too much rolling is as bad as not enough; in fact, it is better to do too little, as it is possible to re-roll a tube if the tube has not been thinned out by excessive rolling. If the life has been squeezed out of the tube by too much rolling a good job cannot be made of it, and, besides this, the tube sheet by injudicious rolling may be badly injured and a new tube sheet will be required, which, at best, is an expensive thing. In using an expander a good supply of oil is necessary, and in small tubes the author recommends that the expander be dipped in oil as a convenient method of lubricating it thoroughly. A most important point to be borne in mind is that the thinner the tube the more care must be taken with rolling. Those who are just learning to use expanders should be cautioned that if the taper pin is driven in too hard it is liable to fly out and seriously hurt the operator. The first few blows on the pin should be gentle.

There are tube expanders on the market called sectional expanders which are made with flats on the taper pin and, of course, with corresponding flats on the segments. This style of expander is not given a rotary motion, but the expanding is done by the pressure obtained by driving the pin into the segments. After a few blows with the hammer the pin is then withdrawn and the expander is turned a little.

It is claimed that these flat surfaces give a much larger bearing surface than when a round pin is used, and that they consequently present a greater wearing surface, which results in a longer life for the tool. This type of tool is used where the tube is double beaded, as shown in Fig. 17. In this case a ferrule is used. Fig. 16 shows the general construction of a sectional expander.

Before going further with the description of boiler makers' hand tools it will be well to get a clear idea of the material used in making them. It would not be possible to go fully into the very interesting subject of steels, as that of itself is a most complex study, yet we can explain certain of its features to advantage briefly.

TOOL STEEL

Cast steel or, as it is often called, "tool steel" is made in many grades, some being admirably adapted for tools where a keen cutting edge is required but where in its use there is no shock, as, for instance, in a razor blade. For such purposes keenness is demanded, but no blow-resisting qualities are required. On the other hand, in a chisel there must be blow-resisting qualities and a lasting edge. In the razor the steel is in a state of brittleness, but in the chisel there is toughness. The same grade of steel can be used in both articles and meet the requirements, but as a rule two grades are selected for the two tools, although the treatment must differ.

Broadly, the treatment is this: The steel is forged to the required shape, care being taken not to overheat it while working. After forging it is brought to a good, red heat; that is, a heat which in a moderate light shows red. At this heat the tool is plunged into water and cooled down so no color shows. With a piece of emery cloth tacked on a piece of wood, say a piece of lath, the cutting edge is rubbed bright. It is then held over the fire and reheated slowly. The bright part will then begin to show what is called "color." At first a very faint yellow will appear. This soon deepens into a darker yellow, or straw color, and then a faint tinge of blue appears and darkens to a very deep blue, until finally this color disappears and the steel assumes the color of the bar before it was forged.

When the steel is plunged into water its condition at first is very hard and very brittle. In this state we say the steel, or tool, is "hardened." The operation of reheating, polishing and allowing the colors to run is called "drawing." In its hardened state the steel is not suited for ordinary tools on account of its extreme brittleness, but when the faint yellow starts this condition begins to change to greater toughness and less hardness. It also becomes springy. As the color deepens this condition goes on, and as the blue begins to show the springiness is increased. But this also soon stops, and the steel, when it again assumes its original color, is in the same state as before it was forged. It could be said that this reheating completes a cycle from the original state through all the degrees of hardness and elasticity back to what it was before being forged and treated. Generally it may be said that light straw colors are proper for such tools as are used by machinists in lathes, planers, etc., while yellows are suitable for boiler makers' hand tools.

In order to fix the color wanted, when it appears the tool is instantly plunged into water. This arrests the action of the heat and the tool is ready for grinding. It is advantageous to mix some common salt with the water, and the water should not be too cold. A temperature of about 60 degrees is good.

In order to harden and draw tools properly considerable skill is required, and, of course, this comes only with practice. The various grades and qualities need quite different treatments. Some are what is called "tender"; that is, they require to be heated just so and brought to just such a heat or they are ruined. Such steels are, however, very serviceable, while on the other hand there are steels which need much less care in working and from which very good results can be obtained.

High-Speed Steel

Again, there are steels of special grades known to-day as "high-speed" steels, or self-hardening, although this latter name is misleading at times. This grade of steel requires no drawing, but some require a special cooling process by means of an air blast. These high-speed steels must usually be forged at a very low heat and with great care, yet there are steels of this grade which we are told to work at high heats. When no air blast is to be used the tools are left to cool in any dry place, but they must never be thrown on the floor where there is any dampness, since if cooled suddenly they crack. In the old times the machinists and boiler makers were able to forge most of their hand tools. This was not as true of the boiler makers' trade as in the machinists' trade, but to-day it is rather uncommon to find men in either trade that can do such work—more's the pity.

The steel which boiler makers now use as the material for boilers is not at all like the steels just described, as what is wanted in boiler steel are purity and toughness. This grade of steel is what is known as "low-carbon" steel. It is very ductile or pliable; that is, it can be worked into various forms without cracking.

From this very short description it can be well understood that much depends on the quality of the tool steel used in hand tools. If a good selection of material is not made good results cannot be expected. It is impossible to tell just what a steel is by looking at it. Many men will look at a broken piece of steel and say "it shows a good fracture," and look very wise; but the only way to know how good a steel is for your work is to try it. In fact, the name of the steel maker is about the best guide as to its quality. There are many reputable makers who have made steels for years, and what such makers state can be relied upon. Their experience is freely given to those who want steel for any purpose, but they must be told just what the work to be done is, and the material must be handled as they advise.

Annealing Steel

We have remarked that hammering steel makes it brittle, so in turning flanges and in many kinds of boiler work wooden "malls" are used in place of sledges, but where hammering has to be done brittleness can be overcome by what is called "annealing." This is nothing more or less than heating the piece to a good, red heat, then letting it cool slowly. This can be done by covering the piece well with ashes, and if special softness is wanted by packing in charcoal, and then covering the charcoal with ashes. Several hours must be given the steel to anneal, and the slower it is done the better. The annealing restores the strength of the metal by relieving the strains set up by hammering, and turns the crystalizing particles back into fibrous conditions, or, as one might say, it turns the crystalized lump sugar into stringy molasses candy.

Chisels

Fig. 18 shows a cold chisel. Here it will be noticed the edge is hardened while the end is left soft, or just as it comes from

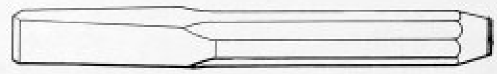


FIG. 18.—COLD CHISEL

the bar. If the end or head were hard the blows of the hammer would soon crack it to pieces, while if the cutting edge were not hardened and drawn. it would very soon be blunted and of no use. In dressing a cold chisel the head is worked down into a cone shape, as this form prevents a heavy burr being formed by the blows, yet this burring will take place even when the end is coned, and it should be ground off from time to time.

Chipping

To chip well is an art, which is not possessed to the extent it once was, as to-day there is less of this work done than, say, twenty-five years ago. The introduction of air-actuated tools has changed the chipping work, and later on we will

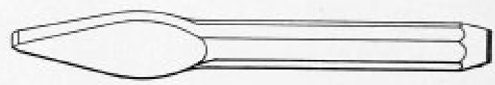


FIG. 19.—CAPE CHISEL

describe the air tools and their uses which have made such a great change in boiler shops. It is only by practice that a man can learn to chip; a book full of explanations would not prevent him from knocking the skin off his knuckles and the chisel out of his hands. The eye and muscles require training, and mental thought will not by itself give manual skill. This is a fact that all who wish to become skilled boiler makers will do well to remember. The best advice is to say, "Keep at it and use your brains as well as your hands, and you will at last accomplish the end." The swing of a hammer in the hands of a first-class chipper is a delight to watch, and when this swing is once learned it is never forgotten. A man may and

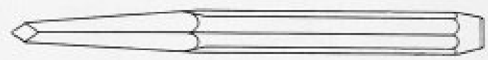


FIG. 20.—DIAMOND POINT CHISEL

will become rusty in the use of a hammer, but it takes but a short time for him to strike his "stride" again.

In chipping, the chisel shown in Fig. 19 is advantageously used. This form is known as a "cape" chisel, and when there is considerable metal to be removed furrows are chipped out, leaving, say, ⅛ inch between them. This metal is then cut off with the chisel shown in Fig. 18. It can easily be seen that this method has its advantages, as the smaller surface of the cape chisel is more easily driven through the metal, and the metal left between the furrows is likewise cut off with less effort. It must be understood that to make a nice, smooth job the cape chisel must leave enough metal to allow a dressing cut to be taken with the flat chisel. Sometimes, when space will permit, a second row of furrows is chipped at right angles to the first. This leaves a lot of squares which can be cut off with ease, and when the metal is cast iron much time is saved, as the squares break off with little effort, a smoothing chip being taken, of course, to make a good finish.

(To be continued.)

The Boiler Maker

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

NOTICE TO ADVERTISERS.

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

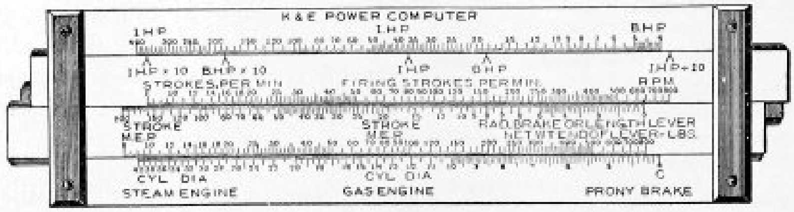
One of the early dreams in the life of every successful boiler maker, if he is capable of dreaming at all, is that to-morrow or the next day some one of those brilliant ideas that are continually flashing through his mind will take shape in the form of a most useful invention, and that the newly created device or improvement, bearing his name, of course, and fully protected by iron-clad patents, will immediately be established on the market and his future assured. It is true that such things have happened, and are still happening; but, at the same time, it is stated on good authority that out of the endless procession of patent applications entering the Patent Office more than 20,000 of these find an early grave in the cemetery of abandoned applications annually. Why? Principally, the same authority assures us, because the would-be inventor has an imperfect knowledge of the science and prior art of the field in which he is working. A hasty examination of the boiler patents that are granted each month, or even of the very few that are selected for publication in our columns, tends to verify this conclusion. Knowledge is unquestionably the backbone of achievement in any field of endeavor, and especially in the field of boiler making is a knowledge of the science and previous development of the trade essential. No better advice could be given to young boiler makers, or to the older ones, too, for that matter, than to study diligently and learn thoroughly every phase of the subject of boilers and boiler making. Once a thorough knowledge of such things is obtained it can be turned to account in improvements, and the hitherto futile applications to the Patent Office will begin to bear fruit. We have no desire to discourage any attempts at invention or improvement, but rather to encourage in every way such attempts by impressing upon our readers the absolute necessity of first obtaining a thorough knowledge of the science and previous development of boiler making. There are plenty of instructive books, records, technical journals and courses of study which will help to accomplish this end, provided they are not neglected; so if the early dreams are to come true, school yourself for the accomplishment of great things.

Some of the first things that a young man must learn when he starts in as an apprentice in a boiler shop are the names and uses of the various tools which he must know how to use with skill before he can become a first-class boiler maker. Many of the tools are simple in construction and operation, and the beginner quickly becomes familiar with them, at least in the "fetch and carry" sense; but he cannot become skillful in their use until after long, painstaking practice. In spite of the fact that there are only a comparatively few tools that a boiler maker must use in his work, there are some things about the tools which he will probably never learn unless someone tells him about them. In the last issue we began the publication of a series of articles describing the different tools made for boiler makers and their uses. It is not the intention of the author of these articles to attempt to lay down any hard and fast rules or regulations for handling these tools, but simply to point out in a clear manner just what the tools are designed to do and why they are made in the form in which the boiler maker finds them. An intelligent understanding of the materials of which the tools are made, how they are made, and why they are shaped and designed in their present form will help much in the successful use of the tools, besides avoiding abuse and waste. The tools which are described first are the hand tools, which, of course, require the greatest skill for proper handling. In many of the operations for boiler making to-day hand tools are being superseded by air-driven or electrically-driven tools, which not only speed up the work and enable the workmen to perform a given task in far less time than would be possible with ordinary hand tools, but also enable a single workman to perform work which would be far beyond his strength if only hand tools were to be used. The air and electric tools will be described in future issues, and the series will conclude with a discussion of boiler makers' machine tools and all power driven appliances used in a boiler shop, covering as thoroughly as possible every item of boiler shop equipment that a boiler maker has to use or operate in his everyday work.

Engineering Specialties for Boiler Making

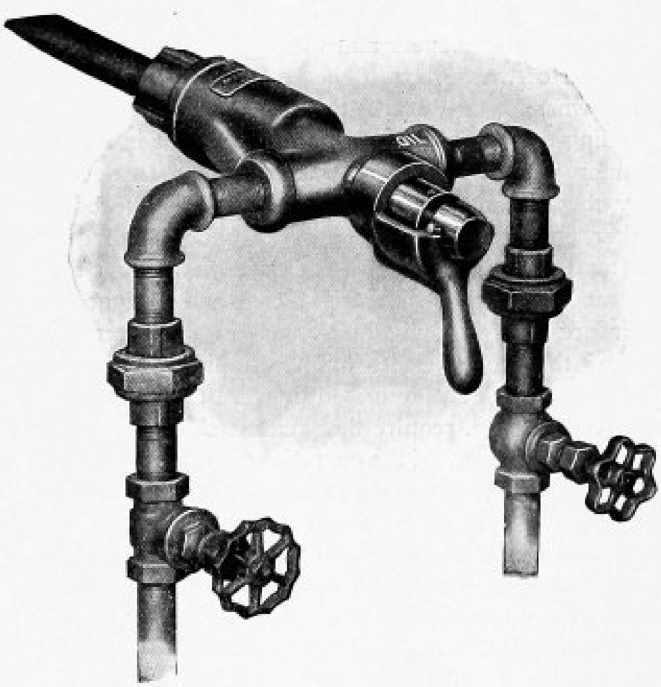
Power Computing Slide Rule

Keuffel & Esser Company, Hoboken, N. J., have recently developed a new slide rule for computing the power and dimensions of steam, gas and oil engines. The construction of the power computing slide rule is similar to that of the well-known Duplex slide manufactured by this company. The face of the rule, as shown in the illustration, carries five series of special graduations to be used in determining brake horsepower, indicated horsepower, or principal dimensions of steam, gas and oil engines of any size. On the reverse face of the rule are engraved the *A*, *B*, *C* and *D* scales usually found on the Mannheim slide rule. The new rule measures 7½ inches by 2 inches, making it of convenient pocket size.



Oil Burners for Steam Boilers

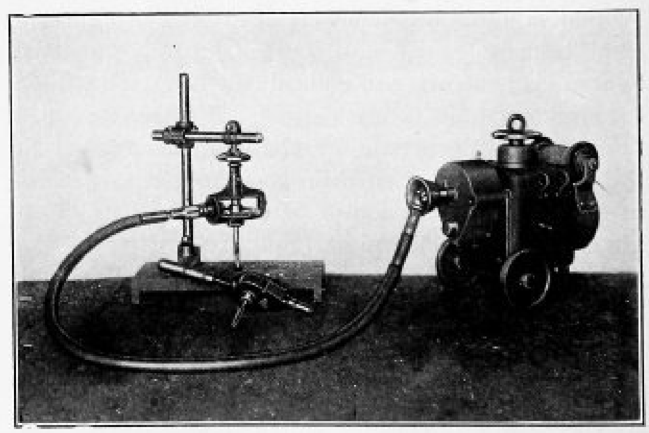
For complete combustion of oil in a steam boiler furnace the air must be intimately mixed with the fuel and there must be a sufficient supply of air and the gases must be kept at the ignition temperature long enough to insure their burning. These last two conditions are functions of the furnace and the installation wherein the oil is to be burned, but the intimate



mixing of air and oil is done by the burner. A burner which is designed to accomplish this purpose is manufactured by Tate, Jones & Co., Inc., Pittsburg, Pa., which is known as a combination high and low-pressure burner. The oil is fed to the burner at a pressure of from 15 to 25 pounds per square inch, and at the burner it is atomized by a small quantity of compressed air (or steam under certain conditions) at a slightly lower pressure. After the atomization, an air blast of from 4 to 6 ounces is used to supply the necessary amount of oxygen for complete combustion. As can be seen from the illustration, the supply of oil and compressed air or steam is regulated by one lever, the ratio between the air and oil always remaining at the constant point, which is found to give the proper proportion for complete atomization for the particular grade of oil which is being used as fuel. The advantages of this combination of compressed air or steam for atomizing and air blast for combustion are increased capacity of the burner, minimum amount of compressed air or steam used in operation, regulation of air entering the furnace to suit intensely hot or mild fires, minimum amount of noise, and the elimination of a steam blower or high stack.

Combination Stow Flexible Shaft and Electric Motor Drive

A useful combination for transmitting power where portable machines are to be used is the Stow flexible shaft and inclosed multi-speed electric motor made by the Stow Manufacturing Company, Binghamton, N. Y. Where electric power is available this combination has proved to be a most practical and economical portable tool. It is well known that portable tools receive hard usage and must be built to withstand such conditions. In this case the motor is furnished complete, as shown in the illustration, and includes a speed regulator, starting and stopping device (both contained within



the frame), reduction gears, truck, reel and 60 feet of insulated wire. It is simply necessary to connect the wire on the reel with the power current and the plant is ready for work. The old type of complicated rheostat and starting box is entirely done away with. The standard motors furnished with this combination are wound for 110, 220 and 500 volts, although they can be made to order for any practical voltage. Practically any desired speed can be obtained by means of the speed regulating device or the substitution of suitable gears. The motors are designed to carry for a short time a 50 per cent overload.

Rivet Sets for Pneumatic Hammers

One of the difficulties experienced by the manufacturer of machine-turned sets is the general lack of uniformity in the steel itself, either in chemical composition or in the heat treatment. Forged rivet sets overcome this difficulty. They have made some wonderful records for service and endurance and are becoming more popular every day. The Chicago Pneumatic Tool Company, Chicago, Ill., has installed up-to-date furnaces and power hammers and are turning them out in great quantities. With the aid of electric pyrometers they are able to preserve uniformity in heat treatment, thus placing entirely within their control one of the vital features of their construction. The general demand for rivet sets is for those cupped for button and conical heads, and which they have designated as standard. But they are prepared to furnish them in all shapes and sizes for special work.

Technical Publications

Steam Boiler Construction. By Edward G. Hiller. Size, 5½ by 8¼ inches. Pages, 167. Illustrations, 117. Manchester, England, 1912: Taylor, Garnett, Evans & Company, Ltd. Price, 1s.

This book contains the rules of the National Boiler & General Insurance Company, Ltd. (of England), together with notes on material, construction and design of steam boilers and similar vessels. The book is written by the chief engineer of this boiler insurance company, and while the results and notes which he gives embody the principal features of this particular insurance company, they are also based on the experience and experiments of various authorities. The book is, of course, a short one, and much has been omitted that one would expect to find in a comprehensive treatise on boiler construction. The information relates particularly to English practice, which in many essential features is quite different from American practice. Most of the commonly used types of boilers are described rather briefly, including Lancashire and Cornish boilers, vertical boilers, locomotive boilers, marine boilers and the various types of watertube boilers. Some chapters which are of particular value to boiler makers are those relating to riveting, welding, reinforcement of manholes, mudholes and other openings in boiler shells, the staying of flat and curved surfaces and the reinforcement of cylindrical furnace flues, etc. In the final chapter some references are made to the principal boiler fittings.

Book of Standards. (National Tube Company.) Size, 4 by 4½ inches. Pages, 559. Illustrations, 136. Pittsburg, 1913: National Tube Company. Price, $2.00.

For some years the National Tube Company, which manufactures boiler tubes, wrought iron pipe, water and gas mains, mechanical tubing, miscellaneous forgings and malleable, cast iron and brass fittings and valves, has published at intervals a convenient handbook, in which are given all of the dimensions and data pertaining to the tubular goods which the company manufactures. The handbook which is published this year contains, besides the data regarding the manufactured products, a good many pages of valuable information on certain subjects which are closely related to the uses of pipe and tubes. The engineering data given were obtained in all cases from well-known engineering authorities. Two of the subjects which are of particular value to boiler makers are the strength of pipes under internal fluid pressures and the determination of collapsing pressures on pipes or tubes subjected to external pressure. Separate sections are given to the discussion of the physical properties of gases, the flow of gas in pipes, the properties of steam, both saturated and superheated, the flow of steam through orifices, and the loss of heat from steam pipes. The foregoing are only a few of the many subjects which are discussed in the handbook. In every case the data given are thoroughly up to date, and are presented in a very clear and convenient form by means of tables, formulæ and diagrams which may be readily interpreted. The book has been well indexed and is a convenient source of information for the engineer.

Engineering Handbook on Patents. By William Macomber. Size, 4⅜ by 6¾ inches. Pages, 288. Boston, 1913: Little, Brown & Company. Price, $2.50 net.

From the large number of patents which are granted in the United States each year relating to boilers and boiler construction, a large percentage of which, if investigated, prove to have been granted to boiler makers, or men actually engaged in the design or construction of boilers, it would seem that boiler makers should be thoroughly conversant with the subject of patents. Judging, however, from the great number of patents which are of little or no value, the device patented being either impracticable or fulfilling a useless claim, there is good reason to believe that a little information regarding patents would not be out of place among boiler makers. A thorough understanding of what a patent is, what is patentable, how to obtain patents, patent litigation, property rights, etc., would save the expenditure of a good deal of time and money which is now wasted. The handbook which we have under review, while it is addressed especially to engineers, will be found of use to inventors and manufacturers generally. The author of the book, who is a leading patent lawyer and professor of patent law in Cornell University Law School, states in the preface that the book is by no means a treatise on patent law, nor is it a textbook, but that it is simply a handbook in which are presented in simple language, omitting entirely legal phraseology and terminology the theories which underlie successful inventions and which tend to guide the inventor along successful lines. A careful study of this book would undoubtedly enable the user to avoid the lines of thought which have resulted in past failures of other inventors, and will inform him of the steps necessary to secure for himself the full benefits of a successful invention.

Personal

Robert Hewitt, of Escanaba, Mich., has been transferred to the West Fortieth street shops of the C. & N. W. Railway, Chicago, Ill., as special inspector.

D. M. Chaison, formerly with the New York, New Haven & Hartford Railroad at Readville, Mass., is now with the Rutland Railroad as foreman boiler maker at Rutland, Vt.

E. A. Scott, managing editor of the *Metal Worker*, has been appointed secretary of the American Society of Heating and Ventilating Engineers.

Patrick W. Cantwell, for many years president of the Boiler Makers' and Iron Shipbuilders' Association of America, died Feb. 7 at his home in Greenpoint, Long Island.

J. L. Didier, formerly foreman boiler maker of the Southern Railroad Shops, Alexandria, Va., has been appointed master boiler maker for the Southern Railroad Company at Spencer, N. C. Mr. Didier has had a wide experience in the boiler-making field covering a period of many years, and his many friends congratulate him most heartily upon his well-deserved promotion.

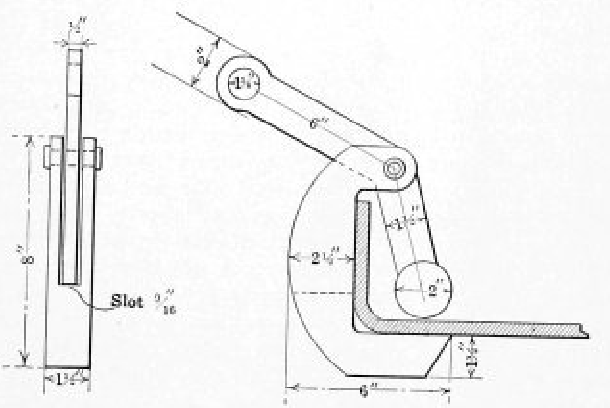
Master Boiler Makers' Convention

The seventh annual convention of the Master Boiler Makers' Association will be held at the Hotel Sherman, Chicago, Ill., May 26, 27, 28 and 29. Arrangements have been made for the exclusive use of the second floor of the hotel during the convention for the exhibits of the supply men. This includes the use of a number of private rooms and a large banquet hall adjacent to the convention hall. Electric current, air, steam or water pressure are available for operating working models of machinery, etc., so that the exhibition of boiler makers' tools and supplies this year should be of particular value.

Letters from Practical Boiler Makers

Clamp for Holding Flat Flanged Plates

I have been interested and helped by the "kinks" that have appeared in THE BOILER MAKER from time to time, so I am sending a sketch of a device which I have made for holding flanged plates, hoping that it will be found useful by some of the other readers of this journal. It is a simple device and the



SLING CLAMP FOR HOLDING FLANGED PLATES

drawing is self-explanatory. The device has an advantage over the screw clamps, in that it is easily slipped on and off, also it does away with the danger of the screw working loose, which frequently happens with screw clamps when the work is brought near the fire. I have found this kink very useful when flanging fire holes in door sheets by hand.

Stratford, Ontario, Can. R. W. BARRETT.

A Convenient Rule for the Layerout

The accompanying sketches show simple methods of solving some everyday problems which a layerout is frequently called upon to work out.

Fig. 1 shows how to find the length of the side of a square, the area of which is equal to the area of a rectangle, the dimensions of which are known. Let *A B D C* represent a rec-

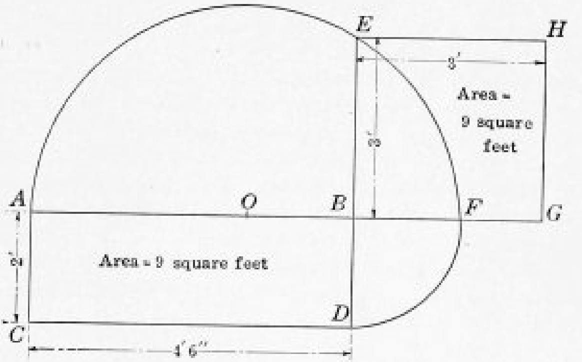


FIG. 1

tangular section 2 feet by 4 feet 6 inches. This is a section sometimes used in up-takes or breechings. To find the length of the side of a square which has the same area as the rectangle *A B D C*, extend the line *A-B* indefinitely, as is shown from *B* to *G*. With *B* as a center and the distance *B-D* as a radius, draw the quarter circle *D F*, locating the point *F* on the line *A-G*. Bisect the distance *A-F*, locating the point *O*, and with *O* as a center set the trammels to the distance *O-A*, and draw the semi-circle *A E F*. Now extend the line *D-B* until it intersects the semi-circle at *E*, then the distance from *B* to *E* will be the side of a square equal in area to the rectangle *A B D C*. In this case the area of these two figures is 9 square feet, and the length of the side of the square 3 feet.

Fig. 2 shows the method of finding the diameter of a circle and the length of the side of a square of equal area. First,

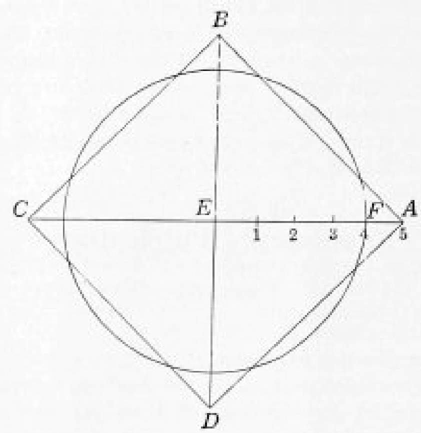


FIG. 2

find the diameter of a circle whose area will be equal to the area of the square *C B A D*. Draw the diagonal lines *A-C* and *B-D*, their intersection at the point *E* locating the center

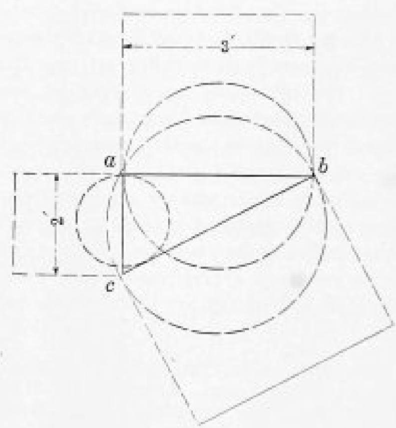


FIG. 3

of the circle. Divide the distance *E-A* into five equal spaces. Then with *E* as a center and a distance equal to four of these spaces as a radius draw the circle shown, which will be equal

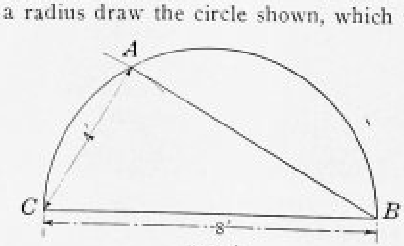


FIG. 4

in area to the square. If the circle is to be changed to a square of equal area divide the radius of the circle into four equal parts, as from *E* to *F* in Fig. 2; then add one of these spaces to the line *E-F* outside the circle, and the length of the diagonals of the square is obtained.

Fig. 3 shows how to find the diameter of a branch pipe which is connected to two pipes, one of which is 2 feet in diameter and the other 3 feet in diameter. Draw the line *a-b*,

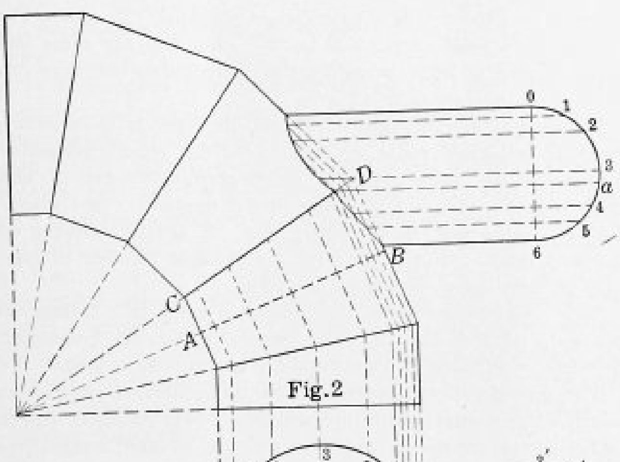
Fig. 3, 3 feet in length. At *a* drop a line at right angles to it and make it 2 feet long. Then draw the line *c-b* and the length of this line will be the diameter of the main pipe. Thus a pipe of this diameter will have the same sectional area as the sum of the areas of the two branch pipes.

If we have a system of branch pipes, the main pipe of which is 8 feet in diameter, to which are connected two branch pipes, one 4 feet in diameter but the other of unknown diameter, how shall this unknown diameter be found? Draw a line *C-B*, as shown in Fig. 4, making it 8 feet long, and strike a semicircle, using *C-B* as the diameter. Then with *C* as a center and a radius of 4 feet, strike an arc intersecting the semicircle at *A*. Connecting the points *A* and *B*, and the line *A-B* will be the diameter of the other branch pipe, which in this case will be very nearly 7 feet. JOHN COOK.

Springfield, Ill.

Layout of Elbow Intersected by Pipe

Figs. 1 and 2 show the plan and elevation of an elbow intersected by a straight pipe. Draw a half profile of the intersecting pipe in both the plan and elevation. Divide these half profiles into any number of equal spaces (in this case six



FIGS. 1 AND 2

have been used), then in the elevation draw projection lines from these points of division and extend them a short distance beyond the outline of the elbow. At the same time draw projection lines in the plan, extending them to the large circle representing the plan of the end section of the elbow. Project these points of intersection to the elevation until they intersect the corresponding projection lines on the intersecting pipe in the elevation.

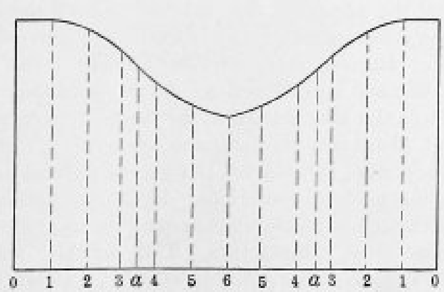


FIG. 3

To lay out the pattern of the elbow section, take the stretchout line from the large circle in the plan and transfer it to Fig. 4, as shown, adding the line 1', 2', 3' at the proper points; then set the dividers from these points on the line *A-B* in the elevation to the points on line *C-D*, and transfer these dis-

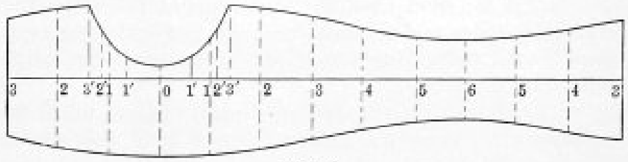


FIG. 4

tances to the corresponding lines in Fig. 4, as shown. Trace the outline of the pattern through the points thus located; allow the required amount for laps, and the pattern is complete.

The pattern of the small pipe is shown in Fig. 3. It is a simple projection pattern, and the drawing is self-explanatory, the spaces being laid out by taking the lengths of the projection lines from the elevation. A. E. CLEMENTS.

A Sense of Honor

Probity in business is the keystone of successful commerce. This undoubted fact is becoming daily more appreciated. Professional honor, esteemed as particularly the possession of the practice of medicine, and in the combatant services of the State, is jealously guarded by those serving in the capacities indicated. On the reverse side of the picture, the estimable virtue—sense of honor—has its corresponding vice in the rancor of professional jealousy; than which no distorting mirror can image a more startling perversion of sane reflection.

In so far as our word has been proved to be our veritable bond are we of value in a credit relation.

Inasmuch as we are willing to serve the greater ends of unity of effort and purpose, while sinking our individual disagreements, are we of disciplined use to the community at large. The tocsin "Deeds of Authority" has been loudly sounded; this, if true, is no alarming fact, so that authority had not reason to back its commands. Blind obedience is no virtue where orders issue from unproven authority, merely because of birth, position, wealth or rank. The reason behind acknowledged dictatorship must necessarily be intellect, power or superior skill; it may even be in minor matters that psychological power of hypnosis may be possibly seen at its best in a successful salesman.

Even here the customer under its influence must unconsciously be persuaded of the superior knowledge of the goods offered enjoyed by the salesman. Were the customer convinced of his own judgment, salesmanship dependent upon personal hypnosis is of little value. A competent traveler shifts his ground according to conditions and, lacking some power of psychological diagnosis, his career cannot be successful.

Enthusiasm is contagious; and in the matter of sales, that man is most successful, all else being equal, whose belief in his goods is most profound and who infects his customer with his own belief.

"What are you trying to do?" was once asked a mechanic busily engaged. "I'm not trying—I'm doing"—was the answer. Here is belief in himself made manifest in the reply.

Lack of confidence in a superior is demoralizing to the rank and file. "Carry on at all costs" is right or wrong dependent upon the man in power. A really skillful chief will hail a change of plans from existing methods in a fashion to cause no disturbance or raise a suspicion of change of mind, even where such change may be fundamental.

The possession of a sense of honor, considered in its finest aspect, creates many difficulties for its possessor; it is difficult to tell half-truths either directly or by inference. If, in addition, is added conscientious sensibility—the two are usually intimately coupled—life tends to become more complex and difficult.

How far is authority issuing incorrect instructions binding? How far is it right to consider the aspect of the employer, and how far, at the same time, the less equipped fellow worker? Is it right, under any circumstances, say, to shield other's mistakes, to tell unblushing falsehood? These are some of the recurrent daily problems.

One foreman, a capable and good man, came to the writer for advice. Honor he understood not from the obvious limitations of his education; any exposition of so abstruse a topic would have puzzled him. By the fact of the problem he brought, it was clear that his sense of honor was keen.

Two men, both about fifty-five years of age, were in his charge, both of them having been with the concern thirty years. Their natural force was not abated and their work was satisfactory, except that younger men might have accomplished more. In addition they were somewhat cantankerous and eyed new ideas with suspicion.

The firm, expecting on the part of the foreman a sense of honor to themselves and loyalty to their interests, not caring to officially discharge the men in question, repeatedly told the foreman he should get rid of these two older men.

My friend desired advice, adding that if they quietly died all trouble would be avoided; but from existing indications they were both good for another score of years. "If I gave them the sack," he said, "they wouldn't believe I meant it. If shut out they would probably sit on the doorsteps for weeks. I can't say that their work is unsatisfactory, and they have been under me twenty years. Probably they will waylay me every meal time, and they are too old to expect a regular job elsewhere, and it's a burning shame if I have to run them out." He fenced the matter of their discharge, to his own great credit, for the space of two years, and death in his own case released him from the complexities of the situation.

This is a case where the supreme authority desired to shift odium from their own shoulders on to an employee from whom they expected loyal service. Had he imitated the precedent set him in any matter affecting the interest of the firm he would have been sharply reprimanded.

In another case a brilliant man of about thirty was asked to reorganize the methods of an old-established firm. In conversation it was elicited that he for one did not intend to fire all over forty. He believed in the steadying influence of the older men familiar with the products of that shop. Naturally some, disliking new ideas, left; some did not suit and had to go; but quite a number remained, and he was firmly of the opinion that their retention was a business proposition which handsomely paid.

A sense of honor and its correlative loyalty to employer's interest depend in a large measure on the terms of service and the personal aspect of the concern with regard to its staff. If an employee is regarded merely as a tooth in the industrial machine, hired or fired as the tide of trade flows or ebbs, it is folly to expect that the interests of the employer will be studied or safeguarded. A man's first duty is to himself, and the firms which emphasize this point by meeting fluctuation of trade by wholesale discharges at the first symptoms of change cannot expect loyalty. A man in continuous fear of dismissal, with his bread and butter in daily jeopardy, can hardly give intelligent service when his thoughts are concentrated on daily necessities. To pervert Napoleon's maxim, labor marches on its stomach. Intermittent employment makes for insufficiently fed labor, with corresponding decrease in efficiency.

There is a natural compensation—such firms get invariably the dregs of whatever labor they employ. If a good man pushed by necessity starts, he stays just long enough to satisfy present necessity, and at the first opportunity goes elsewhere to better conditions even at no increase in pay. There is value to the employer of a real, tangible kind in continuity of employment.

On the other hand, in military service, while severe compulsion can be exerted, considerably more loyalty is displayed. A sense of honor is studiously cultivated in all ranks; the honor of the regiment is proverbial, and even the new recruit is speedily infected with the prevalent spirit. There is some possibility in the cultivation of a similar spirit in the industrial army equally important, equally honorable. The modern ideal of an army is one composed of disciplined units; each unit, however humble, is in warfare expected to show individual intelligence. Simultaneous movement at the word of command is scarcely now the ideal training, but rather intelligent, independent, concerted action under fire in scattered formation. This has been brought about by the necessity imposed by the more deadly precision of modern firearms. While the barrack square and its attendant drill has utility, less reliance is placed upon its direct outcome than formerly.

The State takes away from the soldier to a great extent his liberty, but—and here is the great difference—feeds and clothes him. Realizing the disabilities his service subjects him to, the State sees in return that lack of the necessities of life presents no problems to its combatant servants. In return the country gets loyal service; disloyalty while bearing arms has most frequently been caused by the State failing to carry out its side of the contract.

In manufacture the older ideal of drilled precision of movement is becoming more apparent year by year. Simplified operations and more complex tools permit the use of less skilled labor. It seems probable that in commerce and manufacture, as in war, that country has the greatest chance of ultimate success which possesses the greatest number of men who are intelligent, independent units.

Lack of employment in the industrial army is a failure on the part of industry to make provision for its combatant servants, in addition to a drain on the community at large.

The considerations advanced and the contrasts cited seem worth some thought from the widest possible national aspect, and not from the point of view of a single, isolated competitive firm.

The conditions generated under the newer aspect of manufacture are, it is submitted, the reverse of those needed to produce either a sense of honor or its related loyalty to service. The employee has no stake in the concern and no pride in excellence of product; his brain, deprived of exercise, becomes atrophied, while his only interest is in his daily task or quantity on which his wages depend.

That country adopting such processes to the exclusion of real craft stultifies the mental equipment of a large proportion of its citizens, and ultimately will drop behind those competitors who retain such opportunities of craftsmanship.

This is truly a machine-made age; but, much as we have advanced, the products of 1,000-2,500 years ago along certain lines produced by craftsmen who worked with their hands the best part of their lives excite our wondering admiration yet.

No one will contradict the assertion that, prior to the newer systems and the advent of the unskilled or semi-skilled operator, good engineering products were made. Their relative cost was higher; but reduction in cost by half is no unmixed blessing. We are still to a large extent dependent upon the race of mechanics who started in the business twenty to thirty years ago. These are the men who are guiding the products of to-day, and who, by progress along quite natural paths, have led us to the modern conditions. Even now difficulties are being experienced in obtaining men qualified to guide the more complex aspects of manufacture. This difficulty will become more acute as time goes on.

A man interested in the labor of his hands, where interest is possible, usually has a sense of honor in his product. Deprive the labor of interest and you take away the conditions leading to excellence of output. In addition, interest in daily work gives a man fuller and more satisfying life, better worth living because less monotonous. Since skill and interest are absent more discontent is present. A distinct connection can be traced between the large concern minus personal contact of employer, monotonous toil and labor unrest.

Is there any "joy" in working under such conditions as outlined? Such a phrase under modern conditions seems amusing. Real craftsmanship, dependent upon trained mind and correlated hand and vision, has its own peculiar pleasure.

The "joy" of independent creation is shared both by the true mechanic and the painter, sculptor, architect, musician and poet. All are kinsmen. With the real craftsmen, their pay is not all in the weekly envelope; some is in the supreme satisfaction, than which life has little better to offer, of work well done. All are alike in the possession of a sense of honor, manifested in the creation of their hands, and continuous advance in executive skill.

If a man merely represents to his employer a certain weekly sum in exchange for the hire of his ten fingers (the phrase "hands wanted" nauseated Ruskin), then honor under these conditions cannot live. We carry away what we bring always and everywhere. Like master like man is almost too trite to quote.

He who serves is intrinsically the equal of him who commands, provided each equally fulfils his appointed functions. Both have an equal right to consideration; and there is much more in the cultivation of a sense of honor than the average employer will admit. It is certain that each owes the other more than is represented by the monetary payment; and were this point frankly conceded much more might be accomplished by those to whom the command of the industrial army falls. In personal contact, personal consideration seems one of the remedies scarcely tried but which has definite value in the opinion of the writer, which has the added advantage of costing nothing other than a change of mental viewpoint on the part of both master and man. A. L. HAAS.

London, England.

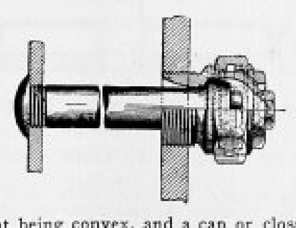
Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

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

1,042,833. STAY-BOLT FOR BOILERS. BENJAMIN E. D. STAFFORD, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

Claim 4.—A stay-bolt structure comprising a bolt having a head, a sleeve or bushing having an internal seat for said head, the sides of said



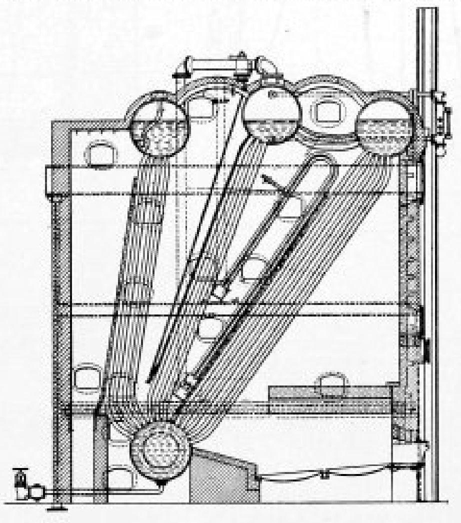
sleeve below the seat being convex, and a cap or closure for said sleeve or bushing. Four claims.

1,045,484. LOW-WATER ALARM FOR STEAM BOILERS. LEWIS S. WATRES, OF SCRANTON, PA., ASSIGNOR TO HULL MANUFACTURING COMPANY, OF SCRANTON, PA., A CORPORATION.

Claim 1.— low-water alarm, comprising a water column provided with connections for attachment to the steam space and water space of a boiler, a vertically moving float in the water column, a downwardly extending valve directly connected to the float, a steam pipe extending from the steam space of the water column, a valve seat in the inner end of this steam pipe into which seats the valve carried by the float when the float descends a diaphragm in a closed chamber to one side of which the outer end of the steam pipe is connected, another steam pipe extending from the steam space of the water column to the other side of the diaphragm chamber, a valve carried by the diaphragm, and a steam whistle, the steam passage of which is normally closed by the diaphragm valve. Two claims.

1,045,207. SUPERHEATER BOILER. JAMES P. SNEDDON, OF BARBERTON, OHIO, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

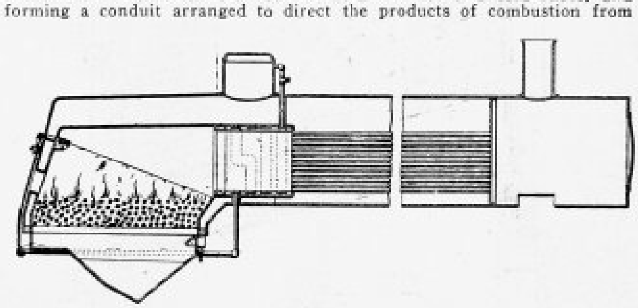
Claim 3.—A steam superheater having headers within the boiler setting, and extending beyond said setting, and tubes connecting said headers within the boiler setting, a dead-header adjacent to the lower



header and extending beyond the boiler setting, an inlet pipe exterior of the boiler setting leading from the steam space of the boiler to the dead-header, connections between the dead-header and the lower header and an off-take pipe exterior of the boiler setting communicating with the upper header. Three claims.

1,044,297. SMOKE-CONSUMING DEVICE. DAVID TOWNSEND, OF PHILADELPHIA, PA., ASSIGNOR TO CORNELL ECONOMIZER COMPANY, OF PHILADELPHIA, PA., A CORPORATION OF NEW JERSEY.

Claim 1.—The combination with a boiler having a furnace, and tubes arranged to convey the products of combustion from said furnace; of an annular retort mounted between said furnace and said tubes, and forming a conduit arranged to direct the products of combustion from



said furnace to said tubes, and having a passageway through its walls for the passage of steam to be superheated; means directing steam from said boiler into said passageway where it is superheated, by the heat from the furnace, passing through the said retort; and, means directing the superheated fluid into the furnace chamber whereby it is mixed with the products of combustion of the coal in said chamber. Six claims.

1,044,970. GRATE PROTECTOR. WILLIAM A. BAKER, OF TOLEDO, OHIO.

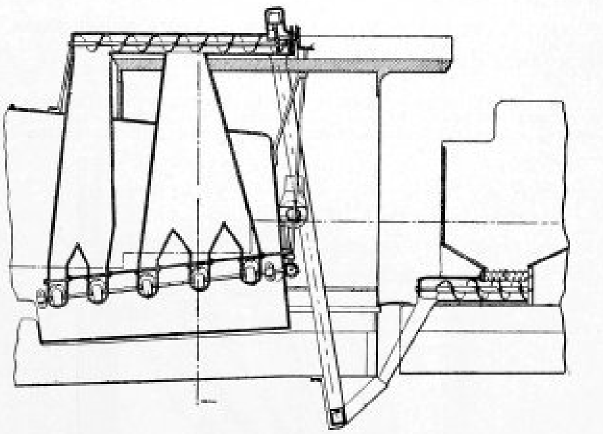
Claim 1.—The combination of a fire pot provided with a fuel feed opening, a fire door for said opening, a grate in the fire pot, an ash pit below the grate and means in the ash pit normally disconnected from the fire door and movable by a predetermined amount of ash accumulation in the ash pit to preclude opening of the fire door, whereby the grate is protected from the accumulation of any undue amount of ash in the ash pit. Four claims.

1,043,895. SMOKE-CONSUMING FURNACE. SVEN O. BERG, OF CHICAGO, ILL.

Claim 1.—In a furnace of the kind described the combination with a fire-box and a bridge wall in the line of draft of said furnace, of members on said bridge wall against the side walls of said furnace, each of which is provided with passages therethrough to collect gases from the side of said fire-box and deliver them transversely of such fire-box over the central portion of the bridge wall, there being a restriction in the intermediate portion of each of said passages; and a means for admitting outside air in said passages at the point of greatest restriction. Three claims.

1,044,939. LOCOMOTIVE STOKER. FRANK H. STROUSE, OF OSKALOOSA, IA.

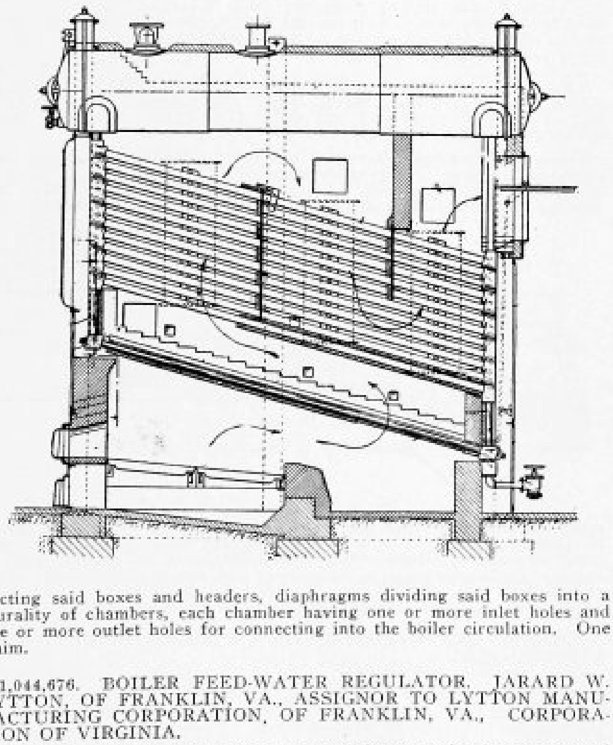
Claim 2.—In a locomotive stoker a fire-box, a vertically disposed conveyor, a horizontally disposed conveyor, a plurality of hoppers adapted to receive fuel from said conveyors, said hoppers being formed with diverging delivery chutes communicating with both sides of the fire-box, fuel feeding valves arranged adjacent the delivery ends of said chutes, a



rod arranged on either side of the fire-box and pivotally connected to each of said valves, an arm secured to each of said rods, and a cam arranged to simultaneously impart movement to said arms to open the fuel feeding valves one one side of the fire-box and close the fuel feeding valves on the remote side of the fire-box. Five claims.

1,044,660. WATER-TUBE BOILER. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim.—A water-tube boiler having a bank of inclined tubes, front and rear headers into which said tubes are expanded, a row of tubes below said bank, boxes into which said lower tubes are expanded, nipples con-



necting said boxes and headers, diaphragms dividing said boxes into a plurality of chambers, each chamber having one or more inlet holes and one or more outlet holes for connecting into the boiler circulation. One claim.

1,044,676. BOILER FEED-WATER REGULATOR. JARARD W. LYTTON, OF FRANKLIN, VA., ASSIGNOR TO LYTTON MANUFACTURING CORPORATION, OF FRANKLIN, VA., CORPORATION OF VIRGINIA.

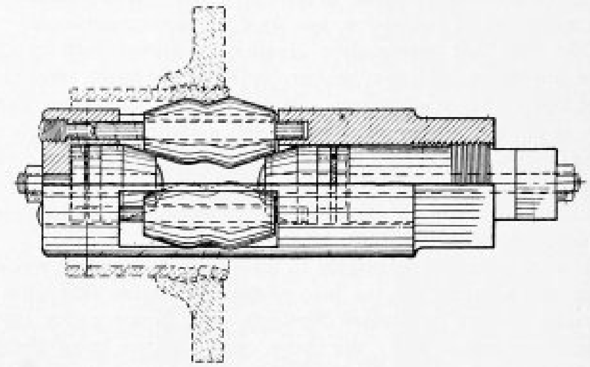
Claim 1.—A feed-water regulator comprising two chambers connected only at the top, an open float in one of said chambers adapted to fill with water and discharge the same into the other chamber, a boiler feed-water connection, a valve controlling the same operated by the movement of said float, and a connection from each of said chambers adapted to open into a boiler at such points as to be closed by water against the passage of steam when the water rises to its maximum level. Fourteen claims.

1,044,520. LOCOMOTIVE. GEORGE J. HATZ, OF OMAHA, NEB.

Claim 1.—In a draft arrangement for locomotives the combination with the usual boiler and smoke box, of a drum mounted in the smoke-box and having substantially coaxially therewith, said drum having imperforate heads and having cylindrical walls made up of a forward foraminous portion and a rearward imperforate portion; a stack to withdraw gases from said drum; a blast pipe discharging through said drum and adapted to create a draft out through said stack; a vertical guide partition extending between the rear head of the drum and the tube sheet of the boiler; a vertical partition longttiudnally dividing the forward portion of the interior of the drum; a partition extending across the smoke-box from the tube sheet of the boiler over the top of the drum; an annular baffle plate extending inward from the walls of the smoke-box to within a short distance of the walls of the drum; and an ejector to withdraw cinders from the smoke-box. Thirteen claims.

1,046,457. DEVICE FOR EXPANDING PIPES, TUBES, ETC. HORATIO G. GILLMOR, OF QUINCY, MASS.

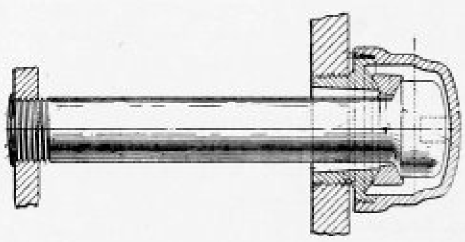
Claim 1.—An expander including in combination with a plurality of rolls, each having oppositely tapered ends, a cage constructed to hold said rolls, so as to permit rotation and limited radial movement thereof



and a bearing in two parts having oppositely inclined conical surfaces engaging with the tapered ends of said rolls and arranged to rotate within said cage and to transmit to said cage the end thrust of said rolls upon said bearing. Seven claims.

1,046,600. COMPENSATING BOLT CONNECTION. CHARLES F. KAHLER, OF CLEVELAND, OHIO.

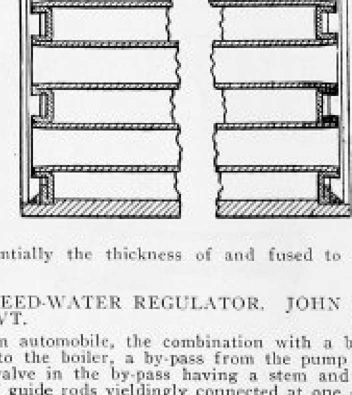
Claim 3.—The combination of a tension rod having a convex head, a convex seat facing the convexity of the head, and an interposed annular



member loosely surrounding the rod and concave on its opposite sides to engage the convex surfaces mentioned. Sixteen claims.

1,046,132. BOILER. WILLIAM H. WINSLOW, OF CHICAGO, ILL., ASSIGNOR TO THE STEAM POWER DEVICES COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

Claim 1.—In a boiler, the combination of a head, and flues extending through the head, such head having flanges formed thereon around the



flues' of substantially the thickness of and fused to the flues. Nine claims.

1,045,821. FEED-WATER REGULATOR. JOHN J. DEWEY, OF HARTFORD, VT.

Claim.—In an automobile, the combination with a boiler, a pump to pump water into the boiler, a by-pass from the pump to the source of supply and a valve in the by-pass having a stem and provided with a valve casing, of guide rods yieldingly connected at one end to said valve casing, a horizontally-arranged expansion tube situated at approximately the normal water level in the boiler having one end thereof rigidly connected to the other end of said rods, the other end of said tube being rigidly connected directly to the valve stem, and means connecting one end of the tube to the top of the boiler and the other end of the tube to the bottom of the boiler whereby said tube will fill immediately when the water level falls below normal. One claim.

THE BOILER MAKER

APRIL, 1913

Practical Marine Boiler Design

BY JOHN GRAY*

PREFACE

It is the author's experience when lecturing to boiler makers that he is often asked by apprentices or young journeymen boiler makers to recommend an elementary book dealing in a simple way with the design of a marine boiler. The following matter is written especially for THE BOILER MAKER, in the hope that it will appeal to the numerous students, apprentices and young journeymen of boiler design as well as many of the older hands.

At the end of each chapter I have set a few practical questions which are to be found in daily experience. These questions are only suggested here, but should be worked out and followed up by all students of boiler making.

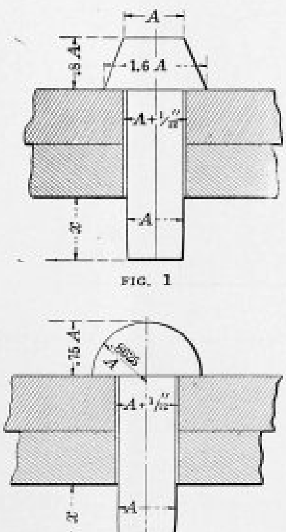


FIG. 1

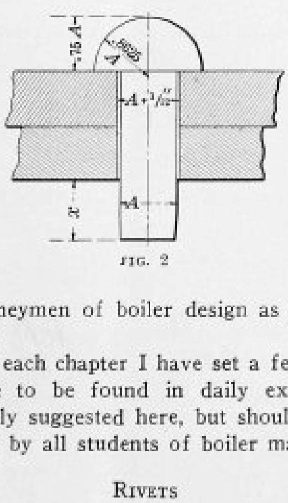


FIG. 2

RIVETS

A rivet is the simplest form of fastening and can be removed only by chipping off the head. In dealing with rivets and rivet heads for cylindrical boilers, the following are the proportions generally adopted. Pan heads are generally used in butt straps, end circumferential seams, front and back cross seams, etc., and well designed rivet heads should be of the following proportions (Fig. 1).

The length of the part marked x, to form the snap, varies according to whether it is to be hand or machine riveted, and also according to the number of plates it passes through. x is usually finished off with a snap and the allowance for 15/16-inch diameter rivets and under is two diameters when the rivets are machine riveted. If over 15/16-inch diameter, 1½ times d + ⅛ inch for every thickness of plate it passes through.

For hand-driven rivets in all cases allow one diameter.

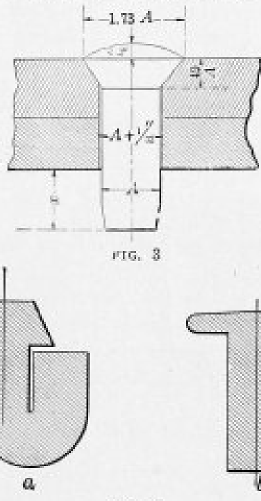


FIG. 3

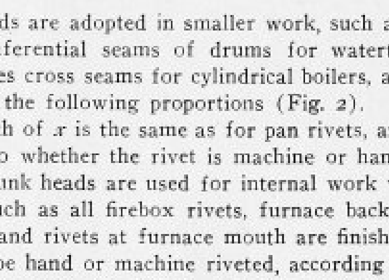


FIG. 4

Snap heads are adopted in smaller work, such as buttstraps and circumferential seams of drums for watertube boilers, or sometimes cross seams for cylindrical boilers, and the head is made of the following proportions (Fig. 2).

The length of x is the same as for pan rivets, and will vary according to whether the rivet is machine or hand riveted.

Countersunk heads are used for internal work within reach of flame such as all firebox rivets, furnace back to back of tube plate, and rivets at furnace mouth are finished off flush. They may be hand or machine riveted, according to the position they occupy in the boiler, and the head should be proportioned as shown in Fig. 3, the distance x being the same as found in other cases.

The rivets, like the plates in a boiler, have some very important tests to pass before they are selected by the surveyor, as the following will show. The rivet shanks are to be bent cold and hammered until the two parts of the shank touch in the manner shown in Fig. 4 (a) without fracture on the outside of the bend. The rivet heads are to be flattened while hot in the manner shown in Fig. 4 (b) without cracking at the edges. The heads are to be flattened until the diameter is 2½ times the diameter of the shank. The tensile strength

* Lecturer on boiler making, Govan High School, Barrow Technical School (Scotland), author of "Practical Design of Single and Double-Ended Marine Boilers," etc.

of the bars from which the rivets are made should be between the limits of 26 and 30 tons.

Fig. 5 represents the graphical method for finding the size of a rivet head after it has been knocked down with the snap, or die, in the machine.

$A =$ diameter of rivet.
$B =$ Size C.
$R =$ Radius of finished head.

The sectional part represents the die used for squeezing the rivet. The student should work out the sizes of heads and length of shank for various diameters of rivets, in order to thoroughly acquaint himself with the proportions adopted,

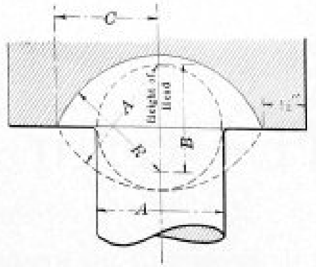


FIG. 5

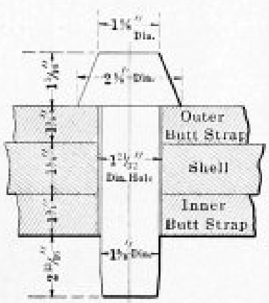


FIG. 6

as well as find graphically the finished head for different diameters of rivets.

Question 1.—What will be the length of shank and proportions of head for a machine rivet 1⅝-inch diameter, if the thicknesses of plates it passes through are shell plate 1⅝ inches, outer butt strap 1⅜ inches and inner butt strap 1⅜ inches?

Question 2.—What length of shank must a ⅞-inch diameter machine rivet be supplied with if the cross seam of a boiler has 1¼-inch and 13/16-inch thick plates.†

Question 3.—What are the proportions of a snap-headed rivet 1¼ inches diameter? ‡

Question 4.—From Fig. 1 work out the proportions of a pan head rivet ¾-inch, ⅞-inch and 1 1/16-inch diameter, respectively.

Question 5.—Work out the dimensions of the head and find the weight of 1⅝-inch diameter pan head rivet with shank 5¼ inches long.

Riveted Joints

A riveted joint may give way: First, by tearing of the plate between the rivets, as in Fig. 7 (*a*); or, second, by shearing of the rivets, as in Fig. 7 (*b*); or, third, by breaking of the plate between its edges and the rivet holes, Fig. 7 (*c*), and for this reason the Board of Trade have certain distances

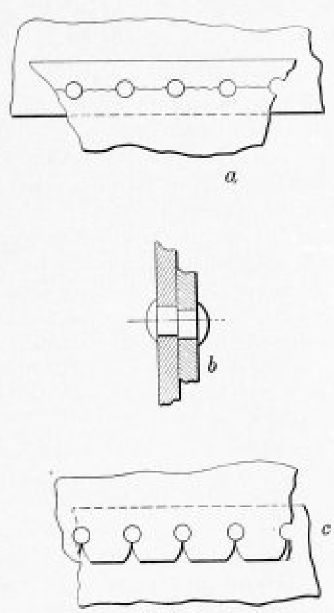


FIG. 7

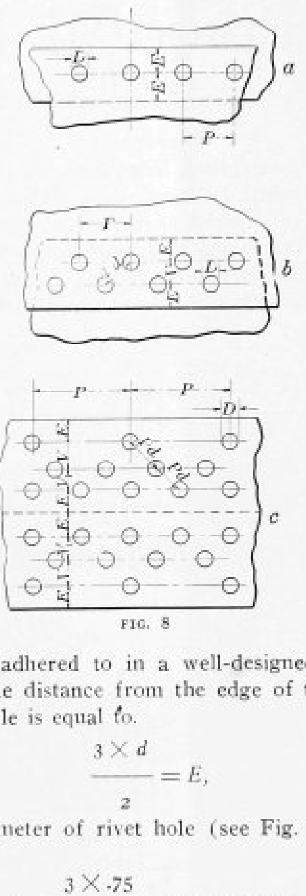


FIG. 8

which must be adhered to in a well-designed joint. In all riveted joints the distance from the edge of the plate to the center of the hole is equal to.

$$\frac{3 \times d}{2} = E,$$

where $D =$ diameter of rivet hole (see Fig. 8 (*a*)), taking ¾-inch holes,

$$E = \frac{3 \times .75}{2} = 1.125 \text{ inches.}$$

In a double riveted joint the space between the rivets is found from the following formula:

$$V = \frac{\sqrt{(11 P + 4 d)\ (P + 4 D)}}{10}$$

where $P =$ pitch of rivets.
$D =$ diameter of rivet holes (see Fig. 8 (*b*)).

With the same diameter of holes as above and $P = 2¾$ inches

$$V = \frac{\sqrt{(11 \times 2.75 + 4 \times .75)\ (2.75 + 4 \times .75)}}{10}$$

† It is a good practice for the student to sketch down the part involved before working out the questions. It enables him to become familiar with the various details of the boiler as he goes along; for instance, Question 1 ought to be answered as in Fig. 6.

‡ Like the foregoing note, it is not sufficient simply to state these proportions, but the answers ought to be accompanied with a sketch and the proportions worked out and marked on the sketch.

$$= \frac{\sqrt{(30.25 + 3) \times (2.75 + 3)}}{10}$$

$$= \frac{\sqrt{33.25 \times 5.75}}{10} = \frac{13.8}{10} = 1.38 \text{ or } 1\tfrac{3}{8} \text{ inches full.}$$

E of course remains the same as in our first instance. The diagonal pitch is as follows:

$$\frac{6P + 4D}{10} = Pd.$$

$$Pd = \frac{(6 \times 2.75) + (4 \times .75)}{10} = \frac{19.5}{10} = 1.95 \text{ or 2-inch base.}$$

In treble riveted joints E, V, Pd and pd are found in a similar manner (see Fig. 8 (*c*)).

$$V = \sqrt{(\tfrac{11}{20} P + D)\ (\tfrac{1}{20} P + D)},$$

assume in this instance $P = 10$ inches,

$D = 1\tfrac{7}{16}$ inches diameter,

then $V = \sqrt{(\tfrac{11}{20} \times 10 + 1\tfrac{7}{16})\ (\tfrac{1}{20} \times 10 + 1\tfrac{7}{16})}$

$$= \sqrt{(\tfrac{11}{2} + 1\tfrac{7}{16})\ (\tfrac{1}{2} + 1\tfrac{7}{16})}$$

$$= \sqrt{(\tfrac{11}{2} + \tfrac{23}{16})\ (\tfrac{1}{2} + \tfrac{23}{16})}$$

$$= \sqrt{\frac{88 + 23}{16} \times \frac{8 + 23}{16}}$$

$$= \sqrt{\frac{111}{16} \times \frac{31}{16}} = \sqrt{\frac{3441}{256}} = 3.71 \text{ or } 3\tfrac{23}{32} \text{ inches.}$$

$$V_1 = \frac{\sqrt{(11P + 8D)\ (P + 8D)}}{20}$$

$$= \frac{\sqrt{(11 \times 10 + 8 \times 1.4375)\ (10 + 8 \times 1.4375)}}{20}$$

$$= \frac{\sqrt{(110 + 11.5)\ (10 + 11.5)}}{20}$$

$$= \frac{\sqrt{121.5 \times 21.5}}{20} = \frac{\sqrt{261.25}}{20} = 2.55 \text{ or } 2\tfrac{9}{16} \text{ in.}$$

$$Pd = \frac{3}{10} P + D = 3 + 1.625 = 4.625 \text{ inches.}$$

$$pd = \frac{3P + 4d}{10} = \frac{(3 \times 10) + (4 \times 1.4375)}{10}$$

$$= \frac{30 + 5.75}{10} = \frac{35.75}{10} = 3.575 \text{ inches.}$$

E in treble riveted joints is the same as in single and double riveted joints.

The student should draw the various types of joints for himself and work out from the above formulæ the sizes to suit the different diameters and pitches he may be using. It should be noted in passing that there is a limit to the maximum pitches of rivets, which is fixed by the Board of Trade in conjunction with the type of joint and thickness of plate, to ensure the pitch being within a reasonable distance which allows the seam to be calked and kept tight. This table is fully worked out in the author's *Practical Design of Single and Double Ended Boilers*, and should be studied by those designing boilers.

The edges of the plates should be beveled off at an angle of 75 degrees to facilitate calking, which is necessary in high-presssure boilers in order to have the seams perfectly tight.

Question 6.—Find the distance from the edge of plate to center of rivet, if the diameters of rivet holes are 15/16, 1¼ and 1⅝ inches respectively.

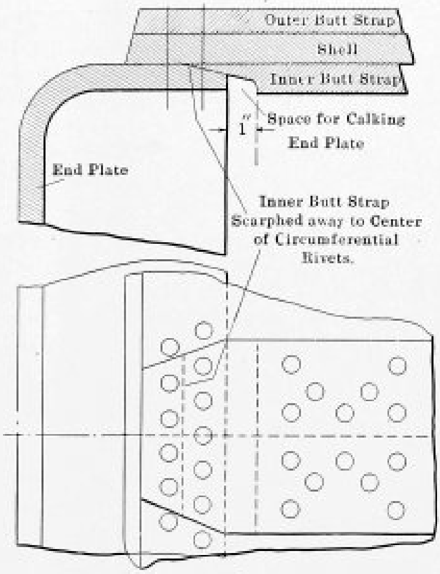


FIG. 9

Question 7.—Sketch a single lap and double lap joint, also a single butt and double butt strap joint, showing five rivets to the pitch.

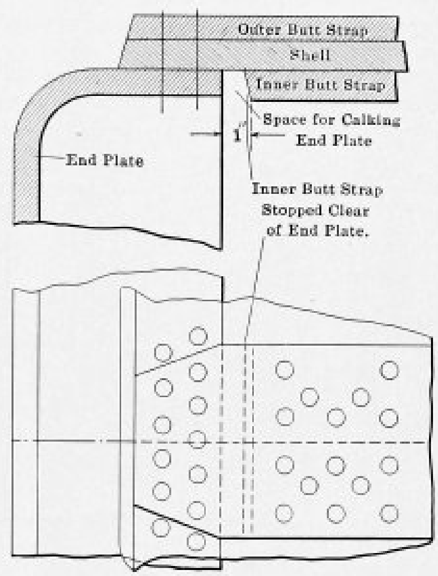


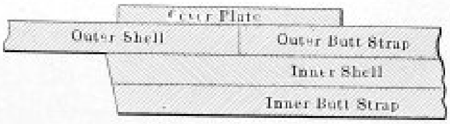
FIG. 10

Question 8.—Sketch a section of a joint showing the rivets in single shear and in double shear.

Question 9.—Give a description of how you would calk a plate, sketch the tool used and what angle the edges of the plates are made to suit the calking.

Arrangement of Shell and End Plating

The shell of a cylindrical boiler is sometimes made in one strake in length and sometimes two, and almost always two strakes circumferentially. These circumferential strakes are joined by double butt straps, the outer strap being carried along to the end of each strake with the inner strap usually tucked under the end plates, as in Fig. 9. The end plate is scarphed in way of the inner strap, and the circumferential end seam rivets are arranged to come through the strap, as in the illustration. Care should be taken that the number of



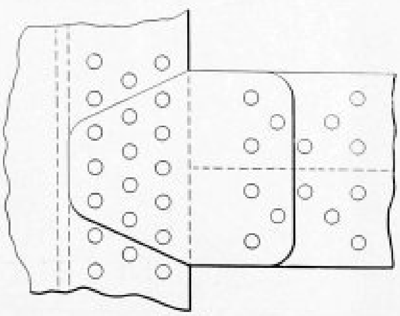


FIG. 11

rivets in the end and mid circumferential seams are made even, so that the rivets will come through the other strap in exactly the same position, and therefore making one template do for all the straps.

Sometimes the inner strap is stopped short of the end plate, as in Fig. 10. If this arrangement is adopted it saves the scarphing of the end plate and the thinning of the inner butt strap. Care should be taken here, however, to carry the inner strap the whole length of the longitudinal rivets, in order to have no rivets in single shear. This method is gradually becoming more common even for the largest diameters of boilers

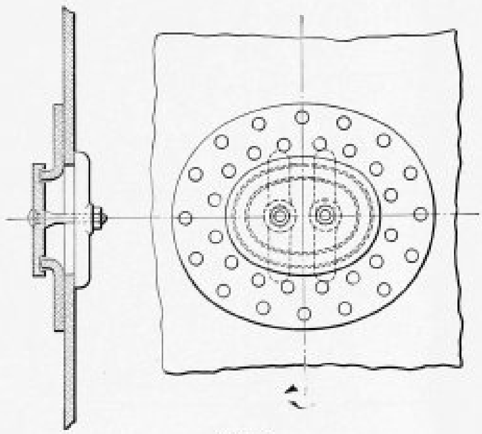


FIG. 12

and highest pressures, and if carefully calked there is no reason why it should not be preferred to the first instance, as it is a most difficult operation in the boiler shop to thin the butt strap into the end plate and make it steam tight.

Another method adopted by some boiler makers in way of mid circumferential seam is to butt the outer strap against the end of the shell strake and form a cover plate on top $\frac{3}{4}$-inch thick for calking purposes (see Fig. 11). This method saves the uncertainty of a badly tucked-in butt strap and still gives a good calking plate.

The shell manhole is usually made 16 inches by 12 inches, the long axis being placed circumferentially on the shell. The hole in the shell is compensated by a flanged plate, usually of the same thickness as the shell. If the shape of the plate is made an ellipse, the same as the door, it facilitates the cutting of the plate, as it is done on the same machine which

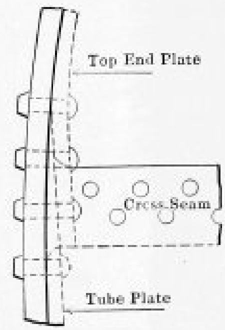


FIG. 13

cuts the door hole and door. The plate is fitted inside the shell and machine riveted.

The door is usually a flat plate $1\frac{1}{4}$ inches thick with a groove cut out to fit the flange of the compensating plate. It is held in position by means of dogs, the ends of which are carefully bedded to the shell (see Fig. 12).

The steam space, or top end plates, are flanged inward to the shell, and where they join the mid plate the flange of the mid plate is scarphed away and the flange of the top plate is upset for about three circumferential pitches (see Fig. 13). This scarphing, like the tucking of the inner butt strap into the end plate, must be carefully done in order to avoid any

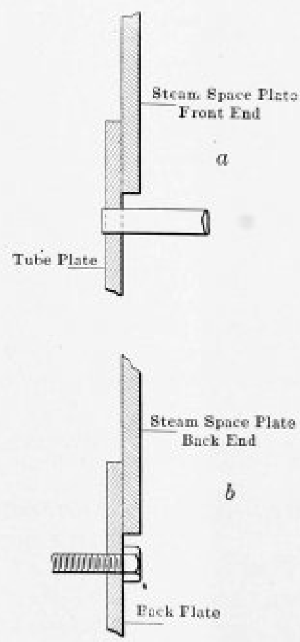


FIG. 14

leakage and trouble at the joint, and this is similarly done at all corners of the cross seams.

The cross seams are double riveted with 1-inch diameter holes, and the mid plate at the front end is usually arranged on the outside of the steam space plate, as in Fig. 14 (*a*). This adds an amount equal to the thickness of the steam space plate to the length of the tubes, which in a number of tubes means a considerable amount of extra heating surface. Where possible, however, as in the back end, this cross seam ought to be arranged with the mid plate on the inside of the steam space plate, as in Fig. 14 (*b*). This does not retard the upward circulation of the water, as the first instance is apt to do, and consequently there is less chance of a leaky joint.

The steam space plates are supported by stays going from the front end to the back end of the boiler. These stays may be screwed into the front and back plates or the holes in the plates may be 1/64-inch larger in diameter than the stays and the plate calked into the stays. If the stay is screwed into the plate, then one end of the stay is swelled ⅜-inch larger in diameter to allow it to pass through the front end, as shown in Fig. 15. Should the stay be calked into the plate, then both plates have a clearance hole as in Fig. 16, and a nut which has a thickness two-thirds of the diameter of the stay is fitted inside the plate.

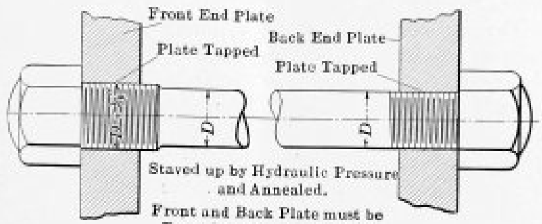


FIG. 15

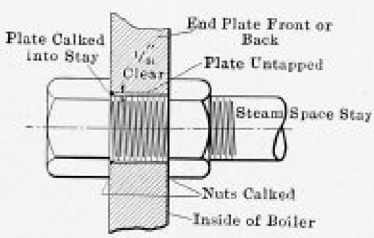


FIG. 16

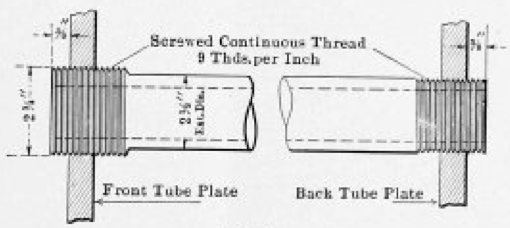


FIG. 17

These steam space stays, like the shell plates, have a tensile strength of from 28 to 32 tons per square inch. The rivets we saw were made of milder steel, 26 to 30 tons per square inch, because they had to be worked in the fire. Likewise all the flanging plates, including all firebox plates, are 26 to 30 tons per square inch tensile strength. The shell plates and the steam space stays, however, are not subject to heat or flame, therefore they can be made of higher tensile steel, as also can the girders on top of the combustion chamber. The normal tensile strength of the shell plates is 28 to 32 tons.

The front and back tube plates are supported by stay tubes as well as the plain tubes. The tubes may be 2½ inches external diameter for forced draft boilers or 3 inches to 3½ inches external diameter for natural draft boilers. There is, as a rule, 1¼ inches water space between the tubes to allow a good circulation of water. The stay tubes are swelled ¼ inch at the front end, and are threaded with a continuous thread 9 threads per inch through both plates. (See Fig. 17.) The ends of the tubes project ⅜ inch through the front and back plates. The plain tubes are expanded into the front and back tube plates. They are swelled 1/16 inch at the front end to facilitate the entering of the tube through the hole, and are allowed to project ⅜ inch beyond the plates, the same as the stay tubes. (See Fig. 18.)

The efficiency of the heating surface is reckoned on the external diameter of these tubes by the length between the

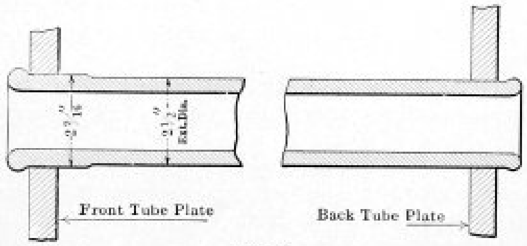
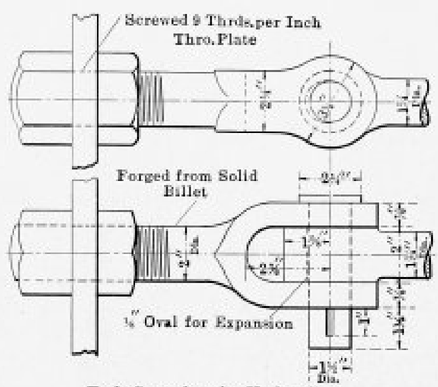


FIG. 18

tube plates, and the thickness varies according to the flat surface they have to support. In forced draft boilers retarders are fitted inside the tubes in order to make the gases take a circuitous route through them. Otherwise the very high velocity in which the gases pass through would reduce the efficiency of the tube heating surface. These retarders are not necessary in natural draft boilers.

The bottom end plates are flanged inwards to the shell, the same as the top end plates. The front bottom plate has a manhole 16 inches by 12 inches between the furnaces to permit access to the bottom of the furnaces. This plate is supported in the same manner as the steam space plates, having three stays round the manhole going from the front end to the back end of the boiler. As well as these stays there are the breast stays, which run from the bottom front plate to the back tube plate. These breast stays are screwed through the back tube plate and fitted the same as the steam space stays in the front plate. Owing to the position which they necessarily must occupy in the boiler they are apt to block the clear space for getting at the tops of the furnaces, and as it is important to scale the furnace tops the breast stays



Ends Staved up by Hydraulic Pressure and Annealed Afterwards

FIG. 19

are often made portable, so they can be removed when occasion demands. In this case the knuckle is forged from the solid and the ends screwed through the back and front plates. An allowance of ⅛ inch is made for expansion, and the end of the screwed part of the knuckle is left a little longer for adjusting the stay in the boiler, as shown in Fig. 19. The bottom front plate, however, is flanged inwards to take the furnaces, which makes it naturally strong. The bottom back plate is supported with screwed stays from the combustion chamber back, as well as the three longitudinal stays round the manhole at the front end.

The student should make himself familiar with the various details of the shell plating, and methods of supporting same, by sketching the separate parts and piecing them together, showing the arrangement of shell and end plates complete, with butt straps and cross seams in position. It is only by procedure such as this that he will learn how the plating is put together. Many boiler students, I find, know the various parts separately, but when asked to connect them together in their respective places, are quite unable to do this work correctly.

Question 10.—Find the heating surface of a tube 2½ inches diameter external diameter, 8 feet 3 inches long between tube plates.

Question 11.—If a boiler has two wing combustion chambers, each with 125 2½-inch external diameter tubes and one center combustion chamber with 133 tubes, and the length between tube plates is 7 feet 11 inches, what is the tube heating surface in square feet?

Question 12.—Assuming the weight of a square foot of steel plate 1 inch thick is 42.48 pounds, find the weight of a boiler shell 16 feet 3 inches internal diameter and 1⅝ inches thick by 10 feet 9 inches long, neglecting rivet holes.

Question 13.—Allow ¼ inch each side for shearing, what size of plate would be required for a shell 16 feet 6 inches diameter and 1½ inches thick by 10 feet 3 inches long?

Question 14.—If a boiler has 244 plain tubes 2½ inches external diameter by ⅛ inch thick, and 36 stay tubes 2½ inches external diameter by ⅜ inch thick, and 162 stay tubes 2½ inches external diameter by 5/16 inch thick, what is the cross sectional area through the tubes?

Question 15.—Find the weight of a boiler end 12 feet diameter by ⅞ inch thick if the two holes for furnace mouths are each 2 feet diameter, assuming the weight of a square foot of plate 1 inch thick to be 42.48 pounds.

Question 16.—If a steam space stay is 2¾ inches diameter and requires to be upset at one end to 3⅛ inches diameter by 9 inches long, what extra length of stay must be allowed to swell the end?

Question 17.—How would you find a right angle, suppose you had no square?

(To be concluded.)

Mechanical Stoking of Locomotives

The idea of automatic stokers for locomotives is not new. There have been many attempts, and repeated failures have led some to believe that mechanical stoking is not practicable. It has been the individual appliance or type which has failed, and not the principle. The fact that efforts to attain success have been so persistent shows that the end sought is a desirable one. The story is not new or unique; no matter how many failures there are, success comes at last to one or two. And the stage now arrived at is that machine stoking of locomotives is a success in regular service and that the remaining work is for the railway companies to put the apparatus into service. The experimental and development stages have been passed.

The primary object of placing a stoker on a locomotive is to be able to secure from that locomotive its full working capacity at all times and under all conditions. For short periods of time under favorable conditions, with good hand firing the full capacity of most locomotives may be reached; but it is not possible at all times and under all conditions to work the Mallet and Mikado locomotives to their full capacity, and most consolidations work up to capacity only a portion of the time.

Regularity, at highest point of capacity, is the essence of efficiency. Fuel economy is incident to this, but is not the highest consideration. Under test conditions an expert will obtain as great fuel economy by hand firing as can be obtained by any stoker on a locomotive or stationary boiler. But in actual service the expert cannot keep it up right along; nor is it practicable to obtain the experts. The average fireman under operating conditions uses from twenty-five to thirty percent more fuel than an expert does under test conditions. Here is where the machine comes in; with the mechanical stoker the fireman must operate his engine so as to produce more nearly theoretical results than he can secure under hand firing. In hand firing every principle of good stoking for securing fuel economy may be ignored and yet the locomotive still have steam and get its train over the road. The stoker insures handling the locomotive nearly right at least in order to get over the road at all. It is a regulator of furnace feeding, which under all conditions of weather and grades keeps the needed supply on the fire. It does not get tired or cold or overheated, and when doing its maximum work does not discount its efficiency by opening the firebox door. It teaches and compels the fireman to use his brains, while hand firing has directly the opposite effect. Physical over-exertion weakens immediate brain power and leaves the body an ungoverned apparatus for throwing coal spasmodically—over-feeding and under-feeding successively. The machine quickens the brain without wearying the physical man and the result is a fuel-feeding commensurate with the power demands made upon the locomotive. There is the further psychological effect that the fireman operating the mechanical stoker comes back from his work in good physical condition and ready to enjoy and profit by his rest, while the hand fireman leaves it with a tired and discouraged feeling that he has reached or gone beyond the limit of endurance. Result on the one hand, pride in his job, and a desire to retain it; on the other, disgust and an impulse to quit or strike. These conditions are not fanciful or unpractical; they are very real and have as direct bearing upon earnings as the extra loaded cars which are drawn by an automatically stoked engine as a result of its working regularly up to full capacity.

There are other important considerations. Locomotive maintenance costs continue to rise in a threatening manner. It seems to be demonstrated that the even temperature maintained in the firebox at all times by the mechanical stoker reduces the cost of repairs to flues and end-sheets and brick arches. The maintenance cost of the stoker is so slight as to be almost a negligible expense, the saving on these parts being enough to maintain the stoker and pay the interest on its first cost.

The fireman using the stoker sits on the seat most of the time, in a most advantageous position for observing signals. His freedom from physical fatigue keeps his mind more alert and increases his value as an aid to the engineer in insuring safety.

While all of these facts combine to favor mechanical stoking, the great argument in its favor is the dependable nature of its work. To keep up the required head of steam in all kinds of weather on all grades and all conditions of track means a great reduction in locomotive failures and the detentions of traffic which constitute one of the greatest leaks in railway revenue to-day. To know that an engine can take its maximum load for its run, with the steam gage holding right where it ought to hold from start to finish, is worth a great deal anywhere. The experience of a number of roads of large traffic shows that supplementing the human machine with its varying conditions of mind and body, by a mechanical apparatus guided by brains freed from the domination of physical limitations, gives results which can be clearly figured out in dollars and cents as profitable, and beyond that a range of results which are of even greater economic value, though they cannot be put in statistical form.—*The Railway and Engineering Review.*

Inspection of Locomotive Boilers*

BY JOHN F. ENSIGN†

The law requiring the proper inspection and repair of locomotive boilers and their appurtenances is of such recent origin, and in its application has been so freely discussed, that all mechanical men should be reasonably conversant with its provisions. It is, perhaps, not unnatural that in the interpretation of the law there should, as is usually the case, be some diversity of opinion as to just what it requires, and the proper method of complying with its terms; therefore, in the hope that a more uniform understanding of what we believe is required may be brought about, this paper will consider some of the questions that have come up since the law became effective.

The most frequent objection encountered with regard to our method of inspection has been that defects not at the time considered in distinct violation of the law are reported, resulting in mechanical officers being frequently asked by managers to explain why such defects were permitted. It seems to me that those who raise this objection must do so without giving the matter very careful thought. The obvious purpose of this legislation has been to promote safety, not to collect penalties; although the penalty must also have been provided for, as otherwise the law might be ignored.

We have endeavored, however, and in a majority of instances with very gratifying success, to obviate the necessity of bringing suits to collect penalties, and this to a great extent has been accomplished by the practice of reporting all defective conditions as found, so that remedies might be applied before these same defects developed to such a degree as to become dangerous enough to amount to a positive infringement of the express enactments of Congress.

This policy, it is true, can only be successfully followed in cases where there exists a sincere desire to better conditions, and an honest effort is being made by officials to comply with the requirements and the spirit of the law. Where attempts are made to place the entire burden of inspection upon the Government by neglecting defective conditions until attention may be called to them by a Federal inspector, an entirely different course will have to be pursued, as the law did not contemplate nor provide a sufficient number of inspectors for the Government to do this work alone.

Section 6 of the law provides that:

> "The first duty of the district inspector shall be to see that *the carriers* shall make inspections in accordance with the rules and regulations established or approved by the Inter-State Commerce Commission, and that the carriers *repair the defects* which such inspections disclose before the boiler or boilers, or appurtenances pertaining thereto, are again put in service."

It is evident from this requirement that the principal duties of the Government inspector should be of a supervisory nature; and that it was the intention of Congress to place the burden of making thorough inspections and the responsibility for the condition of all locomotives in service entirely upon the carriers.

The law provides that the district inspector

> "shall make such personal inspections of locomotive boilers under his care as may be necessary to fully carry out the provisions of this act and as may be consistent with his other duties,"

and this is the course which is being pursued.

Where attempts are made by any railroad to shift the burden of inspection upon the Government by continuing defective equipment in service until the defects are discovered and ordered repaired by a Government inspector, it will be necessary to resort to Section 9 of the law, which provides a penalty to cover three distinct forms of violation:

First, for violation of the law itself;

Second, for violating any rule or regulation made under its provisions; and

Third, for violating a lawful order of any inspector.

Under these provisions it is manifest that railroads are to be held just as liable to penalty for permitting the operation of a locomotive in a condition contrary to the law's requirements, although such defects may not have before come to the notice of a district inspector, as they would be were they to operate a locomotive after its having been ordered from service by an inspector. Congress recognized the fact that it would be impossible for fifty inspectors to at all times keep in touch with the condition of each of the 65,000 locomotives in service; and accordingly the responsibility for the making of proper inspections, prompt repairs, and for the general condition of equipment was placed primarily on the carriers, and a penalty provided in case of their failure to meet the requirements, regardless of whether a district inspector may have previously notified them of the existence of the defective condition or not.

Of the rules concerning which there has been evident misunderstanding in some cases, are Rules 45 to 48, governing the washing of boilers. On some roads where water conditions are such that it is necessary to wash boilers more frequently than the minimum of once a month required by the rules, it seems to have become a practice to remove all the washout plugs but once each month, allowing some of the plugs to remain and giving only a partial washout on the other occasions. This is not in accordance with the rules. Rule 45 requires boilers to be thoroughly washed as often as water conditions require, but not less frequently than once each month; and Rule 46 provides that when boilers are washed *all* washout, arch and water bar plugs must be removed. We do not consider that this applies to a water change, when only the washout plugs in the water-legs are removed to facilitate emptying the boiler. But where a hose is used to wash sediment out of the boiler, and, perhaps, other washout plugs are removed, crown sheet rinsed, or the barrel of the boiler partially washed, we consider it a washout, and all plugs should be removed and the boiler thoroughly washed as required. All we are asking in this respect is a reasonable and fair compliance with the plain requirements of the law. Roads which are indulging in what might be termed "sharp practice" in this respect, some of which I could name, are only deceiving themselves, and will eventually find it would have been to their advantage in many ways to have kept their equipment in such condition as to meet all the requirements of the law.

Rule 50 is another apparent source of some misunderstanding, or at least is not being properly observed by many carriers. This rule provides that

> "All steam valves, cocks and joints, studs, bolts and seams shall be kept in such repair that they will not emit steam in front of the enginemen so as to obscure their vision."

We believe this provision covers every point where steam leaks may occur. The object of this rule is to insure to

* Abstract of a paper read before the St. Louis Railway Club.
† Chief Inspector, Division of Locomotive Boiler Inspection, Inter-State Commerce Commission, Washington, D. C.

the enginemen a reasonably clear view of the tracks and signals. We have found that in many instances no inspection of the locomotive while under steam is made by the railroad's inspector. This naturally is the only time when he would be able to determine whether steam leaks exist or not; but still his report certifies that all steam leaks have been repaired. Inasmuch as the United States statutes provide a very severe penalty for a false certification on a report of this kind, this places the railroad inspectors in a very undesirable position. The law requires a sworn report of each inspection, and of the repairs made as a result of the inspection, and as the inspector is responsible under the law for the correctness of the statements that he certifies to, the report should show conditions exactly as he finds them.

It is not a proper compliance with the law, neither is it fair to the railroad inspector, that he be required to certify to a report for the Government showing everything in good condition, and at the same time be required to make out a different report for the railroad company, showing firebox sheets and flues "fair," "poor," or "bad," as the case may be; yet we know of cases where this has been done.

Another point, the importance of which we believe is not fully realized, is the responsibility of the man who signs reports as officer in charge. Rule 7 provides that

> "The mechanical officer in charge at each point where boiler work is done, will be held responsible for the inspection and repair of all locomotive boilers and their appurtenances under his jurisdiction. He must *know* that all defects disclosed by any inspection are properly repaired before the locomotive is returned to service."

The officer in charge is required to sign the following certification:

> "I hereby certify that to the best of my knowledge and belief the above report is correct."

The rule above quoted, requiring positive knowledge on the part of the officer so certifying that all defects disclosed by the inspection to which he certifies have been repaired before locomotive is returned to service, places even greater responsibility on him than on the inspector; because, in addition to knowing that the inspection and repairs have been made, he must also know that the report is correct. For this reason the officer in charge at points where inspections are made should give more of his time and attention to this work than is frequently the case at present.

The proper care and adjustment of safety valves is another matter which does not always receive the attention that it should. Rule 34 provides that

> "Every 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 5 percent above the allowed steam pressure."

This rule does not mean that the Government shall design the safety valves, prescribe what make they shall be, or anything of that kind. It simply fixes a minimum capacity below which you shall not go. When it has been demonstrated by test that the boiler can generate steam faster than the safety valves can take care of, we have asked, and will continue to insist, that the capacity of the safety valves be increased to meet the requirements of the rule. If the capacity of the valves has been decreased by lack of attention, or improper repairs, proper attention should be given them; if their capacity was originally insufficient, the remedy is obvious and should be applied. Of the first fifty locomotives on which a safety valve test was made by us 58 percent had safety valves which would not relieve the pressure in accordance with Rule 34. Immediate steps were taken, however, to remedy this condition and a material improvement has resulted, although there is need for still further improvement in this direction.

A recent issue of the *Railway Age Gazette*, in referring to the classification of accidents resulting from the failure of locomotive boilers and their appurtenances during the past fiscal year, comments that

> "Although these pertain to the boiler of the locomotive they were not all 'failures' in the true sense of the word. An analysis of these causes shows that about 90 percent of the deaths were due to low water in the boiler, which is a man failure, rather than one of design, and although the crown sheet failures are classified as to the contributory defects, the fact remains that low water was the prime and only cause of such explosions. Aside from explosions, 759 other accidents are listed, resulting in 10 killed and 796 injured. These are listed under items which do not contribute to boiler structural weakness, but are of the class of mechanical defects that are inherent in all branches of human endeavor, in which perfection cannot be obtained."

A general résumé of the work done by the Division of Locomotive Boiler Inspection during the fiscal year which ended July 1, 1912, is given in the annual report recently issued, an examination of which will, we believe, show the inaccuracy of the conclusions reached by the writer of the article. This report contains a complete list of all accidents that occurred during the year, briefly stating the cause, so far as it could be determined at the time of the investigation. When investigating accidents inspectors are instructed to take nothing for granted, and to make no statements which are not borne out by facts disclosed at the investigation. Our only object is to discover the cause of the accident, and then take the proper steps to prevent, if possible, similar accidents in the future. Where any indication of weakness in construction or defective material is found, tests are made to determine positively if such conditions exist. The total number of accidents due to the failure of locomotive boilers or their appurtenances during the year was 856, in which 91 persons were killed and 1,005 persons injured. Many of these accidents, in fact a majority of them, were of a minor character which formerly would have caused very little comment, but which proper attention to equipment would absolutely have prevented. With this idea in view they have been investigated, the cause determined and reported, and steps taken to prevent a recurrence of such accidents. In cases where a road might have had an epidemic of minor accidents of a certain character, investigation invariably disclosed the fact that they were due to improper equipment being used, or to neglect in repairing small defects. In such cases the proper remedy was recommended and applied. An analysis of the accident records shows that 29.6 percent of the deaths and 4 percent of the injuries were due to boiler shell explosions caused either by overpressure or defective boiler shells; 38.4 percent of the deaths and 12.8 percent of the injuries were caused by crown sheet failures, due to overheating, for which no contributing cause could be found; 20.8 percent of the deaths and 3.9 percent of the injuries were caused by crown sheet failures for which contributing defects, or defects which may have caused the accident, were found; 11.2 percent of the deaths and 79.3 percent of the injuries were due to other defects, including defective appurtenances.

In order that no misunderstanding could possibly arise, each accident was listed under the name of the road on which it occurred, arranged alphabetically.

The report shows that during the year 74,234 locomotives were inspected, of which 48,768 were found defective. This does not mean that 48,768 locomotives were found which did not meet the requirements of the law; because in that case the inspectors would have had to serve a written order to hold them out of service for repairs, as the law allows no discretion in the matter. It does mean, however, that under the policy which we have adopted, and which we expect to continue, of inspectors reporting defects and endeavoring to have them repaired before they cause an injury, or subject the company to the liability of a penalty, that these locomotives contained defects which should have been repaired before they were placed in service.

The next item in the report shows that 3,377 locomotives were ordered out of service for repairs, and this represents the number found with defects which were in violation of the law. In addition to this the pressure was reduced on 699 locomotives and seams were reinforced by welt plates on 327 locomotives to insure a proper factor of safety; 698 were permanently removed from service on account of defective condition. Of 992 the water glass was raised, and on 408 the lowest gage cock was raised to meet the requirements of the law; 351 required the application of braces of greater sectional area, and 116 required additional support for the crown sheet.

It will thus be seen that a total of 6,968 locomotives, which is more than 10 percent of the total owned, were either held out of service for repairs or changed and strengthened to conform with the requirements of the law. There is a distinction made in the report between defects which are in violation of the law and the defects which are reported in our efforts to prevent violations. In order to prevent any misconstruction, except a wilful one, being placed on it, each defect is tabulated so that anyone can determine the exact number and nature of defects reported by district inspectors on any railroad.

What James J. Hill says of terminals, or rather the lack of terminal facilities for cars, applies with even greater force to terminals and proper accommodations for the housing and care of locomotives. Many of the complaints which are heard regarding "car shortage" should be more properly chargeable to locomotive shortage. There are many places where locomotives are taken care of out-of-doors through the lack of roundhouse, shop or other accommodations for either men or material. Boilers are supposed to be washed and work done on engines at such points, often when the thermometer registers below zero, which we, as railroad men, know is an utter impossibility. At all division points where trains are to be made up, every facility necessary for the proper care of locomotives should be installed. It does not matter how costly are the terminals, how capable the railroad officials, nor to what degree of proficiency the employees may have attained, if the locomotives are not kept up to such a standard that they can be operated at their greatest degree of efficiency, the railroad is not earning a maximum return on its investment, owing to the disadvantage under which it labors in the operation of worn-out or improperly repaired locomotives.

During the last year large sums have been expended toward bringing the locomotive to a higher standard of efficiency. Especially is this true in the case of what is known as the superheater; the application of which is undoubtedly productive of excellent results, when properly maintained, by reason of the economy thereby effected in steam consumption. Yet, it is an almost daily sight to witness a locomotive leaking steam from pistons, valve stems, cylinder saddles and other appurtenances sufficient almost to operate the machine, if it were being properly utilized; this entirely aside from the danger of collisions likely to result from the obstructing of the enginemen's vision.

A statement of tons carried in 1893 as compared with tons carried in 1911 will illustrate the growth, of the locomotive more than I could do along other lines in an hour.

In 1893 the number of tons carried on the railroads of the United States was 745,119,482; in 1911 the number was 1,781,638,043, an increase over 1893 of 1,036,518,561 tons. The number of tons carried one mile was 93,588,111,833 in 1893, as against 253,783,701,839 in 1911, an increase of 160,195,590,006 ton miles. With this increase in traffic came a relative decrease in the number of men directly employed to handle it. The number of trainmen employed by the railroads in the United States in 1893 was 146,544, and in 1911 it was 221,426. The average number of tons in a train in 1893 was 184; this had increased to 383 in 1911, or more than 100 percent. The number of tons carried for each trainman employed in 1893 was 5,085; in 1911 it was 8,046, an increase of 2,961 tons per man. The number of tons carried one mile for each trainman employed increased from 638,635 in 1893 to 1,146,133 in 1911. This increase was effected notwithstanding there was a decrease in the number of train miles run for each trainman employed, the figures being 5,764 in 1893 and 5,589 in 1911.

These facts appear in tabular form as follows:

	1893.	1911.
Number of tons carried	745,119,482	1,781,638,043
Number of tons carried one mile	93,588,111,833	253,783,701,839
Average number of tons in train	184	383
Number of trainmen employed	146,544	221,426
Number of tons carried for each trainman employed	5,085	8,046
Number of tons carried one mile for each trainman employed	638,635	1,146,133
Number of train miles run for each trainman employed	5,764	5,589

The points which I have discussed to-night have not been brought out with a desire on my part to magnify the importance of the work which is being done by the department of the Government with which I am connected, nor with a desire to unjustly criticise the condition of railroad equipment or the work of the railroad officials who are in charge of such equipment. Every question relative to locomotive boiler inspection which has been touched upon has come up in the regular course of our work and information has been frequently requested relative thereto. Our policy has been to freely and frankly discuss matters of this kind with railroad officials in order to bring about a better understanding of what we believe the law requires, to the end that the desired improvement may be brought about without the necessity of resorting to the courts. In this course we have met with gratifying success, due in large measure to the co-operation we have received from a large majority of the railroad officials of the country.

It is, of course, impossible for us to meet and personally discuss these matters with every railroad official who has charge of such work, and I have accordingly taken the opportunity of discussing them here for the benefit of all. If what has been said has been the means of clearing up any doubtful points for anyone and thus bringing about a change in any improper practices which may have existed in the past, or will be the means of encouraging co-operation to a greater degree in the future, I shall feel that much has been accomplished.

It's just a big business proposition; something for all of us to do, and if through our combined efforts we keep some fellow citizen from personal injury or death, we have done something worth while.

LARGE LOCOMOTIVE ORDERS.—According to the *Iron Age* one of the largest locomotive orders in many months has been given to the Baldwin Locomotive Works by the Baltimore & Ohio Railroad, calling for sixty Mikado type and thirty Pacific type engines. The Pennsylvania Railroad has placed 170 locomotives at its Juniata shops at Altoona, Pa., filling them up for the entire year. The Missouri Pacific has ordered twelve locomotives from the American Locomotive Company. The Cincinnati, New Orleans & Texas Pacific has ordered ten locomotives from the Baldwin Locomotive Works and seven from the American Locomotive Company. The Detroit Terminal Railroad has ordered five switching locomotives from the latter company. The Burlington has bought twenty-five switching engines from the Baldwin Works.

Brick Arch a Factor in Boiler Performance

The series of comparative tests made at Coatesville, Pa., last year under the direction of Dr. Goss, on two locomotive boilers identical in their general dimensions and differing from each other only in the fact that one was fitted with a Jacobs-Shupert firebox and the other with a radial-stay firebox, affords an excellent basis from which to determine the value of a brick arch in a locomotive firebox. Some of these tests were run with no arch; the others were run with an arch. They involve both the Jacobs-Shupert boiler and the accepted as representing the performance of both boilers without the arch fired with Scalp-Level coal. Similarly, the points located by squares represent results from both boilers with the arch. Six of these points represent tests with Scalp-Level coal, and the long full line may be accepted as fairly representing them. The addition of the arch raised the performance of these boilers from that represented by the dotted line to that represented by the full line, an increase of 0.6 of a pound in the amount of water evaporated per pound of coal.

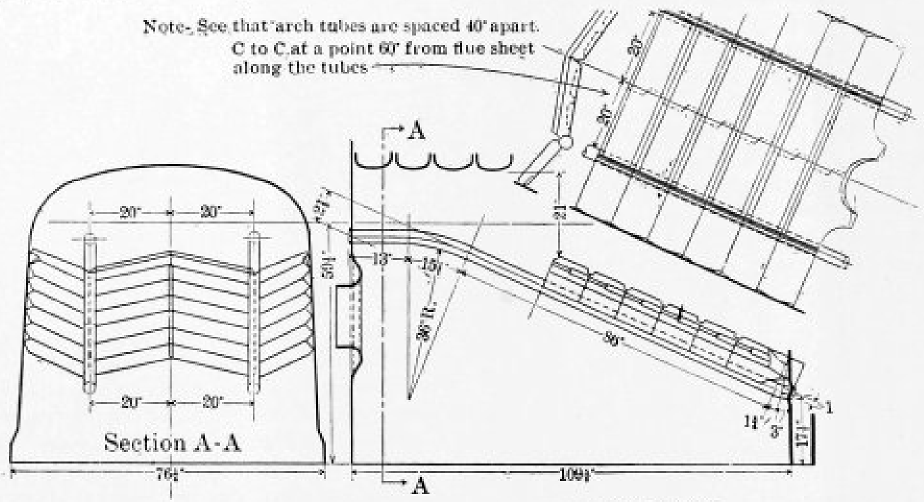


FIG. 1.—BRICK ARCH AS APPLIED TO JACOBS-SHUPERT FIREBOX

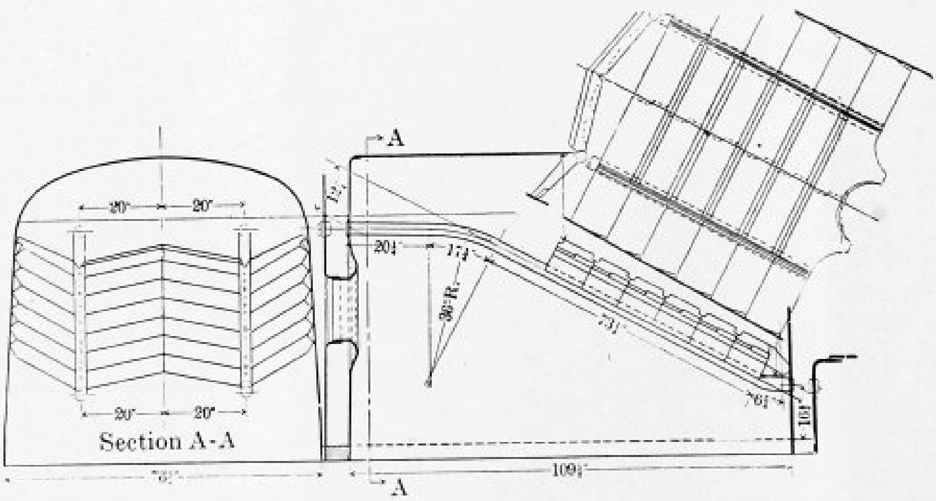


FIG. 2.—BRICK ARCH AS APPLIED TO RADIAL-STAY FIREBOX

radial-stay boiler. Scalp-Level coal was used for some of these tests and Dundon coal for the others.

The arches used in these tests were supplied and installed by the American Arch Company. They were substantially the same for both boilers, but the curvature of the firebox sections of the Jacobs-Shupert boiler made necessary some slight differences in design. The arch as installed in the Jacobs-Shupert boiler is shown by Fig. 1, and as installed in the radial-stay boiler by Fig. 2.

The evaporative efficiency of the boilers with and without the arch is well shown by Fig. 3. In this figure the points shown as triangles represent tests without the arch. Nine of these tests were run with Scalp-Level coal, five on the Jacobs-Shupert boiler and four on the radial-stay boiler. The long dotted line drawn through this group of points may be

For example, assuming the boilers to have been fired with 6,500 pounds of Scalp-Level coal per hour, they will evaporate 7.35 pounds of water per pound of coal without the arch and 7.95 pounds of water per pound of coal with the arch, a gain of 8 percent. Comparisons involving lower rates of combustion lead to smaller gains when these are expressed as a percentage of the evaporative efficiency. In the light of these experiments, it is fair to say that the addition of an arch in the firebox of locomotives using Scalp-Level coal, results in increasing the efficiency from 5 to 8 percent.

The points representing tests with Dundon coal are three in number. One representing the Jacobs-Shupert boiler and one the radial-stay boiler without the arch are shown on Fig. 3 as triangles enclosed in circles, and one representing the Jacobs-Shupert boiler with the arch as a square enclosed

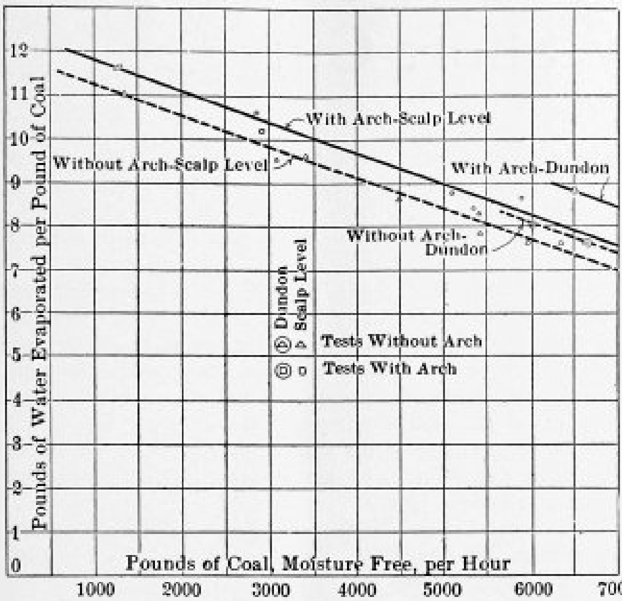


FIG. 3.—THE EFFECT OF THE BRICK ARCH IN FIREBOX ON EFFICIENCY

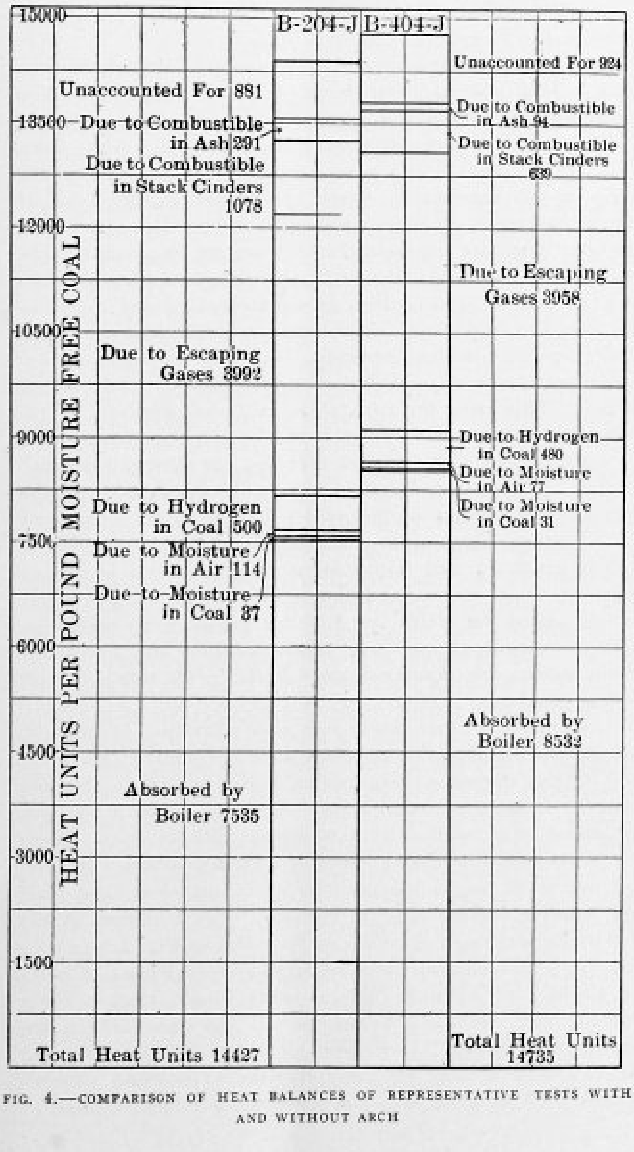


FIG. 4.—COMPARISON OF HEAT BALANCES OF REPRESENTATIVE TESTS WITH AND WITHOUT ARCH

in a circle. A short dotted line is drawn through the two points representing the two tests without the arch, and a short full line through the one point representing the test with the arch. The difference in the location of these lines measures the effect produced by the arch. It represents an evaporation of one pound of water. Thus, when 6,500 pounds of Dundon coal are fired per hour, the boilers without the arch will evaporate 7.7 pounds of water per pound of coal, and with the arch they will evaporate 8.7 pounds of water per pound of coal. This means that with Dundon coal the addition of the arch resulted in increasing the evaporative efficiency to the amount of 12 percent.

The results of the heat analysis for two tests at substantially the same rate of power, one with the arch and one without it, are presented as Fig. 4.

The difference in the effect produced by the arch in connection with the two grades of coal is doubtless to be found in differences in the manner in which the coal burns. The Scalp-Level coal has only half the volatile matter of the Dundon coal. The benefits to be derived from the presence of an arch—the longer flame way, the better mixing of gases, and the conserving of high furnace temperature—are all matters which affect its combustion favorably, but the long-flame Dundon coal being in greater need of these advantages, naturally profited most by the presence of the arch.

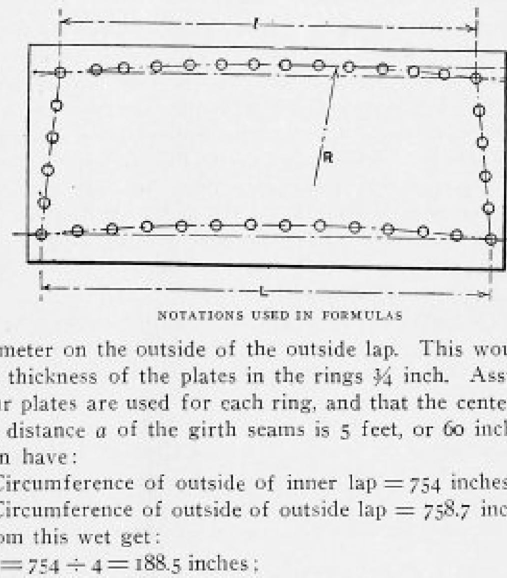
Camber in Plates

When the specifications for certain work do not allow the drifting of rivet holes, or in a stack or stand-pipe, when the plates are thick and the lower lap of the top ring is on the outside of the upper lap of the bottom ring, it is necessary, in order to have the holes match, to throw a camber in the plates. This can be determined by the following formula:

$$K = \frac{L\,(L - l)}{8a} \qquad (1)$$

in which the reference letters denote the dimensions given in the accompanying engraving.

As an example, assume that a stand-pipe is 20 feet in diameter on the outside of the inner lap and 20 feet 1½ inches in



NOTATIONS USED IN FORMULAS

diameter on the outside of the outside lap. This would make the thickness of the plates in the rings ¾ inch. Assume that four plates are used for each ring, and that the center to center distance a of the girth seams is 5 feet, or 60 inches. We then have:

Circumference of outside of inner lap = 754 inches;

Circumference of outside of outside lap = 758.7 inches.

From this wet get:

$l = 754 \div 4 = 188.5$ inches;

$L = 758.7 \div 4 = 189.67$ inches.

Then, by applying Formula (1), we have:

$$K = \frac{189.67\,(189.67 - 188.50)}{8 \times 60} = 0.46 \text{ inch.}$$

R. H. Crevoisie in Machinery.

Some Geometry Short-Cuts

BY JAMES F. HOBART, M. E.

"Yes, Mr. Hobart, I'm in trouble all right—in trouble up to my eyes, and then some. Here is the layout job which calls for the working out of a lot of dimensions, which are not given on the drawing. Fig. 1 shows how the drawings come into the shop, now how am I going to find where to punch those holes and how am I going to lay them out properly?"

"You are sure up against it this time, John. You are sick, that's sure, and your disease is a mild case of 'structuralis engineeris,' and I will let you figure, until next month, just what that is in plain English! Now, about Fig. 1, that appears to be a bit of a regular drawing for a structural steel building frame. What is the matter with it?"

"Why, the Old Man wants me to lay out a template for the plate which connects the three double angles. That plate is marked P. H. 9½ inches × ¼ inch × 0 feet 10½ inches. I suppose that is the size and thickness of the plate, but what I want to know is: How am I going to locate all the nine rivet holes in that plate? There are holes on three different lines or angles, and there are no dimensions given at all, as to how far from the edge of the plate any of the holes are to be located. It looks to me as a pretty stiff proposition! How is a fellow to get hold of this problem?"

"Come, come, John! This matter is not one-half as bad as it looks, and if you begin at one corner and keep digging away, you will soon get the whole plate laid out as nice as you please. You say you have no starting point, but that's a mistake. Point *A* is the starting point for the whole business, plate and angles, and near *E* you will find the dimensions 1¾ inches from line *A E* to the edge of the angle. As a dotted line near *A* shows that plate *H* does not go quite to the edge of the angle, we will regard it as 1½ inches from the hole *A* to the edge of the plate *H*, and we will lay down that distance from line *D A* to line *H I*, which forms the lower edge of plate *H*. From that line lay off 10½ inches and draw line *J K*, and the top and bottom of plate *H* are located, also point *A* in the plate, and from this point all other dimensions and directions will be found to radiate!

"To find the sides of plate *H*, first locate the holes on lines *A G* and *A F*, but first the 'spring line' *B A C* should be located, and line *A F* being perpendicular to the 'spring line,' or 'square with it.' Locating the 'spring line' locates line *A F* also. There is nothing in the small portion of the drawing shown by Fig. 1 to tell what the 'spring line' is, but this line represents that portion of the structure where the vertical wall ends, and an arch begins. As the arch is not shown in the bits of detail, Figs. 1 and 2, we have nothing to do with them, and merely use the 'spring line' because it is convenient to work from that line."

"But, Mr. Hobart, how am I going to find the angles which the three lines of holes are punched on? I don't see a single angle marked in degrees, in the whole shooting match?"

"No, John, the structural folks don't use degrees very much for marking angles. Instead, they use the little triangles, two of which are shown on lines *A E* and *A G* respectively, and these two triangles fix all the angles you need to use. Don't you remember how I told you about the use and meaning of these dimensioned triangles in a 'geometry stunt' talk a few months ago?"

"Oh, yes! I remember now! And is that the way they use those little 'angle triangles?'"

"That's just the way, and to lay down line *B C* on Fig. 2 just get a steel square, take 12 inches on the blade and place that point fair with point *A*, then find 3 3/16 inches on the tongue, place that point fair with line *A E*, keeping the 12-inch mark fair with point *A*, then draw a line along the blade of the square and that line is *B C*, the 'spring line' shown in Figs. 1 and 2."

"Oh, say! Can't we get line *A F* by squaring up from point *A* on the 'spring line?'"

"Sure! That is the way to locate line *A F* and to find line *A G*. Make use of the little triangle, '11-12,' shown on line *A G*, Fig. 1. Take 12 inches and 11 inches on the blade and tongue of the square respectively, place the 12-inch point on line *B C*—the 'spring line'—with the 12-inch mark at *A*, and the blade of the square accurately along spring line *B C*. Mark from the tongue of the square the point 11 inches, draw a line from that point to *A*, and the line *A G* has been developed and located."

"Well, say! That's a right pert scheme, getting all those lines without figuring a bit; but now, tell me, how do you locate the sides of plate *H*?"

"That's dead easy, John. Just draw two vertical lines 9½ inches apart, placing the lines equal distances from holes *F* and *G*, and there you are."

"But suppose you wanted to find the distance apart of holes *F* and G, so as to know how much width to leave on either side? Then, how would you find the distance accurately between holes *F* and *G*? Can it be done?"

"Sure! Everything and anything can be done if you will work hard enough and go about the work in the right way. You can safely undertake any job which comes along, provided you have time and money enough back of you! Why, John, you are safe in taking a contract to build a railroad to the moon if you have time enough and money enough back of you, so don't ever say that anything is impossible, for it isn't. Lots of things are impractical which are not impossible. The finding of the horizontal distance between vertical lines through holes *F* and *G*, Fig. 2, is unnecessary, but it can be accomplished easily and with considerable accuracy. Meanwhile, for all practical purposes, just scale the distance between the two holes and find if it is not pretty close to 3¾ inches? This being the case, allow half that distance, or 1⅞ inches, on either side of holes *F* and *G*, and the edges of the plate are located with sufficient accuracy for all requirements."

"But, tell me, Mr. Hobart, were it necessary to find the degrees and minutes of the angles followed by the lines of holes *F* and *G*, Fig. 2, what would be the best way to proceed?"

"Use geometry and trigonometry. This science is just as necessary as geometry, and geometry and trigonometry may well be called the 'knife and fork' of engineering; therefore, don't be afraid to use 'trig' when possible and necessary. When eating, one don't use one's knife at all times, for all things, you know."

"Yes, that's so; but won't you just show me, right now, how to find the angles of the lines *A G*, *A F* and *A D*?"

"You can calculate these angles, John, but life is far too short, nowadays, to spend time calculating angles when you can arrive at a solution in some easier, quicker way. There is a book published called 'Smolley's Tables' which will hand you out about any angle used in structural work, and that, too, without making any calculations. For instance, in the case of the angles of the lines of the holes in Fig. 2, you note that the little triangles which locate the several lines of holes are all laid off with one leg 12 inches long. This is for a purpose, and Smolley's tables are all calculated for a leg length of 12 inches. Therefore, to find the angle of 'spring line' *B C* turn to page 307 (seventh edition) and find 3 inches at the top of the page, then run down the left hand column to

3/16 inch, thence across along that horizontal line to the last three columns on the page and find 14° 52′ 13″, which is the angle of the 'spring line' *B C*, Figs. 1 and 2."

"Can you find the angles of lines *F* and *G* in the same manner?"

"Sure! The angle of *F* will be the same, from a vertical line, as the spring line is from the horizontal, and subtracting that angle from 90 leaves 75° 7′ 47″ as the angle *F A E*."

"That's easy, but how do you find the angle of line *G A*?"

"Look on page 315 of 'Smolley's,' and there you find under 11 inches 42° 20′ 38″, which is the angle of line *G A* from 'spring line' *B A G*. And, John, if you intend to monkey around with structural work—yes, with boiler layout work as well—then by all means you should have a copy of 'Smolley's,' for he not only saves a whole lot of time for your shop, but a great deal of very hard work for you—for it is the hardest kind of work calculating angles with pencil and paper by multiplication and division. The use of 'Smolley's' will enable you to dispense with all the 'hack-work calculations' incident to structural and boiler work, and a man who has once used 'Smolley's' in either of the above-mentioned lines will never try to work without that book."

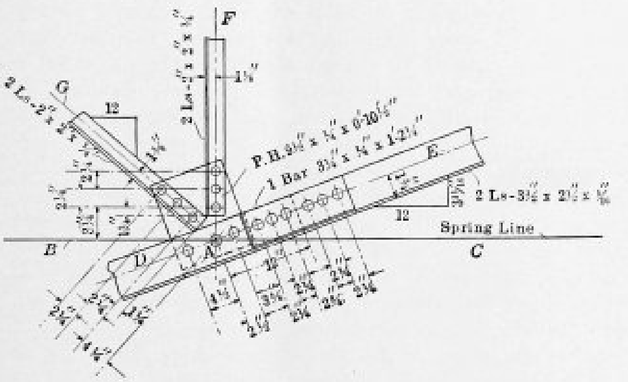


FIG. 1

"Say, Mr. Hobart, that sure must be some book. Does it have anything else inside of it besides the tables showing degrees of any required angle?"

"Sure, John. That table I quoted from not only gives the angles in degrees, minutes and seconds of every angle with 12-inch base between ordinates of 1/32-inch and 12-inch rise, but it also gives the logarithms of the sine, cosine, tangent, secant, etc., of each and every angle between 1/32 inch and 1 foot, above noted. There are other tables in the book of even greater value when laying out a complicated lot of holes, lines and angles. All the numbers in these tables have been carefully figured out and they are real and actual 'short-cuts' given to us by geometry and trigonometry, so as to save us work and time. The man who made this book just figured out, once for all—made a good job of it, too—all the angles we can ever need in laying down work or in designing structures or boilers."

"What other things are there in the book, Mr. Hobart?"

"The first tables, and the longest and most important, are what are called parallel tables of logarithms and squares, of feet, inches and fractions of inches, varying from 1/32 inch to 50 feet, and from 50 to 100 feet, by sixteenths of an inch. This set of tables fills more than 300 pages of the book, and is worth all kinds of money for the layer out and the designer. There is another short cut in that book in the shape of tables of rivet spacing up to 30 holes, from 1¼ inches to 6 inches. Take the line devoted to 2⅞-inch spacing. It reads as follows:

In.	1	2	3	4	5	6	7	8	9	
2 7/16	2 7/16	5¾	8⅝	11½	1-2⅜	1-5¼	1-8⅛	1-11	2-1⅞,	etc.

This makes a mighty handy 'short-cut' for use when a man is in a hurry, as he is apt to be in our work. A glance at this table will show instantly the number of rivets required in a given space, and, better than that, it will show whether or not a given pitch of rivets will space evenly over a given width of sheet. For preliminary laying out this table is invaluable, as it shows the layer out at a glance what pitches he must confine himself between in order to keep within the limits of plate section called for by the designer.

"The designer of boilers will save a lot of time both in his own office and in the shop if he will only use this book and the table of rivet-spacing when laying down seams, in order that all the spacing may be equal and according to the book. That means that when a certain distance comes out 5 feet 0 inches long and it is desired to space the rivets 2⅞ inches in the length given, referring to page 318 of the seventh edition, it will be found that 21 spaces of the pitch named will require a distance of 5 feet ⅜ inch, therefore the designer can probably arrange to secure the required extra ⅜ inch and make the spacing come out even."

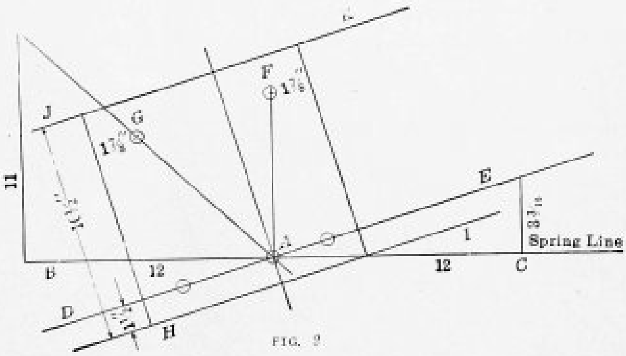


FIG. 2

"That sounds mighty good! Do you mean to say that the table has all the distances multiplied out up to 30 rivets?"

"Yes, for 30 spaces, which, of course, means for 31 rivets, and for all pitches between 1¼ inches and 6 inches at that!"

"Is there anything else in that wonderful book you are telling me about? Just let me hear, will you?"

"Sure, John, there is a whole lot more in that book, including a fine table of logarithms, tables of natural and also of logarithmic sines, tangents, etc., a big bunch of reciprocals and 'sich like.'"

"Say, Mr. Hobart, just put a bolt in that hole, will you? What is a 'reciprocal,' anyway? I find a bunch of them in my 'Kent,' but I haven't got wise to them yet."

"Oh, yes, John! I should have told you about reciprocals before. That stuff is just another 'short-cut,' that's all. The 'reciprocal' of any number is 1 divided by that number, and when we want to divide one number by another we can change hard division into easy multiplication by simply multiplying by the reciprocal instead of dividing by the number. Thus: Divide 4,631,573 by 250. The reciprocal of 250 is .004, and $.004 \times 4,631,573 = 18,526.292$. Saves a bit of work in large numbers, and when there are fractions."

"That's what, Mr. Hobart, and I'm going to have one of those books next pay day!"

CORRECTION.—In the review of the National Tube Company's "Book of Standards," which was published on page 89 of the March issue of THE BOILER MAKER, the following statement is made: "For some years the National Tube Company, which manufactures boiler tubes, wrought iron pipe, etc." This statement is incorrect, and should read: "For some years the National Tube Company, which manufactures boiler tubes, wrought pipe, etc." The National Tube Company has not manufactured wrought iron pipe for years. The reasons for discontinuing the manufacturing of wrought iron pipe have been thoroughly exploited in the advertising pages of THE BOILER MAKER during the last few years, and are probably well known to our readers.

Development of a Helical Chute

BY C. B. LINSTROM

Fig. 1 represents a helical chute made up in three pieces, the bottom and two sides, held together by angle irons, as illustrated in Fig. 1. This figure represents a working drawing as received in the shop, from which the layer out is required to produce the patterns. The plan is (a), elevation (b) and end view showing a section through the chute at (c). Inspecting the drawing one recognizes a practical application of the helix. The bottom of the object has a double curvature, or, in other words, it is a warped surface. Theoretically it cannot be developed. However, patterns can be made which closely approximate the helical form.

Fig. 2 shows in detail the developments the layer out must produce before he can secure the patterns. Comparing Fig. 1

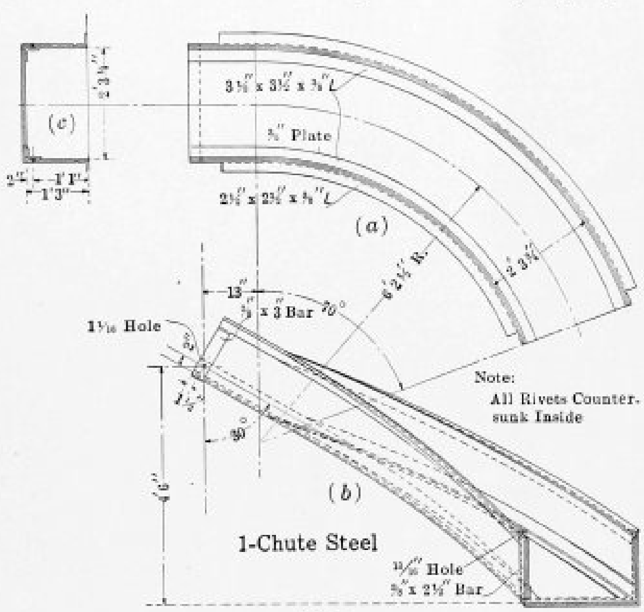


FIG. 1

with Fig. 2 it will be noted that a slight difference has been made between them.

First, Fig. 1 represents the chute drawn in the third quadrant, or, in other words, the third angle. Fig. 2 shows it in the first quadrant or first angle.

Second, drawing of Fig. 1 shows detail construction, while Fig. 2 shows only development required for laying off the patterns A, B and C.

Third, Fig. 2 not drawn to same scale as Fig. 1.

Construction of Fig. 2

Draw the plan showing width of chute and its path circumferentially. Space off on the inside and outside arcs f a and f' a' any number of spaces; it is better to make them equal, as will be understood later. Then in the elevation locate the required pitch the chute is to make. The pitch from a to f is for the base of the chute, from a' to f' the pitch of the top. Divide these pitches a f and a' f' into the same number of equal parts as contained in the arcs of the plan. Determine by construction the path of the chute. Examining the drawing, it will be understood that in order to do this we must work from the extreme outer edges of the conveyor which have already been determined. In the plan is the base showing the width required, and the elevation shows the height of the given sides. The curve on the side at the bottom of the conveyor is found as follows: From the points a, b, c, d, e and f erect perpendiculars of an indefinite length. From the corresponding points a, b, c and d, etc., of the elevation draw horizontal lines intersecting the ones drawn from the plan. Through their points of intersection draw the curve for the bottom inside edge. Directly above this curve and lying in the same plane is the curve of the upper edge of the side of the chute. It is produced in exactly the same manner, using, of course, the pitch given for this part.

The outer curves are produced in the same way. Having obtained the outside and inside curves as required, connect the points b b and c c, etc., in the elevation. Consider these as elements, and it is evident that they are all equal in length to line a a of the elevation. As these elements are all equal, it is only necessary to find the diagonal distance between two of them in order to lay off the pattern, and since the elements are equal it is evident the diagonal distances will also be equal. The diagonal distances between the two elements a a and b b is then determined as illustrated to the right of the elevation; a b is the required length and is the hypotenuse of a right angled triangle whose base is equal to a b' of the plan, and the height of which is equal to the vertical distance between the elements a a and b b of the elevation.

Before the pattern of the bottom of the chute can be laid off it is necessary to secure the true length of the arcs on the inside and outside of the chute. This is readily accomplished because, according to geometry, the curve of a helix may be determined by wrapping a right angled triangle of a given dimension around a cylinder, the hypotenuse forms the helix. By reversing the method it is evident that a right angled triangle can be constructed whose hypotenuse will give the required length of the helix. Accordingly, the height of such a triangle, considering the inside edge at the bottom of the chute, equals the altitude or pitch of the chute given in the elevation from a to b. The base equals in this case for a one quarter turn one-fourth the circumference of the inside circle, or the length of the inside arc plan view. The hypotenuse should then be divided into the same number of equal divisions as in the plan. The principle employed for laying off the true length of either of the curves of the chute is to be used in determining the patterns for the sides A and B. For A lay off the arc distances from a to f inclusive of the plan, erect perpendiculars therefrom and from the elevation project the corresponding points in that view on the top and bottom of the side to the perpendicular lines. Connect the points of intersection which gives the shape of pattern A. Pattern B can be obtained likewise. The space between a' and b' respectively in both views is to be used in laying off the pattern for C.

Development of Pattern C

Draw lines a a equal to a a of the elevation. With a at the top as a center, and with a' b' of A as a radius, draw an arc. With a at the bottom as a center, and a' b of B as a radius, draw an arc. Then, with a b of the triangle, which is the diagonal distance between elements as a radius, and with point a as a center at the top of the pattern, draw an arc intersecting the other arc at b. Continue laying off in this manner, using the four required lines, which are the true lengths of the arcs on the inside and outside of the chute, the width of the chute and the diagonal distance between two of the elements. It is advantageous to make the bottom in more than one piece, because owing to the irregularity of the surface, which not only requires bending but "raising" to form it, difficulty is liable to ensue if made in one piece when working the material. The number of pieces should be governed by the size of chute and thickness of material used.

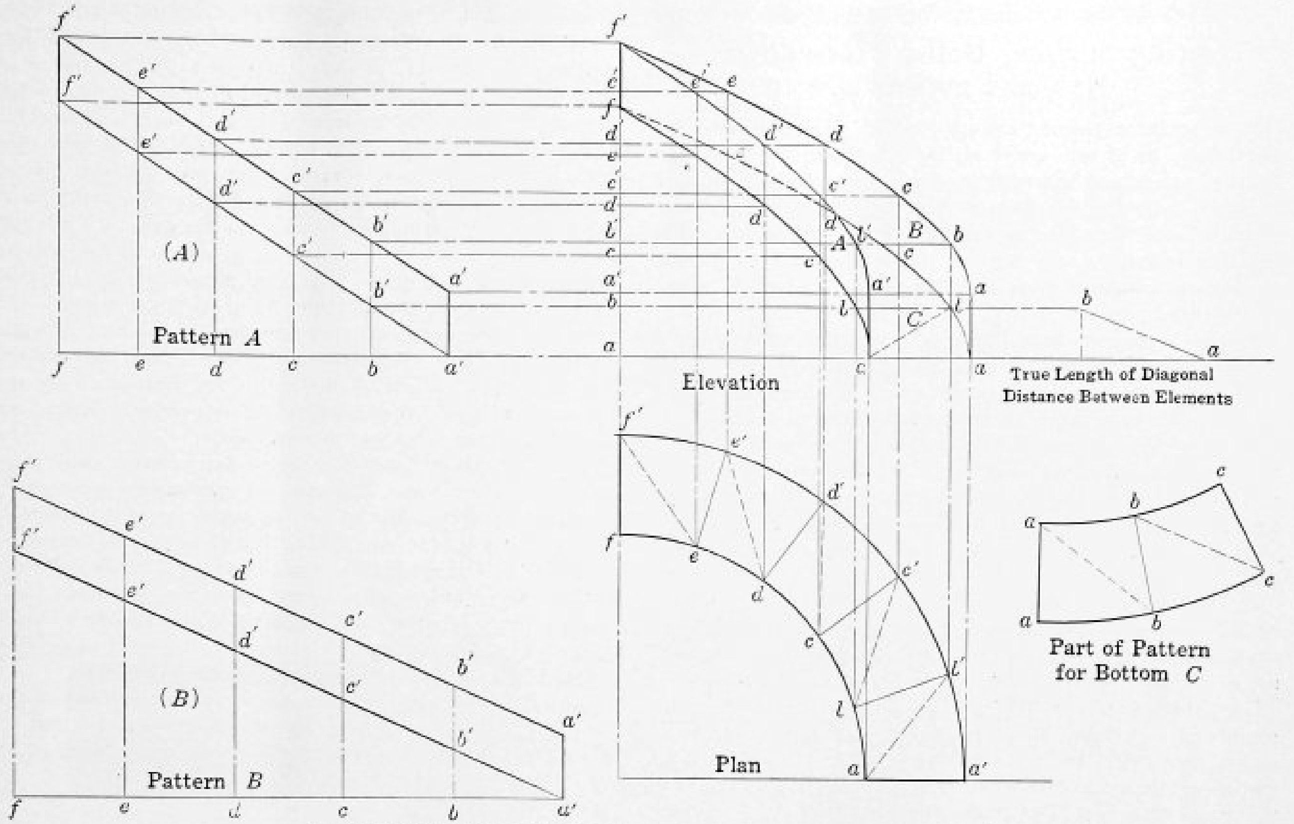


FIG. 2.—DEVELOPMENT OF HELICAL CHUTE. (FOR DESCRIPTION SEE OPPOSITE PAGE)

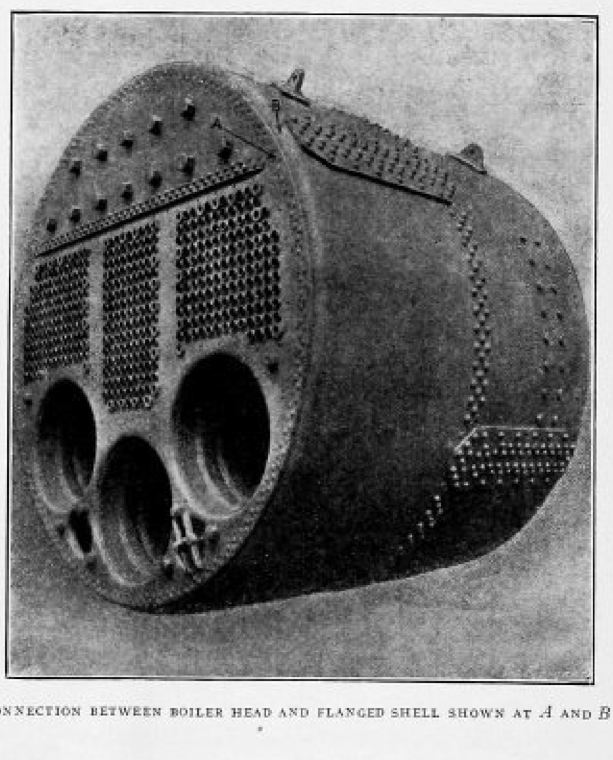
Scotch Boiler with Flanged Shell

In an article published in recent issues of *The Engineer* a description is given of an up-to-date cargo ship designed and built by the Central Marine Engine Works, West Hartlepool, England. The boilers in this ship are of the Scotch type, designed for a working pressure of 180 pounds per square inch. There are four single-ended boilers in all, each boiler containing three furnaces with separate combustion chambers. They are operated under Howden's system of forced draft, and are equipped with the Central Marine Engine Works' system of superheating.

These boilers are a particularly interesting piece of work, both as regards design and construction. In the first place, the shell instead of the end plate is flanged, and the longitudinal seam is welded for a few inches beyond the turn of the flange, and then covered by the strap so that a perfectly flat face without any seam is provided for the end plates, which makes a much easier job of the joint, both for riveting and calking. This construction is shown at the points marked *A* and *B* on the accompanying engraving. The end plates, too, when they are too large to be made in one piece are welded at the corners of the seam, the two plates being brought together so as to form a continuous flat surface for some few inches around the circumference, the rest of the seam being riveted as usual. Thus the end plates form flat surfaces and fit on the shell joint just as a cylinder cover fits on a cylinder flange, though, of course, with rivets instead of studs, and no packing pieces are required except in the combustion chamber, and the rivets are all in tension instead of shear. The back plates are hydraulically riveted, hand riveting being used on the front plates.

The whole of the boiler shell, after welding and flanging, is lowered into a big gas furnace and annealed, so that any internal stresses that may have been set up in the metal in the process of flanging are released and a very snug job results.

Although this practice has been in force for some years at the shops of the Central Marine Engine Works, it probably is not well known in American boiler shops, as this method of construction has rarely, if ever, been used in America. The construction of boilers of this type calls for large capital expenditure on the plant for flanging, riveting, annealing, etc., but when that is once done a better, if not cheaper, boiler results, while the fact that the flange on the shell necessitates the furnaces being located further up from the bottom of the boiler insures a better circulation, which is an important factor in the Scotch type of boiler.



CONNECTION BETWEEN BOILER HEAD AND FLANGED SHELL SHOWN AT *A* AND *B*

Heating Surface, Boiler Horsepower*

BY F. L. JOHNSON

At a recent engineers' examination in Ohio this question was asked one of the candidates for a license: "What is the heating surface and horsepower of a horizontal return-tubular boiler 60 inches in diameter, 16 feet long, having forty-four 4-inch tubes?" The heating surafce of a boiler is that portion which is exposed to the heat of the furnace and to the hot products of combustion on one side and is covered by water on the other.

In the horizontal return-tubular boiler the water-covered surface exposed to heat is made up of the lower half of the shell, the inside area of all of the tubes and the area of one head less the area taken up by the tubes in both heads.

In these calculations one-half the area of the shell is taken, because that part of the shell below the line where the brick-work is closed in and comes in contact with the shell and limits the height to which the fire or hot gases may rise, closely approximates one-half of the circumference of the shell.

In calculating the heating surface of the tubes, the interior or fire surface is taken because the water will take away from the outside and greater area all of the heat that can be transmitted through the tube from the inside and smaller area.

The area of only one head is reckoned because the total surface of both heads which are exposed to heat is but little, if any, more than this. At the rear the setting is closed in just above the upper row of tubes, cutting off nearly one-half the area of the head, and at the front the surfaces below the tubes and above the waterline transmit no heat to the water. This is practically equal to the area of one head. From this area must be subtracted the cross-sectional area of the tube ends in both heads, as they present no surface whatever to absorb the heat of the passing gases.

Horsepower is a rate of work, and in steam engines is measured by the foot-pounds of energy developed in a given time. In a steam boiler the energy developed cannot be measured or expressed in foot-pounds; for the work done is the conversion of water into steam and must be measured in terms of heat units.

In 1876, the committee of judges of the Centennial Exposition, in order to correctly compare the performance of many competing boilers, formulated what is known as the Centennial rule for the horsepower unit of steam boilers. This unit is the evaporation of 30 pounds of water per hour into steam at 70 pounds gage pressure from feed water at a temperature of 100 degrees F., an equivalent of the transfer of 33,305 heat units from the furnace to the water. This rule was accepted in 1884 by a committee of the American Society of Mechanical Engineers, which recommended its adoption by the society as a standard for use in all boiler trials.

As the value of the heating surface of a boiler depends on the quantity of heat generated in the furnace per square foot of heating surface of the boiler, the number of square feet required to develop a boiler horsepower will depend on the conditions of operation in each case.

From the earlier days of steam boiler practice until comparatively recent times, the rates of combustion were moderate, and 15 square feet of heating surface was the common allowance made for one boiler horsepower. By common consent it was dropped to 12 square feet for horizontal return-tubular boilers and 10 square feet for watertube boilers.

Some years ago the New England Boiler Builders' Association adopted 10 square feet as the area required to develop 1 horsepower in horizontal return-tubular boilers.

Taking the boiler given in the question, the total area of the shell is found by multiplying the diameter by 3.1416 and by its length; 60 inches is 5 feet, hence the surface of one-half the shell is

$$\frac{5 \times 3.1416 \times 16}{2} = 125.664 \text{ square feet.}$$

The inside diameter of a standard 4-inch boiler tube is 3.74 inches, which multiplied by 3.1416 gives the inside circumference

$$3.74 \times 3.1416 = 11.75 \text{ inches.}$$

Hence each foot of length of a 4-inch boiler tube will contain

$$\frac{11.75 \times 12}{144} = 0.979 \text{ square feet}$$

* From *Power*.

TABLE 1.—PRINCIPAL DIMENSIONS OF STANDARD BOILER TUBES FROM 2 TO 4 INCHES OUTSIDE DIAMETER.

External Diameter.	Standard Thickness.	Inside Diameter.	Inside Circumference.	Outside Circumference.	Heating Surface per Foot of Length.	Length per Square Foot Heating Surface.	Cross Section in Square Feet	
							Outside Diameter.	Inside Diameter.
2	0.095	1.810	5.6858	6.2832	0.4739	2.11	0.0218	0.017870
2¼	0.095	2.060	6.4717	6.7066	0.5393	1.86	0.0276	0.023112
2½	0.109	2.282	7.1691	7.8540	0.5974	1.67	0.0341	0.028402
2¾	0.109	2.532	7.9545	8.6394	0.6629	1.51	0.04120	0.034870
3	0.109	2.782	8.7399	9.4248	0.7283	1.37	0.04909	0.041451
3¼	0.120	3.010	9.4562	10.2102	0.7880	1.27	0.05761	0.049412
3½	0.120	3.260	10.2416	10.9950	0.8535	1.17	0.06681	0.05796
3¾	0.120	3.510	11.0270	11.7810	0.9189	1.08	0.0767	0.067195
4	0.134	3.732	11.7244	12.5660	0.9790	1.02	0.0872	0.075270

TABLE 2.—AREAS TO BE DEDUCTED FROM AREA OF BOILER HEAD FOR ANY NUMBER OF TUBES FROM 2 TO 4 INCHES DIAMETER.

External Diameter of Tubes.	1	2	3	4	5	6	7	8	9
2	0.0218	0.0436	0.0654	0.0872	0.1090	0.1308	0.1526	0.1744	0.1962
2¼	0.0276	0.0552	0.0828	0.1104	0.1380	0.1656	0.1932	0.2208	0.2484
2½	0.0311	0.0682	0.1023	0.1364	0.1705	0.2046	0.2387	0.2728	0.3069
2¾	0.0412	0.0824	0.1236	0.1648	0.2060	0.2472	0.2884	0.3296	0.3708
3	0.0491	0.0982	0.1473	0.1964	0.2455	0.2946	0.3437	0.3928	0.4419
3¼	0.0576	0.1152	0.1728	0.2304	0.2880	0.3456	0.4032	0.4608	0.5184
3½	0.0637	0.1274	0.2011	0.2548	0.3185	0.3822	0.4459	0.5096	0.5733
3¾	0.0767	0.1534	0.2301	0.3068	0.3835	0.4602	0.5369	0.6136	0.6903
4	0.0872	0.1744	0.2616	0.3488	0.4360	0.5232	0.6104	0.6976	0.7848

TABLE 3.—HEATING SURFACE IN HALF SHELL OF CYLINDRICAL BOILERS.

Length in Feet.	Diameter of Shell, in Inches.						
	42	44	46	48	50	52	54
14.	76.96	80.63	84.29	87.96	91.64	95.30	98.95
14.5	79.71	83.51	87.30	91.10	94.91	98.70	102.48
15.	82.46	86.39	90.31	94.24	98.18	102.10	106.02
15.5	85.21	89.27	93.32	97.38	101.46	105.51	109.55
16.	87.96	92.15	96.33	100.53	104.73	108.91	113.09
16.5	90.71	95.03	99.34	103.67	108.00	112.31	114.62
17.	93.47	97.91	102.35	106.81	111.28	115.72	120.16
18.	98.95	103.67	108.37	113.09	117.82	122.52	127.22
19.	104.45	109.43	114.39	119.37	124.37	129.33	134.29
20.	109.94	115.19	120.42	125.66	130.90	136.14	141.36
Area of head, square feet..	9.62	10.56	11.54	12.57	13.64	14.75	15.90

Length in Feet.	Diameter of Shell, in Inches.						
	56	58	60	62	64	66	68
14.	102.63	106.29	109.96	113.62	117.28	120.95	124.62
14.5	106.29	110.09	113.88	117.68	121.48	125.27	129.07
15.	109.96	113.88	117.81	121.74	125.66	129.58	133.52
15.5	113.62	117.68	121.73	125.80	129.85	133.90	137.98
16.	117.29	121.47	125.66	129.85	134.04	138.22	142.43
16.5	120.95	125.27	129.58	133.91	138.23	142.54	146.88
17.	124.62	129.07	133.52	137.97	142.42	146.86	151.32
18.	131.95	136.66	141.37	146.09	150.80	155.50	160.22
19.	139.28	144.25	149.23	154.20	159.17	164.14	169.12
20.	146.61	151.84	157.08	162.32	167.55	172.78	178.02
Area of head, square feet..	17.10	18.35	19.63	20.97	22.34	23.76	25.22

Length in Feet.	Diameter of Shell, in Inches.						
	70	72	74	76	78	80	84
14.	128.28	131.94	135.61	139.28	142.94	142.94	150.27
14.5	132.86	136.66	140.46	144.25	148.05	148.05	155.64
15.	137.44	141.37	145.30	149.23	153.15	153.15	161.00
15.5	142.03	146.09	150.14	154.20	158.26	158.26	166.37
16.	146.61	150.79	154.99	159.17	163.36	163.36	171.74
16.5	151.19	155.51	159.83	164.15	168.47	168.47	177.11
17.	155.77	160.21	164.67	169.12	173.57	177.99	186.93
18.	164.93	169.64	174.36	179.07	183.78	188.46	197.92
19.	174.10	179.06	184.05	189.02	193.99	198.93	208.92
20.	183.26	188.48	193.73	198.97	204.20	209.40	219.92
Area of head, square feet..	26.73	28.27	29.87	31.50	33.18	34.91	38.49

of heating surface, and in 44 tubes each 16 feet long there will be

$$16 \times 44 \times 0.979 = 689.216 \text{ square feet.}$$

The area of a 60-inch (5-foot) boiler head is

$$5 \times 5 \times 0.7854 = 19.635 \text{ square feet.}$$

The cross-sectional area of a 4-inch boiler tube is 12.566 square inches, and in 88 tube ends there will be

$$\frac{88 \times 12.566}{144} = 7.679 \text{ square feet.}$$

Therefore, the heating surface of the boiler will be, in the shell,

$$\tfrac{1}{2} \times 5 \times 3.1416 \times 16 = 125.664 \text{ square feet.}$$

In the tubes

$$16 \times 44 \times 0.979 = 689.216 \text{ square feet.}$$

In the heads

$$19.635 - 7.679 = 11.956 \text{ square feet,}$$

adding

$$125.664 + 689.216 + 11.956 = 826.836 \text{ square feet.}$$

If 10 square feet of surface are allowed per horsepower, the boiler will be rated as

$$\frac{826.836}{10} = 82.68 \text{ horsepower.}$$

Tables 1, 2 and 3 have been prepared for the purpose of shortening the process of calculating the areas of heating surface. In Table 1 will be found all of the principal dimensions of standard boiler tubes from 2 to 4 inches in diameter. Table 3 gives the heating surface of one-half the shell and the area of the heads of boilers from 42 to 84 inches in diameter and from 14 to 20 feet in length. Table 2 gives the areas to be deducted from the area of the boiler head for various sizes and numbers of tubes.

To illustrate the use of the tables, take the same example, shell, 5 by 16 feet, forty-four 4-inch tubes.

Opposite 16 and under 60 in Table 3, the number 125.66 is found. To find the total cross-sectional area of the eighty-eight 4-inch tube ends to be deducted from the area of one head, use Table 2. Under 8 and opposite 4, 0.6976 will be found. This is the area in square feet of eight 4-inch tube ends. By moving the decimal point one place to the right, the number is multiplied by 10, and becomes 6.976, which is the area of 88 tube ends, which added to the other number gives the total area desired:

$$0.6976 + 6.976 = 7.67 \text{ square feet.}$$

Or the area of one tube end 0.0872 square feet may be multiplied by the number of tube ends:

$$88 \times 0.0872 = 7.6676.$$

Adding the area as found in the tables, the total heating surface of a 5 by 16-foot boiler having forty-four 4-inch tubes is found to be:

In one-half the shell, 125.66 square feet; in forty-four 4-inch tubes, 689.21 square feet; in the heads, 11.96 square feet, making a total of

$$125.66 + 689.21 + 11.96 = 826.83 \text{ square feet.}$$

Locomotive Boiler Explodes in Mexico

An oil-burning locomotive operating on one of the Mexican railways exploded Feb. 18 with the disastrous effects shown in the accompanying engraving. The engine had been in service for two months with a new firebox. The cause of the explosion is said to be low water. This explosion is remarkable in that no one was killed, notwithstanding the fact that three men were on the engine at the time of the explosion, when the engine was hurled from the track and turned end over end. The three men on the engine were only slightly injured.

ANOTHER LOW-WATER EXPLOSION

AMERICAN SOCIETY OF ENGINEER DRAFTSMEN.—At the annual meeting of the American Society of Engineer Draftsmen, held recently in New York, the following officers were elected for the ensuing year: Prof. Charles William Weick, president; William D. Harsel, first vice-president; Charles A. Clark, second vice-president; C. B. J. McManus, third vice-president; L. T. Maenner, fourth vice-president, and E. F. Chandler, Henry L. Sloan and C. W. Fleming, board of governors. Walter M. Smyth, 116 Nassau street, New York, is secretary.

Tools for Boiler Makers and Their Uses—III

BY W. D. FORBES

On the edge of a steel plâte this system cannot be used. In very heavy chipping another form of chisel is used which differs from that described. Fig. 21 shows such a tool. This is often called a "rivet buster." It is a chisel so made as to receive a handle. This handle is very often made from the spoke of an old or broken wagon, and for this purpose discarded spokes are excellent, as they are cheap, strong and easily fitted to the eye of the chisel. They can be used to advantage in a number of tools about a boiler shop.

Instead of the ordinary hand hammer a sledge is used with the "buster," and sledges are to be had in a number of weights, the class of work determining which to use. Of course, the

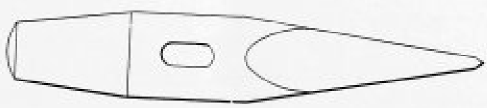


FIG. 21.—CENTER CUT CHISEL OR RIVET BURSTER

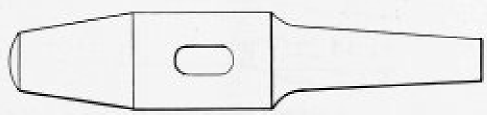


FIG. 22.—BACKING OUT PUNCH

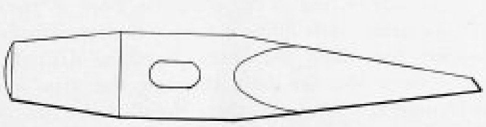


FIG. 23.—SIDE CUT CHISEL

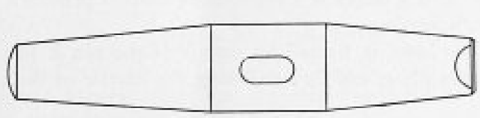


FIG. 24.—HANDLE RIVET SET

heavier the work is the heavier must be the sledge. One man holds the buster and a second man swings the sledge. Fig. 23 represents what is called a "side-cut" chisel, which is of use in many cases where the one shown in Fig. 21 could not be used to advantage.

Center Punch

A hand tool which is of very great value to the boiler maker is the center punch. This is sometimes called a "prick punch," and it may be said that it is the "lighthouse" of the boiler maker; that is, it marks the path or shows where to go. A very usual form is shown in Fig. 25. In laying out work it is used to prick-punch the lines which have been drawn on the boiler plate in chalk, so that in handling them the marks if rubbed out can be remade with ease. Again, the center punch can be used to prick-punch a point in laying out any work which requires a circle to be drawn or struck, as one foot of a pair of dividers can be placed in the punch mark for this work.

A light hammer is used with the center punch, and while the illustration shown is the usual style used a round piece of steel is often used, and when a boiler maker wants to be very much up-to-date he buys a prick-punch like the one shown in Fig. 26. This is the same old center punch, but it looks as if it had been to college. While on the subject of college-looking tools we wish to say that while the boiler makers' trade is a rough one there is no reason why nicely finished hand tools should not be used by a boiler maker. In fact, by being willing to use any old tool the boiler maker makes his trade rougher than it need be, and we hope when any young boiler maker wants a hammer or a prick-punch he will get a nice-looking one.

In using the prick-punch the novice will find trouble in holding it, as it has a way of flying out of his fingers when struck with a hammer, so the octagonal steel or the knurled body has an advantage over just a round piece of steel. A prick-punch must be kept in good shape ; that is, the point must be sharp. To grind it on an emery wheel or grindstone is quite a trick.

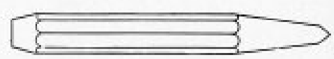


FIG. 25.—USUAL TYPE OF CENTER PUNCH

FIG. 26.—SPECIAL CENTER PUNCH

The angle is about 45 degrees, and as it is pressed against the stone a rotary motion must be given to it so as to produce a true cone. Some practice is necessary to do this, especially if the emery wheel or grindstone is in the condition usually found in boiler shops. Some very bad accidents have been known to occur from the disgraceful condition of these two shop tools. Care should be taken by those who try grinding any tool for the first time, as the pressure of the tool against the wheel tends to drag it down, and the hand can easily be drawn against the stone with the possibility of a very painful wound.

When grinding any tool water should be used, as otherwise the heat which results from the pressing of the tool against the emery wheel will draw the temper. Neglecting to have water at hand has resulted in a very great loss to shop owners. It is very hard to get them to believe this; but when they remember that any 10-cent store will sell them a tin pail which does not leak, and that the old rusted-out tomato can now in use requires a trip to the sink every time a 40-cent man wants to grind a tool the value of the investment will be clear to them.

Ratchets

In many cases holes have to be drilled in boiler and tank work by hand, and what is known as a ratchet is used for this work in connection with a drill. Fig. 27 shows one of the many forms of this very useful tool. The particular type illustrated is called a differential ratchet, and was the invention of Mr. T. A. Weston, who also invented the differential pulley block, a device which is used so extensively in lifting work about boiler shops.

The main trouble in making a good substantial ratchet lies in the necessity for strong teeth, and yet they must be made so that the swing of the handle will not be too great for confined spaces, otherwise a tooth would not be caught by the pawl. If made small they are apt to break or soon wear out. Mr. Weston overcame this difficulty by using two ratchets and two pawls, one set above the other, with the teeth set "staggering"; that is, so that the teeth of the upper ratchet were between the teeth of the lower ratchet. This gave great strength and yet allowed a short swing of the handle. In England the makers of this ratchet used to advertise that no burgler's kit of tools was ever captured that did not have one of the Weston differential ratchets in it.

There are a great many good ratchets in the market, a representative type of which is illustrated in Fig. 28. The

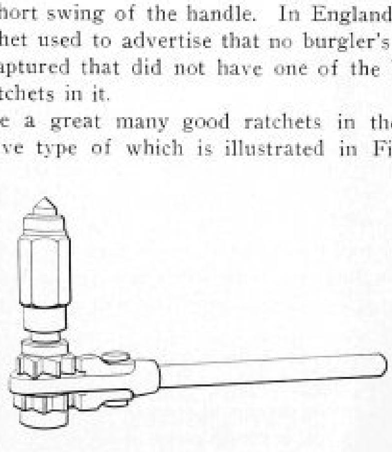


FIG. 27.—RATCHET FOR GENERAL PURPOSES

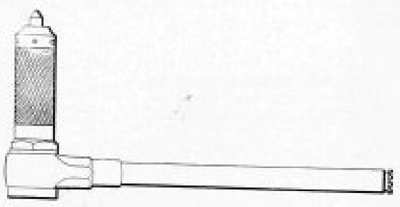


FIG. 28.—REVERSIBLE RATCHET

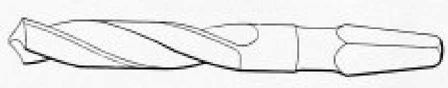


FIG. 29.—TAPER, SQUARE SHANK, RATCHET TWIST DRILL

higher grade of material now obtained allows the use of finer teeth without the danger of their breaking. Some ratchets are made to work by a friction device, and in this case no teeth are required.

There are several tools of the ratchet type where the drill is given an almost continuous turning movement by having the ratchet pawl reverse and act through a second ratchet and pawl, but it has not become very popular with those who have to swing the handle, since to push against the cut of the drill and also pull against it becomes very tiresome in heavy work.

Ratchet Drills

Two styles of drills are used in ratchets—the twist drill (Fig. 29) and the flat drill (Fig. 30). Either of these drills can be fitted with a taper or square shank, and, of course, the ratchet socket must be made to suit. The flat drill has held its place for years and in confined spaces it is easier to handle. Very short drills are made, and special short ratchets are on the market to be used where the limits of space demand it. Fig. 31 shows one of the special short ratchets.

The "Old Man"

When using a ratchet some kind of backing has to be provided in order to steady the drill and allow it to be fed into the material. Usually what is called an "old man" is used, as this is easily made and attached. The material is iron or steel, and for everyday work is about 5/8 inch thick and 2 inches wide. The reach can be made any length desirable, but a length of about 8 inches is handy. The height under the arm should be 12 inches. The foot is usually a little longer than the arm, say 3 inches more, and a series of holes 3/4 inch diameter is drilled in it. On the under side of the arm is provided a series of heavy prick-punch marks, and into one of these the head of the feed screw of the ratchet is placed after the "old man" is bolted to the plate.

Referring to Fig. 32, a very handy style of "old man" can be seen which can be bought at any supply house. Its value lies in the fact that the arm is adjustable in height and it can also be swung around the vertical bar into any desired position. This in itself is a great advantage, as at times the positions of the holes in the boiler or plate to which the foot must be bolted cannot be reached with the ordinary style of "old man," but, in spite of this fact, it is strange that very few boiler shops are properly provided with this valuable tool.

Operation of a Ratchet Drill

The feed screw of the ratchet has a cone-shaped head, as can be seen in Fig. 31. In this head are drilled holes into which a pin is inserted in order to turn the feed screw. The cone-

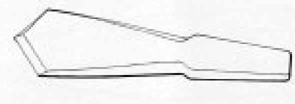


FIG. 30.—FLAT DRILL

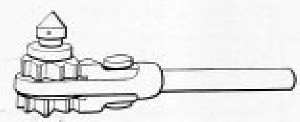


FIG. 31.—RATCHET FOR CONFINED SPACES

shaped point very soon wears down, or becomes cut, due to the fact that oil cannot be fed to the cone, as, when in operation, it is under the arm. It is quite a simple matter, however, to provide means for oiling the screw head by drilling small holes, say, with a No. 40 drill, through the arm into the prick-punch marks. Through these small holes oil can be easily fed to the cone head.

It is wise to countersink the prick-punch hole enough to give the screw head a larger bearing surface than is provided by the prick-punch marks.

When the head is turned by means of the pin it forces the drill into the plate, and by oscillating the handle of the ratchet

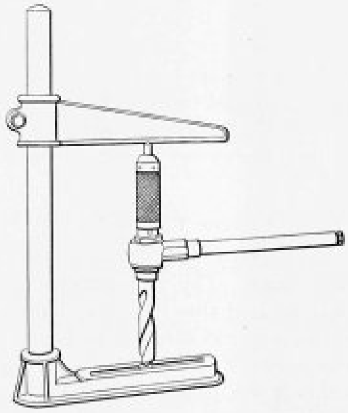


FIG. 32.—DRILL POST OR "OLD MAN"

the drill is revolved and a chip taken. There is a certain amount of spring in the "old man," no matter what style is used, which acts while drilling, making the feed fairly constant for a few turns; but it must be remembered that, as the drill is about to break through the metal, the feed must be made very light, or the drill will catch and it will have to be taken out and the last part of the hole chipped out, which does not make a nice job. For this work, therefore, the driller should remember "feed slow when the point of the drill comes through the plate."

When drilling, oil should be used freely on all material except cast iron or brass. On these two materials oil is of no value.

In getting a hold for the "old man" considerable skill is required, and much ingenuity is shown in such work. A chain passed entirely around the boiler is a handy way to get an anchorage. Sometimes a piece of rope and a board can be used when no other way can be found to back up the drill.

In feeding the drill to the work, as already noted, a pin is used to turn the feed screw. Some ratchets, however, are not made with a screw, as described in the preceding paragraph. Fig. 27 shows a ratchet where the feed screw is provided with a threaded sleeve which fits the thread of the feed screw. It is provided with squares on which a wrench can be used to get the feed.

Other Ratchet Tools

The ratchet idea is used in many ways in machine work, one use of the idea being to set up nuts. Fig. 33 shows a wrench for such work, in which, of course, the hole in the ratchet can be either a square or a hexagon and of any required size.

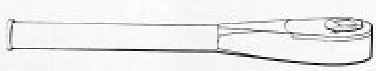


Fig. 33.—Reversible Ratchet Wrench

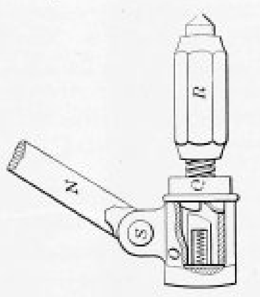


Fig. 34.—Swivel Handle Ratchet

This tool is a money-saver, but it is not found as often as it should be in boiler shops. In fact, it is very seldom seen there.

In a very confined space it is convenient to have a ratchet with a handle which swivels, as it allows a man to work the handle at different angles. A ratchet of this class is shown in Fig. 34.

The Sledge

The sledge, which has already been referred to, is only an overgrown hammer, but it is a very handy tool in a boiler shop. At first sight it looks like quite an easy task to swing a sledge, yet it requires practice and skill to use it to advantage without hurting your fellow workmen or yourself. In fact, some very serious accidents have resulted from a glancing blow from a sledge. The uses for the sledge are too numerous to mention. In backing out rivets, driving drift pins and driving rivet sets the sledge is, of course, indispensable.

A rivet set is a piece of tool steel turned up on the shank when used in what is called an "air gun," or forged, as shown in Fig. 24, and cupped out so as to form either a round or cone-shaped rivet head. When the rivet is driven the workman holds the set over the roughly-formed rivet head, and the helper swings the sledge, with the result that the rough rivet head is worked into a smooth form, making the work look shipshape.

Use of the Drift Pin

The drift pin is called in some parts of the world "the boiler maker's best friend," but it is the enemy of good work. It has its legitimate use in assembling boiler work, but it is used far too often to correct poor punching, with the result that sheets are strained and trouble results. Not infrequently deaths have been attributed directly to the use of the drift. The drift in itself is a piece of tool steel drawn to a taper and hardened. The small end may be about ⅜ inch diameter and the taper 6 inches or 8 inches long. When two rivet holes do not match up the drift is driven into the opening and the sledge swung onto it. Thus the two holes are made to line up after a fashion, but a botch job is made. Most boiler shop proprietors have the idea that in their works the drift is not used, but that in all other boiler shops it is used to a very great extent. It is true that since the electric and air drills have come into use the drift is not employed as much as it was some years ago, but its use has not been discarded as it should be. The heavy plates now used make the drift a danger even in the hands of a skilled man. Cases have been known where the drift when driven flies out with a force great enough to break a man's arm.

In backing out rivets for repair work, or in backing out a

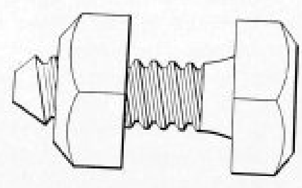


Fig. 35.—Steel Boiler Bolt

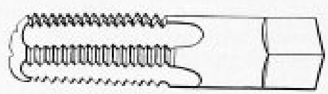


Fig. 36.—Patch Bolt Tap

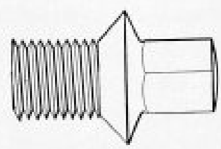


Fig. 37.—Boiler Patch Bolt

faulty rivet, the rivet's head is first cut off with a rivet buster, as was described earlier in this article. Then the backing-out punch, Fig. 22, is held against the rivet and a few sharp blows knock the rivet out. We say "sharp blows," because if light tapping blows are given the rivet will be upset on its end and it will become so firmly set that it will have to be drilled out, which is a long process compared with backing it out. There are times, however, when the very heavy blows should not be used, as in flange turning, where a number of light blows delivered along the edge of the plate being flanged do not strain the iron or stretch it too much. In such work a wooden maul is very often used, as it does not dent the metal but still forms up the material.

Patch Bolts and Patch Bolt Taps

Taps of various kinds have been mentioned before. There is, however, another very useful kind of tap known as a patch bolt tap, Fig. 36, which has not been mentioned. This tap differs from the standard taps by having a slight taper. This results, of course, in producing a taper-tapped hole so that in screwing a bolt into it a tight joint is made. For use in connection with this tap there is a special patch bolt, as shown in Fig. 37.

In using the patch bolts the patch is fitted to the shell of the boiler or wherever it may be required. It is then taken to the drill press, and the holes are drilled as seems best suited to make the patch hold. It is again laid on the sheet and the holes marked from it. These holes are then drilled after the patch is taken off again, but it must be remembered that these holes in the sheet have to be of tapping size, and not as large as those in the patch. These holes are then tapped with the patch bolt tap and the patch is placed in position. After suitable packing has been properly applied, and the patch firmly held in place by means of cap screws, a countersink of proper size for the bolt used is employed, but it should not be the ordinary type of countersink, but one which is provided with a "pilot"; that is, a teat on the small end which fits the tapped hole. This teat acts as a guide for the countersink and reams out a coned-shaped hole which is concentric with the tapped hole, so when the patch bolt is screwed home the bevel on the bolt will fit nice and snug and make a good, tight joint.

Erecting Bolts

In assembling boiler and plate work it is, of course, advantageous to get the sections together as quickly as possible. The regular bolts to be found in the market have standard threads, as explained before. In boiler work it is rare to find bolts of less than ¼ inch diameter or larger than 1½ inches diameter. Fig. 35 shows a bolt on which a coarse thread is used; that is, there are fewer threads to the inch than is usual, which makes it possible to run the nuts on them much quicker, but it must be remembered that these quick-thread bolts do not hold well nor can the nut be set up snug or solid, but since the nuts are made loose they can be put on with the thumb and finger and the plates brought together rapidly. The following table gives diameters and lengths of these quick-thread bolts, all of which can be secured in the open market:

Diameters and Lengths of Erecting Bolts

Diameter in Inches	Length in Inches	Diameter in Inches	Length in Inches
½	1½	¾	2
½	1¾	¾	2½
⅝	1½	¾	3
⅝	2	⅞	2
⅝	2½	⅞	2½
¾	1½	⅝	3

(To be continued.)

Programme of Boiler Makers' Convention

The seventh annual convention of the Master Boiler Makers' Association will be held May 26, 27, 28 and 29, 1913, in the Hotel Sherman, Chicago, Ill. Special rates on the European plan have been made at the Hotel Sherman, the rates ranging from $2 to $5 per day for a room, according to the number of persons occupying the room and whether with or without a bath. Special arrangements have also been made for extensive exhibits of boiler makers' supplies, electricity and compressed air power being available for operating the machinery exhibited.

The programme of the convention is as follows:

May 26 (2 to 5 P. M.)

Invocation, the Rev. Jenkin Lloyd Jones, pastor All Souls Church.

Addresses by Mr. W. L. Park, vice-president and general manager, Illinois Central Railroad; Mr. C. A. Seeley, mechanical engineer, Chicago & Rock Island Railroad; Mr. John F. Ensign, chief Federal Boiler Inspector, Washington, D. C.

Responses by Mr. A. N. Lucas, Mr. John A. Doarnberger, Mr. Charles Hempel.

Address by Mr. M. O'Connor, president of the association.

Routine business.

Miscellaneous business.

May 27 (9 A. M. to 1 P. M.)

Address by Mr. B. A. Worthington, president, Chicago & Alton Railroad.

Report of committee on "How Many Rows of Expansion Stays is it Advisable to Apply to a Crown Sheet to Secure the Most Efficient Service, Considering the Wear and Tear of Boilers?" E. W. Rogers, chairman.

Report of committee on "Is There Any Limit to the Length of a Tube in a Boiler Without a Support Midway of Boiler, and will a Support Prove Objectionable in Circulation?" J. A. Doarnberger, chairman.

Report of committee on "When is a Boiler in a Weak and Unsafe Condition?" Edw. Young, chairman.

Report of committee on "Best Method of Welding Superheating Tubes and Tools Used for Same." B. F. Sarver, chairman.

Report of committee on "What Effect do Superheaters have on the Life of Fireboxes and Flues?" Charles L. Hempel, chairman.

May 28 (9 A. M. to 1 P. M.)

Address by Mr. Robert Quayle, superintendent of motive power and machinery, Chicago & Northwestern Railway System.

Report of committee on "What Are the Advantages and Disadvantages of Using Oxy-Acetylene and Electric Processes for Boiler Maintenance and Repairs?" A. N. Lucas, chairman.

Report of commitee on the "Proper Inspection of a Boiler While in Service." George B. Underwood, chairman.

Report of committee on "Best Form of Grate to be Used to Insure Removing of Fire at Terminals with the Least Abuse of Fireboxes and Flues, Insuring Most Economy as well as High Efficiency." C. J. Murray, chairman.

Report of committee on the "Best Method of Applying and Caring for Flues While Engines are on the Road and at Terminals." W. H. Laughridge, chairman.

Report of committee on "Steel vs. Iron Tubes—What Advantages and What Success in Welding Them and Advantages of Either in Maintenance, Mileage, Etc.?" D. G. Foley, chairman.

Report of committee on "What Benefit Has Been Derived from Treating Feed Water for Locomotive Boilers, Chemically, etc.?" A. E. Shaule, chairman.

May 29 (9 A. M. to 1 P. M.)

Address by Mr. J. F. Devoy, assistant superintendent of motive power, C. M. & St. P. Railroad.

Report of the committee on "Law." George W. Bennett, chairman.

Report of committee on "Subjects." James Crombie, chairman.

Report of auditing committee.

Miscellaneous business.

Unfinished business.

Correspondence, resolutions, etc.

Selection of next place of meeting.

Good of the Association.

Election of officers.

Adjournment.

The Boiler Maker

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

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

No better evidence of the benefits of the brick arch as a factor in locomotive performance could be obtained than the results of the comparative tests of the radial-stay and Jacobs-Shupert boilers, published elsewhere in this issue. In these tests it was found that the addition of a brick arch in the firebox of locomotives using long-flame coal increased the evaporative efficiency as much as 12 percent, while with coal having half the volatile matter the increased evaporative efficiency amounted to from 5 to 8 percent. The early objections to brick arches on account of difficulties in installation and maintenance seem to have been wholly overcome in recent years by the manufacturers of this device, and henceforth there seems to be no reason why the brick arch should not be universally adopted where the question of economy is of first importance, as it usually is in railroad service.

One of our readers wishes to know if any of the boiler shops engaged in a general line of contract work have adopted the Taylor, Gantt, Emerson or any other system of scientific management, and, if so, what practical results were obtained from the adoption of such a system? We hope that any of our readers who are in a position to do so will send us some information on this point for publication in our next issue, explaining the practical workings of the system adopted and what was accomplished by its use. Scientific management is a subject that cannot be ignored in such an important industry as boiler making, for the various systems so thoroughly developed by the famous engineers mentioned above all have this in common, that they are intended, first of all, to increase shop efficiency by directing the forces of production to the best advantage in economy. With such an object in view it makes little difference whether the industrial unit is large or small: increased shop efficiency is much to be desired in either case, although in a large plant the benefits, of course, are more conspicuous. Just how to adopt successfully in a comparatively small contract boiler shop methods of scientific management that have found ready application in some of the largest manufacturing and operating institutions in the country might seem difficult to one who understands thoroughly the principles of the system but has had no opportunity to study its practical application, and for this reason we hope that our correspondent's question will be fully answered by some of our readers in the next issue.

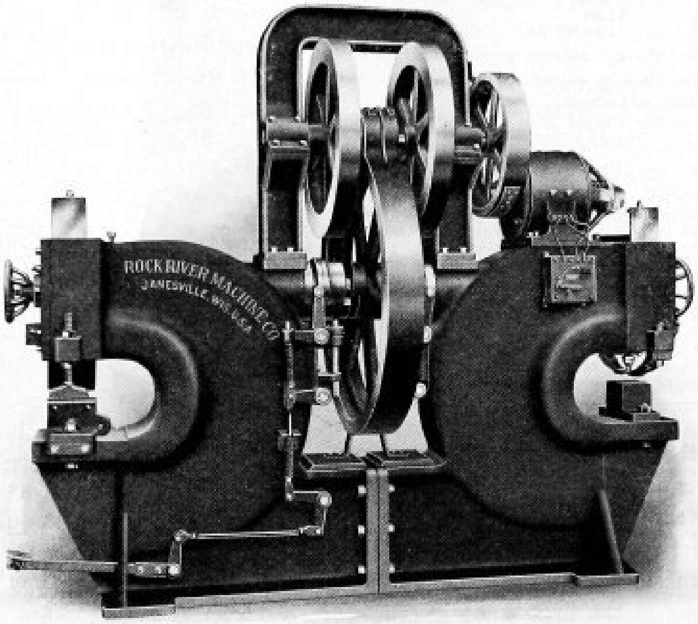
One of the most important events of the year in the boiler making field is the annual convention of the Master Boiler Makers' Association. This year the convention will be held in Chicago from May 26 to the 29th, and a glance at the programme of the meetings outlined elsewhere in this issue should convince every member of the association, as well as those master boiler makers who have not yet become identified with this society, that the time and effort spent in attending these meetings will be well repaid. A great many important subjects are to be discussed, and many prominent railroad officials will address the association. As is customary, the work of the association is carried on throughout the year by carefully chosen committees, which will present exhaustive reports on the subjects which they have had under consideration and which will form the basis for discussion at the convention. Although most of the topics relate chiefly to railroad boiler problems, it should be remembered that the Master Boiler Makers' Association is by no means solely a railroad organization, but that its purpose is to cover the whole boiler making field, including the contract and marine branches as well as the railway field, and that the contract and marine boiler makers should turn out in force and sustain their share of the activities of the association. The special problem relating to contract and marine work will receive as careful consideration as the railway problems if the men engaged in such work will only attend the convention and present their difficulties. At all events, it is hoped that each branch of the craft will be fully represented, and that the old-time enthusiasm of the regular members will be doubled and the forthcoming convention made the biggest and best convention the association has ever held.

Engineering Specialties for Boiler Making

Double End Punch and Shear.

The double end punch and shear illustrated on this page has just been completed by the Rock River Machine Company, Janesville, Wis., for shipment to the Pacific Coast. The machine is arranged for motor drive and all the gears are guarded to comply with the strict factory safety laws which are now in force. Although such laws are not yet in effect in every State in the Union, undoubtedly they will be in the near future. In this machine, however, the safety guards are a part of the standard equipment of each machine regardless of State factory laws.

The main bodies of the machine are cored and of boxed housing design, which adds materially to the strength of the machine without adding excessive weight. The lateral strength of a hollow section, as used in this case, it is claimed, exceeds that of a solid section of the same sectional area by as much as 40 percent. The flywheels, which are turned all over and properly balanced, are located inside the bearing instead of overhanging, as is generally the case in machines of this type. The main bearings are fitted with bronze bushings and provided with proper lubrication. The eccentric shaft is approximately 50 percent carbon steel, annealed, rough turned and carefully ground to size. The main frames and gears are of semi-steel, the strength of which is considerably over that of gray iron castings. All punch and shear blocks are held in place by bolts, fitted to reamed holes. These bolts line up the shear or punch accurately, so that no hammer is needed to adjust them once the nuts have been tightened. The strippers and hold-downs are made of steel forgings of such proportions as to render springing or bending impossible. An automatic stop is provided which, it is claimed, is absolutely positive, preventing the machine from starting up of its own accord, should the eccentric shaft be turned in one or the other direction.



The machine illustrated has a depth of throat of 20 inches. It has a capacity for punching 1¼-inch holes in 1-inch steel plate; for splitting ⅞-inch steel plate; shearing 1¾-inch rounds, 6-inch by 1-inch steel bars or 5-inch by 5-inch by ⅝-inch angles. A 7½ horsepower motor is provided, running at 250 revolutions per minute, the ratio of gearing being 9 to 1.

These machines are handled by the Vulcan Engineering Sales Company, Chicago, Ill.

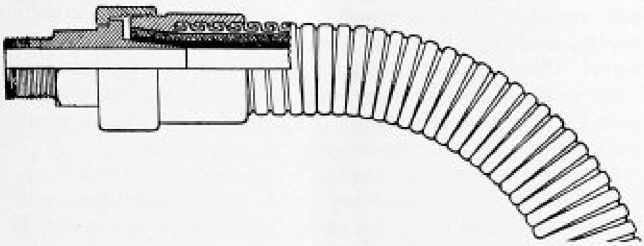
Fay Template Board

The Fay Manilla Roofing Company, Camden, N. J., has on the market a new material especially adapted for template work in shipyards. Laying off by the mold system is generally recognized by shipbuilders as the cheapest method of laying off ship plating, bulkheads, tank tops, frames, etc. In fact, laying off such work from templates made in the mold loft, even when the molds are made of wood, as was formerly the custom, costs only about one-third as much as laying out each piece separately in the yard. Wood templates, however, entail a heavy expense for material and labor, besides encumbering the mold loft on account of the bulk of the material, and so the use of a material such as the Fay template board, which is practically a very stiff, thick paper, specially prepared to resist tearing, distortion or shrinkage from rough usage, makes it possible to reduce the cost of the mold system very materially by the saving in labor and material. Templates made on Fay template board, which is supplied in rolls 105 inches wide, containing 2,000 square feet to the roll, can be rolled up and stowed in racks or bins, where they are ready for use at a moment's notice as often as they are needed.

Fay template board is equally applicable to boiler work and the layout of sheet metal construction, since accurate patterns first laid out on the template board can be quickly transferred to the sheet metal when required.

A New Flexible Hose that Doesn't "Kink"

Users of hose or flexible connectors for steam and pneumatic service have always sought for a high-pressure hose that wouldn't kink, flatten, puncture or collapse at inopportune moments. Troubles of this nature have become so common with ordinary hose that they are accepted as a matter of course, to be dealt with philosophically, just as other vexing problems are met in the course of daily routine, but a new coupling known as the J-M Flexible Metallic Combination Hose has been placed on the market by the H. W. Johns-Manville Company, of New York, which is said to have overcome these difficulties. This connector consists of a superior grade



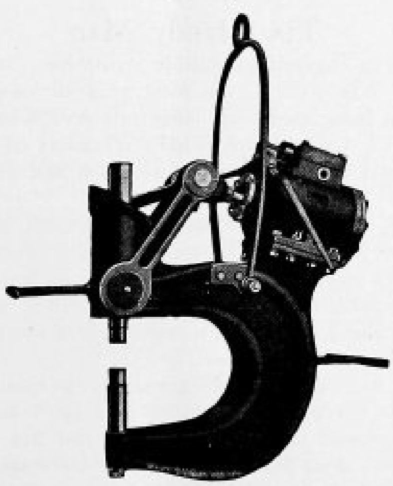
of durable rubber hose, protected against outward injury by a stout metal armor made in the form of a ribbon, with crimped edges, forming, when wound, a continuous, interlocking flexible spiral, which is said to be practically pressure-tight in itself without the inner tube. As the interlocking construction of the spiral restricts the curvature, sharp bends are impossible. Consequently the inner tube cannot kink or flatten, and is always open to its full diameter, permitting an unrestricted flow of steam, gas or fluid. Owing to its unusual strength, the armor is practically proof against damage from the outside, and the substantial construction of the armor permits the use of a much lighter inner tube than is ordinarily used. The exterior surface of the hose, it is claimed, does not become excessively hot when used for steam service, drills, blowing out boilers, etc., and therefore can be conveniently handled under such conditions. Further, there are no rough edges in the metal armor to cut or chafe the inner tube or to cut or scratch the hands of the user.

Specially designed couplings of malleable iron or brass are furnished with each length of hose.

J-M combination hose can be furnished in any length, in any inside diameter up to 12 inches, of any metal, and for all working pressures. It is also made with an inside pressure-tight metallic lining as well as outside metal armor, for suction service, oils, etc.

Compression Riveters

The compression or squeeze riveter shown in the illustration may be used advantageously where the riveting to be



done is more or less uniform and accessible and where it is done in large quantities. This riveter is used extensively in the structural iron and steel industry, as well as in boiler shops, steel car plants and shipyards where the cost of riveting is an important item. The use of this riveter is claimed to effect a material reduction in the cost of riveting. The manner of operation is evident from the photograph, the power generated by the action of compressed air on the piston in its cylinder is transmitted through a series of levers and toggles to produce a compounded effect, making it possible with 80 pounds of air pressure to produce a final pressure of as high as 75 tons on the rivet. The riveter may be fitted with yokes of various dimensions adapting it to a wide variety of uses. Lugs or feet may be cast on to the frame, or yoke, so that the machine may be fixed in a horizontal or vertical position as desired and used as a stationary machine.

This riveter is manufactured by the Chicago Pneumatic Tool Company, Chicago.

Technical Publication

Boiler Explosions, Collapses and Mishaps. By E. J. Rimmer. Size, 5½ by 8½ inches. Pages, 135. New York, 1912: D. Van Nostrand Company, and London, 1912: Constable & Company, Ltd. Price, $1.75 net, and 4s. 6d. net.

Whenever boiler explosions are the subject of comment in the daily or technical press attention is invariably called to the fact that England, in spite of her immense industrial activities, is practically immune from disastrous boiler explosions. In fact, England is frequently held up as a model in this respect, although little is said about the laws and statutes that bring about this much-to-be desired state of affairs. It is doubtful if many boiler makers or engineers in the United States have a very clear idea of what these laws are, or how they are enforced. As a matter of fact England is by no means immune from boiler explosions, but each explosion that occurs, whether in a railway, marine or stationary boiler plant, is thoroughly investigated, and every possible means is utilized to establish beyond a doubt the actual cause of the explosion. The knowledge gained by such thorough investigations serves as both a warning and a guide for further construction, operation and inspection of steam boilers, and tends to raise the standard of safety to the highest level. All legislation in England in regard to boilers and boiler explosions is contained in the following statutes: Boiler Explosions Acts, 1882 and 1890; Factory and Workshop Acts, 1901; Railway Regulation Act, 1871; Metalliferous Mines Regulation Act, 1872; Coal Mines Act, 1911; Quarry Act, 1894; Merchant Shipping Act, 1894; Notice of Accidents Acts, 1894 and 1906; Railway Employment (prevention of accidents) Act, 1900. The most important statutes affecting all steam users are the first of the above named; that is, the Boiler Explosions Acts, 1882 and 1890. In this volume the author has endeavored to bring together the results of all the inquiries and investigations made under these two acts. There have been over 2,000 of these inquiries, and though each in turn has been the subject of comment by various authorities in the engineering press, it is very likely that the lessons which they teach have been forgotten or else have never been brought to the notice of the general body of steam users. Placing before the reader in this small volume the gist of all these inquiries, logically arranged and appropriately classified, so that the lessons which they teach as to the cause and prevention of boiler explosions may be thoroughly understood, is a task for which the author deserves great credit. The book is divided into four sections, as follows: Legislation in Regard to Boilers and Boiler Explosions; Formal Investigations and Findings of Commissioners as to Negligence; The Cause and Prevention of Explosions and Evidence of Causes and Explosions. The book has been ably prepared, and should prove of great value to boiler makers and boiler users.

Letters from Practical Boiler Makers

Explosion of a Butt-Strapped Horizontal Tubular Boiler

The writer read with great interest the article by Mr. F. W. Dean on American boiler practice in the current issue of The Boiler Maker, which is most interesting, especially on the remarkable results obtained with different types of boilers all of fire-tube design. I would, however, like to take exception to a statement regarding the horizontal return tubular boiler. The paper states in reference to this boiler:

> "But this boiler when built with longitudinal joints butted has never exploded, and thus is almost unique in boiler history."

In 1909 a horizontal return tubular boiler which was insured and regularly inspected by a competent inspector exploded, although it was only about five years old. The dimensions of this boiler are 6 feet diameter and 16 feet long, built of 7/16-inch steel boiler plate, with double butt strap joints triple riveted having an efficiency of 87 percent. The explosion was caused by the joint giving away.

After the explosion the writer had a part of the longitudinal seam at the back end of the boiler taken apart when the plate itself was found to be cracked between several rivet holes, many of the cracks extending from hole to hole. The probable reason that this boiler did not explode before this or warn the operators by the joint leaking was probably due to the fact that the boiler was operated at a margin of safety generally between six and seven. The writer has also seen several plates that were cracked between the rivet holes under the straps, and has several times seen articles in the technical press of similar defects.

This is not intended to show that the butt strap joint is a defective one, but the joint must not be accepted to be altogether faultless.

J. O. B. Latour,
Chief Engineer, The Canadian Casualty and Boiler Insurance Company.

Toronto, Ont., Can.

Boiler Explosions

There are few facts more difficult to get at than those relating to boiler explosions, and owing to the absence of reliable data on this subject, the most absurd notions have been brought forward to account for the disastrous effects under all sorts of conditions, from the simple rupture to the true explosion. Among the causes assigned at one time or another may be mentioned the following: Electricity, decomposition of steam resulting in the generation of explosive gases; overheating of plates; over-pressure; the spheroidal theory, in which a large volume of steam is supposed to be instantly generated by coming in contact with highly heated plates, the water having been previously repelled from the plates by over-heating, or by the formation of a vapor between the boiler plate and the water, thereby preventing contact for a time. As explosions seldom or never give any warning, and are of momentary duration only, it is a very difficult thing to arrive at the true cause of any disaster, and a remarkable thing about it is the evident unwillingness on the part of the owners or those in charge to tell what they do happen to know in regard to the boiler. Undoubtedly this has had much to do with surrounding boiler explosions with the air of mystery now so common, and it has, no doubt, been a means of perpetuating so many of the absurd theories so common a few years ago and still believed by so many.

There is little doubt that the vast majority of boiler explosions can be traced directly to over-pressure. A boiler may be unable to withstand a calculated strain, from one of the following causes: First, an original defect in the boiler plate, and second by bad workmanship. It is possible, and it actually occurs, that these two are sometimes combined in the same boiler. That a boiler containing these two defects should at some time or another meet with disaster is not improbable, but should not be considered as mysterious or due to occult causes beyond human knowledge or prevention.

Over-pressure may be sudden or gradual, and when it exceeds its limit of strength the boiler bursts, sometimes with little violence and doing but little damage, in which case it is commonly said to be a simple rupture; at another time the boiler bursts with terrific violence, doing great damage and ending in a total wreck of the boiler.

It is common practice to permit a pressure per square inch of one-sixth the total strength of the boiler. In all ordinary cases there is an ample margin of safety, but if any one of the plates composing the structure have a hidden and undiscovered defect the boiler may fail in its first trial, notwithstanding the fact that every care may have been exercised in design and construction.

Defects of this kind rarely occur, the most common being that of bad workmanship occasioned by wrong punching, excessive drifting, wrong crossing of seams, overheating of plates in flanging, grooving with a calking tool, etc. These all tend to lower the strength and safety of the boiler, and it is to be regretted that there are boiler makers who are either so ignorant of proper methods of construction or so indifferent to the value of life and property that defects of this kind are allowed to pass from them into the hands of an unsuspecting and innocent purchaser. If disaster should follow such a transfer, and the facts should be ascertained, they would at once and completely dispel any finespun theory of occult causes, not only so far as related to such a boiler, but the aggregation of such testimony would in time place the causes where in most cases they properly belong.

A new boiler ought, if the materials and workmanship are good and the design suitable for the pressure, to be safe from bursting up to within a very small margin of the calculated strength.

Charles Miller.

Albany, N. Y.

The Handy Man

Having been engaged as outside repair man for a number of years, I have come across some very curious conditions, among them being that very dangerous person known as the "handy man." I would like to tell the readers of The Boiler Maker a little of my experience with him and the firms that employ him.

Receiving instructions to take all the tools and material necessary for putting up a crown sheet on a locomotive boiler of the dinkey type, I proceeded to a point in Maryland, some 165 miles distant, where I was to be met by a representative of a constructing firm who would conduct me to the camp where the boiler was located.

Arriving on the scene of operations, I asked about the engine I was to repair, when, to my surprise, I was shown an engine with steam up ready for work, and was told one of their men had done the job, and at the same time I was requested to look at the crown sheet and pass my opinion upon the job done by their man. I asked one of the firm if the job satisfied him, but he would not commit himself, but still wanted me to pass upon the job. But I gave him to understand that I was not there to give my opinion upon work done by his men, but to put the crown sheet up and the boiler in safe condition, and that I was ready and willing to do the work if he wanted it done, otherwise I would return home.

Finally I got to work on the boiler and found the following conditions: The engine was what is known as a 9 x 14 tractor's crown bar firebox, 4 bars with 8 bolts to the bar, 16 of the crown bolts were drawn through the sheet and had been replaced by ¾-inch rough bolts with nuts, washers and gum gaskets on the firebox side and screwed up almost to the bars, the handy man having overlooked the fact that there were ferrules between the bar and sheet. Now here was an engine that was working on a large job among a large gang of men and, had I said it was all right, no doubt would have been put to work among these men to endanger their lives. The contractors were ignorant of the danger they ran, and their man was not man enough to say that the job was something that he did not understand

Another case very similar to the above was that of an engine of the crown bar type engaged on construction work on a large river dam. Arriving on the job and making an examination, I found the crown sheet down and a man working upon it. Reporting to the superintendent of the works my finding, he asked me how long it would take to put the boiler in good condition. Having told him what would have to be done before I could get at my work, and that it would take four or five days to complete the job, he cut me short with, "Oh, h——l! I have a man here that can do the work in four or five hours." I told him that he did not want a boiler maker and that I would return to the works, reporting the circumstances to the manager, who told me I had done quite right in returning; but it did not end here, for about three weeks after I was told to go to the same company and make an examination of a boiler on one of their locomotives. This was at another dam on another river. Thinking it a little queer that a firm with three locomotives should have so much trouble with dropped crown sheets, I kept my eyes open on arriving at the dam, and, sure enough, there was the same engine which had been shipped to the other job.

Upon examination I found the boiler in a worse condition than on the first occasion, and when questioned by the superintendent as to the repairs required, I told him a new firebox was the only thing that would put that dinkey in good condition. Here again was a case of the handy man and his work, for it is quite impossible for men not familiar with work of that kind to do a job that will last any length of time.

Now, sir, the handy man is not a thing of to-day; he was at his work fifty years ago, for Mr. Samuel Nicholls, in his *Theoretical and Practical Boiler Maker*, page 178, speaks of him and says in part: "No time, however valuable, should be grudged to the proper execution of repairs, as quite as much care and judgment is often necessary to the repairs of an old boiler as in the making of a new one." Yet how often do we find evidence of tinkering which the boiler has received. There have been complaints made by honest men in the trade, which, unfortunately, become more intolerant every year, and which must be our apology for now calling attention to such a subject.

A case of very bad repairs came under our notice only very lately. The boiler, a Cornish one, had been short of water. The flue did not collapse, but the top of the firebox was badly sprung at the rivets and calking. Now, instead of sending to a respectable firm to examine and repair the boiler, which could have been done for thirty shillings (about $6), they got a country blacksmith to examine and calk it. This man, being quite ignorant of this class of work, but thinking, I suppose, that he could cure the leakage by calking, decided to do so; but instead of making a cure, he broke the plates by wedging the seams open with a chisel, with the result that the plates had to be removed and the works shut down for ten days.

As a rule, the handy men are made up of steam shovel engineers, etc., who are paid from $125 to $150 per month, and they do not fill the bill at any price. The above are only two cases of many that I know of where the handy man has cost large sums of money to the firm employing him. Therefore I ask the question: "Does it pay the steam user to keep the handy man?" Echo says, "No!" Flex Ible.

Pittsburg, Pa.

Testing Welded Joints

From the letter under the above caption on page 56 of the February issue it seems that there is a dearth of information on this subject. No rules have apparently yet been laid down to cover this very important modern innovation. The method cited—hydraulic pressure and hammer test while pressure is maintained together with close visual examination—is quite good.

Without, however, wishing to be involved in a controversy, my personal opinion is that for welds in a material of considerably thickness, the use of a scarfed joint and clean fire is superior to gas welding. It is relatively more expensive, but no one has yet suggested welding boiler flues by the oxyacetylene process, and it is probable that no responsible authority would permit such welds in any important structure as a boiler. Repair work is not, of course, under discussion. Next in order of merit seems to be the electric weld, the important advantage of which is that the metal alone is fused without the chance of deleterious gas changing the composition of the material. It is not desired to minimize the utility of the gas process, which for relatively thinner gages of metal and for repair work is a valuable tool.

For a vessel subject to pressure my opinion is that ¼ inch is the limit with the gas process for welding, and I consider 3/16-inch thickness more desirable as a maximum. This as a manufacturing proposition, combined with cost and relative efficiency.

My opinions in this matter are borne out by the experience of a concern utilizing both electric and gas welding with whose practice I am familiar. Gas welding with them is a general utility tool for difficult and awkward jobs, while for manufacturing on repetition work they use the electric arc process.

This firm's business is welding, and much experimenting was done by them to get their processes in the present condition.

They use a method of test to prove all their welds easily applied and guaranteed to discover a very slight want of soundness. Their sole business being the manufacture of welded articles, their experience in testing has considerable value.

This method utilizes common kerosene, and this not under pressure. The junction of the flat head and body of an article leaves, if the edges welded are turned outwards, a small annular space inside. A pint of kerosene is sufficient for the test at this point. Along the seam of the body the same amount suffices. Needless to say, the weld to be tested is placed at the lowest point during the test in each instance.

Kerosene has that insidious creeping tendency, the despair of usual methods of calked riveted seams, as all who have had the misfortune to do with bulkheads in tank steamers can testify.

The remarkable point about testing in this manner is that kerosene will come through and stain the outside of the weld, where articles are sound under other methods of test. A really unsound spot in a weld shows up in a few minutes. The articles are left four hours to give the capillary action a real chance before being turned over to test the other welds in the article.

The writer knows of one instance where the job was proved by hydraulic pressure and kerosene subsequently applied, and by some oversight left in the vessel for a period of three days, when no stain had shown itself. The tester was called away and upon the following morning found that a stain had come through. In this instance no other method would have detected the minute fault existing. The case cited is unusual, since in further experimenting it was found that in no instance did a stain appear after the second hour standing.

As only a very small quantity of the fluid is needed, and this acts by creeping, it is a simply applied and thoroughly reliable test. Kerosene could, of course, be applied under pressure like an ordinary hydraulic test, but from experience this does not seem to be needed. Extended experience confirms the fact that under this test electric welding is much sounder than gas welding, the percentage of unsound welds using gas being much higher than with the electric arc.

Where the taint of kerosene is undesirable, it can be removed by subjecting the vessel to steam at 10 pounds pressure for a few minutes, which effectually disposes of any taint left by the test. This removal of the kerosene is doubly necessary if an unsound spot is found in the weld. Considerable danger would be incurred if it were left in, especially with a gas weld. A. L. HAAS.

London, England.

Talks to Young Boiler Makers

In my last talk to young boiler makers I mentioned a table of rope strength, but the table was not published with the article. As it will be found useful I give it below.

WEIGHT AND STRENGTH OF MANILA ROPE
(SPENCER MILLER FORMULA)

Breaking weight, pounds = circumference² × a coefficient which varies from 900 for ½ inch to 700 for 2-inch diameter rope, as below:

Circumference...	1½	2	2½	2¾	3	3½	3¾	4¼	4½	5	5½	6
	900	845	820	790	780	765	760	745	735	725	712	700

Names sometimes give a lot of trouble to young men. Some of the names do not convey any real meaning, and often this is the reason why the boys think that they cannot understand what in plainer words would be clear, and they get what the boys call "cold feet."

Take the word "energy." This is rather apt to frighten a young fellow when he reads about "the conservation of energy," and he feels sure something he cannot understand is to follow. Now it is a very important matter to know something about what the "high brows" call energy. To put it very simply, energy means force, but we must remember that there are two kinds of energy, or force. For instance, one kind is in a ton of iron up in the fifty-seventh story of a New York office building. There is the iron on the floor just as solid as can be, and it does not seem true that it has any force at all. Suppose now you tie that ton of iron on a rope and you hang it out over the street, and you have made a mistake, not using the above table properly, and the rope breaks. When the ton of iron hits the street there would be a big blow struck. This blow would be called by the college fellows the "kinetic" energy of the ton of iron, but the energy that it had up in the fifty-seventh story is called "potential" energy. Now sometimes they hand it out to you as "static" energy and "dynamic" energy, but to get right down to plain talk we will call the blow active energy, and the ton up in the air "pent up" energy. When Bill punches Tom on the nose that is active energy, as Tom will at once understand, but if Tom wants to shoot Bill for the punch and has a "gun" the powder in the cartridge is static energy, or pent up energy. What is the good of all this talk about energy? Well, it is this, there are no end of young men who get an idea in their heads that they can make something out of nothing—in other words, men who think they can get what is called perpetual motion If this interesting subject of energy was understood by them they would not waste their time and money on this absurd idea. A lot of boiler makers have chased after the impossible, and I want to try and keep them from doing so any longer.

No energy can be produced except by some effort, and energy once produced cannot be destroyed, but only turned from one form into another, so all energy in the world cannot be added to or taken away from. I know a lot of fellows will think this is not true, but I will try and make it clear.

Our one ton of iron required force or power to carry it upstairs fifty-seven stories. Now the force that this ton of iron will strike the ground with will exactly equal the power it took to get it upstairs, not a bit more or a bit less. But, you say, when the iron hit the ground its power is lost, there is nothing more doing, so there is a destruction of energy. Not at all; when the blow is struck heat is produced and is radiated off into the earth and air. There it goes on doing work, moving the air waves or heating the ground, and passes on forever.

When we get down to the very end, heat is the source of all energy and it all comes from the sun. Without the sun's heat nothing would grow nor would we now have the stored-up energy in trees and coal. True, in the river in the Mammoth Cave there are fish that never get the direct rays of the sun, and, by the way, these fish have no eyes, but the food they eat is produced outside from the effect of the sun's heat, so even the blind fish have to depend on the sun's energy for their existence.

We take the wood of the trees or coal and burn it and get the pent-up energy which has been stored there for years or centuries, and get steam and pass it through an engine and obtain active force, yet you see that it is only turning one form of energy into another. The sun made the grass grow which fed the horse used by Watt when he started in to find out what power a horse had. Now all these storages of energy are potential or static, and it is through the boiler and engine that we convert them into active or dynamic or kinetic work.

This heat business has been investigated by a lot of "high brows" for many years, and at first a chap called Aristotle, an old-time Greek, about 400 years before we began to count the years from the birth of Christ, thought that heat was an element and it soaked into things as ink does into blotting paper. At that time and for many years after the belief existed that there were four elements—earth, air, fire and water. Now we know that these are not elements at all. Then the idea was held by a few that perhaps heat and motion were not far apart, and Sir Humphrey Davy about 1800, or 113 years ago, gave this idea a great push, and to-day it is accepted that heat is a form of motion.

That motion can be turned into heat any boiler maker can very easily prove. If there is, say, a drill press in the shop, let him pick up a chip, if the drill press hand is taking a good chip, and he will often find that it is a bit warm. Now the belt that drives the press is not hot, but it had motion, and that motion turned its power into another form of motion—that is, heat. Here we have, then, the whole story of the conservation of energy—a big sound, but it does not convey to many fellows very much until some one gets up and puts it in everyday language, as I hope I have done.

New York. F. ORMER BOY.

Examination Questions for the Boiler Inspector

We are indebted to Mr. Charles J. Mason, of the International Correspondence Schools, Scranton, Pa., for the following list of questions given by the Hartford Steam Boiler Inspection & Insurance Company to candidates for the position of boiler inspector. These questions will undoubtedly give our readers a good idea of the extent of the knowledge which a boiler inspector is required to possess, as well as an opportunity to test their own knowledge and ability.

1. What is the efficiency of a 72-inch diameter boiler, 7/16-inch plate, 55,000 T. S., double-riveted lap seam, 7/8-inch steel rivets, 3¼-inch pitch?

2. What is the safe working pressure at a factor of safety of 4.5?

3. What is the efficiency with iron rivets?

4. What pressure would be allowed on above boiler under Part II, Board of Boiler Rules?

5. What is the efficiency of double-riveted butt joint 5 inches by 2½ inches pitch?

6. What is the safe working pressure at a factor of safety of 5?

7. What is the efficiency of quadruple butt joint, pitch 15 inches by 7½ inches by 3¾ inches?

8. What is the safe working pressure at a factor of safety of 4.75?

9. How many 1⅛-inch diagonal crow foot braces at 7,500 pounds per square inch are required for a segment containing 714 square inches, working pressure 100 pounds?

10. How many rivets, and what size, are necessary for a 1-inch brace?

11. How should braces be distributed?

12. What is the height of fire line of an externally fired boiler?

13. How should safety valve be attached to boiler?

14. Would it require a larger safety valve for 100 pounds pressure than for 25 pounds?

15. What is the radius of the bump of a convex head 30 inches in diameter, bump 4 inches high?

16. What is the safe working pressure of a convex head, 30 inches diameter, ⅜-inch thick, 60,000 T. S., radius of bump 30 inches?

17. What is the safe working pressure of a concave head, same dimensions?

18. What is the pitch of 7/8-inch weldless stays for a pressure of 110 pounds?

19. How many 1¼-inch diameter weldless stays are necessary for a 72-inch diameter boiler, 28-inch segment, 150 pounds pressure?

20. How many check valves are necessary for two or more boilers and where should they be placed?

21. Make sketch of water column and connections.

22. Where should the fusible plug be placed?

23. What is the safe working pressure of ¾-inch stays pitched 4¾ inches, using 7 for factor of safety and 42,000 pounds as T. S. of bolts?

24. Why are generating tubes in watertube boilers placed in an inclined position?

25. Why are the ends of tubes in watertube boilers flared or beaded?

26. Describe briefly the construction of a boiler to comply with Part II, Board of Boiler Rules.

27. What pressure would be allowed on a boiler 36 inches diameter, 5/16-inch plate, 70 percent efficiency of joint, under Part II Board of Boiler Rules?

28. Give bursting pressure of tube ligament and riveted seam of a Stirling boiler, 36-inch drum, ⅜-inch shell, 9/16-inch tube sheet, 7/8-inch steel rivets, double lap, 3-inch pitch, tubes 3¼ inches, pitched 5½ inches by 6¾ inches, 55,000 T. S.

29. Do bumped heads require bracing? Does radius of bump effect strength of head?

30. How are furnace flues strengthened to resist collapse?

31. Does the length of the flue sections affect the strength of it?

32. What is meant by tensile strength?

33. What provision is made for the expansion and contraction of tubes in watertube boilers?

34. How is a safety valve looked after?

35. When a crack or blister appears on a boiler, what should be done?

36. What is done with a fusible plug when used? How taken care of?

37. How should the horizontal seams of a patch more than 24 inches in length be designed?

38. Make a sketch of a patch necessary to repair shell plate having a fire crack at the girth seam over the fire.

39. What is available heating surface in H. T. and W. T. boilers?

40. What is the meaning of combustion as used in steam engineering?

41. What two ingredients in water are the chief causes of incrustation in boilers?

42. How many heat units are there in 1 pound of carbon?

43. At what point should a water glass be located?

44. Why?

45. Why is a trap or syphon placed under a steam gage?

46. What are the functions of a fusible plug?

47. Why does an injector work?

48. How would you determine the size of a steam header for a battery of boilers?

49. If you discovered a boiler with no water in the gage glass, what would you do?

50. What precautions should be observed when preparing to empty a boiler for cleaning?

Laying Out Circular Courses

The difference of opinion of different foremen and layer-outs in regard to laying out work as we read about it in the technical journals is certainly surprising. The writer has been in a good many shops during his lifetime, but has seldom seen two shops using the same rules and regulations in laying out the work. Each one seemed to have different ways of doing things. That, by the way, is one of the reasons why apprentices should travel after they have served their time; for an apprentice may be a first-class man in the shop where he has worked for a long time, but would be rated only as a second or third-class man in some other shops where different methods are in vogue.

It has been pointed out in these pages that some foremen and layerouts insist that all inside and outside circular courses should be laid out by adding an allowance to the neutral circumference for the outside ring or *vice versa*, a deduction from the neutral circumference for the smaller ring of from ⅛ to ½ inch, and sometimes even more.

The writer's practice is to get one course, either the large or the small one, and then either add or deduct seven times the thickness of the metal for courses which are rolled to small diameters, and on courses rolled to large diameters adding or deducting six and one-half times the thickness of the metal. As an example, assume a 36-inch shell, the large course would be 36 inches inside diameter, and if the metal were ¼ inch thick the neutral diameter of the large course would be 36¼ inches. The circumference of a 36¼-inch diameter is 113⅞ inches. Now to deduct seven times the thickness of the metal, or seven times one-quarter, would leave 112⅛ inches as the circumference of the small course. This would leave ⅛ inch more than would be found by calculating exactly the two neutral circumferences. The neutral diameters for the two courses would be 36¼ inches for the outside course, 35¾ inches for the inside course, the circumferences being 113⅞ inches and 112¼ inches, respectively, with a difference of 1⅝ inches, or six and one-half times the thickness of the plate.

If one course was rolled up and it was necessary to put another course on, it would be a simple matter to go around the rolled course with a wheel or tape line, and if an outside ring was necessary three times the thickness of the metal would be added. If an inside ring was needed it would be necessary to go around the inside of the rolled-up ring with a wheel, and deduct three times the thickness of the metal. Some layerouts allow three and one-third times the thickness of the metal, but three times the thickness will bring it out right.

In following this plan the layerout must be sure of the thickness of the metal, and to be sure of this he must caliper it, as it would hardly do to allow seven times the thickness of ¼-inch metal when as a matter of fact the metal was 1/64 inch or 1/32 inch less in thickness. John Cook.

Springfield, Ill.

Personal

T. W. Hind, foreman boiler maker, has been transferred from the Canadian-Pacific Railroad shops at Winnipeg, Manitoba, to the Ogden shops, Calgary, Alberta. Mr. Hind's many friends wish him every success in his new position.

Abraham Lucas, formerly general foreman of the locomotive department of the Chicago, Milwaukee & St. Paul Railroad at Milwaukee, Wis., has accepted a position with the Jacobs-Shupert U. S. Firebox Company, Coatesville, Pa., with headquarters at Chicago, Ill.

George W. English was appointed general manager of the Zug Iron & Steel Company, Pittsburg, Pa., on Feb. 1.

George M. Basford, assistant to the president of the American Locomotive Company, resigned recently to accept a position as chief engineer of the railroad department of Joseph T. Ryerson & Son, Chicago, with headquarters at 30 Church street, New York. Mr. Basford was graduated from the Massachusetts Institute of Technology in 1889 and entered immediately upon railroad work, serving in various capacities on different railroads from shop work to responsible positions in the motive power departments, and finally specializing in signal work. In 1895 he left signal work to become mechanical department editor of the *Railway and Engineering Review*, and from 1897 to 1905 was editor of the *American Engineer and Railroad Journal*, a position which he relinquished to become associated with the American Locomotive Company. The following is an interesting account of his past work, which appeared in the *Railway Age Gazette* of March 14, 1913:

"Few men associated with the railway interests can number so many friends—real friends—as can Mr. Basford. And this he richly deserves, for he has been untiring in aiding others, either with advice or by helping them to better their condition. He has an unerring engineering instinct, which enables him to discard those things which are superficial and quickly get at the heart of a problem. It was this instinct, coupled with an extensive experience, and with his splendid character which made him such a power as an editor—for many years the *American Engineer* was informally designated as 'Basford's paper,' and still is by some, although it is seven and a half years since he left it. And when we recall that for a considerable part of his eight or nine years' work on that paper he had no editorial assistant, no stenographer, and that the office was not equipped with a telephone, we marvel at the powerful influence he was able to exert through its pages in securing a more fitting recognition of the real importance of the motive power department in the railway organization.

"In the fall of 1903 Mr. Basford was in receipt of a signal honor, the like of which has never been conferred upon a man in the railway or railway supply field before or since. In a quiet way fifty-eight of the railway and railway supply men who were known to be close personal friends of Mr. Basford joined together and presented him with a volume of personal letters expressing their appreciation of him, and accompanied by a substantial check to defray the expenses of a trip abroad.

"Mr. Basford is widely known because of the impetus he gave to the development of the movement for educating and training apprentices and workmen, for he had a keen realization of the fact that the most vital problem confronting the railways is that of *men*. In 1905, after he had given several years of careful study to the situation he presented a paper before the Railway Master Mechanics' Association on 'The Technical Education of Railroad Employees—The Men of the Future.' The principles which he outlined in this paper attracted wide attention, not only in the railroad field but in the industrial world as well, and were taken as the foundation of such modern apprenticeship systems as those on the New York Central Lines and the Atchison, Topeka & Santa Fe. And it may be said at this date, almost eight years after the presentation of the paper, that apprenticeship systems on the railways have proved successful in so far as they have followed the fundamental principles laid down in Mr. Basford's address. The preparation of this paper might well be studied by young men who are ambitious to make their efforts felt in the railway field, and it affords a marked contrast to some of the papers and reports which are often presented before railway clubs and technical associations. It was the result of years of study of conditions on the railroads in this country and a practical experience in mechanical department work. Foreign methods had been carefully looked over on his trip abroad and then the whole scheme was carefully planned and outlined. The paper was then drafted roughly and was rewritten and rewritten until every sentence was carefully rounded out and every superfluous word removed, so that the thought was clear and forceful throughout. It was then submitted for criticism to a number of leading railway officers and industrial managers, and their comments were carefully considered in its revision, although it may truthfully be said that such revision as was made was very slight indeed. And dominating it all was a broad spirit of fellowship for his fellow man, which is so characteristic of Mr. Basford. It is little wonder that it marked the real corner-stone of railway apprenticeship education in this country, and it is to be regretted that more railroads have not adopted and lived up to its spirit.

"Mr. Basford's hobby has always been the locomotive, and his efforts in its development were recently summed up by one of his friends as follows: 'He has persistently striven to impress upon every one connected with the work, both through his paper and through his personal contact, with a possibility of improving locomotive practice by rational and progressive engineering methods, and is largely responsible for the improvement that has taken place not only in the general design of the locomotive, but also in the improvement in the construction of its various parts which has so largely increased its efficiency and economy in operation. The care which Mr. Basford took in carrying out the experiments on locomotive front ends and nozzles, which led to the completion of these experiments by the Master Mechanics' Association, is only one example of his endeavors to place the design of the locomotive on a thoroughly sound foundation. The success of these experiments was no doubt a strong factor in the adoption of the locomotive testing plant, and the knowledge we now possess as to what engines are actually doing, and what results can be obtained from them. Not only in locomotive design, but in shop practice and road work generally, Mr. Basford has energetically encouraged his friends and acquaintances, including all the important mechanical men in the country, to continually improve their results. I do not think you will make any mistake in crediting him with a large share of the development in the last fifteen years.'"

Obituary

CHARLES H. REID, treasurer of the Zug Iron & Steel Company, died from pneumonia March 8 in Pittsburg.

DANIEL F. COONEY, senior partner of D. F. Cooney & Company, dealers in iron and steel at 88 Washington street, New York, died March 16 from heart disease at the age of 67 years. Mr. Cooney was born in New York City. His first employment was with the iron merchants James H. & John Haldane. This firm dissolved in 1866, and two new firms were formed, in one of which James H. Haldane and Mr. Cooney were associated as partners. In 1875 J. H. Haldane retired and Mr. Coney continued the business in his own name until 1901, when he took into partnership his nephews, Andrew B. and Austin J. Murray. In recent years Mr. Cooney has suffered much from ill health. He was a member of the New York Chamber of Commerce and of several clubs in New York City.

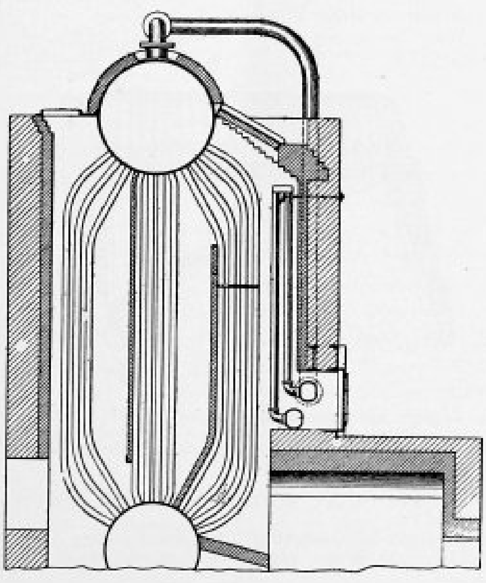
Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

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

1,047,027. STEAM SUPERHEATING APPARATUS. ERNEST H. FOSTER, OF NEW YORK, N. Y.

Claim.—The combination of a steam boiler, comprising upper and lower drums connected by vertical boiler tubes, a curved boiler setting having its front wall adjacent to the boiler tubes and having a furnace in the lower end thereof, a superheater comprising substantially straight inlet and outlet headers located in a chamber in said front wall and without the path of the hot gases, horizontal tubes of graded length connected to and extending inward from said headers, substantially U-



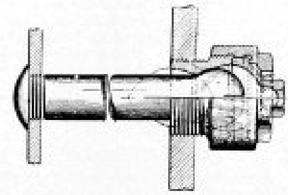
shaped vertically extending superheating tubes connecting said horizontal tubes, the length of the aforesaid horizontal tubes being such that the superheating tubes are in the path of the hot gases at the outside edge of the boiler tubes, and means for deflecting the hot gases passing from the furnace among said superheater elements. One claim.

1,045,904. STEAM REGENERATOR. ADOLPH SORGE, OF ST. JOSEPH, MICH., ASSIGNOR TO AMERICAN REGENERATOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 4.—In a steam regenerating apparatus, the combination of a regenerating chamber, a storage chamber for part of the regenerating liquid, communications between the regenerating chamber and storage chamber, means to introduce exhaust steam into the regenerating chamber, a gate oneratively related to said steam introducing means and mounted so as to be moved by the incoming exhaust steam, and a system of valves controllin« the communication between the two chambers and in operative relation with the gate. Sixteen claims.

1,042,832. FLEXIBLE STAY-BOLT FOR BOILERS. BENJAMIN E. D. STAFFORD, OF PITTSBURG, PA., ASSIGNOR TO FLANNERY BOLT COMPANY, OF PITTSBURG, PA.

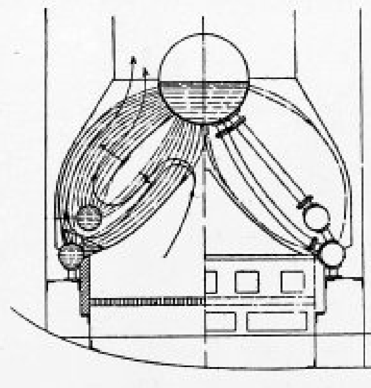
Claim 2.—A stay-bolt structure comprising a bolt having a head, a sleeve or bushing having an internal seat for said head, a soft metal cap



having a centrally located external angular boss, the said cap being mounted on said sleeve or bushing and forming a closure for same, and a nut for locking the cap to the bushing. Two claims.

1,046,387. WATER-TUBE STEAM GENERATOR. RICHARD HELM, OF STEGLITZ, NEAR BERLIN, GERMANY.

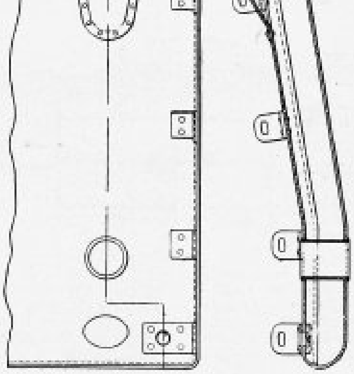
Claim 1.—In a steam generator, an upper water drum, lower water drums on each side of the furnace, groups of water tubes connecting said upper and lower water drums, lowermost water drums on both sides



of the furnace and below said lower water drums and groups of water tubes connecting said upper drum and lowermost water drums and inclosing said lower water drums and the other groups of tubes. Three claims.

1,047,055. WATER JACKET. HENRY C. HOLTHOFF, OF MILWAUKEE, WIS., ASSIGNOR TO ALLIS-CHALMERS COMPANY, OF MILWAUKEE, WIS., A CORPORATION OF NEW JERSEY.

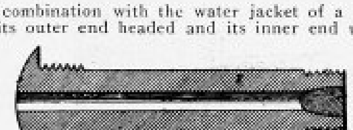
Claim 1.—In a furnace jacket, a fire sheet, and an outside sheet spaced from said fire sheet, the corresponding peripheral edges of said sheets



being gradually inwardly directed toward each other and united to form an inclosed chamber between said sheets. Two claims.

1,050,097. STAY-BOLT FOR BOILERS. JOSEPH BOERO, OF NEW YORK, N. Y.

Claim 2.—In combination with the water jacket of a furnace, a tubularbolt having its outer end headed and its inner end unheaded, and a



plug driven into the inner end of said bolt to prevent water leaking into the fire-box in case the body of the bolt within the water jacket becomes fractured. Three claims.

1,046,583. LOCOMOTIVE FURNACE. DANIEL GOFF, OF MILLVILLE, N. J., ASSIGNOR TO GOFF GRAVITY BOILER FEED COMPANY, OF CAMDEN, N. J., A CORPORATION OF NEW JERSEY.

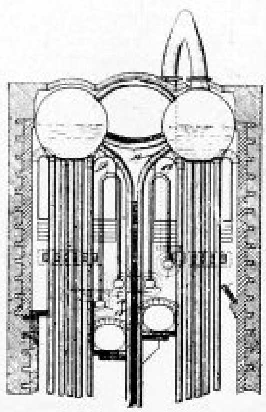
Claim 1.—In a device, a locomotive boiler, a fire-box therefor having a plurality of air inlets in opposite walls thereof, a suitable grate, a plurality of sets of steam nozzles alined with said air inlets, one set of said nozzles projecting into said air inlets and the other set terminating exteriorly thereof, a superheater box transversely disposed in said fire-box, and provided with a plurality of steam discharge nozzles, means for conducting steam to said superheater, a furnace door for said fire-box, and means controlled by the movement of said door for regulating the flow of steam to said steam nozzles. Five claims.

1,047,647. BOILER. WALTER JOHNSON, OF LINCOLN, NEB.

Claim 9.—A boiler comprising a casing having a steam dome, a combustion tube arranged longitudinally of the casing and extending beyond the same at each end, a pipe arranged spirally of the tube in the boiler, said pipe communicating with the tube at one end and with the boiler at the other, and a closure for each end of the tube. Twelve claims.

1,047,698. SUPERHEATER BOILER. ARTHUR D. PRATT, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

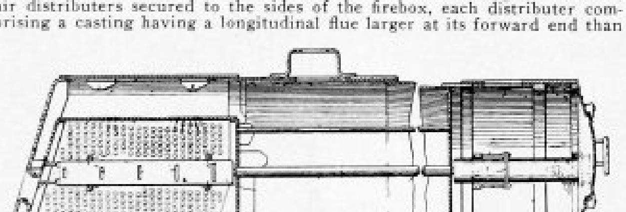
Claim 1.—A superheater boiler having two banks of tubes, a baffle between the banks, and a superheater comprising two connected sets of



U-shaped tubes, said sets being on opposite sides of said baffle, one in the uptake pass and the other in the downtake pass. Six claims.

1,048,297. SMOKE CONSUMER. THOMAS CRAWFORD, OF PHILADELPHIA, PA., ASSIGNOR OF TWENTY-FIVE ONE-HUNDREDTHS TO JOHN M. JAMES, AND TWENTY-FOUR ONE-HUNDREDTHS TO HENRY M. MEASON, OF PHILADELPHIA, PA.

Claim 1.—In a steam boiler, the combination with a fire-box, a smoke-box, a water chamber betwen them, and flues connecting said fire-box and smoke-box, of air-heating chambers in the smoke-box, pipes connected to said air-heating chambers and extending through the boiler, air distributers secured to the sides of the firebox, each distributer comprising a casting having a longitudinal flue larger at its forward end than



at its rear end and communicating at its forward larger end with the said pipes, and closed at its smaller rear end, the inner faces of said castings having discharge openings of varying lengths communicating with the flues, said openings substantially vertical with the largest openings adjacent the forward ends of the distributers, and said openings decreasing in size from the forward to the rear ends of the distributers. Six claims.

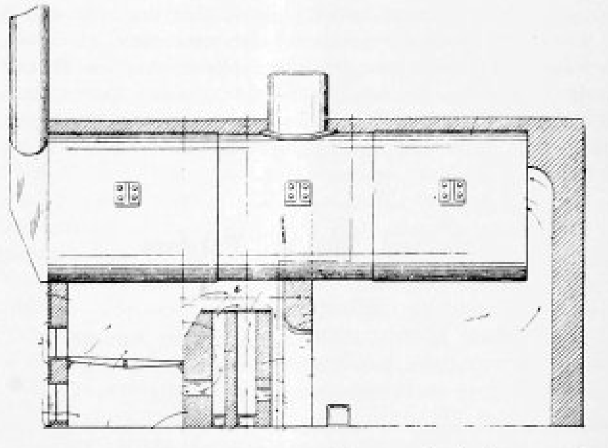
1,048,584. FLUE EXPANDER. GEORGE R. RICH, OF OAK PARK, ILL., ASSIGNOR TO RICH TOOL COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

Claim.—A flue expander, comprising a tapered solid mandrel whose entire working face is formed with longitudinal grooves paralleling its face, each groove being curved in cross section and the radius of the

curve being constant throughout the length of the groove, and a substantially cylindrical expanding member comprising sector-like sections freely grouped around the mandrel, each section having an inner, outwardly curved bearing face of the same radius as any groove on the mandrel, whereby said sections may rock thereon to accommodate changes in the transverse section. One claim.

1,049,079. SMOKE-CONSUMING FURNACE. JAMES G. GRACEY AND EDWARD E. SQUIER, OF ST. LOUIS, MO., ASSIGNORS TO ED. E. SQUIER COMPANY, OF EAST ALTON, ILL., A CORPORATION OF ILLINOIS.

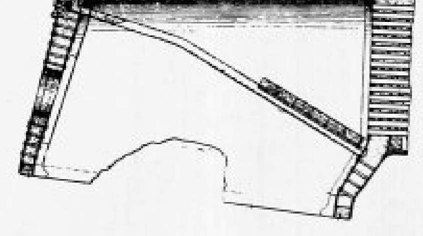
Claim 1.—In a furnace provided with a fire-box, a secondary combustion chamber and a bridge-wall, a boiler, a division wall positioned at the fron tend of said chamber and spaced from the bridge-wall, and extending to the boiler, said division wall being provided with an opening the top of which is depressed a suitable distance from the boiler, a transverse wall rearward of and spaced from the bridge-wall and forming



an air flue therewith, the bridge wall being provided with an opening below the fire-box for conducting air into said flue, a second parallel wall rearward of and spaced from the first transverse wall and positioned in front of the division wall aforesaid and forming a flue with said transverse wall, said second wall having openings opposite the opening of the division wall, the said openings being positioned a suitable distance below the top of the opening in the division wall, the portion of the latter wall between the opening thereof and the boiler causing the gases to dip toward the combustion chamber, and the flues aforesaid discharging into the products of combustion as they pass over the bridge-way. Two claims.

1,049,140. CIRCULATING TUBE FOR STEAM BOILERS. LEGRAND PARISH, OF NEW YORK, N. Y.

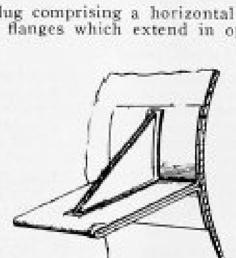
Claim 1.—The combination, with a steam boiler fire-box, of a circulating tube extending upwardly from one water space of the fire-box to



another, a delivery tube fitting the discharge end of the circulating tube, and a cover plate closing an opening in the shell of the discharge water space and detachably connecting the circulating tube and delivery tube. Two claims.

1,049,900. STEEL-PLATE BOILER BRACKET. TEOFIL MOWINS, OF ERIE, PA.

Claim 2.—A boiler lug comprising a horizontal portion having one of its ends provided with flanges which extend in opposite directions from



the said body, an angular strut member having two of its edges provided with oppositely arranged flanges, and means for connecting the flanges of the strut to the horizontal member of the lug and to one of the flanges of the lug. Three claims.

The Boiler Maker

MAY, 1913

Arrangement of Boilers on Board Ship

BY J. CARSON

In arranging a battery of boilers in a ship the first step is to lay out a longitudinal section of the machinery space so as to determine the length of the boiler room. As a problem, we will assume that we have a twin-screw ship in which seven single-ended Scotch boilers, 16 feet 3 inches diameter and 11 feet 10 inches long, designed for a working pressure of 210 pounds per square inch, are to be installed.

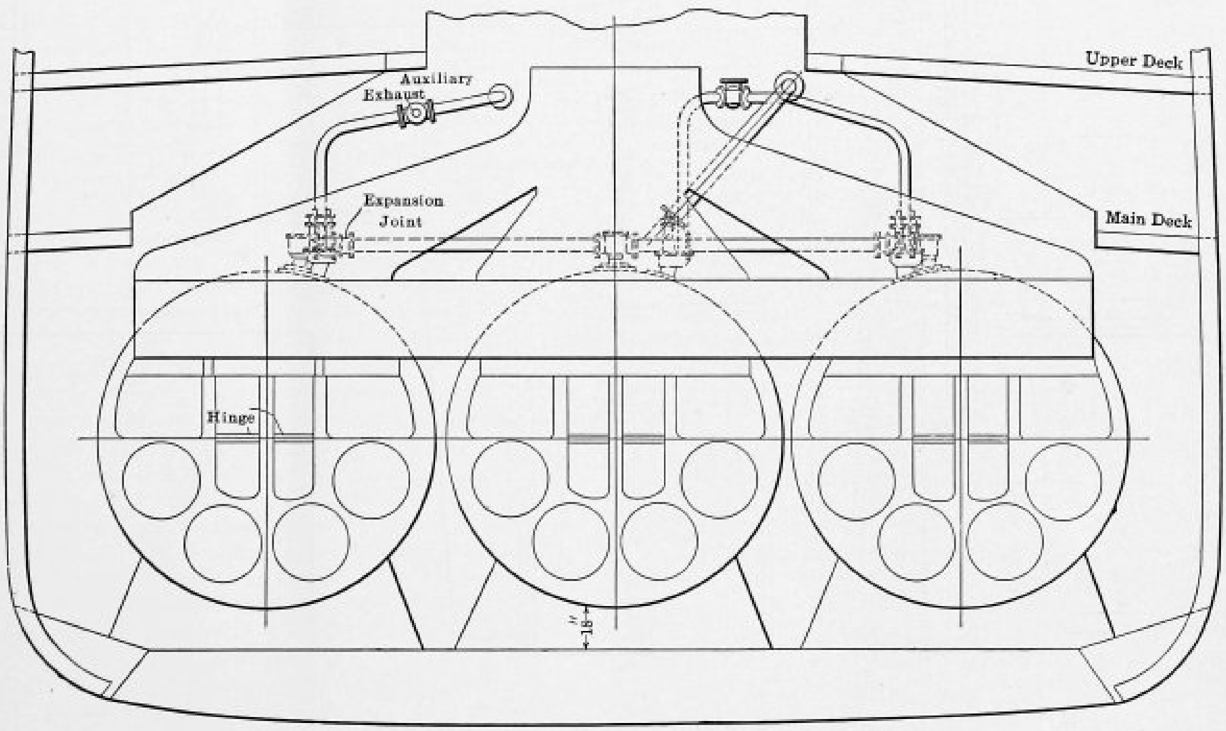


FIG. 1.—CROSS SECTION THROUGH BOILER ROOM OF STEAMSHIP, SHOWING ARRANGEMENT OF BOILERS, UPTAKES AND PIPING

According to Fig. 2 it will be seen that six of the boilers are arranged three abreast, athwartships, the seventh boiler being located in a recess in the forward stokehold. There should be about 18 inches between the back of boiler *A* and the forward bulkhead, in order to allow sufficient space for overhauling stay nuts, etc. The distance between boiler *A* and boiler *C* is sufficient to allow the furnaces to be withdrawn and the smoke-box doors opened. If necessary the center smoke-box doors can be hinged, as shown in Fig. 1. The space between the backs of the forward boilers and the after boilers should be not less than 24 inches, and the distance between the front of the after boilers, *E*, *F* and *G*, and the after bulkhead should be sufficient to allow the furnaces to be withdrawn. By making these allowances the length of the boiler room is determined.

The height of the center of the boilers from the base line of the ship should be arranged to allow at least 18 inches between the bottom of the boiler and the tank top, so that any repair can be carried out from the bottom of the boiler, such as calking, locating rivets, etc. The up-takes are then arranged so as to give a good lead for the gases up to the funnel without any flat surfaces. Then the boiler room casing is arranged as compactly as possible. In laying out the cross section, Fig. 1, it is advisable to keep a distance of at least 1 inch between the boiler coverings, although a greater distance should be allowed if the space will permit.

Having arranged the boilers in the plan, elevation and section, the next step is to lay out the main steam pipe lines. Consulting the engine specifications we find that the diameter of the throttle valve in this case is 9 inches. As we are dealing with a twin-screw ship, the main steam pipes will be arranged so that three boilers can supply each engine. The area of a 9-inch throttle valve is 63.6 square inches. As three boilers are to supply steam to a valve of this area we divide 63.6 by 3, which gives 21.2 square inches. Twenty-five percent of this should be added, which will make the area of the main stop valves for each boiler 26.6 square inches. This is very nearly equal to the area of a 6-inch valve, so we will make the diameter of the main stop valve 6 inches.

Assuming that wrought iron pipes are specified, straight lengths will be adopted as far as possible with expansion joints. Some superintending engineers prefer expansion joints; while others will not use them, as they argue that at sea if the expansion joints are giving trouble the engineer will hammer them up tight so that they become almost solid and refuse to expand. For this reason they prefer to use bends for taking up the expansion. However, this is all largely a matter of opinion, and the superintending engineer has the option.

Referring to the plan of the boiler room, Fig. 2, it will be seen that boilers *E*, *F* and *G* are connected up with the main steam pipe which leads along the starboard side of the ship to the starboard engine. Boilers *B*, *C* and *D* are connected up to another main steam pipe which is led along the port side of the ship to the port engine. The main steam pipe in both cases is 9 inches diameter. The forward boiler, or the boiler marked *A* in the plan, is also connected to the port main steam pipe. To balance the steam on either side there is a cross connection made near the engines, which is 6 inches diameter with a shut-off valve. Should anything go wrong with either the port or starboard range of main steam pipes, then by means of this cross connection steam can still be supplied to both engines, thereby allowing the ship to proceed normally at about half-speed instead of having one engine running at full speed and the other totally disabled.

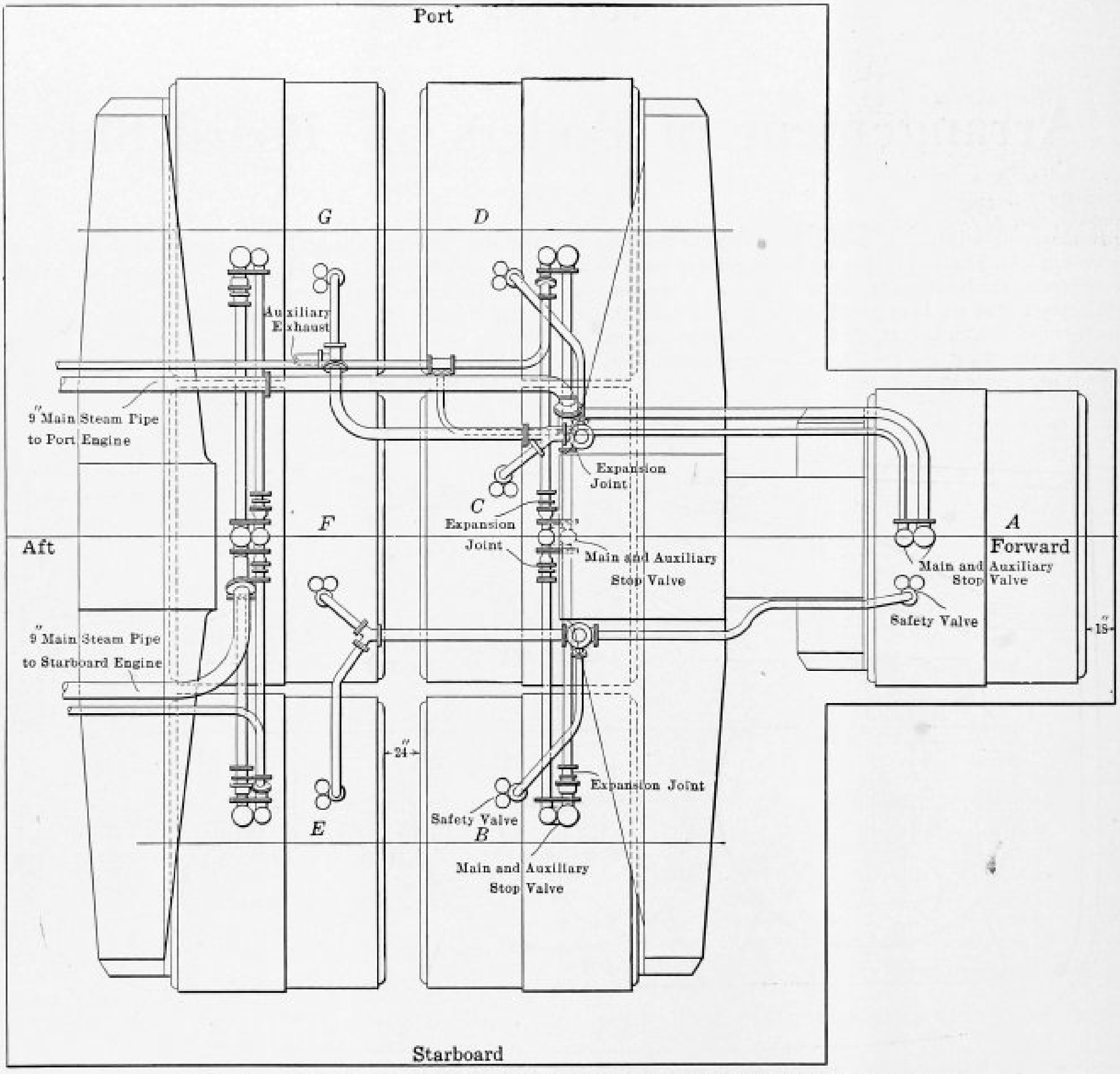


FIG. 2.—PLAN OF BOILER ROOM ON TWIN-SCREW STEAMER EQUIPPED WITH SEVEN SCOTCH BOILERS

The up-take between boilers *C* and *D* is especially designed to allow the main steam pipe from boiler *A* to be connected to the main steam line without having to extend up over the up-takes or having to build a tunnel through the up-take. Another advantage of the design of up-take used in this arrangement of boilers is that the steam pipes for steam to the water gages are not required to pass over the top of the up-take, and thereby a saving is made in copper pipe.

In determining the size of safety valves, the working pressure, less 25 percent, is taken for forced draft and for natural draft the working pressure is taken less 10 pounds.

As a forced draft arrangement is used in this case with the boilers operating at 210 pounds per square inch, we use 75 percent of 210 or 157.5 pounds. From the Board of Trade Rules it is found that the constant C for this pressure is .217. This is multiplied by the grate area, which in this case is 80 square feet. Therefore, $.217 \times 80 = 17.36$, and divided by 2 (for two valves) $= 8.68$ square inches area, or 3⅜ inches diameter. Therefore two 3⅜-inch double spring safety valves are ordered, and the waste steam branch is arranged to suit the best lead of the pipes. The waste steam pipes are arranged so that the boilers *A, B, E* and *F* will exhaust up one pipe to the atmosphere, and boilers *C, D* and *G* will exhaust up the other. As there are only three boilers on the port side exhausting to the atmosphere and four boilers on the starboard side, it should be arranged that the auxiliaries which exhaust to the atmosphere should join the waste steam pipe on the port side, as shown in plan, Fig. 2. The waste steam pipes should be arranged so that they will drain to the boilers.

To determine the size of the auxiliary steam valve on the boiler we take the area of all the steam valves on the auxiliaries that are likely to be used in port at one time and find out the size of pipe necessary to supply this, then take the area of all the steam valves on the auxiliaries that are likely to be going at the same time at sea and use whichever is the larger. Sometimes one of the boilers is arranged as an auxiliary boiler, and in that case it alone is fitted with an auxiliary steam valve, with perhaps a connection from the main steam range to the auxiliary steam range; but in our case we will arrange all boilers capable of supplying the auxiliary steam. To do this we can put a separate valve on each boiler, but perhaps the more compact way is to design a combined main and auxiliary stop valve with a common neck on each boiler equal to the area of both valves. We can thus arrange our line of auxiliary steam pipes similar to the main steam, but connecting all boilers to a common pipe running along the port side of ship, or the boilers may be divided and a steam pipe located along both the port and starboard sides, as shown in plan.

The water gage pillar is attached to the style plate of smokebox, and arranged so that when water disappears from the glass there is still at least 3 inches of water above the top of the combustion chamber. The steam and water pipes are then led to it from cocks attached to the boiler, care being taken that there are no pockets in these pipes, otherwise a false reading might be indicated by the glass, and accidents might occur. If there is no space available on the front of boiler for a cock to connect to the water gages, then a wrought iron pipe or a brass casting must be arranged to pass through the air space, with one end attached to the boiler and the other end attached to the air casing plate, with a spigot passing through to take the cock. Closed bottom cocks should be used in all cases where they are subject to boiler pressure.

The whistle should be connected direct to at least one boiler with a pipe led up as straight as possible, for draining purposes, to prevent water being blown out on deck when the whistle is being blown. A connection should also be made to the main auxiliary steam ranges, thereby providing that the whistle can have steam at any time should the boiler that is supplying it direct be under repair.

The surface blow valves can now be arranged, and the pipes from them led down and connected to the bottom blow pipes, and both led through a common pipe to a cock on the ship's side with a Board of Trade guard on it. An internal pipe is connected to the surface blow cock and led to a scum pan near the center of the boiler, the top of the scum pan being about flush with the top of the water.

Instead of bottom blows being taken to a cock on the ship's side, they could be connected together by pipes and led by a common pipe into the engine room and there joined to a change cock, with a connection to the sea and another to a donkey pump. By this means the water in the boilers could be circulated while steam is being raised, as the donkey pump could suck through the bottom blow and discharge back to the boiler by the main feed range.

Another way of circulating the boiler is to fit an internal pipe from the auxiliary feed range valve on the boiler to the bottom of boiler, and the feed pump can now draw from bottom of boiler through the auxiliary feed range and discharge back through the main feed range; but to do this the auxiliary feed valve on the boiler must be a 3-position valve; that is, it must be a screw-down, non-return and lift valve.

The feed check valves on the boiler should be in all cases non-return, and internal pipes led from them up to surface of water. Some superintendents specify that a shut-off valve be fitted between boiler and non-return feed check valve for overhauling purposes.

The salinometer cock may now be arranged, and it is placed at any convenient height from the floor and in such a position on the boiler as to make it easily accessible.

In arranging the position of the manhole care must be taken that it is quite clear of the water space stays, so that there will be no difficulty of getting in and out of the boiler. Some firms cut the manhole in the shell plate before it is rolled, and in that case care must be taken that the center of the manhole is at such a distance as will allow the plate to get into the machine. Other firms mark the manhole off after the shell plate is rolled, and then by means of boring a series of small holes the manhole is cut out. The latter method is the better, as when rolling the plate after the manhole is cut there is a danger of cracks showing in the vicinity of the manhole. Boiler shells have given way during water tests at this particular place, and this has been blamed on the former method. A pressure gage cock is also fitted on the top of boiler, and led to a gage placed in a convenient position in the stokehold where it may be easily seen.

Transmission of Compressed Air

All piping should be carefully inspected, rapped to break loose inside scale and then blown out. All joints should be made up with lead and screwed up tight, and every precaution taken to make the work permanently air tight. At suitable points drip tanks or separators should be inserted in the mains, these being provided with drip cocks. Drip cocks should also be placed at all low points. Further, it should be the duty of some one to see that all drips are blown off frequently and properly. Only the best grades of hose should be used, wire wound for the longer or leader hose, and a short length of plain hose for connecting with the leader. All hose should be cared for. It is expensive and deteriorates rapidly, and it has been shown that many troubles charged against the tool have been due entirely to the use of poor grades of hose, which stripped or scaled inside and clogged the valve or working part of the air tool equipment. The hose should be regarded as part of the tool equipment, and each man to whom hose is issued should be held responsible for its return in good condition. The valve at the outlet should be opened an instant before connecting the hose. The hose should then be blown out, and then only should the hose be connected to the tool.—*Ideal Power.*

SUMMER SCHOOL OF UNIVERSITY OF WISCONSIN.—Announcement is made of the thirteenth annual six weeks' summer school of the College of Engineering of the University of Wisconsin, Madison, Wis., which opens on the twenty-third of June. Courses of instruction and laboratory practice are offered in electrical, hydraulic, steam and gas engineering, mechanical drawing, applied mechanics, testing of materials, machine design, shopwork and surveying, in addition to which subjects may be taken in the College of Letters and Science.

Investigation of Electrolysis in Boilers

BY W. R. C. CORSON

About a year and a half ago a case of abnormal tube pitting was brought to the attention of the Hartford Steam Boiler Inspection & Insurance Company, and its assistance asked in seeking the cause and a relief for the trouble. The investigation which followed resulted in the discovery of so unexpected an electrical condition of the affected boilers that it is believed a description of it and of the apparently successful remedy which was applied will be of general interest and suggestion to those who may have steam vessels similarly circumstanced.

At first sight the trouble appeared but the commonplace pitting which frequently occurs where a "pure water" is used for the feed, and an analysis of it promptly pronounced the water in that category. The action of such waters has been discussed at length in *The Locomotive* for June, 1896. It is here but necessary to say that it is attributed to the acids or oxidizing gases generated in a boiler from a water which does not carry alkaline salts to neutralize them. In the case in hand tube pitting was to be expected from the "pure water," but the rapidity of the corrosion aroused the suspicion that some other influence existed to exaggerate that action, and as the boilers were in the power house of an electric railway, electrolysis immediately suggested itself among the possibilities.

Now it should not be understood that those who were assigned to this investigation jumped at any conclusion thus suggested. One, at least, of these investigators (the writer admits identity) very much doubted the possibility of any such explanation. The general theory of the action of a current straying from the rails of an electric road was understood, but that it could wander into a boiler and cause any action there was not comprehensible. As *The Locomotive* once put it in doubting the responsibility of a stray current for the corrosion of an internal feed pipe: "It is hard to understand how an electric action from such a cause could take place within the closed conductor formed by a boiler shell." It was accordingly with a skeptical mind, but in a spirit of thoroughness, that preparation was made to investigate the electrical situation.

The boilers—three Manning vertical tubulars—were found in a power house typical of street railways of the smaller class. It was located in the rear of a car barn and repair shop, which in turn fronted on the highway and main track of the railroad. In the power house a room containing the engines and dynamos was nearest the car barn, and immediately behind it the boiler room. In a rear addition a storage battery was installed for equalizing the load on the station.

Hydrants on the highway at either side of the car barn corroborated the statement of the superintendent that a water main was buried in the street and paralleled his rails for a considerable distance. These hydrants were the points selected for the first of the electrical tests. A low-reading voltmeter was used and connected with one terminal in contact with the hydrant and the other with a rail. The object, of course, was to determine whether a difference of electric potential existed between these structures, and if it did, what its value was and which structure was of higher potential. The reading of the instrument fluctuated to some extent, but was a maximum at about two volts, with the hydrant at the higher or positive potential. The condition thus indicated was expected, as it is characteristic of underground piping near a railway power house. The readings if anything were lower than usual, but served to show that the pipe and rail were not metallically connected in that vicinity, and that there was the tendency for a flow of electricity from pipe to rail through the earth.

In a pit near the front of the car barn access was possible to the pipe which supplied the plant with water and which appeared to branch from the main directly in front of the building. Similar tests with similar results were made between this pipe and the rails in the barn, but no sufficient length of this branch pipe was exposed to give opportunity for determining by test whether current was flowing on it or not.

Perhaps it is well here to say for the benefit of the non-technical reader that by potential is meant a sort of electrical pressure, and that where two potentials differ in value there will be—as there would be with two differing pressures of steam or air, for instance—a tendency to flow from the higher to the lower. If there is a path suitable for its conduction between such points, there will be an actual flow of current. Now a pipe, being of metal, is a suitable path for conducting electricity. If, therefore, two points on it are found at differing potentials there is clear evidence of the existence of a current in it. The tests thus far made had disclosed a difference in potential between pipe and rail, and had indicated the probability of a flow of current from the former to the latter, conceiving the ground as a suitable conducting path. It was probable that much of this current came from a distance along the structure of the water main itself, but it was essential to determine whether any flow actually existed on the branch pipe supplying the power house.

Opportunity was given by an exposed feed pipe in the engine room to make such a test, and by using an instrument capable of measuring a milivolt (one one-thousandth of a volt), an indication over a short length was had that current was flowing and that it was in the direction of the street.

This was the first surprise for the investigator, for a flow in that direction meant from the boiler room, and his doubt of electrolytic action began to weaken. Further tests along the feed pipe followed—past the pumps and heater and up to the boilers. At the first of these—that in which the pitting was most aggravated—a distinct reading of nearly one milivolt was indicated between a point on its shell and the brass feed pipe near its entrance to the vessel. The instrument needle at this connection, however, was subject to frequent reversals; sometimes the shell was at higher potential, sometimes the pipe. The prevailing indication seemed to show the current flow from boiler to pipe, and the potential difference a maximum in this direction.

Then the instrument was connected between the entering feed pipe at the top of No. 1 boiler and the blow-off pipe at its bottom. The needle of the instrument swung promptly to a maximum of six milivolts, and in a direction indicating that the blow-off was at higher potential. Here was certain evidence of a flow of electricity at least through the metallic structure of the boiler from its bottom to its top.

The blow-off pipes on the three boilers ran separately to a brick-lined well on the outside of the building, entering it horizontally about 2 feet below the surface of the ground. The ends of the pipes were well above the water in it, but from the boiler house they passed through earth which was maintained in a generally wet and conductive condition by the hot vapor with which the well was filled. Tests made by the milivolt meter between different points on the same blow-off pipe showed current flow from the well, and, while the theory was not proved, it was believed that the electricity was drawn from the earth through its wet contact with that pipe.

Here, then, existed one element of the situation which the writer had doubted. Current was wandering into and through a boiler, and that it was caused by the operation of the railway was evident from the behavior of the instrument used. Its needle, instead of remaining in any fixed and constant position, swung from one point to another as rapidly as that of the switchboard instrument which measured the current supplied to the trolley. The operation of the cars on the road accounted, of course, for the swing of the latter instrument, and it was a fair conclusion that the motion of the milivolt meter was due to the same cause. Had it been perfectly steady, a leak from the lighting wires or from the storage battery cables might have been suspected, but as it was the movement of the needle at times so exactly corresponded to the increments of current occurring when an electric car is started that one could note the steps of the operation as the motorman moved the handle over the controller. However, to be on the safe side, the run of all wires and of the cables from the battery were carefully looked over in an effort to locate any leaks which might reach the boilers and none was found.

It was clear from these tests, then, that an unexpected and unusual electrical condition existed in the boilers. But something unusual was necessary to explain the rapidity of the tube pitting, and so in spite of previous skepticism and present perplexity the probability of a connection between the one situation and the other had to be admitted. It was still difficult to see how electrolysis "could take place within the closed conductor formed by a boiler shell," but it had been equally difficult to understand how a stray current from the rail could reach the boiler, and that seemed to be a proven fact.

It had been shown by the tests that a difference in potential existed between not only the extreme pipe connections, but also between one of them and the boiler shell. Other tests showed similar difference of greater or less value between the other pipe and the shell and even between the pipe and its blow-off cock. The instrument readings were much higher in every case for the No. 1 boiler, but the same general situation was indicated on all three. Of course, these differences were most minute, but it began to be clear that if similar conditions existed in the internal structure of the boiler the current which produced them might be an influence in the corrosion.

It has been stated that a difference in potential on a conductor is evidence of a flow in it. It is now best to further explain that the magnitude of this difference will depend on two conditions, viz.: the amount of current flowing and the resistance offered to its flow by the conductor on which the difference is measured. A small current on a conductor of high resistance may produce a potential difference as great as that of a large current on a conductor of low resistance This broad statement of these relations seems necessary to explain the reason for an experiment which the situation next suggested.

A piece of trolley wire of No. 0000 gage was bound and soldered at its one end to the feed pipe and at the other to the blow-off pipe of No. 1 boiler. If the difference of potential previously existing between these two pipes was due to a large current flowing over a comparatively low resistance in the boiler structure, the connection of this wire would have little or no effect, for it would not have influenced the amount of current, and its cross section was so small compared with that of the metal in the boiler that even though of superior conducting material it would but to a small degree reduce the total resistance. On the other hand, if the original potential difference was due to a small current traversing a comparatively high resistance, perhaps due to the various joints and seams of the vessel or the water in it, then the relative improvement of the path by the addition of the wire might be marked. The result proved that the latter situation was the case, for the bond formed by the trolley wire reduced the potential difference between the pipes to practically zero, the instrument needle moving perceptibly, but not enough to determine a value.

Strangely enough, however, the small reversing potential difference which was noted as existing between the boiler shell and the feed pipe did not seem to be affected by the connection. It remained in fact, and was clearly indicated by the instrument after the power house had ceased operation for the night, and when all lights were turned off and the storage battery disconnected from its circuit. The only explanation offering was that it was due to galvanic action between the feed pipe, which was of brass, and the steel of the boiler.

Now this paper is more in the nature of a narrative of an investigation than an explanation of the phenomena discoved. It is not difficult to form a probable theory to account for current through the boiler, but to demonstrate it would require more space than is here available. There was such a current undoubtedly, but it may not be so assuredly stated that it by electrolysis produced corrosion. The further investigation showed that the boilers had accumulated a mass of magnetic oxide scale, and that oxide was in evidence at every water drip and leak. This substance was not only indicative of the action of acids in the boiler, but by its accumulation there, under the action of the heat, produced further oxidization of the metal parts. It did—and does now—seem probable, however, that there existed the elements essential to electrolytic action—water more or less acid for an electrolyte and metal parts of differing potentials for the electrodes—and that, therefore, there was cause for suspecting such action as an influence in this trouble.

Accordingly, it was recommended that, for a time at least, the wire bond which had been connected as an experiment be allowed to remain. Other remedial measures were also suggested, such as the thorough cleaning of the boilers and the neutralizing of the water in them by the use of soda ash. For while it was appreciated that if all were applied it would be impossible to determine from a resulting improvement which of the remedies had been most effective, it was thought more important to take every measure of protection at once. Those in charge of the boilers, however, apparently had a greater confidence in the wire bond, and took the responsibility of ignoring the other suggestions. That this confidence seems to have been justified by the result is indicated by the following quotation from a letter recently received from the superintendent of the railroad: "The bond which you put in between the blow-off and feed pipe still remains, and as we have had no more trouble from pitting would say the trouble was due to electrolysis. We ran the boiler from August, 1910 (the time of the investigation), until September, 1911, without repairs. Since that time the boiler has been shut down."

Now the facts stated in this quotation may not, perhaps, seem sufficient evidence to justify the superintendent's conclusion as to the responsibility of electrolysis. Taken with the other circumstances they would seem, however, to indicate a strong probability that such action occasioned the trouble. It is because of this probability, rather than of any positive conclusion, that it is hoped that this description may be suggestive to those who operate steam vessels under similar circumstances.—*The Locomotive.*

Trade Press Convention.—President H. M. Swetland, of the Federation of Trade Press Associations in the United States, has announced that the eighth annual convention will be held at the Hotel Astor, New York, Sept. 18 to 20, 1913. The Federation includes the New York Trade Press Association, the New England Trade Press Association, the Chicago Trade Press Association, the St. Louis-Southwestern Trade Press Association, the Philadelphia Trade Press Association and a number of unaffiliated publications, the total membership being two hundred and thirty-six, representing over seventy-five different trades, industries and professions. The idea of business promotion through trade press efficiency is to be featured.

Sheet Steel Pipe Plant at Richmond, Cal.*

The Western Pipe & Steel Company, of California, was organized in 1907 at Los Angeles and took over the plant of the Thompson & Boyle Company. The business grew so rapidly that the company was reorganized in 1910, and in May of that year took over the business of Frances Smith & Company, of San Francisco. At the present time the company is operating factories at Los Angeles, Taft and Richmond. The first of these is also the oldest, and all the company's work for the southern part of the State as well as for Arizona, Utah and Mexico is turned out here. The Taft factory is located in the center of the oil fields, and the work there consists principally of tanks and oil well casings. The output of the other two plants is a general class of sheet metal and plate work, in addition to the manufacture of riveted, galvanized surface irrigation and dredging pipe, well casing, steel and galvanized tanks and steel flumes, heaters and smokestacks.

After the purchase of the Frances Smith business in San Francisco, 12 acres of land was purchased at Richmond, Cal., where a new factory was pushed rapidly to completion. This was modeled after the Los Angeles one with several minor changes, and was completed in October, 1911, all of the machinery from the recently-acquired San Francisco plant being moved to the new factory. The location of the plant is found favorable for economical manufacturing. A spur track from the main line of the Atchison, Topeka & Santa Fe Railway runs into the yard and directly under the traveling crane in the assembling shop. Additional transportation facilities are afforded by the Southern Pacific lines and the Richmond Belt Railway, which run past the property. It is planned to build a spur connection from the Southern Pacific lines in the near future, and water transportation facilities will be greatly improved by the completion of the Richmond Inner Harbor project which is now under way, the docks being located less than ¼ mile from the factory.

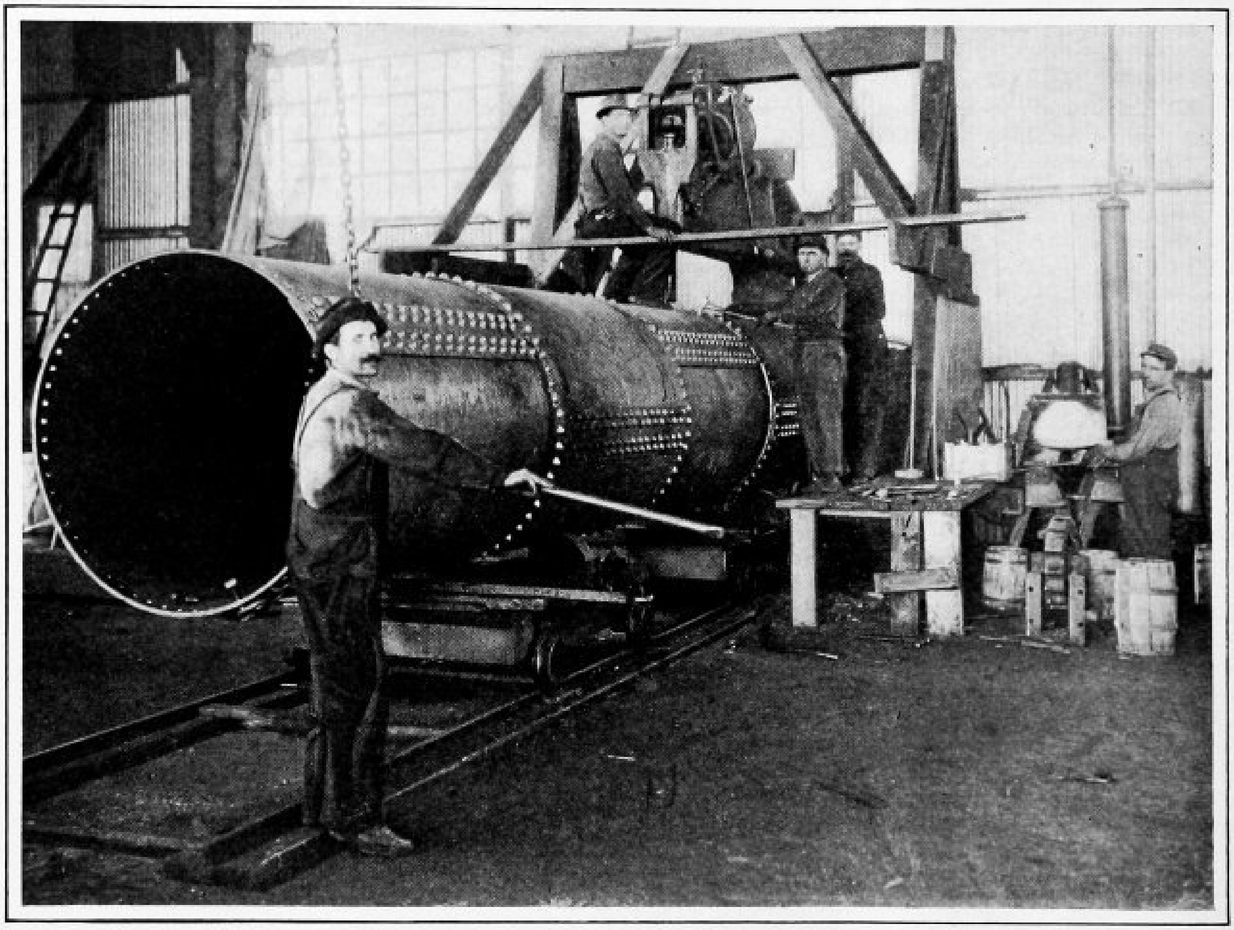


FIG. 1.—VIEW IN THE ASSEMBLING SHOP, SHOWING A PNEUMATIC RIVETING MACHINE AT WORK ON 48-INCH PIPE FOR A PENSTOCK. THE PLATES ARE ¾-INCH THICK AND ARE RIVETED WITH 1¼-INCH RIVETS

The main building is laid out in three sections, as will be noticed by referring to Fig. 2. The east wing, which is 52 by 256 feet, with a 40 by 96-foot L-shaped extension, contains all the machinery and tools for the manufacture of light riveted water pipe and well casing. The north end of the wing contains all of the machinery, the smaller machines being driven from a main lineshaft, while the larger ones have individual motor drive.

The west wing, which is slightly larger, measuring 60 by 256 feet, is devoted to the manufacture of heavy plate work, heavy riveted pipe and tanks. All of the machines in this wing have individual direct-connected motor drive, and all of them are served with jib cranes equipped with electric hoists. The tool room is located in the north end of this wing.

* From *The Iron Age.*

The main section of the building, which is used as an assembling shop, measures 72 by 385 feet, and is served by an electric traveling crane running the entire length of the building. The extreme north end of the shop is used for the storage of plates and sheets, the material being directly unloaded from the cars which are switched under the crane. The only machinery in this shop is the pneumatic riveting machines at the extreme southern end, and the special machinery for the manufacture of galvanized surface irrigation pipe, located for the manufacture of light galvanized irrigation pipe. This machine will rivet a 10-foot section of pipe in one operation, and has a capacity of from 4,000 to 5,000 feet per day. It is so arranged that pipe from 6 to 12 inches in diameter can be riveted, the changes necessary to accommodate different sizes being made in less than one-half hour.

To the north of the west wing and connected to the main assembling shop is the dipping shed. The dipping kettle is equipped with burners for using crude oil as fuel and is served

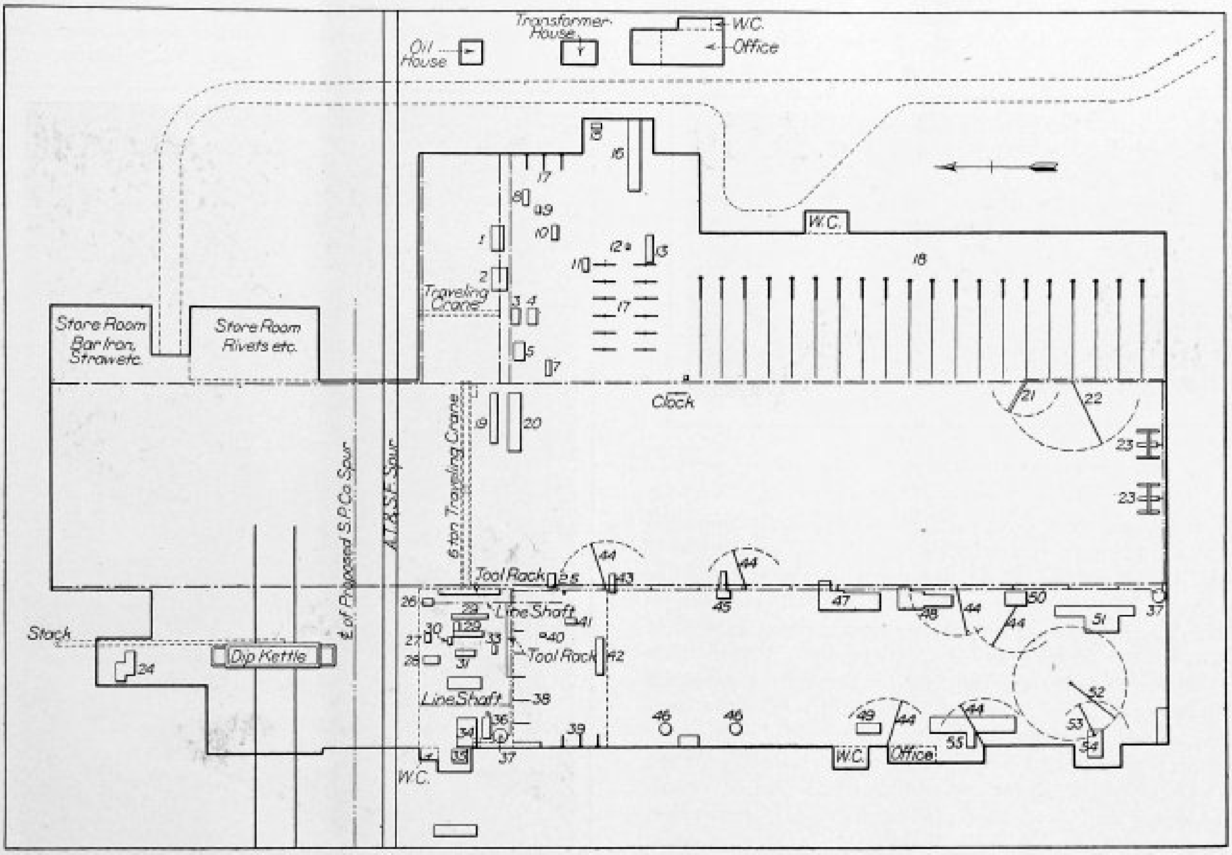


FIG. 2.—GROUND PLAN OF THE RICHMOND PLANT OF THE WESTERN PIPE & STEEL COMPANY

1—48-Inch Multiple Punching Machine
2—60-Inch Gate Shearing Machine
3—40-Inch Multiple Punching Machine
4—40-Inch Multiple Punching Machine
5—40-Inch Shearing Machine
7—40-Inch Casing Rolls
8—36-Inch Casing Rolls
9—Scarfing Hammer
10—48-Inch Water Pipe Rolls
11—Perforator
12—Shear Blade Grinding Machine
13—Casing Trimming Machine
14—Casing Driver
15—25-Horsepower Motor
16—Straight Seam Riveting Machine
17—Straight Seam Riveting Stakes
18—Round Seam Riveting Stakes
19—10-Foot Surface Pipe Rolls
20—10-Foot Power Riveting Machine
21—Wall Radial Drilling Machine
22—24-Foot Jib Crane
23—Pneumatic Riveting Machine
24—Hoist for Dipping Kettle
25—Splitting Shearing Machine
26—Motor-Generator Set
27—Motor
28—30-Inch Radial Drilling Machine
29—Lathe
30—30-Inch Shaping Machine
31—Lathe
33—Wet Emery Grinding Machine
34—Two-Stage Air Compressor
35—75-Horsepower Motor
36—Single-Stage Air Compressor
37—Air Receiver
38—Riveting Stakes
39—Riveting Stakes
40—Emery Wheel
41—22-Inch Drilling Machine
42—8-Foot Power Brake
43—30-Inch Punching Machine
44—16-Foot Jib Crane
45—Horizontal Punching Machine
46—Blacksmith's Forge
47—12-Foot Rolls
48—8-Foot Rolls
49—Flange Fire Forge
50—Bevel Shearing Machine
51—60-Inch Multiple Punching Machine
52—Revolving Crane
53—12-Foot Jib Crane
54—40-Inch Punching Machine
55—12-Inch Punching Machine

along the east wall. In Fig. 1 a portion of this shop is reproduced, showing one of the pneumatic riveting machines at work on pipe 48 inches in diameter for a penstock. The plates are ¾ inch thick, and are riveted with 1⅛-inch rivets. It will be noticed from the engraving that the pipe is brought under the machine on low four-wheel trucks. To facilitate the turning of the pipe for riveting, chains, which are fastened at the end to bolts in the work, are run through overhead pulleys, and the pipe is turned on the cars by placing a crowbar in one of the holes. Along the east wall of the assembly shop there is a set of 10-foot light rolls and a special power riveting machine, which has been developed and patented by the company by an electric crane. The riveted pipe is carried by the traveling crane in the main building from the riveting stakes to the skids running from the dipping kettle into the assembling shop. From here it is handled by the electric crane which serves the dipping kettle, and the skids extend from the west side of the dipping kettle to the storage yard, where space is provided for about 200,000 feet of pipe of different sizes. A revolving crane with an electric hoist is employed to load the pipe from the storage yard upon the cars for shipment.

In the heavy pipe department the plates are taken from the storage space in the north end of the assembling shop and are carried by the traveling crane to the southwestern end. Here they pass successively through the shearing and punching machines, the scarfing hammers and rolls, and are finally delivered to the assembly shop for riveting. The plate is then riveted by pneumatic yoke riveting machines, the compressed air for this operation and the calking being supplied at a pressure of 100 pounds by a motor-driven Ingersoll-Rand air compressor located in the tool room. The capacity of this compressor is 500 cubic feet, and a smaller compressor of 150 cubic feet is used as an auxiliary.

All of the machinery in the factory is driven by electric motors. Some of the smaller machines in the pipe shop and in the tool room are driven from lineshafts, while all of the larger machines have their own individual direct-connected motors. Alternating current at a potential of 2,200 volts is led into the plant, and is stepped down to 440 volts before being used. In the tool room there is a 25-kilowatt motor-generator set, which is employed to generate direct current at 220 volts for the traveling crane and the electric hoists. With this exception alternating current is used throughout the plant. The transformer house is located on the east side of the main building, and is a separate structure.

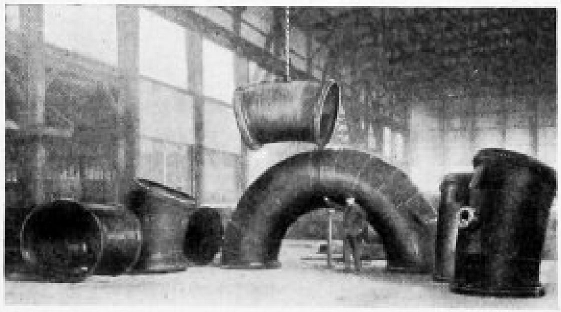


FIG. 3.—SOME TYPICAL PRODUCTS OF THE PLANT

The arrangement of the machinery and the routing of the work were given considerable thought, with an idea of obtaining the minimum loss of time. In the water-pipe department the sheets are unloaded from the cars to a storage space directly back of the shearing and gang punching machines in the north end of this department. From here they pass through the shearing machines, the gang punching machines, the scarfing hammers and the rolls, which are so arranged as to eliminate any extra handling of material. After this three or four rivets are put in each section of pipe to hold it together while running through the straight seam riveting machine. The rivets are "stuck" in by hand, and are riveted on a power machine that operates by direct pressure on a large stake upon which the pipe is placed after the rivets have been put in. A roller carriage, operated by a screw feed, travels forward and back over a die plate in which are placed sets for forming the rivet heads. This machine turns out about 1,200 feet of pipe per day, and from here the sections are taken to a round seam stake where the sections are riveted together into lengths of from 20 to 25 feet. The completed sections are next moved out into the assembling shop, and are picked up by the crane and carried to the dipping kettle. The riveted pipe turned out in this department is made from 4 to 30 inches in diameter, and from steel of No. 16 to No. 7 gage. it is used principally for irrigation, hydraulic mining, water supply systems and for small power plants.

The machines for the making up of well casing adjoin the punching and shearing machines for the water pipe. The material goes successively through the shearing and punching machines and the rolls to the riveting stakes, and from there to a trimming machine, where the ends are squared up. The sections go from here to the drive stakes, where the casing is made into sections, ranging from 10 to 20 feet in length, and is then placed under the crane in the assembling shop.

Some idea of the output of this plan can be obtained from an examination of Figs. 3 and 4. The first is a view of the north end of the assembling shop, and shows some riveted ⅜-inch steel plate elbows, 48 inches in diameter, with special ends for connection to continuous wood stave pipe of the same size. In the upper portion of Fig. 4 is shown a cone-shaped suction chamber for a gold dredge, which is made of 5/16-inch plates. This chamber is 12 feet in diameter at the center and is 12 feet long. In the foreground of this engraving is shown some 22-inch pontoon pipe for a suction dredge, made from

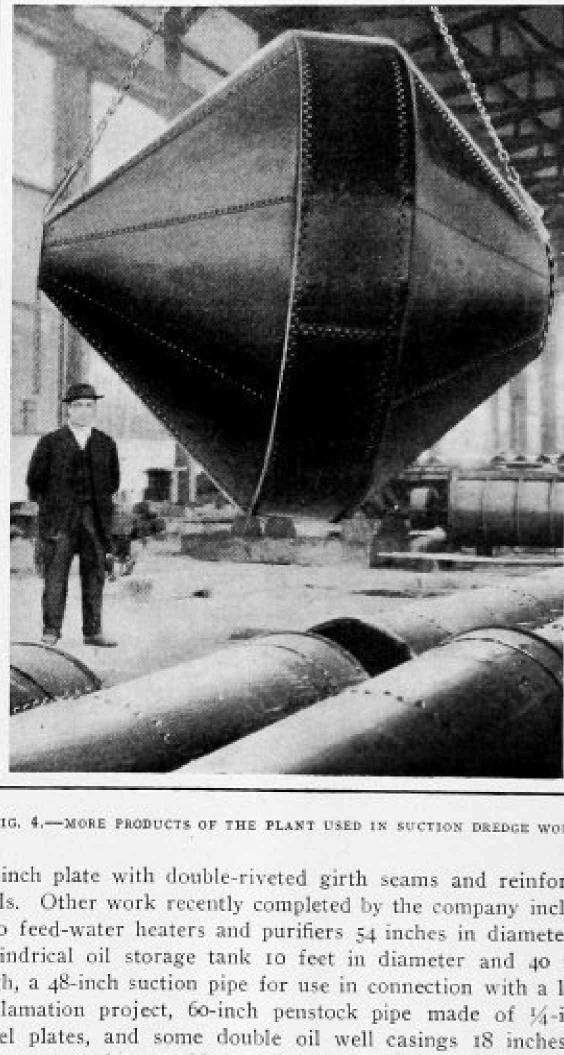


FIG. 4.—MORE PRODUCTS OF THE PLANT USED IN SUCTION DREDGE WORK

¼-inch plate with double-riveted girth seams and reinforced ends. Other work recently completed by the company include two feed-water heaters and purifiers 54 inches in diameter, a cylindrical oil storage tank 10 feet in diameter and 40 feet high, a 48-inch suction pipe for use in connection with a land reclamation project, 60-inch penstock pipe made of ¼-inch steel plates, and some double oil well casings 18 inches in diameter, made from No. 10 gage steel. All of this work was completed before it left the plant, and in addition plates for a pipe line 104 inches in diameter were cut, punched and rolled. This pipe line is composed of 5/16 and ⅜-inch plates, and will be erected in the field.

THE WARREN CITY TANK & BOILER COMPANY.—The Warren City Tank & Boiler Company, Warren, Ohio, whose plant was burned Feb. 24, is making arrangements to build immediately a temporary shop which will be operated night and day. This shop will be of sufficient capacity to take care of the company's customers until it erects a new plant either at Warren or whatever point may hereafter be decided upon. Until the completion of the temporary plant the company's pressing orders will be taken care of by other shops with which it has made arrangements.

Common Sense, Horse Sense and Geometry

BY JAMES F. HOBART, M. E.

"John, by the look on your face, you want to say something which wouldn't look well in print! What's the matter?"

"Nothing much, Mr. Hobart, except I'm up against another of those neutral axis bending propositions! Here is the stunt: In Fig. 1 there is a channel ring riveted to an inner and to an outer shell, with 4 inches between them, the 4 inches being the thickness of the ring."

"Well, John, I don't see anything out of the ordinary with that problem. Why don't you go ahead and have the ring bent up and welded, or otherwise joined together, then make up the shells to fit the ring? That seems easy enough!"

"Yes, Mr. Hobart, there is nothing hard about that, but the 'Old Man' won't have it that way. He wants me to make up three pieces, two of plate and one piece of channel, with the holes all laid off so they can be punched before and come fair after bending. After that last talk you gave us about the neutral axis business, I am afraid I can't do what the 'Old Man' wants; but I don't see yet just how or why that 'neutral axis' don't stay put where it belongs, and not go snooping all around. Will you tell us just how and why this is?"

"Sure! Pleased to do that and everything else I can to help you boys along. Now, that double shell business. Have I

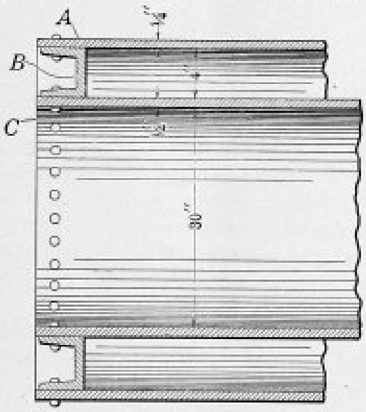


FIG. 1.—DOUBLE SHEET AND CHANNEL RING PROBLEM

got that right as shown by Fig. 1? Is *A* the outer shell, *B* the channel, and *C* the inner shell? All right, then, and the sheets are ¼ inch thick, with a 4-inch channel between and the inside shell 30 inches inside diameter? All right; now we are getting facts, but just tell me again exactly what trouble you ran up against."

"Why, when I laid off an inner shell with a circumference to fit a diameter of 30¼ inches, and then laid off a channel for a ring 34¼ inches in diameter, the holes wouldn't come right after the pieces were punched and rolled. The channel ring was too long or too large in diameter, and the outer shell, laid out in the same way, was too small for the outside of the ring. The holes in the two shells came pretty fair with each other, but they did not fit the holes in the ring; and after cutting a piece out of the ring to make it of the right diameter, then the holes wouldn't fit either the inner or outer shells."

"Right you are, John; and now I suppose you want to know how and why the channel doesn't bend up to the proper radius, and what the cure is for the trouble? The trouble is the moving of the neutral axis in the channel during the bending operation, and the axis shifts toward the inside of the ring because of the change of channel section made during the bending. Fig. 2 may make this a little plainer."

"But how can the section of a channel change during the bending? I should think that if a channel changed shape when it was bent, that a plate, or a shape of any kind whatever, would also change?"

"And that is right; they all do change when bent, and the sharper the bend the greater the change of section. Now, just look at Fig. 2. This picture shows a section of channel

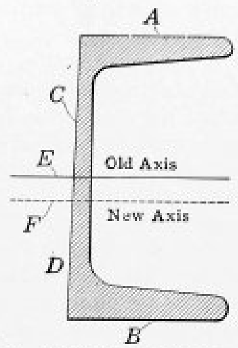


FIG. 2.—SHIFTING OF NEUTRAL AXIS

supposed to be cut from a short radius bend, something as shown at *S T*, Fig. 3. That is, cut right through the bent channel at *S T*, Fig. 3, and the cut portion will look something like Fig. 2."

"Why, one flange of the channel is a good deal thicker than the other! What did that?"

"Bending, John, bending. When a channel is bent slightly, as shown at *A*, Fig. 3, there is a little, but a very little, change in the section and in the position of the neutral axis—bending axis, it might well be called, as shown at *B*, Fig. 3. But when

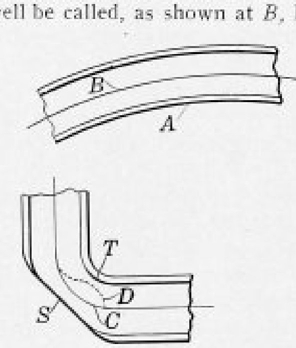


FIG. 3.—EFFECT OF RADIUS ON NEUTRAL AXIS

the bend is a very sharp one—that is, when the radius is short—then things happen, and the bend looks about like that shown at *S T*, Fig. 3. The inner flange *T* thickens up, and the thicker it becomes the more resistance it offers to compression, and the more it is able to resist the compressive force. On the other hand, the flange *S* becomes thinner as the bending proceeds, and the thinner it gets, hardening of the metal excepted, the less resistance it can offer to the stretching force, therefore the outer flange is weakened by bending and stretched, while the inner flange is strengthened and compressed. The effect of this can only have one result, viz., to move the neutral axis toward the inner flange, as shown by the dotted line *D*, Fig. 3.

"Shortening the radius of the neutral axis in the manner described, or in any other manner, can have only one result—the bent angle or channel comes out too long, for the reason that it has stretched more than it compressed; therefore the ring is too large and the distance between holes is too great."

"Then, Mr. Hobart, how are we going to find out the exact length to which these channels may be cut short? Is there not some geometry stunt which will tell how to do it?"

"Probably there is, John, but I have never come up with it yet. I have had inquiry for a rule to cover this point, and one may have been worked out by some 'Exalted Geometry Sharp,' but I have not yet heard of such a rule. Probably both geometry and the calculus would needs be used in making up such a rule, for the lengthening of the bent angles increases, not only with the length of the bended part, but also with the sharpness of the bend. The geometry sharp, when talking in his own language, would say, 'The increase is directly in accordance with the length of bended part, and inversely with the radius of the bend.' John, you may figure out what that means between now and our next talk."

"Oh! I savey that dope all right; he wants to say that the longer the bent angle and the shorter the radius of the bend, the greater will be the increase in length of the bent angle!"

"You are right, John; and now to make up the templets you require I know no better method than to bend up a channel which has been cut to the proper calculated length. Then note the excess of length, and cut the pattern or templet short an equal amount; then lay out the holes in the required number and space them equally around the ring. In this manner a templet can be made which will work properly."

"Say! Isn't that a rather expensive proposition? It seems so—to make a trial channel for each and every ring of different diameter which comes through the shop?"

"It is not as an expensive proposition as it looks. The trial ring may be cut off to its proper length and the holes drilled or punched therein, and the channel used. When there are a number of rings to be made the waste of one for experimental purposes will amount to very little, and you can figure out which is the cheapest—to waste one channel or to waste the extra time required to do the punching and cutting off after the trial ring has been formed up."

"Oh, Mr. Hobart! I see now how the structural shapes stretch more than they compress during bending, and I see, too, why the ring becomes too long; but why does the sheet show a variation also? There is no flange on a sheet to thicken or stretch, and it seems as though the neutral axis ought to stay where it belongs, instead of snooping around all the sheet thickness?"

"But it don't, John; the neutral axis changes in a sheet the same as it does in a shape, but the movement is not as great, although it is in the same ratio to the thickness in both shape and sheet. Therefore, though the neutral or bending axis does shift according to the shortness or radius of the bend, the amount of movement is so very slight that it may be neglected. The movement of the axis in a shape 4 inches or more in thickness is about sixteen times as much as it will be in a ¼-inch sheet, which is probably never more than 1/32 inch at the most."

"I see. So you think I had better make up a templet in order to find the correct length of the ring channels, and so change the templet that it may be used as one of the rings?"

"I certainly do at this stage of knowledge concerning the movement of the neutral axis during bending of structural shapes. And, furthermore, if you will keep a record of the various jobs, note and record the amount of lengthening beyond the calculated circumference, by different shapes bent under various conditions, to different radii, then you will soon be able to obtain constants for the correction necessary in bends of a given radius. You can get some rules in this way, John, but I fear it will be about like getting up rules for spelling the English language. One old professor started it, so the story goes, but when he got done he had a rule for each and every word, and an exception for each rule. And I fear there would be about as many rules and exceptions in circle-bending constants appertaining to various structural shapes."

"All right, Mr. Hobart, I'll work out the trial templets as you say. Suppose I will have to tell the 'Old Man' that he isn't in it in this job, with his straight layout for the sheets and ring to be punched flat. But, say, I know what I'll do, I'll just ask him to lay out one ring and a couple of sheets for me, so I can get hold of his way better. I reckon that will cork him up for a while."

"Good enough, John; but for what is that bank of figures on the new sheets over there? Looks as if all the figures in the country were having a campfest over there. What are they all about?"

"Why, the 'Old Man' wants to make up a flue to handle as much smoke as can pass through a dozen small openings, and I was figuring it out for him."

"But, John, for gracious goodness' sake, why didn't you work out that problem with the steel square without making a single figure? I showed you how away back last fall or winter!"

"I know you did, and I worked out the matter that way for the boss, but he didn't seem satisfied, and made me work it all out by hand to see if the two results would check each other up."

"That's all right, but just look at the hundreds of figures on that sheet! Must have taken you all day to have made them?"

"Well, I was chalking that sheet for more than a half a day, but the answers came out alike by both methods, so the 'Old Man' is satisfied. It was fun for me and didn't hurt the sheet."

"Yes, John, I know that, but I'm ashamed of you all the same. I shouldn't think you would use up the company's time like that when there is no need of it."

"Say, Hobart, what'r you giving me, anyway? If I want to find the size of a hole equal in area to one hole 5½ inches in diameter, one 8⅝ inches, one 9⅝ inches and two holes 6¾ inches in diameter, haven't I got to square all these diameters separately, multiply each square by .7854 to find its exact area, then add all the areas and take the square root of the sum in order to find the diameter of the large flue required? Haven't I got to do all that?"

"Not by a good deal! If you are bound to work out this problem by hand you can use a little horse sense as well as figures, and horse sense, or common sense, as it might be called, will save you at least one-half the chalk work of figure making."

"How is that, Mr. Hobart?"

"Well, to begin with, there is no need of multiplying the several squared numbers by .7854. When you square the numbers you find the area of a square as big across as the diameter of the circle. When you multiply by .7854 you only knock off the corners of the square and leave the true circular area. But to compare one circular area with another it is not necessary to 'knock off the corners,' and we can compare the squared numbers direct. It is this way: Suppose you want a flue equal to two 5-inch openings; all you need to do is to say $5 \times 5 = 25$, and $2 \times 25 = 50$, the square root of which is 7, nearly. Therefore a 7-inch flue will nearly equal two 5-inch openings."

"Say, that's some short cut, isn't it? That would have saved me a whole lot of work."

"Yes, but that is not all the work you might have saved yourself by mixing up a dose of common sense, horse sense and geometry and taking it in hourly doses!"

"How's that? I don't understand how I wasted any time in squaring those numbers. There are a whole lot of fractions, and it takes a lot of figures to square mixed numbers."

"Oh! it does, eh! Just show me; I'm right from 'Ole Missouri' this blessed minute, so 'show me' quick."

"Well, here you are:

$$\begin{array}{r} 5\frac{1}{2} \\ 5\frac{1}{2} \\ \hline \frac{1}{4} \\ 2\frac{1}{2} \\ 2\frac{1}{2} \\ 25 \\ \hline 30\frac{1}{4} \end{array}$$

"But, John, why do you go to all that trouble for squaring the number 5½?"

"Why, how would you do it any other way?"

"Take another dose of horse sense, John, then just take the whole numbers just below and just above 5½, multiply them together, add a quarter, and there you are. The numbers nearest 5½ are, of course, 5 and 6. And 5 × 6 = 30, and add a quarter, giving 30¼, which is the exact square of 5½."

"Say, that's great! Will it work with any numbers?"

"Sure. You can't think of a number containing a one-half fraction which can't be squared in that way. Take 10½, for instance, 10½ × 10½ = 110¼, and so does 10 × 11 + ¼."

"Say! that's sure some stunt, all right; but how does it work with other fractions than one-half?"

"It won't work, John, but there is a short cut, geometry horse sense method which will work at any and every time you want it, and here it is:

"Required, the square of 8⅛.

"Answer, 8⅛ × 8⅛ = 66 1/64.

"The process is: Add the square of the fraction to the square of the whole number, and then add twice the product of the whole number and the fraction. The sum will be the square of the given number, including its fraction. The way it is done is: ⅛ × ⅛ = 1/64; 2 × 8 × ⅛ = 2, and 8 × 8 = 64. Their sum = 66 1/64."

"Say, Mr. Hobart, but that's some handy, isn't it?"

Value of Firebox Heating Surface

Within the past few years the attention of engineers has been directed to possible developments in boiler practice from two diametrically opposed points. One of the suggestions advanced was, it must be admitted, little more than carrying to an extreme principles on which there was already considerable knowledge. The other, however, was more novel to the engineering world. Dr. Nicolson's propositions were put forward some four years ago, but in the meantime we have not heard of any great developments on the lines he suggested. The Bonecourt boiler, on the other hand, appears to have made considerable headway during the short time it has been before engineers.

For both systems exceptionally high efficiency is claimed, and it is interesting that this should be so, since they point in different directions. Dr. Nicolson would apparently rely wholly on convection; Professor Bone's system depends entirely on the production of radiant heat. The convection theorists adopt high gas speeds beyond the furnace as their ideal. The radiant-heat school employ only sufficient pressure difference to feed the fuel to their incandescent surface where complete combustion is arranged for. It is many years since Professor Perry sketched an imaginary boiler based on the principle that heat transmission by convection was the most important aspect of steam generation; but little of practical value to engineers has ever come from the suggestion. The original work of Reynolds has also been substantially confirmed in laboratory experiments. A bulletin has recently been issued by the Bureau of Mines of the United States, drawn up by Messrs. H. Kreisinger and W. T. Ray, on "The Transmission of Heat Into Steam Boilers," going into the same subject. These investigators have worked in terms of what they call the "true boiler efficiency," which they explain as the ratio of the heat absorbed by the boiler to the heat available to the boiler, taking as the lower limit for the latter the temperature of the steam produced, instead of the usual temperature of the feed. The results recorded on this basis fairly agree with the theory that the heat transfer is proportional to the velocity of the gases. In their introduction Messrs. Kreisinger and Ray state that a boiler is to be studied as a heat absorber and a furnace as a heat producer. Their laboratory experiments were concerned altogether with the transfer of heat by convection, and the greatest attention is devoted to this factor throughout the report. Nevertheless the authors proceed to apply their result to trials on actual locomotive and watertube boilers, and state as a general conclusion that the principles of the convection theory are shown in these cases to be borne out in practice.

It is rather difficult to see why results based on the theory of convection should be applied, for instance, to a locomotive boiler in which the varying value of radiation plays so important a part. Geoffrey's experiments, conducted in the '60s of last century, showed that, roughly, 40 percent of the evaporation in a locomotive boiler proceeded from the neighborhood of the firebox. The value of the firebox surface has ever since been recognized. Quite recently, in conducting some tests, to which we hope to refer at greater length on a future occasion, on the Jacobs-Shupert type of locomotive boiler, Dr. Goss took the opportunity to ascertain what service it performed in modern boilers. He found that, with oil or long-flamed bituminous coal, the firebox absorbed 42 percent of the total heat taken up by the boiler, and when short-flamed coal was used it took up 35 percent. The ratio of heat absorbed per square foot of firebox-heating surface to that taken up per square foot of tube surface varied between 7.6 and 6.15 to 1 for different fuels.

If reference be made to a paper read before the Institution of Mechanical Engineers in 1908 by Mr. Lawford H. Fry, it will be found that the author there analyzed one of the series of the St. Louis locomotive trials, and attempted to divide the heat utilized in steam production into two portions—viz., the radiant heat and the heat producing evaporation by convection. The radiant heat values were obtained by difference, between the heat produced by the coal and that accounted for by the known amount of air passing through the box at known temperature. Mr. Fry did not claim, of course, that his values were more than tentative. They suggested that some 40 to 50 percent of the heat produced was radiant heat passing direct to the water through the firebox. Subsequently Mr. Fry developed his investigations in these columns, and concluded that, varying with the conditions of working, up to 44 percent of the heat produced was probably absorbed by the firebox. The figures are therefore in agreement with those recently obtained in actual tests by Dr. Goss. It is evident, therefore, that in a locomotive boiler firebox area is extremely valuable. Its value is, moreover, largely due to its absorption of radiant heat, since the transfer of heat by convection in the firebox is comparatively small, the bulk of the gases never coming into contact with the walls before they are drawn through the tubes.

If the convection theory be followed to its logical conclusion the firebox would be replaced by a brick combustion chamber. Dr. Nicolson designs his furnace to produce complete combustion, and little else. In a design of boiler described by him before the Institution of Civil Engineers and Shipbuilders in Scotland, the furnace was little more than a combustion chamber, though some watertubes were run across the roof under a brick lining. In his design for a marine watertube boiler, the furnace is similarly of enclosed brickwork, with only an aperture to allow the hot gases to flow to passages containing the watertubes. Instead, however, of abandoning firebox area, the tendency on locomotives is to be more liberal in this respect than formerly, and it is, without doubt, the most important portion of the boiler as regards steam production. If Dr. Goss's idea of the locomotive of the future, as he sketched it recently before the International Railway Fuel Association, materializes, we shall some day see fireboxes with grates of 150 square feet. The object of such large areas will primarly be to reduce the rate of firing per square foot of grate, in order to bring down the present losses in unburnt coal. The effect, however, would also be to increase largely the firebox heating surface and the total radiation from the grate.

On the other hand, Messrs. Kreisinger and Ray, as we have pointed out, relegate radiation to the background. They state that radiation depends only on the extent of the fuel bed, and is independent of heating area. This considers only the "vision" of the fuel bed, and ignores the fact that flame and volume have in recent research been shown to play an important part in radiation. An increase of volume carries, of course, increase of area with it. In increasing the rate of burning coal in order to pass an increased weight of gas over the tube-heating surface, firebox temperatures are raised and the box more completely filled with flame with increased radiation. It is quite possibly correct to attribute to this latter effect the fact that long-flamed coal produces proportionately more heat in the firebox than short-flamed coal, as shown by Dr. Goss's recent report. Dr. Goss, however, prefers to see the explanation in the sooting up of the tubes. The value of the brick arch, long since adopted in British practice, is probably as much due to its effect in promoting the phenomena on which the high temperatures attained in surface combustion are dependent, as upon its more easily appreciated mechanical function of promoting improved combustion by securing a better mixture of the gases. That its value is appreciable is undoubted. It is, however, not even now adopted to any extent in America, though of late years considerable improvement has come about there in this respect. To many American tests proving its value Dr. Goss has now added another, having in the Jacobs-Shupert boiler trials carried out a series of trials which show a saving of 12 percent in favor of the brick-arch boiler. This figure agrees with others found before, but the practical objections have formerly appeared to outweigh the advantages, and to-day only 11,000 out of some 58,000 locomotives in the United States are fitted with brick-arch boilers.

Dr. Nicolson, in 1910, held out as an alluring prospect the possibility of evaporating 10 pounds to 20 pounds of water per square foot of heating surface per hour if drafts of 11 inches to 20 inches of water were adopted. In the locomotive such rates of evaporation are already secured. Dr. Goss, in the report of the Jacob-Shupert boiler trials, records an equivalent evaporation of 19.13 pounds per square foot of heating surface with coal fuel and a draft of 9.3 inches. In the Altoona and St. Louis trials on the Pennsylvania Railroad testing plant, rates of evaporation of from 12.3 pounds to 16.9 pounds were obtained with drafts of less than 9 inches. The advocates of convection do not appear, therefore, to have very much to offer, while Professor Bone has produced a boiler plant, on the surface-combustion principle, using radiant heat in which equivalent evaporation of 20 pounds and 22 pounds of water per square foot of surface has been secured, with a thermal efficiency of 94.3 percent. It does not seem, therefore, that there would be much advantage in working in the direction of the combustion chamber and convection theory. Judging from results obtained in practice the firebox and radiant heat appear to render excellent service.—*Engineering.*

Are Your Boilers Properly Inspected?

A steam-power plant represents a cash investment from which no direct profits are derived. From the day it is started it begins to deteriorate, parts begin to wear and the metal in the boiler is subjected to the action of furnace temperature, gases and to feed-water impurities.

When a boiler is given proper care and when operating conditions are of the best, it may be in good condition after twenty years or more of operation. On the other hand, if the boiler is abused, left to operate without proper care, it may become unsafe within a few months.

There are three kinds of men in charge of boilers: Those who are careful and know their business, those who are careful but not so well informed, and those who are both careless and ignorant regarding boiler operation.

A boiler in charge of a man of the first class would be in safe hands and would, undoubtedly, be found in good condition. With the second sort of attendant, it would be difficult to hazard a guess as to the condition of the boiler. If the engineer did not know where to look for defects, the boiler might be in a dangerous condition, no matter how careful he might be about maintaining the water level at the proper height and in keeping the boiler clean of scale.

When the man in charge of the boiler is both ignorant and careless, the chances are that the boiler is not cared for and defects are allowed to exist which, even if not of a dangerous character at the time, would soon become so.

In the large, well-kept plant the chief engineer does not have the time nor is it his duty to inspect boilers. Therefore this work is left to a subordinate who may or may not be competent to do the work.

But who is to determine whether the boilers in charge of the two least responsible classes of men are safe to operate or not? What protection have those employed about the plant, in the mill, factory, or passers-by against a deadly explosion? How can these persons be safeguarded in States and cities where the boilers are not under the supervision of the State or city boiler inspectors?

Remarkable as it may seem, a steam boiler can be insured in any reliable boiler insurance and inspection company for, approximately, twelve dollars a year. Such an insurance means that trained experts in their line visit the plant, making one internal inspection and at least one external inspection, two if it is possible to do so, each year. These inspectors work under the direction of mechanical engineers who are authorities on the proper construction and safe operation of steam boilers and their appurtenances.

What is the result? Any defect that can be detected is located. The inspector is competent to determine what repairs are necessary.

An engineer may detect a defect, but rather than shut down the plant will permit the defect to remain until some convenient time for making the repairs. The inspector has no scruples. If the boiler requires repair, it must be attended to at once or the risk is canceled. Consequently, the boiler is kept in a proper and safe condition.

One has but to read the reports of steam boiler inspection companies to ascertain how many boilers are found operating in a defective condition, many of which are dangerous. How many dangerously defective boilers are being operated which are not under the scrutiny of either State, city or company inspectors is a matter of conjecture. When based on the number of defective boilers inspected, they must number among the thousands.

Life is uncertain at best, and it is foolish to invite danger by neglecting to have boilers properly inspected, and even more so when the cost is but twelve dollars a year and a little inconvenience.—*Power.*

Practical Marine Boiler Design*

BY JOHN GRAY†

Combustion Chamber Plating

The furnaces of a cylindrical boiler may be one, two, three or four in number according to the diameter of the boiler. They may also be plain furnaces or corrugated. In pressures up to 150 or 160 pounds per square inch they are often plain, but beyond this pressure always corrugated.

Plain furnaces are often strengthened, if they are very long or if the diameter is very large, by flanging lengths of the furnace tube outwards and riveting together with a flat ring

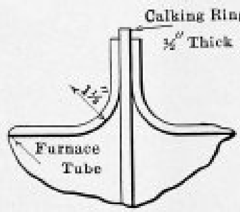
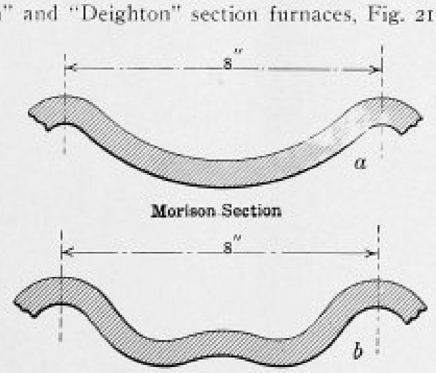


FIG. 20

between them. (See Fig. 20.) This ring allows the joint to be calked from the inside as well as the outside, and is known as a calking ring. This type permits of a slight longitudinal expansion and contraction to take place should this be necessary. It is the nearest approach to the advantages derived from the corrugated type. It has one great disadvantage, however; it cannot be withdrawn. If a plain furnace is not too long sometimes an angle or a T-bar is sufficient to satisfy conditions laid down by the Board of Trade.

Chief among the corrugated types of furnaces are the "Morison" and "Deighton" section furnaces, Fig. 21, and they



Deighton Section
FIG. 21

claim a few advantages that do not exist in plain ones: 1. Their resistance to collapse. 2. Their uniformity in thickness. 3. Easy scaling, practically self-scaling. 4. Their greater heating surface, having 18 percent more than a plain one of the same size. 5. It has in practice the necessary amount of longitudinal elasticity, thus combining all the points which theoretical and practical experience has taught are required in high-pressure boiler furnaces.

In Morison and Deighton furnaces the corrugations consist of a series of ridges which gives strength and stiffness to the furnace, the pitch of these ridges in both cases being 8 inches, and the depth from the inside of the corrugation to the top of the corrugation being the thickness of furnace + 1½ inches.

* Concluded from the April issue.

† Lecturer on boiler making, Govan High School, Barrow Technical School (Scotland), author of "Practical Design of Single and Dougle-Ended Marine Boilers," etc.

These furnaces are conically shaped at the back end for withdrawing, thus making it easy should a repair necessitate the removal, as in Fig. 22. The weld of the furnace will be at the bottom and the position should be below the fire level.

The heating surface of a plain furnace is the circumference of the outside diameter in feet divided by 2 (as only half of each furnace is above the fire level) multiplied the length of the furnace. It is usual to add 3 inches on each side of the half circumference, as the mean level of the fire-bars is 3 inches

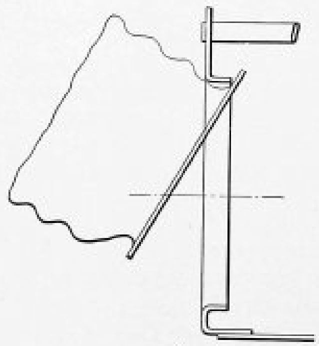


FIG. 22

below the center of the furnace. In corrugated furnaces, however, the circumference is taken on the diameter of the mean of the corrugations in feet divided by two times the length. The length of the furnace is taken between the furnace mouth and the back tube plate, and ¾ inch is added for each corrugation if Morison and 1 inch if Deighton section. The grate area in all cases is simply the length of the fire-bar multiplied by the inside diameter of the furnace.

The back tube plate, we saw, is supported from the tubes, and the back of the combustion chamber, with screwed stays, to the back end of the boiler. The wrapper plates, or combustion chamber sides at the centers, are supported with screwed

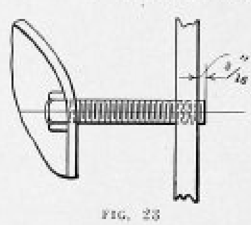


FIG. 23

stays to each other and to the shell at the wings. These screwed stays are screwed nine threads per inch through both plates, and fitted with nuts at each end except at the wing wrapper plate to shell, which has a nut on the combustion chamber plate only, and is screwed through shell and allowed to project 3/16 inch, as shown in Fig. 23. The stay is then calked into the shell.

The combustion chamber top is supported by girders, and the load is transmitted to the back tube plate and back combustion chamber plate. These girders consist of double steel plates, and are bound together by means of washers ½ inch thick bent over at the ends. In addition to the washers the girders are bound by two rivets with a thimble distance piece between them. There is usually a 2½-inch to 3-inch space between the top of the combustion chamber and the bottom of the girder, which allows any deposit that may lie along the top plate to be cleaned. The toes of the girders ought to be carefully bedded into the heel of the back tube plate and combustion chamber back, in order that these plates take the full load of the top of the box. (See Fig. 24.)

The bolts through the girders and the top plate are screwed the same as the combustion chamber sides and back, with a nut

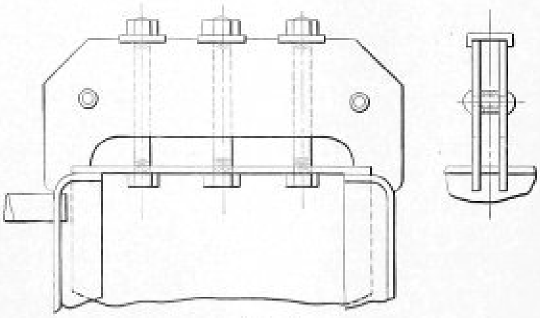


FIG. 24

at either end of the bolt. The heating surface of the combustion chamber plates should be measured from 3 inches below the center line of the furnace on the water side of the wrapper plate, right round the sides and top; this, multiplied by the mean width of the firebox over the back tube plates and back combustion, is equal to the heating surface of the wrapper plates. The heating surface of the firebox backs is equal to the area of the box taken to 3 inches below the center of the furnace and back tube plate the same as the firebox back with the area of the tube holes and furnace openings deducted. No allowance is made for the front tube plate when considering the heating surface.

If the boiler which we are working at should be a double-ended one the combustion chamber is likely to be common to both ends of the boiler, and instead of having a combustion

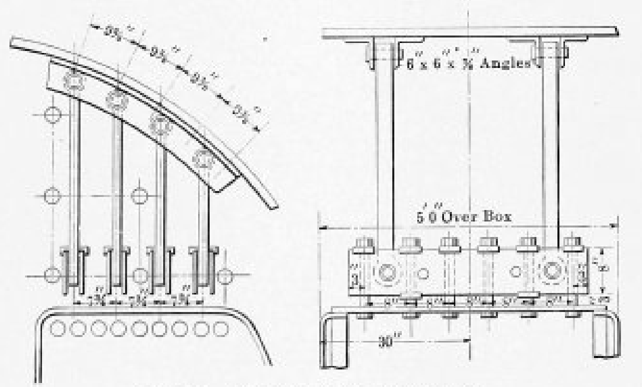


FIG. 25.—DOUBLE HANGING GIRDER STAYS

chamber back, as we had in the single-ended boiler, we have two back tube plates. The girders for this type of combustion chamber are often supported from the shell, due to the extreme width of chamber, and we may arrange two stays, taking the full load on the top of the box as in Fig. 25.

These stays are fixed by pins between two 6-inch by 6-inch by ⅞-inch angle bars, and the angles run round the circumference of the shell, and are riveted with rivets of the same diameter as the longitudinal rivets.

The hanging stays are forged from the solid billet then annealed afterwards. They are left 1/16 inch clear at the top side of the girder pin and 1/16 inch at the bottom side of the top pin when the boilers are cold, to allow for expansion. Should there be hanging stays then the bottoms of the combustion chamber will also be tied to the shell, having two angle bars riveted to the combustion chamber bottom with a plate between them, the plate being bolted to the angle bars with 1-inch diameter bolts, Fig. 26. For details of the hanging stay see Fig. 27.

The student should here make the necessary sketches for girders in boilers of the single-ended and double-ended type, being careful to observe the methods adopted by the boiler maker for fixing those correctly to place; also he ought to sketch a combustion chamber complete with furnaces in posi-

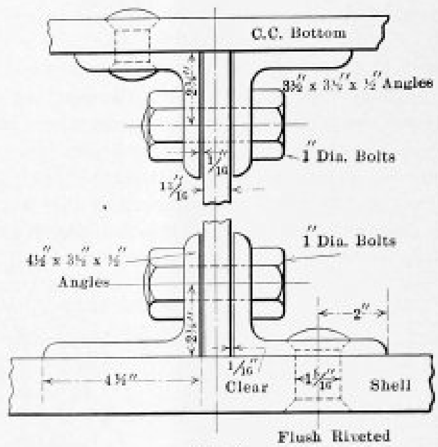


FIG. 26

tion. This will enable him to grasp fully the internal construction and spacing of the boiler, care being taken that at no place should the spaces be cramped less than 11 inches clear, to allow free access between the tubes at wide water spaces.

Question 18.—Sketch a 1-inch diameter bolt and nut (correctly proportioned) for fastening plates to angle bars underneath the combustion chambers.

Question 19.—Sketch sections of angle, T and channel bars. Give two views showing how two steel plates are connected

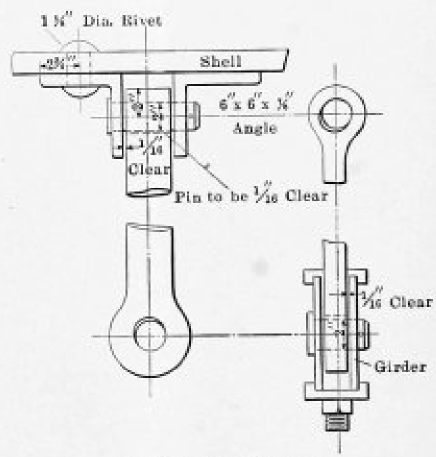


FIG. 27.—HANGING STAY

together by means of angle iron and rivets.

Question 20.—It is required to connect parallel plates together; show three methods of doing this.

Question 21.—Give a description of how you would weld a plain furnaces; say in what position you would put the weld relative to the fire level, and why?

Question 22.—Find the grate surface of a boiler having three plain furnaces 3 feet internal diameter with fire-bars 5 feet 3 inches long.

Question 23.—Sketch sections of Morison and Deighton furnaces, and say what percent greater heating surface can be got from a corrugated furnace than from a plain one.

Question 24.—State briefly the benefits of using a corrugated furnace, and describe the advantage of the conical-shaped back end.

Furnace, Smokebox and Funnel Details

The furnace details of a marine boiler consist of fire-bars, side bars, furnace door, front bearers, back bearers, pricker bar and ash-pit door, etc.

The fire-bars are usually made of cast iron, and either in one or two lengths. If made in one length they are hung on the back bearer, and made free to expand on the front one.

If they are in two lengths the expansion takes place at the front and back bearers, and they are hung on the center bearers, care being taken to allow a lip of about ⅜ inch at the front and back bearers when the bars are cold, so that when the bars become heated and gradually rise, due to expansion, the bar does not work up beyond the flush of the bearers, causing an obstruction when firing. These bars have fitting strips across their length to keep them apart the requisite amount of air space. For natural draft boilers the breadth of bars on the face is ¾ inch, with ½ inch or ⅝ inch air spaces, and with forced draft boilers ⅝ inch on face with ⅜ inch air space. The bars ought not to be longer than 5 feet 6 inches, as there is difficulty in stoking a bar longer than this, and if a bar is badly stoked the efficiency of a furnace is reduced.

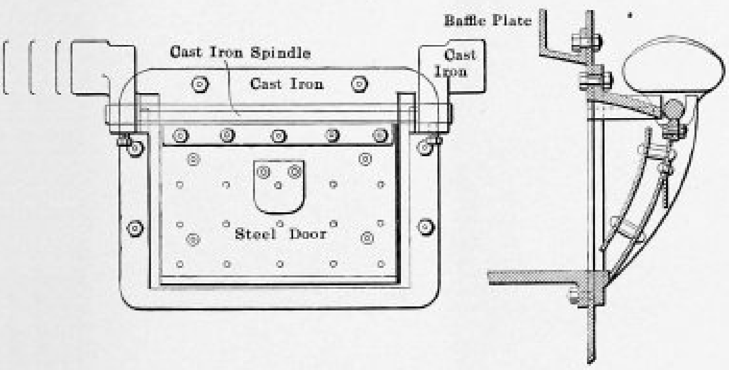


FIG. 28.—FIRE-DOOR

The front, back and center bearers are cast iron, and shaped to receive the fire-bar, the front bearer being made in segments for renewal, as the front part of the bearer when it receives the fire-bar burns away more quickly than the back part. These bearers are made ¾ inch thick, and are fastened to the furnace with angle lugs, being screwed through the furnace plate with a nut inside the furnace.

The side bars ought to be fitted into each corrugation from templates, in order for them to lie as close to side of furnace as possible, and in forced draft furnaces they will have a recess filled with prepared putty to make them air-tight.

The pricker bar in a natural draft furnace is hung on to the front bearer by two straps. It is either a mild steel bar 1¼ inches diameter or a wrought iron tube. It serves the purpose for the fireman to test the pricker bar while cleaning the furnace.

Ash-pit doors are supported from the pricker bar and allow the firemen in natural draft boilers to control the amount of air under the bars. In Howden's forced draft system, of course, the ash pit is entirely air-tight, as the air pressure is led under the furnaces as well as above.

The furnace door for a natural draft boiler consists of a cast iron frame, which has an opening of 18 inches by 12 inches, or perhaps a little less, to suit the diameter of furnace mouth. It is mounted on a steel plate ⅞ inch thick, and fastened to the furnace mouth by means of lugs. The door itself is made of steel plate about ¼ inch thick with a baffle inside it. It is curved to a radius to prevent it buckling, and has about a dozen ¾-inch holes punched out to allow a small quantity of air above the fire-bars. The door is balanced by the side weights, which allow it to swing open and shut quite easily. There is a cast iron baffle plate fitted in segments inside, which protects the furnace front plate. This plate is also fitted with holes for access of air to the fire-bars. (See Fig. 28.)

Howden's furnace door is, of course, like the ash-pit door, air-tight, and a pressure of air is led to grid valves on the side and top of the door for admittance of air above and below the fire-bars.

The furnace bridge at the back of the fire-bars in natural draft furnaces is arranged a height to give a clear area of about one-sixth the grate area through the throat.

The smokebox may be arranged either for natural draft or forced draft. If forced draft, the casing is formed round the tubes and led to a convenient place to the base of the funnel. It is supported by two angle bars running along the top cross seam (the top cross seam being flush riveted to provide for this). Besides these two bars there is a 2½-inch by 2½-inch by 5/16-inch angle, which follows the outside rows of tubes. The heating tubes are arranged in a box immediately above the top row of boiler tubes. This box is for heating the air used for forcing the draft. The hot gases from the furnaces pass through the air-heated tubes, thereby raising the temperature of the air in the box surrounding them. This air is supplied to the air box by a fan, which is connected by a pipe or trunk. By this means a pressure of air is always maintained in the box when the fan is running. From the air-heating box a series of passages is arranged down the boiler front and all connected to the top and sides of the furnaces, and to the ash pits, which, as I have already remarked, are made air-tight by a door.

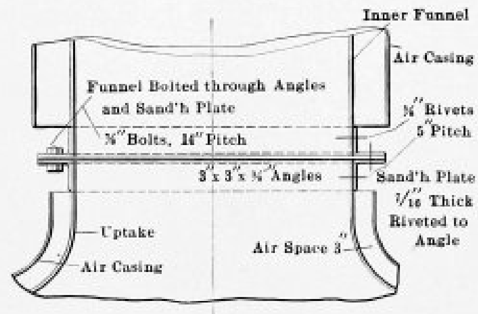


FIG. 29

Valves are provided so that the supply of hot air from the air heater can be regulated to suit the state of fires and steam pressure. By these means when the fan is started cold air is blown into the air heater, where its temperature is raised to nearly that of the gases going up the funnel. This hot air then passes down the trunks on the boiler fronts and plays on the top sides and underneath the fire, thereby increasing the draft.

The advantage of heating the air is apparent, for if it were cold it would require to be heated in the furnaces, thereby using heat which would not be available for steam raising. The chief advantages of Howden's system of forced draft over natural draft are, first, economy in coal consumption; second, less weight to be carried in the ship, as the boilers can be smaller than would be necessary for natural draft.

In natural draft smokeboxes the casing is simply formed round the tubes and led to the base of the funnel. The plates are mild steel, the inside casing usually being 3/16 inch thick and the outer casing being made ⅛ inch thick, with a 2½-inch to 3-inch air space between them. The smokebox doors in both forced and natural draft casings are seldom less than ¼ thick, and have, as well as an air plate outside, a baffle plate inside to protect them from the gases passing through the tubes.

The up-take at the base of the funnel is finished off from the square up-take to the round funnel in merchant ship work always by having a sandwich plate between them. (See Fig.

29.) A hole is cut in this sandwich plate to the diameter of the funnel, and the round base of the funnel rests on the square edges of the plate. Sometimes the up-takes are worked from the square and merged into the round funnel without the intervening sandwich plate; but as this is a costly operation it is mostly used in Admiralty work.

The funnels are made up of an inner and outer tube, the inner tube being, as a rule, 3/16 inch thick and the outer ⅛ inch thick. The circumferential and longitudinal seams in the inner funnel are all lap-jointed. In the outer the longitudinal seams are lap-jointed, and the circumferential butt-jointed and flush riveted. This arrangement adds to the appearance of the funnel on the ship. The inner funnel is often divided into compartments according to the number of boilers, each boiler having a separate compartment to itself, which adds to the efficiency of the draft. In any case, whether the funnel is partioned to suit the total number of boilers or not, the auxiliary or donkey boiler has a separate compartment carried to the top of the main funnel for use in port. A damper is always fitted in natural draft boilers in the funnel to regulate the draft, but in forced draft boilers this is not necessary, as the draft can be regulated from the air valves. There is usually a space of about 1 foot clear between the inner and outer tubes and at intervals distance plates are fitted between the funnels. These distance plates should be riveted to the inner funnel and allowed to slide between angles in the outer one, in order that expansion may take place freely. The funnels are usually raked aft to suit the appearance of the ship.

The student should make himself quite clear regarding the different types of smokeboxes by sketching various parts to suit natural and forced drafts.

Question 25.—Sketch sections of fire-bars. What are the usual spaces between the bars in natural draft and forced draft boilers?

Question 26.—If a funnel for a ship is raked ¾ inch per foot and stands 40 feet high, what is length of each strake of plating, assuming we have five strakes in length and circumferential seams are butted?

Question 27.—If the longitudinal seams of above funnel are lapped and 1½ inches broad, what are the breadth of the plates if funnel is 8 feet 3 inches diameter and it has six plates in circumference?

Question 28.—The bottom strake of a funnel on the forward side measures 11 feet long and the aft side 10 feet 7 inches long, if diameter is 9 feet 6 inches, what must the rake be?

Question 29.—Give a description of Howden's system of forced draft. What are some of the chief advantages over natural draft?

Question 30.—Sketch a front and back bearer for fire-bars, if fire-bar is in one length.

Boiler Mountings

Although it hardly comes under the scope of boiler work, I think every student of boiler making ought to have a general idea of the most important mountings usually placed on the boiler. He may be at a repair, and require to arrange his work to suit mountings already fixed on the boiler, or he may have to replace mountings disturbed in the carrying out of his work, and to have a knowledge of these valves and their uses is very important.

1. The main steam stop valve, usually placed on top of the shell and position fore and aft to suit the main steam pipe arrangement.

2. Auxiliary steam stop valve, usually placed on top of shell or on back end plate if more suitable; it ought to be as high above water level as possible.

3. Main feed check valve, on side of shell, or front end at side of furnace, or on back end, as most suitable.

4. Auxiliary feed check valve, same position as main feed but on opposite side.

5. Water gage. Gage cocks usually fitted to a brass or cast iron stand pipe. This may be on front of smokebox or on back end of boiler if this is in engine room. Usually a cock is placed on the shell for steam connection to stand pipe, and also one below water level, and in a position where there is no violent ebullition of water for water to gage pillar. These cocks are sometimes wanting and stand pipe joined direct to boiler. In small boilers the gage cocks are sometimes screwed into two plates. In all cases gage glass to be placed so that when water disappears out of the glass there is 4 inches of water above combustion chamber top, the normal working water level of the boiler being 8 inches above combustion chamber.

6. Safety valves may be treble, double or single spring, usually on top of shell.

7. Surface blow-off valve or cock placed about water level.

8. Bottom blow-off valve or cock placed as near to bottom of boiler as possible.

9. Test cocks, usually fitted on gage pillar, but sometimes screwed into shell or back end plates.

10. Pressure gage cocks, on top of shell where convenient.

11. Salinometer cock, below water level where convenient.

12. Whistle valve, on top of boiler where suitable.

13. Drain plug, at lowest point on bottom of boiler.

These comprise the main mountings that will be found on a boiler, and the student ought to become familiar with them and the position they are likely to occupy on the boiler.

Switching Locomotives for Illinois Central

Ten switching locomotives of an improved design were recently completed by the American Locomotive Company for the Illinois Central Railroad, and thirty more of the same type are now under construction. The novel features of these engines are the installation of superheaters and the use of the Gaines firebrick arrangement.

While the switching engine is an indispensable unit in railroad equipment, it has not been improved as a type with the same care that is given to the design of other standard types of locomotives. A little investigation in almost any case will show that the switching engine is inefficient as far as consumption of coal is concerned. Frequent stopping and intermittent service allow the cylinders of the engine to cool, coal is wasted, and frequent trips must be made for replenishing the supply of water. It is claimed that by the use of the superheater condensation in the cylinders can be eliminated, and that there will be a saving in the amount of water used, and consequently a saving in fuel. Hitherto superheaters have not been used in switching engines, and so the results obtained in this case will be of particular interest. The type of superheaters installed in these engines is the 19-unit Schmidt superheater, for which nineteen 5½-inch tubes are fitted in the upper part of the flue sheet. The use of the Gaines arrangement of firebrick in the firebox is intended to produce better combustion, besides utilizing to a greater extent the entire heating surface of the firebox. Besides being an advantage in the efficient generation of steam, a further advantage, which, especially in large cities, is of considerable importance, is the reduction of smoke from the locomotive. As can be seen from the drawings the firebox in these engines is 109⅝ inches long and 78 inches wide. A combustion chamber 38 inches long is formed by the arch, which leaves a grate area of 38.8 square feet with a firebox heating surface of 150.5 square feet. Thus with an increased firebox volume and with a better utilization

of the heating surface in the firebox, the advantages above referred to should result.

The design of these locomotives has been worked out with painstaking attention, and every effort has been made to produce a type of switching engine which will overcome many of the disadvantages hitherto encountered and result in better service and increased economy in operation. The boilers are of the "wagon-top" type, with a minimum shell diameter of 63 inches, designed for a working pressure of 170 pounds per square inch. There are nineteen 5½-inch superheater tubes, and 151 2-inch fire tubes, all 13 feet 4 inches long. The heating surface in the firebox is 150.5 square feet, and in the tubes 1,409 square feet, making a total heating surface of 1,559.5 square feet, in addition to which there is a superheating surface of 226.6 square feet. The weight of these locomotives is 166,000 pounds. The tender has a water capacity of 5,500 gallons and a coal capacity of 6½ tons. The total length of the engine and tender is 59 feet 2⅛ inches.

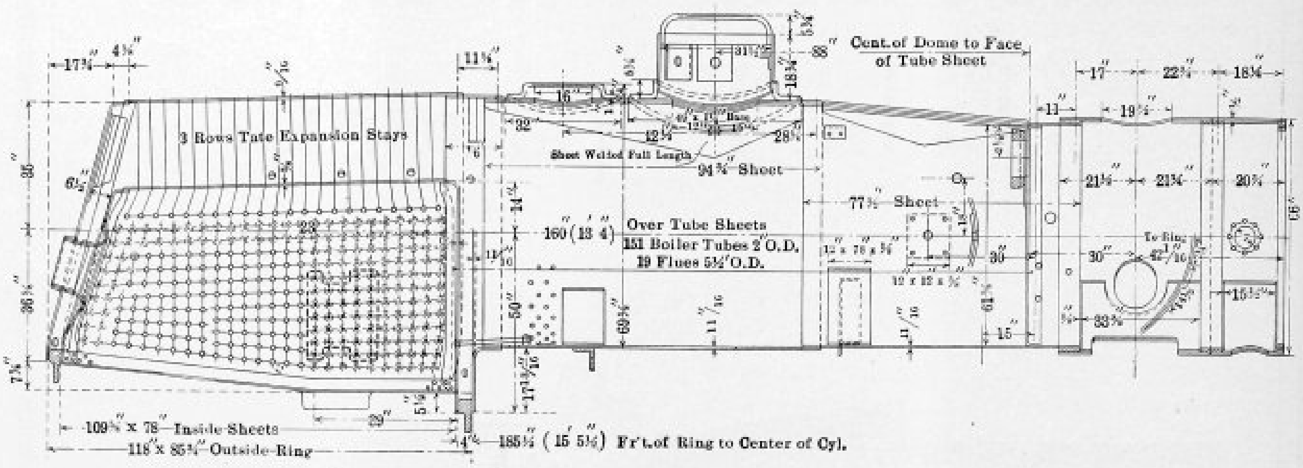


FIG. 1.—LONGITUDINAL SECTION OF BOILER OF ILLINOIS CENTRAL SWITCHING ENGINE

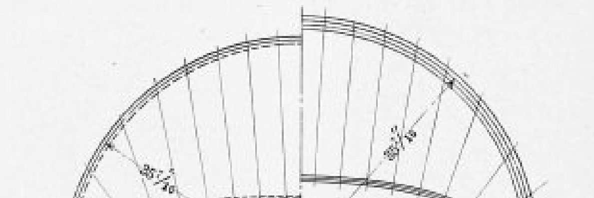


FIG. 2.—FIREBOX SECTIONS

The Siemund Wenzel Electric Welding Company have removed their general offices from 29 Broadway to Room 1823, 30 Church street, New York.

Give the Boiler Tube Its Due

We have recently received questions from several European correspondents who wanted to know the effect on the economical operation of locomotives of the huge grate area for which American locomotives are noted. Experience has taught us that the extremely large grate area, used on many American locomotives, is the cause of waste of heat, and we believe that the fashion of specifying unusually large grate area was based upon a mistake.

A long time ago we began hearing the assertion made and repeated, that one foot of firebox surface was worth five or six feet of tube surface, and the statement was never contradicted or explained with justice to the tube surface. The effect of magnifying the value of firebox surface and making odious comparisons of that with tube area, was to make many men responsible for the designing of locomotives conclude that the larger the firebox in comparison to the tube surface, the greater would be the economy in the combustion of fuel. There is some truth in the assertion that the firebox area is more efficient than the tube surface; but it is the presence of the tubes that makes the firebox of value, and it would not require the enlarging of the firebox surface to be pursued very far before we would have a merely furnace boiler. Moreover, the firebox surface owes its high efficiency to the fact that its sheets receive the first heat from the products of combustion, and that they pass into the tubes robbed of a considerable portion of their original heat. It is impracticable to expose this whole of the heating surface of a boiler to the same high temperature and every attempt to effect uniformity in this respect has ended in failure. Some engineers who believed in giving the tubes their full duty as evaporation surface have introduced fireboxes with surfaces covered by non-conducting material, but such attempts were uniform failures. To make an ideal locomotive boiler firebox and tube surface must harmonize. It must be borne in mind that every foot of surface added to the firebox not only does less work than that done by a foot in the smaller area, but also reduces the latter by reducing the temperature of the fire and that of the tubes by reducing the temperature at which the gases leave the firebox. Although the firebox surface has the advantage of receiving heat both by radiation from the fire and by conduction from the gases, the latter action is in a roomy firebox, so much less effective than that of the tubes that the tube surface may, under certain circumstances, be fully as efficient as the firebox surface. If the influence of speed is considered it follows that in some instances when the velocity of the gases is just right, the evaporation in the flues will exceed that of the firebox, and there is reason to believe that this is frequently the case in practice.

The tendency towards huge grate area, which follows the demand for large fireboxes, has the effect of depressing the temperatures of the firebox and permitting part of the fuel gases to pass away below the igniting temperature. We have never found reason to believe that Daniel K. Clark made a mistake when he asserted, as a result of his experience and experiments, that the smaller the grate area consistent with proper admission of oil, the greater would be the boiler's efficiency. Not a few American railways have found it promoted economy of combustion to put dead plates in the grates of engines having huge fire areas.

Steam engineering provides many examples of boilers that are efficient absorbers of heat with little or no part of the surface exposed to radiant heat from the fuel. The absence of surface, which would abstract heat directly from the fuel, also tends to more perfect combustion by reason of the higher temperature attained, and it is in accordance with the dictum of an eminent authority that "so long as chemical reaction is taking place, all that tends to cool any portion of the gas should be avoided." The more perfect combustion and the readiness with which the gases leaving the firebox at a high temperature subsequently part with their heat, appear fully to compensate for the absence of transmission by direct radiation. Our plea is to give the tubes due credit for their efficiency, remembering that it was the tubes that made the locomotive boiler its great success in providing railways with a high-speed engine.—*Railway and Locomotive Engineering.*

Tools for Boiler Makers and Their Uses—IV

BY W. D. FORBES

Drills can be bought which combine both a drill and a countersink and which are very useful for fitting patch bolts. They are very handy tools and make a good job of the drilling and countersinking at one operation, requiring less skill for their use than two separate tools. When a job of patching has to be done far from the shop and where no air or other drive is available the countersinking can be done very well by the use of a specially designed tool where the threaded stem is screwed into the tapped hole and the bevel mill, as it may be called, is turned on the unthreaded portion of the stem and so arranged that at the same time a feed for the mill can be given. It will pay our readers to remember this tool.

In all the tools used to cut metal, except cast iron, oil should be used freely, and it is our recommendation that with cast iron both reamer and tap should be used. Many dispute the use of oil when using a reamer, but few dispute its use when tapping, yet we know oil saves a reamer from undue wear. A sharp cutting edge is always advantageous, and boiler makers do not remember this fact as they should. A light touch of a tap along its flutes, and a little stoning of the edges of the bevel mill above described, make a vast change in the amount of work done and a better job. We wish to say that it is a very short-sighted idea to try to use any hand tool which is not in good condition, and about the first thing a boiler maker should do after he gets his kit of tools ready for an outside job is to look over every tool closely and be sure that every tool is sharp and otherwise in such condition as will not require returning to the shop to put it in

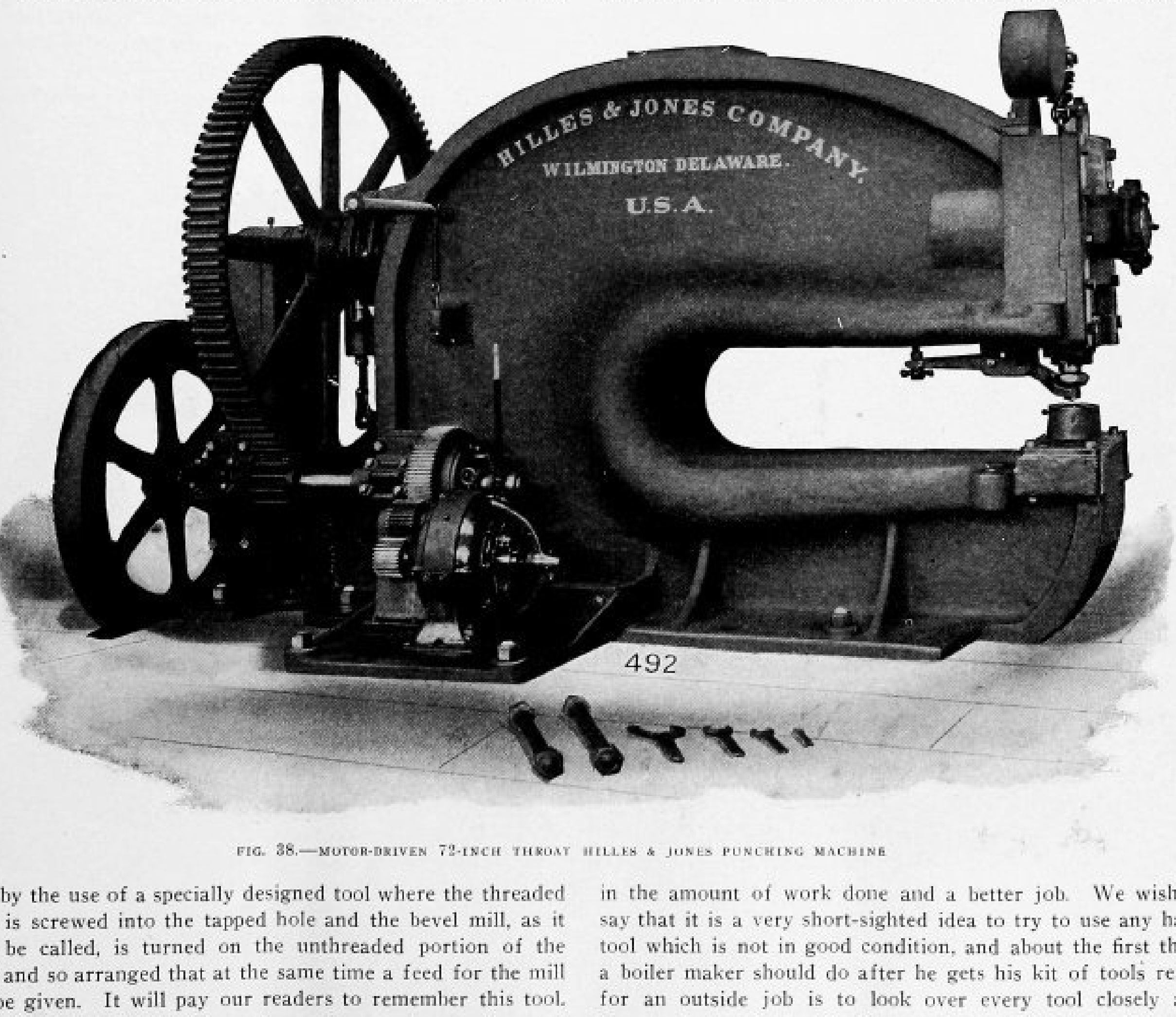


FIG. 38.—MOTOR-DRIVEN 72-INCH THROAT HILLES & JONES PUNCHING MACHINE

working order. The profit on many a job has been lost by neglecting these precautions.

No boiler maker will disagree with us when we say that to estimate repairs on a boiler takes the greatest care and experience, and even then there is always something that may come up to upset the calculations. Most repairs are required in parts of the boiler which are difficult to get at and to reach

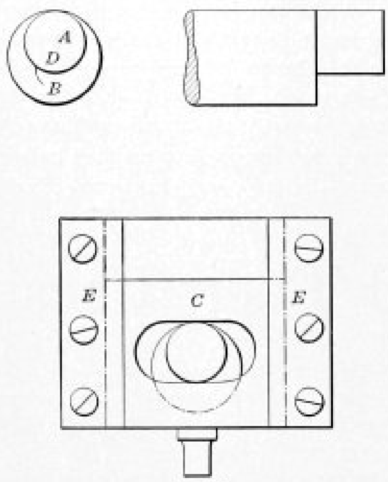


FIG. 39

the place where repairs are required is often as much work as are the repairs themselves. Brick work has to be taken down, coverings and piping got out of the way, and what is often forgotten is that all this work has to be replaced. Again, water has to be drawn off, fires dumped and time must be taken to let the boiler cool. The boiler must be refilled and a pressure put on it. Now all this takes a lot of time, and time that has to be paid for. Owners are very often at fault and object to a bill when it has been made larger than was expected by their not having the boiler ready for the boiler maker to begin work on. No one can expect a man to go into a hot boiler, nor can he be expected to do a proper amount of work if he is burning his knees or elbows, or obliged to breathe air highly heated. The men in charge of a boiler are able to take off handhole plates, and wash out a boiler and have it ready so that some comfort can be had by the workmen who have to enter it. Covering can be removed and replaced by those who have nothing to do while the boiler is being repaired, and such work will be less expensive if done with care, and when a boiler maker is sent to a mill to patch a boiler he will care little whether the owner has a big bill to pay for covering or not; his work is to make the repairs and get back to the shop.

People are apt to get an idea that repairs should be done at about so much. Just why they get these ideas would be hard to say, but about every bill of repairs is disputed. It seems a very simple job to put in three rivets, and the three rivets are all they think about, but the work required to reach the defective part is usually more than is expected, as in most cases the work which can be seen is far from what will be found must be done, and if less work is required the condition is that an unfair amount of profit is made. If more, the owner gets something for nothing and in neither case is there equity.

The question of repairs cannot be considered as presenting an uninteresting part of boiler work, and we think the very greatest skill is often shown by boiler makers in doing such work, and a nice job of this kind is one to be proud of, yet would it not be wise to undertake all repairs at day rates? If a boiler maker is not trusted by a firm, no business should be done with him. If he is, why not show the trust by letting him do the repairs at so much an hour? A better job will result and all concerned will have given or received what is justly due.

Boiler makers' shop tools must necessarily be ponderous, as the work done by them demands great strength in design and great power in the drive. There are two distinct types of these tools—one where rotary motion is used, the other where a liquid or air is employed. The rotary type can be driven by belts or by being direct connected to a steam engine or motor. In some localities water power is also used to drive belted

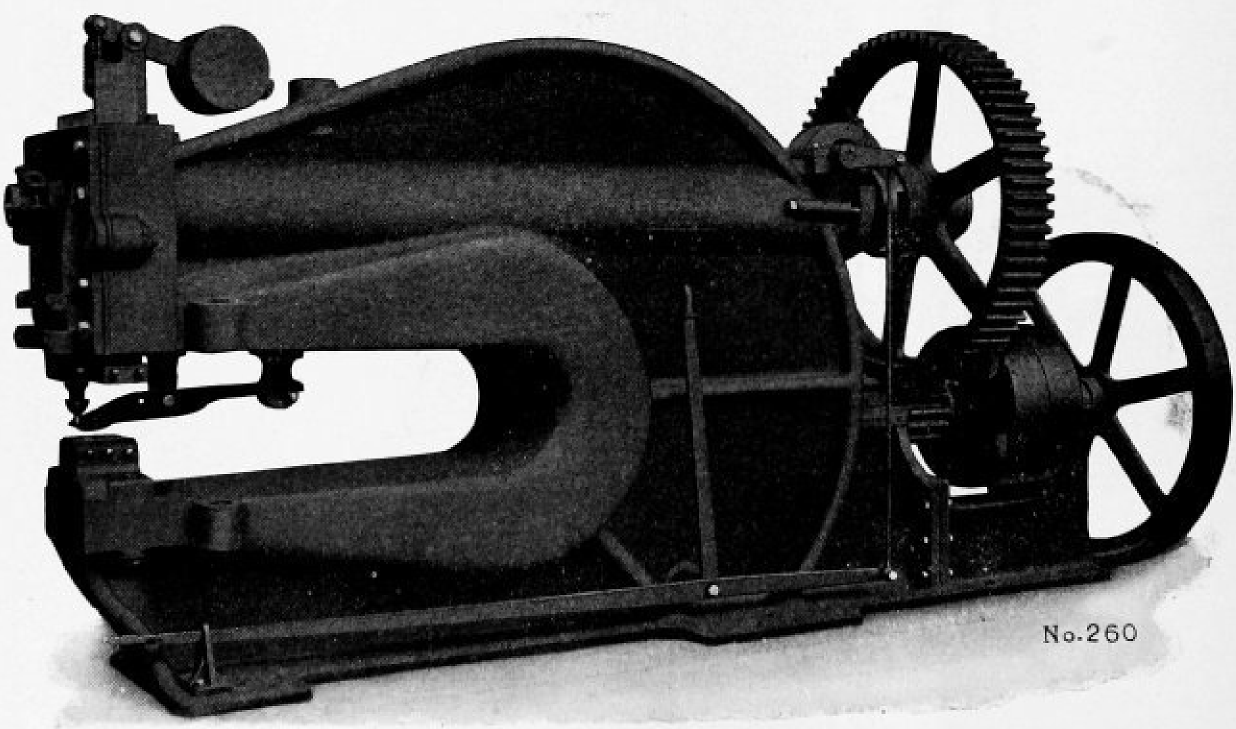


FIG. 40.—HEAVY, BELT-DRIVEN CLEVELAND PUNCH

tools. One of the first things to be considered, therefore, in selecting an equipment for a boiler shop is the design of the tools, and particularly the strength of the tool. It can be well understood that a good design can be offset by having too little metal in the machine; and, again, there may be ample metal but it may not be put in the right place. A heavy tool may not be a strong one.

After strength in a machine itself, we must look to the power in the drive. A good wide belt is required, but if it is run too slow a broad belt may not mean a strong drive. It may be said that all well-known manufacturers of boiler makers' tools now have machines which long experience has made almost perfect, but still there is room for improvement in many ways.

The principal tools required in a boiler shop are as follows: The punch, shears and rolls. All of these tools should be supplied with means for handling the material brought to them, and far too often this is neglected. Without proper cranes and hoists work is made to cost far more than it should, and lack of handling appliances is often the cause for failure to make a satisfactory profit, or any at all.

A very good example of a well-designed punching machine is shown in Fig. 38. Here it is seen how massive such tools must be, but in the tool illustrated the solidity is a little unusual, as the opening in the frame is 72 inches deep. This opening is called the "throat," or more often the "reach," and it means when you say 72-inch "reach" that a hole can be punched 72 inches from the edge of a plate. Most of the holes punched in boiler plates are punched but a few inches from the edge of the material, but often hand and manholes have to be worked out in the middle of a sheet and the long reach as shown becomes of value.

The drive of the tool shown is by means of an electric motor. On the shaft of the motor is a pinion which is comparatively small in diameter and runs at a high speed. This pinion meshes into a larger gear, and just to the right of this gear a handle will be noticed. This handle moves a clutch, which when thrown out disconnects the large gear from its shaft, whereupon the gear continues to run, but the shaft stands still. This clutch therefore controls the starting and stopping of the train of gears which actuate the machine. The clutch shaft extends to the left and is carried in a bearing. Just next the clutch gear, and still further to the left, a second bearing will be noticed. To the right of this bearing a pinion will be seen meshing into the teeth of the large spur gear, and to the extreme left, on the clutch shaft, a heavy flywheel is keyed, the value of which will be explained later.

The shaft on which the large spur gear is mounted extends from a bearing on the support, which can be seen through the arms of the spur gear, and it extends to the right, through the frame to its very front, but the large spur gear is not keyed to the shaft. To the right of the hub of this gear will be noticed a system of levers, one being horizontal, and to the end of which is attached a spring which in turn is made fast to a lug cast on the frame. In a vertical position is a lever attached to what is called a "bell crank," and on the opposite side of the punch, running along the floor, is a rod which is connected to the bell crank lever. This lever extends to the end of the punch. These levers are connected to a clutch which is keyed on the long shaft which carries the large spur gear. Now, if a man puts his foot on the end of the long lever, on the other side of the punch, by pressing down, the clutch, which is keyed on the shaft in such a way as to slide on it yet revolving with it, will engage the clutch and the large spur gear, and as the shaft and clutch are revolving together the large spur gear will be made to revolve also and the sliding head of the punch will be actuated through the long shaft.

(To be continued.)

Firing Up Locomotives

BY C. E. LESTER

It is common custom on practically all railroads in this country to use engine and valve oil on a guarantee and it is doled out to enginemen practically by the drop, yet small account of cheaper oils seems to be taken. It is not uncommon to see engine wipers slap oily waste over an engine like a scrub woman would a mop, as if it didn't cost a cent. In a great many engine terminals it is customary for fire builders to get about two 10-gallon cans of fuel oil each morning for firing up, and when that is gone get as much more and no questions are asked. Where shavings are used the oil and shavings are indiscriminately mixed, no one taking the trouble to determine the cost; apparently it is not considered.

Some time past the writer was instructed to have some experiments made to establish a definite relation between the quantities of shavings and quantities of fuel oil necessary to be used in firing up a locomotive. For the purpose of economy it was, of course, desired to get the quantities down to a minimum. It had previously been determined at some point that oil and shavings as a firing-up medium were more satisfactory and cheaper than wood, or with oil in an oil-burning device. After some experimenting the writer finally recommended 1 gallon fuel oil thoroughly mixed with 1 bushel dry shavings as the proper amount to fire up one locomotive. Several terminals were then instructed to see what could be done along these lines.

I quote verbatim some of the reports received by the officer who directed the work, all of them making it appear that the writer's recommendations were somewhat different than actual requirements. "One engine had the fire go out entirely, one caught very slowly, and was only prevented from going out by careful nursing, and, in fact, only succeeded in getting one good fire out of eight tests, and this was on a hot engine with 100 pounds of steam; we then tried 3 gallons of oil and 8 gallons of shavings with good results; this is about 1 gallon less than we are now using. In making the test I used extra oil to wet waste to start the shavings burning. I would therefore recommend 3 gallons of oil and 8 gallons of shavings."

Another report says, "Fourteen gallons of oil and 14 bushels of shavings were soaked eight hours; at the end of that time 6 inches of shavings at the bottom of the tank were not saturated. Believe better results could be obtained by using 1½ gallons of oil to 1 bushel shavings."

A third report said that 1 1/3 gallons of oil to 1 bushel of shavings would be about the right proportion.

Taking these reports as a basis it was determined that 20 gallons of fuel oil to 15 bushels of shavings was the right proportions, and that 1 bushel of the mixture should be used to fire up a locomotive. This, however, did not change the writer's views, and, as will be noted later, the mixture as first recommended finally proved satisfactory when properly handled.

To secure the best results two soaking tanks should be constructed, each one of sufficient capacity to hold 12 hours' supply. The tanks should have a false bottom of fine mesh, substantial netting or a plate perforated with about ⅛-inch holes, placed about 3 inches above the bottom of the tank. The tank at the bottom to have a drain cock, situated so that all the oil not absorbed by the shavings can be drawn off and used over again.

Every twelve hours the empty tank should be filled. When filling, a layer of shavings about 6 inches deep should first be put in and followed up by a gallon or two of oil, and then thoroughly stirred up. This should be repeated until the tank is filled with shavings and the regular allowance of oil is used. By letting the mixture stand for 12 hours, or until the opposite shift comes to work, the shavings will have absorbed all the oil possible, and the superfluous amount will have trickled on through to the bottom of the tank, to be used again when a sufficient amount has accumulated.

In firing up, the grates should be covered with a layer of coal, then 1 bushel of the mixture thrown on the deck, and a lighted torch or a piece of waste placed in the fire hole and the shavings shoveled up, lighted at the door hole and spread over the grate area. The blower should not be used too strongly until the coal is ignited. It should be borne in mind, however, that this is not an infallible process, and that a grain or two of "horse sense" must be used. The amount is right for a firebox of the "half-deck semi-wide" type about 90 inches by 100 inches. On larger boilers there should be a proportionate increase and in smaller ones *vice versa.* There are also times when damp shavings, wet coal, or coal of low heat value, will require more to be used. It was not intended when advocating the practice of using the prescribed amount that the exact amount should be adhered to in all cases.

The following table shows what is possible along this line. The test covered a period of seventeen days and took engines as they came:

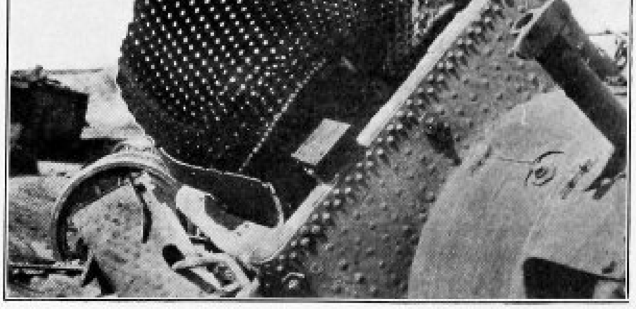
Date	No. engs. days	Fired nights	No. bush. shavings	No. gal. oil	No. gal. oil drawn off and re-used
7-15	15	13	60	60	....
7-16	16	9	15	15	....
7-17	19	10	70	75	....
7-18	18	11	14	20	....
7-19	20	11	24	10	30 gallons
7-20	16	13	28	33	....
7-21	18	12	8	10	....
7-22	15	11	56	60	....
7-23	16	11	14	15	....
7-24	16	15	28	35	12 gallons
7-25	18	13	8	12	....
7-26	18	13	36	35	....
7-27	16	15	38	30	12 gallons
7-28	19	15	30	35	....
7-29	18	18	36	40	....
7-30	18	18	..	..	....
7-31	16	16	28	30	5 gallons
Total	292	224	493	515	

Average engines daily fired, 29.76.
Average bushels shavings daily, 29.
Average gallons oil daily, 30.28.

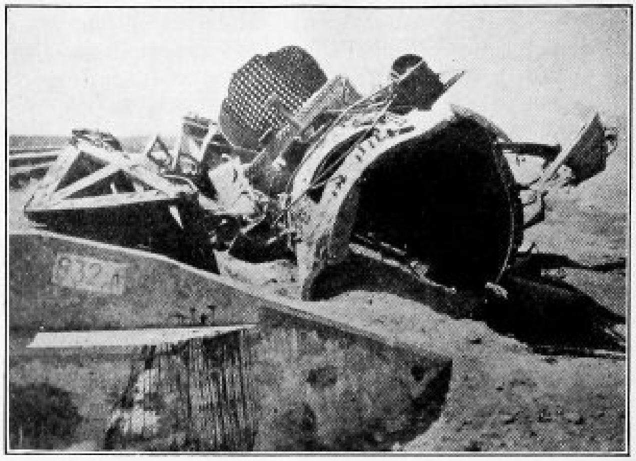
On checking up the amount of oil previously drawn it was found that the average consumption of fuel oil per day was about 150 gallons, a saving of 120 gallons per day, or over 45,000 gallons per year, at a small terminal where the average number of engines fired up is less than thirty every 24 hours. The labor cost, including collection of shavings, saturating and firing up one engine, averages about 11 cents.

One Result of the Mexican Insurrection

The illustrations show an exploded locomotive boiler which met with disaster during the recent Mexican rebellion. The train to which the locomotive was attached was held up by the rebels, and as they commenced firing on the engine crew



THE CROWN SHEET THAT FAILED



RESULT OF A MEXICAN HOLD-UP

the latter left the engine, leaving the oil fuel valve wide open and the injectors shut off; consequently when the water in the boiler dropped below the crown sheet the crown was overheated and the boiler exploded, killing several of the rebels.

Design of Smoke Flues

A boiler maker is often called upon to furnish smoke flues and breechings for boilers at short notice and without the aid of a drawing. In such instances he must be able to figure the size of flue needed as well as the details of construction and installation. The function of the breeching and the flue is to convey the gases from the boiler setting to the smokestack or to the economizer. If the cross section of the flue is larger than necessary, the first cost of installation and the heat losses

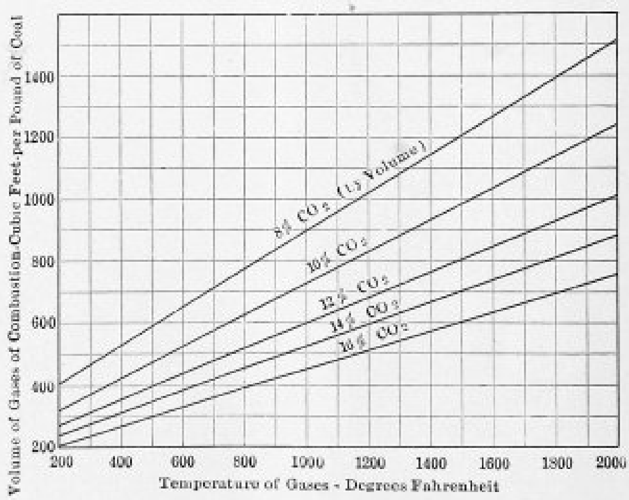


CHART NO. 1.—SHOWING VOLUME OF GASES AT VARIOUS TEMPERATURES PRODUCED BY BURNING ONE POUND OF COAL WITH SUFFICIENT AIR TO GIVE VOLUMETRIC PERCENT OF CO_2, AS NOTED

will be greater than that of a flue of the proper size. A flue too small to handle the gases from a boiler means a loss of draft, which in many instances has been the direct cause of the boiler being pronounced too small for the work it had to do.

The flue of itself has no power to produce draft, the gases are carried along in the flue by means of the draft produced in the chimney. Draft is the difference in pressure which causes gases to rise inside a smokestack. When a gas is heated it expands, and as it becomes hotter each cubic foot weighs less and less. In a stack each cubic foot of hot gas weighs less than a cubic foot of cold outside air, hence the column of inside hot gas from base to top of stack weighs less than a similar column of cold air, and the resulting difference in pressure causes a flow of air through the burning fuel on the grate. As the cold air passes through the fire it is heated, and passing to the stack maintains a column of hot gas in the stack which the cold outside air is at all times trying to displace.

The cross sectional area of a flue or of a breeching must be designed so as to carry off, at a limited velocity, the gases produced in burning the fuel in the furnace. Theoretically to burn 1 pound of coal requires anywhere from 9 to 12 pounds of air. The exact amount depends upon the character of the coal; that is, the amount of carbon, moisture, ash, etc. Now in a boiler furnace it is not possible, at least with present boiler furnaces, to intimately mix with the fuel the exact amount of air needed. In order to avoid large losses due to incomplete combustion an excess amount of air is allowed to pass through the grate. This causes a smaller loss than would result from incomplete combustion of the fuel, and at the same time produces a much larger volume of flue gas than would result if it were possible to secure complete combustion with the exact amount of air required. The volume of flue gas produced per pound of coal depends upon its temperature. A flue leading from a boiler to an economizer must be of larger cross sectional area than a flue leading from an economizer to the stack for the same amounts of gas per hour. The gas being cooled in the economizer occupies less space.

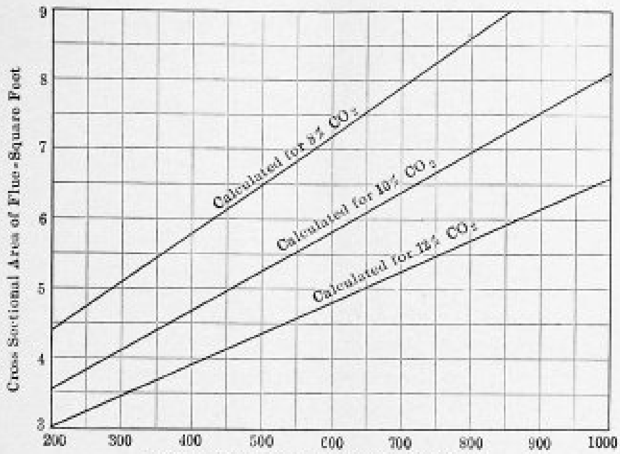


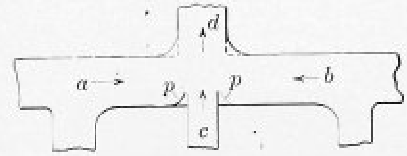
CHART NO. 2.—SHOWING CROSS SECTIONAL AREA OF FLUES REQUIRED PER 1,000 POUNDS OF COAL BURNED PER HOUR FOR GASES AT DIFFERENT TEMPERATURES AND CO_2 AS NOTED. VELOCITY OF GAS IN FLUE TAKEN AT 1,500 FEET PER MINUTE

Chart No. 1 shows graphically the volume of gases at different temperatures produced by burning 1 pound of coal with sufficient air to give the percent of CO_2 as noted. This chart was made for coal containing 63 percent carbon, 30 percent volatile matter and 7 percent ash. For other grades of coal this chart would not be exactly correct, but is sufficiently so for all practical purposes. This chart shows at a glance the large volume of gases passing through the boiler when the percent of CO_2 is low and comparisons of volumes at different temperatures and percents of CO_2 are readily made. Furthermore, it is apparent why the heat losses to the stack decrease as the percentage of CO_2 increases, for all the air passing through the fire must be heated at the expense of the fuel.

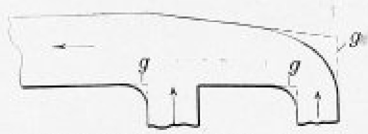
The velocity of the gas in smoke flues and breechings should be about 1,500 to 1,800 feet per minute. At this velocity the friction losses will be small for flues having more than 8 square feet cross sectional area. For smaller flues the velocity should be about 1,200 feet per minute.

To find the proper size flue for any boiler the maximum amount of coal burned per hour should be known, and also the probable temperature of the escaping gases and about what percent of CO_2 the gases will contain. Then from Chart No. 1 the volume of the gas in cubic feet per pound of coal can readily be found. This volume, divided by the allowable velocity, will give the required cross sectional area of the flue. For hand-fired furnaces, small boilers, heating ovens, etc., it is safe to assume a temperature of 500 degrees F. for the gas and about 8 percent CO_2. For stoker-fired furnaces and boilers having good combustion chambers the temperature of the gases can be taken the same, but the CO_2 will be higher, say 10 to 12 percent. To calculate the proper size of flue from economizer to stack the gas temperature can be taken at 350° F.

If the area of the flue is based on these temperatures of gas



THREE-BRANCH FLUE



SEVERAL BRANCHES LEADING TO ONE FLUE

and a velocity of 1,500 feet per minute for the gas, it will be entirely satisfactory as far as draft is concerned, provided that due consideration be given to the following features of design and installation.

1. All sharp turns and angles should be eliminated, and any change in the direction of the flue should be gradual.

2. Gases coming in opposite directions should not be allowed to collide. To avoid this, proper deflection plates should be installed.

To illustrate, assume we have gases coming in three directions, as shown by arrows *a*, *b*, *c*, and that all the gas is to pass through the flue *d*. In such a case proper deflection plates *p* should be built in the flue, and also the corner should be made circular instead of square, as shown by the dotted line.

Where several breechings are led at right angles into one flue, it is customary to make the connections as shown by the dotted line *g*. A much better way is to relieve the square corner by making it circular, which allows the gas to attain the direction of flow of gas in the main flue before it enters it.

Chart No. 2 gives the sectional area of flue required for each 1,000 pounds of coal burned per hour and other items as noted. To find the size of flue for any required horsepower, allow 4 pounds of coal per horsepower per hour. All breechings and flues should be well riveted and made air-tight. A slight vacuum exists in the flue and any small leak will impair the draft. To further provide against loss of draft, and at the same time to secure a cooler fire-room, all flues should be covered with from 2 inches to 3 inches of asbestos or some good non-conductor of heat. A circular flue offers less frictional resistances than a rectangular flue of the same cross section. For this reason it is more desirable, also a circular flue is cheaper to build and to insulate. "ENGINEER."

GOOD HABITS.—Many young mechanics think that they are achieving popularity if they can gain the reputation of being fast in their work and conversation. That has ruined many a promising career. Rules for good work fail without good habits. Good habits are the physical basis of good work, just as love of work is its soul.—*Exchange.*

Final Announcement of the Master Boiler Makers' Convention

Members and guests of the Master Boiler Makers' Association will meet at the Hotel Sherman, Chicago, Ill., on Monday, May 26, for their seventh annual convention.

Registration

Immediately upon arrival, each member should report to the secretary for registration of himself and ladies, etc., and receive convention badges, together with such instructions as may be of value during the four days' progress of the convention. It is important that these instructions should be followed out to the letter, in order to avoid confusion and, possibly, disappointments in securing places in the many convention functions. A uniform type of badge has been adopted for all those who attend the convention, differing only in colors. The members' badges are in red and white enamel,

CONVENTION BADGE

the supply men's in green, and the ladies' in blue. The badges are numbered consecutively, for the members from 1 to 1,000, for the supply men from 1,000 to 2,000, and for the ladies from 2,000 to 2,500. A printed list of all those who attend the convention, with their proper post office address, will be issued on Tuesday morning, and also on Wednesday morning.

The programme is as follows:

May 26 (2 to 5 P. M.)

Invocation, the Rev. Jenkin Lloyd Jones, pastor All Souls Church.

Addresses by Mr. W. L. Park, vice-president and general manager, Illinois Central Railroad; Mr. C. A. Seeley, mechanical engineer, Chicago & Rock Island Railroad; Mr. John F. Ensign, chief Federal Boiler Inspector, Washington, D. C.

Responses by Mr. A. N. Lucas, Mr. John A. Doarnberger, Mr. Charles Hempel.

Address by Mr. M. O'Connor, president of the association.

Routine business.

Miscellaneous business.

May 27 (9 A. M. to 1 P. M.)

Address by Mr. B. A. Worthington, president, Chicago & Alton Railroad.

Report of committee on "How Many Rows of Expansion Stays is it Advisable to Apply to a Crown Sheet to Secure the Most Efficient Service, Considering the Wear and Tear of Boilers?" E. W. Rogers, chairman.

Report of committee on "Is There Any Limit to the Length of a Tube in a Boiler Without a Support Midway of Boiler, and will a Support Prove Objectionable in Circulation?" J. A. Doarnberger, chairman.

Report of committee on "When is a Boiler in a Weak and Unsafe Condition?" Edw. Young, chairman.

Report of committee on "Best Method of Welding Superheating Tubes and Tools Used for Same." B. F. Sarver, chairman.

Report of committee on "What Effect do Superheaters have on the Life of Fireboxes and Flues?" Charles L. Hempel, chairman.

May 28 (9 A. M. to 1 P. M.)

Address by Mr. Robert Quayle, superintendent of motive power and machinery, Chicago & Northwestern Railway.

Report of committee on "What Are the Advantages and Disadvantages of Using Oxy-Acetylene and Electric Processes for Boiler Maintenance and Repairs?" A. N. Lucas, chairman.

Report of committee on the "Proper Inspection of a Boiler While in Service." George B. Underwood, chairman.

Report of committee on "Best Form of Grate to be Used to Insure Removing of Fire at Terminals with the Least Abuse of Fireboxes and Flues, Insuring Most Economy as well as High Efficiency." C. J. Murray, chairman.

Report of committee on the "Best Method of Applying and Caring for Flues While Engines are on the Road and at Terminals." W. H. Laughridge, chairman.

Report of committee on "Steel vs. Iron Tubes—What Advantages and What Success in Welding Them and Advantages of Either in Maintenance, Mileage, etc?" D. G. Foley, chairman.

Report of committee on "What Benefit Has Been Derived from Treating Feed Water for Locomotive Boilers, Chemically, etc?" A. E. Shaule, chairman.

May 29 (9 A. M. to 1 P. M.)

Address by Mr. J. F. Devoy, assistant superintendent of motive power, C. M. & St. P. Railroad.

Report of the committee on "Law." George W. Bennett, chairman.

Report of committee on "Subjects." James Crombie, chairman.

Report of auditing committee..

Miscellaneous business, unfinished business, correspondence, resolutions, etc., selection of next place of meeting, good of the association and election of officers.

Adjournment.

Supply Men's Exhibit

An extensive exhibition of boiler makers' supplies, including machinery, tools, etc., has been arranged at the convention hotel, electricity and compressed air being available for operating machinery exhibits. The following is a list of exhibitors at the convention:

A. M. Castle & Co., Chicago, Ill.; American Arch Company, New York; *The American Engineer*, New York; Bethlehem Steel Company, South Bethlehem, Pa.; THE BOILER MAKER, New York; Brown & Co., Pittsburg, Pa.; Burden Iron Company, Troy, N. Y.; Carbon Steel Company, New York; Champion Rivet Company, Cleveland, Ohio; Chicago Pneumatic Tool Company, Chicago, Ill.; Cleveland Pneumatic Tool Company, Cleveland, Ohio; Cleveland Steel Tool Company, Cleveland, Ohio; Dearborn Chemical Company, Chicago, Ill.; Ewald Iron Company, St. Louis, Mo.; J. Faessler Mfg. Company, Moberly, Mo.; Flannery Bolt Company, Pittsburg, Pa.; Globe Seamless Steel Tubes Company, Milwaukee, Wis.; Hilles & Jones Company, Wilmington, Del.; Independent Pneumatic Tool Company, Chicago, Ill.; Ingersoll-Rand Company, New York; Inland Steel Company, Chicago, Ill.; Jacobs-Shupert U. S. Firebox Company, Chicago, Ill.; Liberty Manufacturing Company, Pittsburg, Pa.; Locomotive Superheater Company, New York; Lovejoy Tool Works, Chicago, Ill.; George F. Marchant, Chicago, Ill.; Monarch Pneumatic Tool Company, East St. Louis, Ill.; Monongahela Tube Company, Pittsburg, Pa.; Christopher Murphy & Co., Chicago, Ill.; National Boiler Washing Company, Chicago, Ill.; National Tube Company, Pittsburg, Pa.; Otis Steel Company, Cleveland, Ohio; Oxweld Railroad Service Company, Chicago, Ill.; Parkesburg Iron Company, Parkesburg, Pa.; The Pearsall Company, New York; Pittsburg Steel Products Company, Pittsburg, Pa.; Ross Schofield Company, New York; Joseph T. Ryerson & Son, Chicago, Ill.; Scully Steel & Iron Company, Chicago, Ill.; S. Severance Mfg. Company, Glassport, Pa.; Siemund & Wenzel Electric Welding Company, New York; Sligo Iron & Steel Company, Connellsville, Pa.; Spencer Otis Company, Chicago, Ill.; Tyler Tube & Pipe Company, Washington, Pa.; Vulcan Engineering Sales Company, Chicago, Ill.; George Whiting Company, Chicago, Ill.; Worth Bros. Company, Coatesville, Pa.; Zug Iron & Steel Company, Pittsburg, Pa.

The Boiler Maker

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GEORGE SLATE, Vice-President
H. H. BROWN, Editor

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CIRCULATION STATEMENT.

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

NOTICE TO ADVERTISERS.

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

The Master Boiler Makers' Association, which meets for its seventh annual convention this month, deserves the unqualified support of every master boiler maker in the country, whether engaged in railway, contract or marine work. No organization has made a better record for itself during a comparatively brief existence, or shown a more determinedly progressive spirit in the advancement of its aims, than has this association. To give it the adequate support it deserves, men from every branch of the boiler making industry should come to the convention and take an active part, not only in the programme for this year's convention, but also in shaping the future activities of the association for the coming year, for a work well begun should not be allowed to rest on its honors, but should be pushed ahead with the utmost vigor until it covers every phase of the field which it represents.

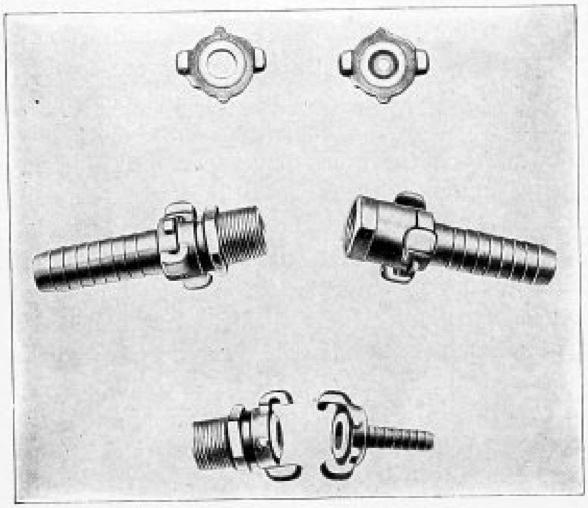
American boiler practice has always been closely identified with the construction of the horizontal cylindrical return tubular boiler, and this type of boiler is often referred to as the standard type for stationary plants in the United States. When built with butt-strapped longitudinal seams this boiler has been remarkably free from disastrous explosions, although exceptional cases are occasionally brought to light where boilers so constructed have exploded through failure of the longitudinal seam. An instance in point was cited in these columns last month, and a complete description of how this particular boiler failed, together with the attending circumstances which led to the failure, will be published in an early issue. It will be recalled that this boiler was not more than five years old, that it was apparently of sound construction, and was properly inspected; but, nevertheless, cracks developed in the longitudinal seams, extending between the rivet holes, and as these cracks were covered up by the butt straps the failure was not detected until the seam gave way. This is by no means the only occasion where such defects have developed, and an exhaustive study into the causes of the formation of such cracks in boiler plate would be of the greatest value in future boiler practice. The horizontal return tubular boiler, of course, is not the only boiler which involves the use of cylindrical shells where butt-strapped longitudinal seams must be used. This form of construction is common to many other types of both fire tube and watertube boilers, and the prevention, or even the detection, of similar defects becomes of great importance.

It is stated on good authority that repairs to the Lancashire type of boiler, which for many years has been the standard stationary boiler in Great Britain, cost practically nothing, or on an average of about twelve cents per boiler per year. These figures relate to boiler practice in England, and are the result of investigations by the chief engineer of the largest steam users' association in that country. It will probably be impossible to produce the same figures for the cost of repairs to the horizontal return tubular boiler, which is the American counterpart of the Lancashire boiler. A further proof of the durability of the Lancashire boiler is found in the fact that boilers of this type are now in operation apparently showing no signs of weakness or deterioration after fifty or more years of continuous service. Some lessons gained from the type of boiler construction which is giving such excellent results elsewhere might be applied to American practice. One lesson is the excellence of the workmanship which goes into these boilers in both the design and the construction. Furthermore, due largely to the influence of the boiler insurance companies, a remarkable uniformity has been brought about in the design of such boilers, so that their construction has been standardized, even to the minutest details, which is an important advantage in any form of boiler construction. It is hard to see why a similar uniformity of design and construction should not be brought about in the horizontal return tubular boiler with corresponding results.

Engineering Specialties for Boiler Making

The Chicago Hose Coupler

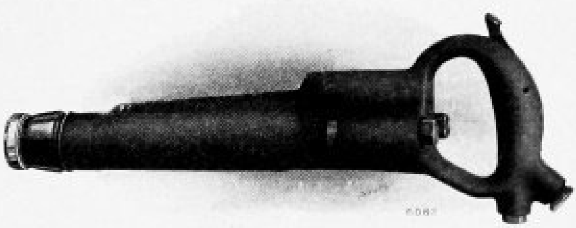
The Chicago hose coupler, manufactured by the Chicago Pneumatic Tool Company, Chicago, Ill., is a universal coupler made of tough bronze which cannot corrode, and which, it is claimed, makes an absolutely tight joint. As can be seen from the illustration, neither half of the coupler is male or female,



but a combination of both, so that any size of hose can be coupled to any other size of hose, whether it be larger or smaller. The gaskets are made of pure rubber, and are so arranged that they cannot blow or fall out, so that no time will be lost in looking for washers. The couplers are manufactured for male or female thread pipe size, as well as for hose from 3/8 inch to 1 inch.

"Little David" Riveting Hammers Nos. 60 and 80

An improved pneumatic riveting hammer which has some novel features was brought out recently by the Ingersoll-Rand Company, New York. As will be seen from the illustration, the valve chamber is independent of the piston chamber, which permits the use of pistons of different lengths without the lia-

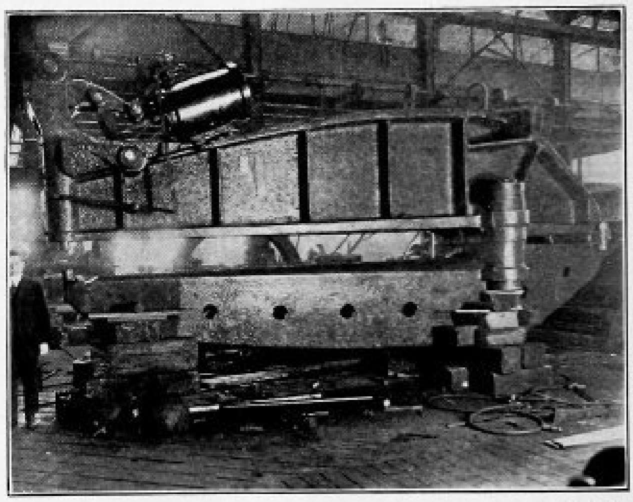


bility of valve breakages so common in pneumatic hammers where the piston travels through the valve or where the construction is such that the valve travels in line with the piston and is shifted by the piston compression. The grip handle is liberal in size, is improved with a single lever throttle with long bearing, and the handle is attached to the cylinder by means of two bolts which are parallel to the cylinder on the sides. This, it is claimed, insures perfect locking of the handle to the cylinder and precludes the necessity of a vise or other mechanical device for holding the tool in taking apart or assembling. This feature is especially convenient to the structural iron workers who are not always equipped with the proper facilities for repairing tools. The hammer can be taken apart on the floor or the bench, and the only appliance necessary is a wrench for removing the nuts on the bolts. There is only one large port down the cylinder, equal in volume to the usual multiple port construction, but eliminating the liability of clogging, frequent in the older designs.

The hammer is short in length, light in weight and easy to handle; it has a very sensitive throttle control, making it specially suitable for drift pin work. The hammer is made in two sizes—No. 60, with a 6-inch stroke and capacity for driving rivets up to 7/8-inch in diameter, and No. 80, with an 8-inch stroke suitable for driving rivets up to 1 1/4 inches in diameter. The cylinder and handle are drop forged and all wearing parts are hardened. Another important feature is the sand blast finish on both the cylinder and handle, which overcomes the hand slippages so frequent with hammers of polished construction.

Hanna Compression Yoke Riveter

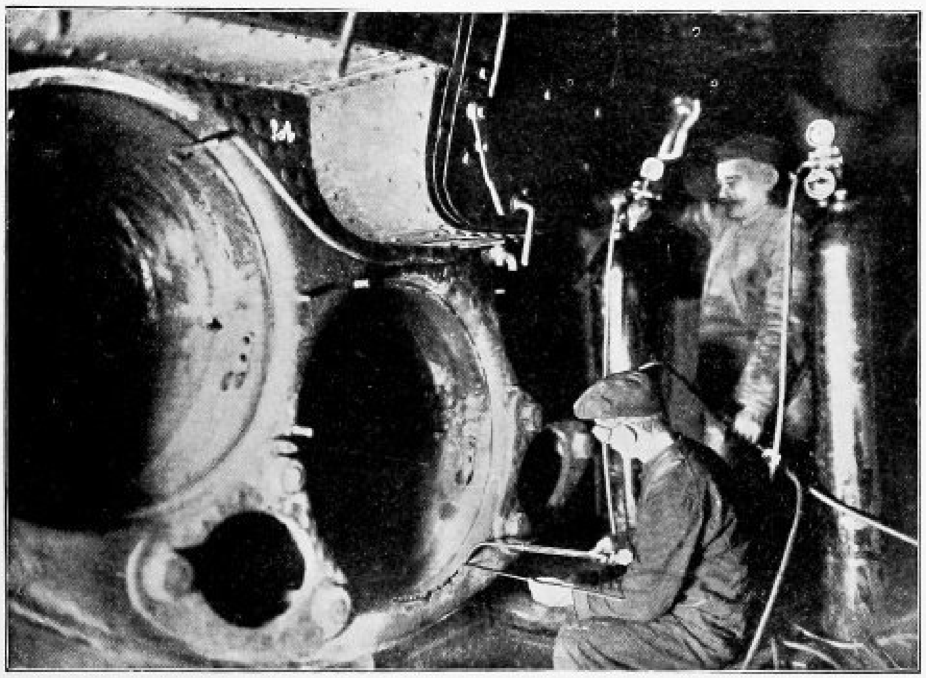
The Vulcan Engineering Sales Company, Chicago and New York, who control the entire product of the Hanna Engineering Works, recently furnished the General Electric Company, Pittsfield, Mass., with a Hanna type compression yoke riveter, weighing 56,000 pounds, for the riveting of transformer cases. This riveter has a reach of 168 inches, a gap of 12 inches, and exerts a pressure of 100 tons on the rivet with 100 pounds air



pressure in the cylinder. The size of the cylinder is 18 inches diameter, 22 inches stroke, and the movement of the plunger and upper die is 5 3/4 inches. Of this distance 4 3/4 inches is traversed during the first 11 inches of the stroke of the air cylinder piston, and the last 1 inch (under approximately uniform pressure and movement) during the last 11 inches of the stroke of the air cylinder piston. This last 1 inch of uniform travel and pressure, it is claimed, gives the machine all the advantages of the hydraulic riveter with the added advantage of low air pressure for actuating the mechanism instead of hydraulic pressure, usually from 1,000 to 1,500 pounds to the square inch. The machine also has the advantage of exhausting into the atmosphere without special provision of exhaust pipe, as is required with the hydraulic machine. These advantages will be readily appreciated by those familiar with the objectionable operating features incident to excessive hydraulic pressure and the difficulty of taking care of the discharge water. But its marked advantage over the hydraulic riveter is in the fact that the air gap is closed at high speed (under the toggle lever action), while the rivet is headed and finished at very slow speed (under the plain lever action), thus giving the plates ample time to adjust themselves and the metal in the rivet to flow sufficiently to fill thoroughly the hole and for the head to set. The fact that the entire travel of the plunger and upper dies in a hydraulic riveter is at a uniform speed necessitates the conclusion that a speed which is economical for closing the air gap is too fast to finish and head the rivet, if the best possible results are obtained.

Oxy-Acetylene Welding and Cutting

Repairs and alterations are often required in boiler installations where room is scanty and other adverse conditions prevail. As a rule this kind of work must be done quickly, and usually the ordinary tools are inadequate. In such cases oxy-acetylene welding and cutting torches have proved of great value and accomplished feats hitherto considered impossible. Work that formerly kept the boiler plant idle for days and weeks may now be done satisfactorily with oxy-acetylene apparatus in a few hours with a proportionate saving of time and money.



An interesting repair job was carried out recently on the boilers of an ocean steamer, as shown in the illustration. There were three double-ended boilers, and on the six front bottom plates of the boilers below the fire tubes and on two plates above the fire tubes eight cracks developed, which had previously been patched with steel plate and bolts. After a short time the seams began to leak again and the cracks kept on widening and lengthening. The defective part was consequently cut out with an oxy-acetylene cutting torch and new plate was welded into the eight openings, each measuring about 3 feet in length. The boiler plate was ¾ inch thick, and the whole work was done by Dougherty & Bachran, Philadelphia, with apparatus supplied by Messer & Company, of Philadelphia. The pressure test after the work was completed proved the job a complete success in every respect. A few days later the vessel went to sea again on schedule time, and it is evident that a great saving was made for the owners by the use of this method of repair.

Cutting all kinds of iron and steel with oxy-acetylene apparatus can be done by any good mechanic after a little instruction, provided first-class apparatus is used, but it must be remembered that reliable welding in boiler work requires experience, and should be done only by men who understand the action of the process on the metal to be welded. Under guidance of a competent teacher this art may be learned in a few weeks, but an inexperienced man should not be entrusted with such work. The range of work which may be done in both cutting and welding is practically unlimited, as evidenced by the numerous instances that have been cited in previous issues of this journal.

The White Mechanical System of Burning Fuel Oil

The White mechanical fuel oil burner, manufactured by the Washington Engine Works, New York City, is a simple device, consisting of an arrangement (Fig. 1) for driving the oil along a cone so that its velocity will not be retarded and impinging it on a second cone with a finer angle, thereby causing it to be delivered from the burner orifice in a very fine spray, which can be ignited with the oil at a pressure of from 20 pounds up. The pressure generally used on the oil is from 60 to 80 pounds. The flame commences at the end of the burner, and it is claimed the fuel is completely consumed in the furnace itself, resulting in a freedom from smoke even when using the heaviest of oils. A special feature of the device is the manner in which the air admission is regulated, and also the manner of completely closing off the air supply when the burners are not in use, so that the danger of leaky tubes and seams in the combustion chamber is eliminated.

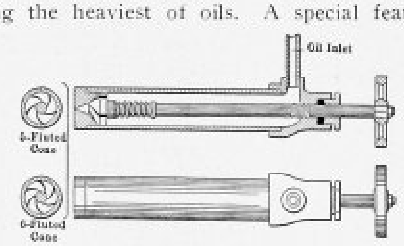


FIG. 1.—WHITE MECHANICAL OIL BURNER

When applied to natural draft boilers the arrangement (Fig. 2) consists of an air-heating front, which is fitted over the mouth of the furnace and formed by a disk casting having a number of projecting vanes forming air passages. The air enters at the periphery of the disk, and passing down these passages absorbs heat from the vanes and disk, becoming heated to a high degree of temperature before coming in contact with the atomized fuel. The vanes in this furnace front conduct the air to the center of the disk, where it is admitted to the furnace, surrounding the burner, which is fitted with a perforated jacket and a sliding cone, which can be regulated to supply the required quantity of air. When applied to marine

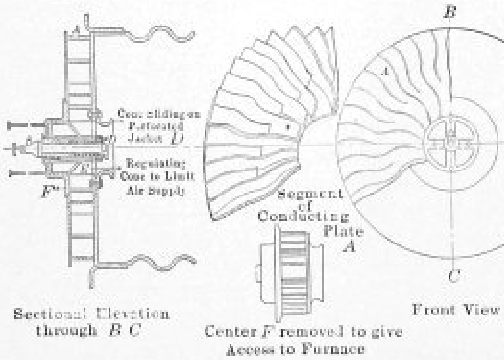


FIG. 2.—ARRANGEMENT FOR NATURAL DRAFT

boilers fitted with the Howden system of forced draft, the doors are the only part removed from the furnace fronts, and the White door, carrying the complete oil fuel burner installation, is fitted in its place. In this installation (Fig. 3) the air passages are cut in the side walls of the furnace casting, and the air is conducted to the center surrounding the burner.

In burning fuel oil by the mechanical spraying system, the oil is first heated to 150 degrees, and in some cases to 260 degrees F., according to the oil used. The oil heaters used in

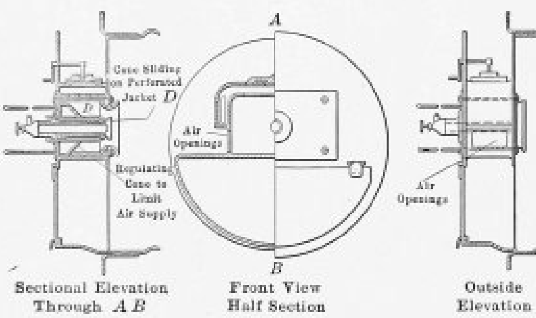


FIG. 3.—ARRANGEMENT FOR HOWDEN'S FORCED DRAFT

this system are of special design, and before the oil is delivered to the burner it is, of course, passed through filters or strainers, which are also of special design.

The advantages of this system are attributed in a large measure to the heating of the air supply, the control adjustment of the air supply, and the method of mixing the air and fuel, resulting in complete combustion in the furnace itself and the eliminating of smoke at the stack. No brick work is found necessary, and none is used, thereby tending to promote the circulation of the water in the boiler. The feature of using radiated heat from the furnace mouth to heat the air has a further advantage by giving a remarkably cool stokehold. Tests show a fuel consumption of only .93 pound per horsepower-hour.

Personal

F. J. STULL has been appointed assistant foreman boiler maker of the Erie at Hornell, N. Y., vice Robert McKenzie.

EDWARD T. HENDEE has been appointed secretary of Joseph T. Ryerson & Son, Chicago, and will be in general charge of railroad sales.

J. F. FITZIMMONS has been appointed foreman boiler maker at the Hornell, N. Y., shops of the Erie Railroad, taking the place of John McNeil.

J. F. DUNTLEY, father of W. O. Duntley, president Chicago Pneumatic Tool Company, and formerly vice-president of that company, died April 5 at Detroit, Mich., aged 71 years.

HENRY JUNGERMAN, formerly with the Motive Power and Inspection Department, Harriman Lines, has been appointed railway representative of Tate-Jones & Co., Inc., Pittsburg, Pa.

J. H. KING, formerly foreman boiler maker of the C. H. & D. Shops at Lima, Ohio, is now general foreman boiler maker for the San Pedro, Los Angeles & Salt Lake Railroad Company, with headquarters at Milford, Utah.

B. BORGMAN, of Geneva, N. Y., who was the principal owner of the Vance Boiler Works, the plant of which was destroyed by fire Dec. 1, 1912, has sold his interest in the business to the George E. Lenley Company, of New York, which is now incorporated under the name of the Geneva Boiler Works, and is rebuilding the plant and enlarging it to twice its former size and capacity. The new plant will be in operation about July 1 with a full equipment for doing boiler, tank, stack and general plate work. The general superintendent of the new plant will be Frank Culver, who was employed in the old shop for ten years and lately as a layerout.

Technical Publications

JOHNSON'S FIRST AID MANUAL. Fifth edition. Edited by Fred. B. Kilmer. Size, 5¾ by 8¼ inches. Pages, 143. Numerous illustrations. New Brunswick, N. J. 1912: Johnson & Johnson. Price, 50 cents.

Accidents are by no means infrequent even in the best regulated boiler shops, and it is of great advantage to have at least one man in the shop, if not more, who has some knowledge of how to give prompt aid to the injured. The book in review is a first-aid manual for everyday use, and almost everyone who can read or understand a picture can gain information from it which will be of great service in caring for injured persons in an emergency. The book would be a handy thing to have around a boiler shop, and serious trouble might be avoided if some of the men in the shop were familiar with its contents.

THE STOKER'S GUIDE TO PROMOTION. Size, 5 by 7¼ inches. Pages, 179. Numerous illustrations. London, 1913: The Fleet, Ltd., 11 Henrietta street, Covent Garden, W. C. Price, 3s. 6d. net.

This book is useful particularly to firemen in the British navy, as it was intended to deal exclusively with the various examinations the naval stoker has to pass for higher rating. Although designed primarily to meet the needs of a certain class of men the book contains information which would be found very useful to a young man trying to work his way up from the stokehold to the position of an engineer in the mercantile marine. The first two chapters contain a concise and straightforward explanation and guide to arithmetic and mensuration. The next chapter takes up boiler questions, and as it is rather brief, considering the subject treated, it is evidently assumed that the stoker is very familiar with the boiler side of the question. The next chapter, and by far the most important in the book, is entitled "Engine Questions," and by giving almost every conceivable question that would be asked in an examination, together with the answers, illustrated in many cases by sketches, the student can gain a very comprehensive knowledge of the various details in a steamship engine room. It is pointed out in the foreword that any one having a good knowledge of the contents of the book is almost certain to pass examinations for promotion from the stokehold.

Letters from Practical Boiler Makers

Calking Tools

In looking over the March number of THE BOILER MAKER I was interested in Mr. Forbes' article on "Calking Tools." During a lifetime service in boiler shops I have done my share of calking, and was therefore surprised at the drawings shown in this article I think a mistake must have been made on the laps of the plates which are to be calked, and no bevel is shown on the plate. Furthermore, the round-nose tool is laid flat on the plate, which I think would result in lifting the top plate from the lower one. Fig. 1, shown herewith, illustrates the method shown in the March issue, while Fig. 2 shows the way I have always been used to doing the work, and I think about every other calker does the same.

The edge of the plate should be beveled to 65 or 70 degrees, and the tool should be held at an angle of 25 or 30 degrees, so that it will drive the metal before it, as shown by the shaded part in the illustration, so that a metal-to-metal joint will result and the top plate will not be lifted from the lower one.

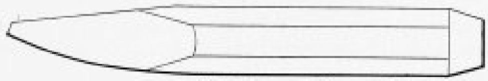


Fig. 6-Square Nose Tool

Fig. 7-Fuller

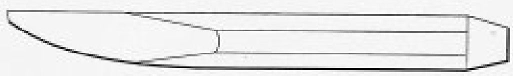


Fig. 5-Splitting Tool

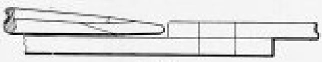


Fig. 1

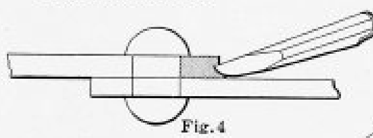


Fig. 4

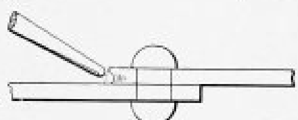


Fig. 2

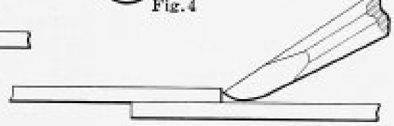


Fig. 3

In Fig. 11 in the March issue, Mr. Forbes shows a square tool to be used as a splitting tool. Fig. 5 of the sketch shown herewith shows a tool which we used in "ye olden times," when cold rivets were the go in Pittsburg and river shops. In those days the only thing that was chipped was the lap, the rest was all split-calked, but that tool was not turned flat to calk the edge left by splitting. We used a tool shaped like Fig. 6 in the accompanying sketch, but about 3/16 inch was left for calking the edge after splitting, and that was tapped very lightly, so as not to lift the sheet or check the lower sheet.

According to Mr. Forbes' article, he does not have much use for the round-nose tool. Now I have seen others, and have myself made tight calking with a round-nose tool when it could not be done with a square-nose tool both on seams and rivets. I have used the round-nose tool back of rivets where the square tool could not be used, and have made tight work of it.

The fuller, long before it was patented, was used on laps and in bad places. It is all in knowing how to use the tool, and when you know how to use it there is no better tool made. It does not check or cut the sheet the same as the square tool, and you do not have to cut the scale off. By using two fullers, a heavy one and a thin one, calking can be done very easily and surely. JOHN COOK.

Springfield, Ill.

Internal Incrustation and Corrosion of Boilers

Incrustation, when allowed to form in any boiler, has the effect of reducing its steaming capacity and also of overheating the plates by reason of its being a non-conductor of heat. The usual means of prevention and removal of incrustation by blowing off is not sufficient, unless some mechanical device is employed to prevent this; what is needed to render efficient and permanent relief is an article that will attack the scale, render it porous and destroy the affinity between it and the iron without any injuries to the latter, and which will hold the minerals and ingredients which are passing in with the feed-water, in the form of slush or sludge, until they can be blown out.

We can readily see, therefore, that intelligent and systematic methods must be employed to prevent the excessive formation of these deposits in the boilers. If not prevented we may expect to find burned sheets, bagging, leaky seams, rivets, etc., all of which are possible causes of disaster and expensive to the owners, and depreciate the capital of the engineer in charge, which is his reputation.

To guard against this potent enemy the condition and location may demonstrate that a treatment quite effective in one case may not be so in another, and here is where the judgment of the engineer is to be exercised. For instance, where using fairly good fresh feed-water but little scale is formed when the bottom blow is judiciously used. Using such water it has been found that by blowing out two or three gages of water two or three times a week, under a pressure of from 15 to 30 pounds, and the matter in a quiescent state, due to having remained several hours or more with the fires either hauled or banked, a large part of the heavier matter sinks to the bottom or lowest point, and may be removed by blowing from the bottom. Where such a course of treatment is observed the deposit will be slight.

A very excellent and inexpensive remedy that may be used, and satisfactorily withal, is soda-ash and kerosene, in the proportion of about 4 pounds ash to a gallon of oil. This amount given twice a week in a boiler under ordinary conditions ought to suffice. This remedy must be used cautiously, as if too much is fed into the boilers at once it will induce priming.

Again, be very cautious in using this remedy. When about to clean boilers do not insert a naked light into them without first permitting a circulation of air through them, which the removal of the manhole and handhole plates will effectually accomplish; thereby the inflammable gases given off by the kerosene will escape. This practice ought to be observed under all circumstances in the case of stationary plants where the boilers either flow into or drain into sewers, as deadly and inflammable gases may be drawn into the boilers therefrom should a partial vacuum form in the boiler after blowing off.

With some waters the fitting of and the proper use of the surface blow is essential, particularly where the water supply is taken from an alkali country, or the water brackish. The use of this blow is for the purpose of merely skimming off the scum accumulations on the surface, and it is generally used often, but a small quantity being blown out at a time.

Where fitted with a surface condenser there are entirely different conditions to deal with. Whatever may be the character of the feed-water, experience has taught that it is advisable to permit a very slight scale to form within the boiler, and it should be maintained. This thin coating of scale acts as a barrier between the pure distilled water fed back to the boilers and the metal of the boiler itself. Were the internal surface not so protected we would likely develop pitting and internal corrosion, due to the fact that distilled water rapidly attacks and destroys the sheets. This effect is heightened by the oil fed into the cylinders being carried into the boilers along with the feed-water, even where intercepters and filterers are employed. This in itself is highly objectionable, as it may become the possible cause of serious damage. The oil combines with the foreign matter precipitated within the boiler, which forms slugs, which adhere to the shell and tubes and form a film, which prevents the contact of the water and the heating surfaces; from this cause may result the same evils enumerated in the case of excessive mud and scale deposits.

The use of sal soda is to be recommended under such circumstances, as thereby the grease is caused to saponify, or become a soap, and may be largely removed by the proper use of the surface blow. Under all circumstances, boilers ought to be washed out and inspected with reasonable frequency, the interval depending on the conditions of service as well as on the nature and quality of the feed-water.

Where the pressure is to be taken off a boiler the same precautions ought to be taken, and for the same reasons against a too sudden change in the temperature thereof, as in the case of getting up steam. It would be unwise to permit the water either to run out of a boiler set in brick from which is radiated any heat, or to be blown out of a boiler under any circumstances in any type or setting of boiler, as the heat in the shell itself is sufficient to bake the scale and mud deposited, making it very difficult to remove. A very good plan, where convenient, is to let the boiler and water cool off together. When cold, if the water is permitted to run off and the boiler is washed out, the scale is then more easily detached, and the mud deposited more easily removed.

CHAS. MILLER.

Albany, N. Y.

Locomotive Boiler Explosions

Referring to the explosion of a locomotive boiler at Rahway, N. J., on March 3, I have made a constant study of the conditions existing in locomotive boilers, and find that on account of their extended dimensions and those of the fireboxes in them, a condition of weakness exists which must be met at once if more lives are not to be lost.

The flat plates drawn out to these extended lengths weaken and crack under the constant expansion and contraction, breaking the staybolts that hold the plates together. A flexible staybolt has been largely used to accommodate the movement of these flat plates, in the error of thinking that it will prevent the breakage of staybolts and cracking of firebox plates. This it will not do, for it is not possible to adjust all these stays in the breaking zone of the firebox to have equal tension on the plates. Hence it will be seen that the fixed stays around them have to take all the strain of the loose tension of the flexible stays, and consequently the fixed stays have full strain brought on them, and with the excess pressure it is too much and the boiler explodes. But instead of giving these reasons the causes for boiler explosions are usually summed up—"the boiler being short of water," etc.

The structural weakness of flat plates has been proved in several recent explosions, and there is no cause to continue them when you can substitute a flexible firebox which will have eight times the strength of the rigid plate construction and will eliminate stays to the number of 750, thus, of course, lessening the danger from broken stays, since there are just so many less to break.

These extended fireboxes of the large locomotives must be met by great consideration and at once, unless we want to have such experiences repeated with increasing fatilities.

Media, Pa.

WILLIAM H. WOOD,
Mechanical and Constructing Engineer.

Camber in Plates

The matter of determining the required camber in patterns of frustums of cones, aspecially as to the methods employed in developing the problems when the taper is small and when thick plates are used, is a subject of comment recently in the columns of THE BOILER MAKER. Herewith is given one of the many solutions. Although it is an approximate one, nevertheless it is a practical graphical solution to the problem, and may be of some interest to members of the laying-out fraternity who are not already familiar with it.

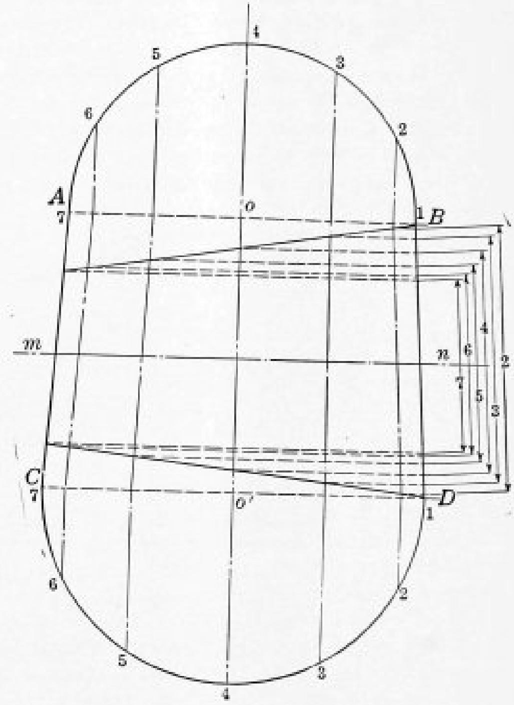


FIG. 1

Fig. 1 represents a section of a telescoping 90-degree elbow. The dimensions of same are taken from the neutral layer of the plate. To lay off the required pattern of such a section when the apex is not attainable within a convenient distance can be readily done as follows, and as illustrated in Figs. 1 and 2:

Draw the center lines of the section as *m n* and *o o'*, Fig. 1. About these lines construct the section of the elbow. Parallel to *m n* and from points *B* and *D* draw lines *A B* and *C D*. Extend side *C A* intersecting sides *A B* and *C D*, thus completing a frustum of a cone of which the elbow section is a part. With points *o* and *o'*, respectively, draw semi-circles, using radii *o A* and *o' C*, respectively. Divide these semi-circles into a number of equal divisions, not less than six, however. Parallel to the vertical center axis *o o'* draw lines from the points of division 2-3-4, etc., of both semi-circles until they intersect the top and lower base of the frustum. Connect the points on both bases with radial lines. Next determine the true length of the radial lines which are within the limits of the elbow section. By projecting them at right angles to the axis *o o'*, and locating them on the outer element of the frustum, as on line *B D*, produces their true lengths.

Fig. 2 shows the different steps in the development of the pattern. There are practically three main steps.

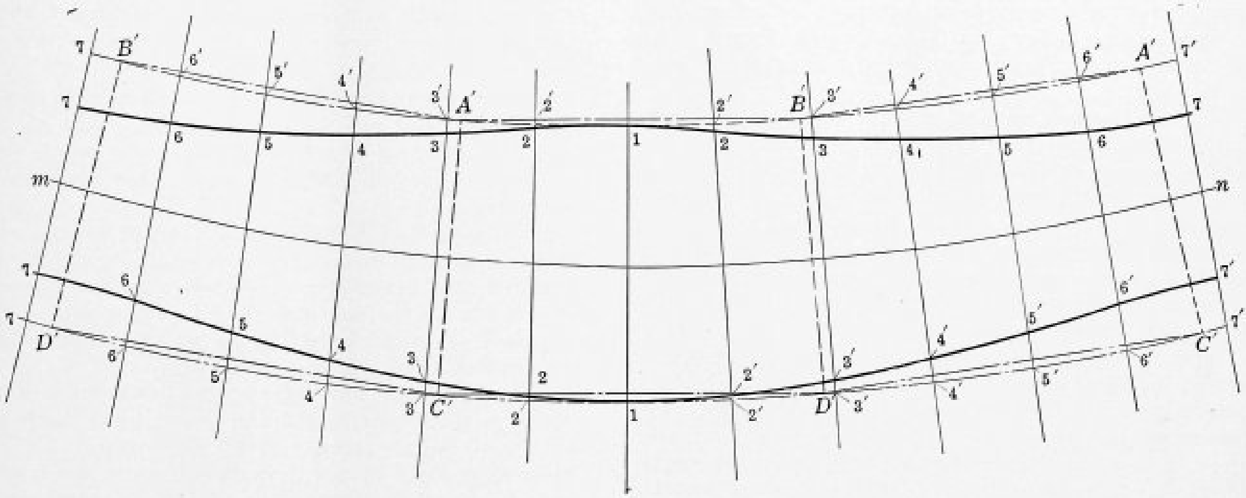


FIG. 2

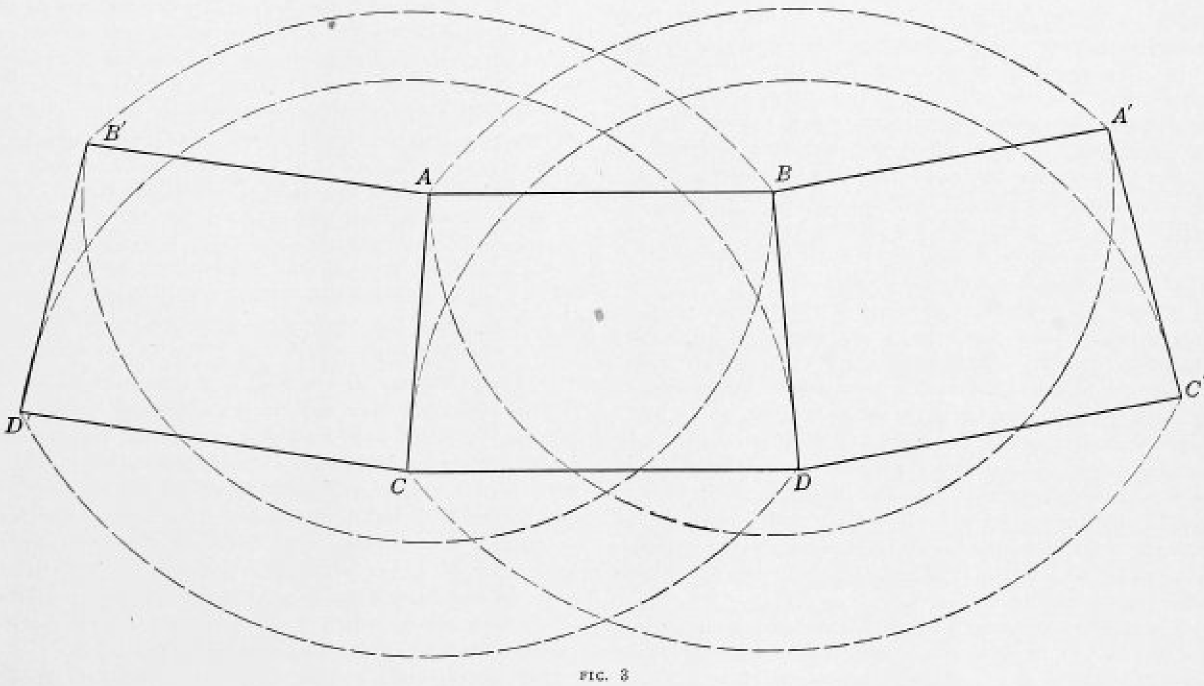


FIG. 3

FIRST STEP

Reproduce three sections of the frustum *A B C D*, Fig. 1, and arrange them as in Fig. 2, indicated by the dotted lines *B' A' C' D'*, etc. Referring to Fig. 2 it will be readily understood by the construction how this is done.

SECOND STEP

Draw through the points *A' B' C' D'*, etc., curves which will give the required camber in the plate. Allow the curves to run beyond the points *A' B' C' D'*, as illustrated. Divide the distance between the upper and lower curves *A' B'* and *C' D'* by the line *m n*.

THIRD STEP

Divide the arc *A' B' A' B'* both sides of line 1-1 into the same number of spaces as in the semi-circle of the small end. Make these divisions equal to the arc distances between the points 1 to 2. Do likewise with arc *D' C' D' C'*, but make the distances between divisions equal to the arc distances of the larger semi-circle. Connect the points 7'-7', 6'-6', 5'-5' with lines as shown.

Using the point of intersection between line *m n* and the radial lines, Fig. 2, locate the true length of the required lines which have previously been determined in Fig. 1.

Scranton, Pa. C. B. LINSTROM.

A Rivet Soliloquy

I was once a red-hot bar of steel, of considerable length. Prior to this my memory is rather vague, for my evolution has been lengthy—rather blurred—for I have had many shapes and contain traces of being a portion of a large mass I heard called a billet.

In the first instance, getting back to the beginning, by slow geological process, in the womb of time my particles were assembled, associated with other elements as a form of rock. Wrested at length from my age-long rest my birth-pangs began.

Into the matrix-rock holes were driven and explosives inserted; masses of my native deposit were thus disintegrated into pieces. After transit and rude handling, I arrived at the place of my metamorphosis.

I next found myself, together with some white and gray brethren to whom I had not formally been introduced, in a chamber with considerable weight pressing me down. The white brother I learned was called limestone and the gray known as coke. This latter member of our community seemed to suffer most by the oppression of the pressure above; but being vain, he boasted of previous experiences, being, he said, the skeleton of a substance known as coal. Not, however, ordinary coal used for ordinary purposes, he boasted, but coal reserved for higher destinies. He was warranted free from injurious constituents and suffered not from the disease of sulphur. He appeared fragile and had a peculiar cellular structure, and said he was selected for another quality—he could support the downward pressure every moment getting more oppressive. I rather pitied the calamities to which he had been subject, but distrusted his boastful character, especially when he asserted that later he would be entirely expended, but to my downfall. I pondered awhile the mystery of his remarks, which he did not condescend to explain. Being hard of face, I did not lose countenance and felt rather nervous in the consciousness of his superior experience.

I next became aware of heat from below, which steadily increased in amount. I became uncomfortably warm, and later began to perspire profusely. My gray friend began first to glow, then we both together grew white-hot; but while I lost my solidity and hardness, he diminished in volume and gradally faded away. I next lost consciousness, and later found myself quite liquid, brother limestone assisting at the crucial moment. Gradually, by reason first of my change of state and also to the weight above, my metallic element gravitated downwards, joining with others in like state, my non-metallic portion becoming separated to form slag.

In this molten condition I again reached the open air, ran out into a sand-bed, became solidified, and when cool found a new name—pig iron. I rejoiced that my troubles were over, and found later I was mistaken as to this.

Rough hands tumbled me over and broke me in two to prove my refinement and grade. A large, round surface descended upon us (we were now a considerable pile); introduced himself as "Magnet." Towards this surface a mysterious force attracted me; clinging tenaciously, I was transported into another chamber. More heat, more birth-pangs, the same agonies of losing my shapely form and becoming fluid. Upon recovering consciousness in a cool condition, I found my identity changed again, this time as a billet of Siemens-Martin steel.

The worst was yet to come; more heat. I was getting used by this time to tropic temperatures and had ceased to feel surprise at transmutation. However, the furnace was different and the temperature less severe.

When withdrawn, two ponderous rolls seized me and passed me back and forth. Elongating at each pass, I got steadily longer and more elegant, until my size was reached. Those rolls did hurt, though, for I was alive to pain the whole time; my structure got steadily denser and denser, and I felt at the last pass as though compression could go no further, and I would not yield, but I had to; the rolls were very severe about it, too.

When cool, I found myself bar steel and of peculiar virtues. I was ductile and of quite high-grade quality. From one end of me a piece was taken and pulled asunder for proof of my virtue; also in the hands of a chemist were my constituent elements made plain.

Troubles appeared to be over. But no; amputation into small pieces was my next change, and each piece, after reheating, was subject to a mighty squeeze. It was after this I became intelligent for the first time; I possessed a head, quite an elegant domed structure. I now felt my pride begin to rise, for I first realized I had a destiny.

After suffering a long wait, together with many of my brethren, in the darkness of a bag, I was drawn forth and found the fire my lot again—not so hot this time.

Taken by a pair of tongs, I was carefully placed in a smooth, bright, drilled, snug-fitting hole, and after another mighty squeeze found myself in the super-proud position of possessing two heads.

Now I had achieved my destiny. From the bowels of the earth, with much travail, do I form an integral portion of the barrel of a boiler. Being of adequate size and placed in correctly drilled plates, I am straight and keep my place with dignity. My neighbor, Boilerplate, says we are of equal ancestry and our marriage predestined. We never quarrel—that might produce disaster—but both together hold with never-sleeping vigilance 160 pounds of steam in safe custody.

When our prisoned pressure reaches his height, he endeavors, unsuccessfully, to cut me in two, using Boilerplate as my executioner. My designer, however, placed me in what he terms a 75 percent efficiency joint with a factor of safety of five. The utmost exertions of the pinioned steam make, therefore, no impression.

When Boilerplate and I discuss the matters of our birth and responsibility, our experiences are more or less similar. Like a fitly mated pair, each carries separate responsibilities; we are mutually dependent, mutually responsible. Our ultimate destiny has, we feel, been worth all the torments of our evolution. We might, perchance, have been mere firebars, saucepans, or something even lower in the social scale, but Fate reserved us for our high estate, and we are not a little proud of our dignified position as complementary portions of a locomotive boiler, which position, I assure you, carries advantages of travel a stay-at-home boiler must lack.

Our achievements are chronicled throughout the land. We proudly draw the limited express in schedule time. It is certain that without our aid, or by reason of our failure, the record of the line would be lowered and possibly a catastrophe too serious to contemplate might result.

We are the product of skill, good design and much thought, wrought into shape by method, experience and willing hands. As to our intelligence, my brethren and I are some hundreds in number in this completed boiler, and I have already pointed out that we are each a phrenological curiosity, for have we not each two heads? A. L. HAAS.

London, England.

Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

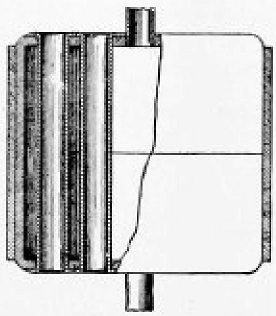
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,045,248. SUPERHEATER BOILER. JOHN E. BELL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—A water-tube boiler having a heated space defined by a wall of the setting, the arch over the combustion chamber and a set of water tubes, and a superheater located in said space and disposed in substantial parallelism with the furnace top. Four claims.

1,046,133. BOILER. WILLIAM H. WINSLOW, OF CHICAGO, ILL., ASSIGNOR TO THE STEAM POWER DEVICES COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

Claim 2.—In improved boiler construction, the combination of an inclosing shell having openings, flues extending through the shell with their



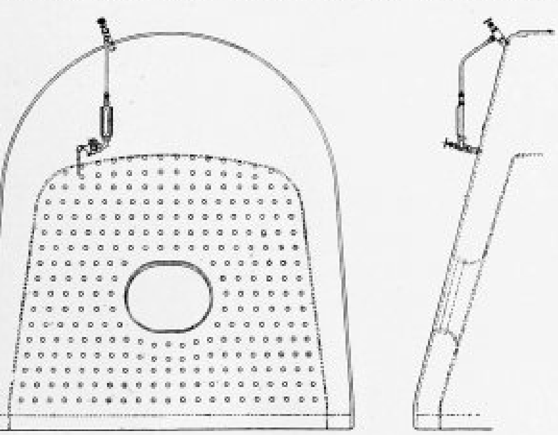
ends extending through said openings, the ends of the flues being bent over and fused together. Ten claims.

1,046,196. SMOKE CONSUMER. HUDSON B. KERRUISH, OF SULLIVAN, MO., ASSIGNOR OF ONE-HALF TO HIMSELF, AND ONE-FOURTH TO WILLIAM BOYNTON AND ONE-FOURTH TO ROBERT H. SHERRY, OF ST. LOUIS, MO.

Claim.—In combination with a flue boiler, a pipe having side portions and disposed at the front of the boiler, with openings for directing jets of air inwardly to meet the heated gases passing from the flues, transverse pipes connected with the side portions of the first-mentioned pipe, and having openings for directing jets of air to meet the gases passing from the flues, and means for supplying the pipes with air. One claim.

1,046,234. GAGE-GLASS CONNECTION. JOHN G. TALMAGE, OF CLEVELAND, OHIO.

Claim 2.—The combination of a boiler sheet out of a vertical plane, a pair of casings secured to the sheet at an angle to each other and each having a valve seat, a valve plug for controlling each seat, a lateral



opening at the side of one casing, an elbow connected with said opening and lying in a vertical plane, a gage glass connected at its lower end with said elbow, and a connection between the upper end of the gage glass and the other casing. Three claims.

1,047,152. STEAM GENERATOR. FLOYD L. BENEDICT, OF SOUTH KNOXVILLE, TENN.

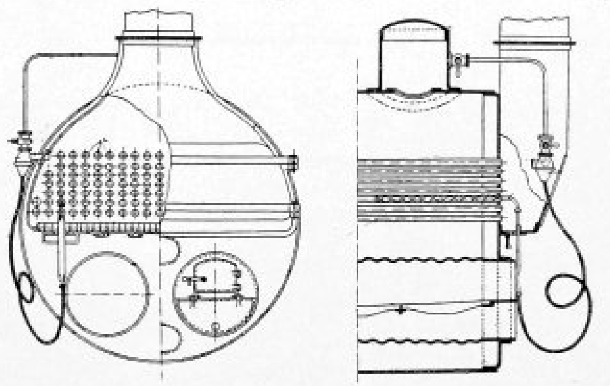
Claim 1.—In a steam generator, a horizontally disposed combustion chamber having a tapered inlet end and a concentrically disposed outlet conduit, a water jacket surrounding the combustion chamber and its outlet conduit, a vertically disposed boiler in communication with the water jacket, the outer end of the outlet conduit being projected into the boiler, a heated gas admitting nozzle disposed concentrically of and within the lower end of the boiler, a valve in said nozzle for closure against exterior pressure, and a gas separating and sediment precipitating means mounted in the boiler and forming an intermediate communicating medium between the outlet conduit and the nozzle. Seven claims.

1,049,100. SMOKE CONSUMER. CHARLES W. JOHNS, OF JERSEYVILLE, ILL.

Claim.—The combination with a furnace comprising a boiler, smokestack, fire-box and ash pit, of a rectangular accumulation tank laterally of said furnace, an obliquely and downwardly inclined pipe leading from said smokestack and vertically entering the top of said tank, a rotary fan in said pipe adjacent to said tank adapted to force smoke from the smokestack into said tank, a steam pipe from said boiler connected vertically to the top of said tank introducing steam thereto parallel to the descending column of smoke from the stack to transform said smoke in part into carbon monoxide, a pipe laterally of said tank opening into said fire-box to convey inflammable gases from said tank to said fire-box, and a pipe from the bottom of said tank to convey precipitated soot from said tank to said ash pit. One claim.

1,050,126. FLUID-JET BLOWER. TEODORO GRUENWALD, OF GENOA, ITALY.

Claim 1. A boiler provided with flues disposed in vertical rows and having a casing extending about the open ends of the flues and provided with a lower wall having an elongated slot, one wall of said slot having



a plurality of guiding recesses disposed in alinement with the centers of a vertical row of flues, and flue cleaning means adapted for insertion through said slots to said casing and movable vertically in said recesses abreast of the said flue openings. Two claims.

1,050,023. LOW-WATER ALARM FOR STEAM BOILERS. HARRY A. HOKE, OF ALTOONA, PA.

Claim.—A thermostatic apparatus for steam boilers comprising a supporting member, a U-shaped member formed of metal having a comparatively small co-efficient of expansion and having the base thereof secured to the supporting member, tubular thermostatic members formed of metal having a comparatively large co-efficient of expansion and clamped to the outer sides of the limbs of the U-shaped member so that the said limbs of the U-shaped member will be flexed inwardly when the tubular thermostatic members are heated to a temperature above the normal, means for causing the tubular thermostatic members to be normally filled with water from the boiler, but to be filled with steam from the boiler when the water falls below a certain level, a head applied to one of the tubular thermostatic members and formed with an outlet, a valve controling the outlet, a valve stem carrying the valve, and means actuated by the opposite thermostatic member for engaging the valve stem and opening the valve when the limbs of the U-shaped member are flexed by the admission of steam to the tubular thermostatic members. Four claims.

1,050,185. FEED-WATER CONTROLLER AND LOW-WATER ALARM FOR BOILERS. LEWIS S. WATRES, OF SCRANTON, PA., ASSIGNOR TO HULL MANUFACTURING COMPANY, OF SCRANTON, PA., A CORPORATION.

Claim 1.—In an apparatus of the character specified, a yieldable diaphragm, a casing in which the diaphragm is held, a rod actuated by the diaphragm and extending through the casing, a pipe connected to the casing for directing an operating fluid to the diaphragm, a water feed controlling valve having an operating stem axially in line with the diaphragm rod and spaced a short distance therefrom and means adapted to be inserted between the rod and stem and to move said stem when the diaphragm is in inoperative position. Four claims.

1,051,106. GAGE-COCK. GEORGE J. HATZ, OF OMAHA, NEB., ASSIGNOR OF ONE-HALF TO CHARLES E. FULLER, OF OMAHA, NEB.

Claim 1.—A gage cock comprising a plug having a passageway therethrough and having an elongated outer portion provided with a valve seat at its end, a chambered body portion engaging said plug and pro-

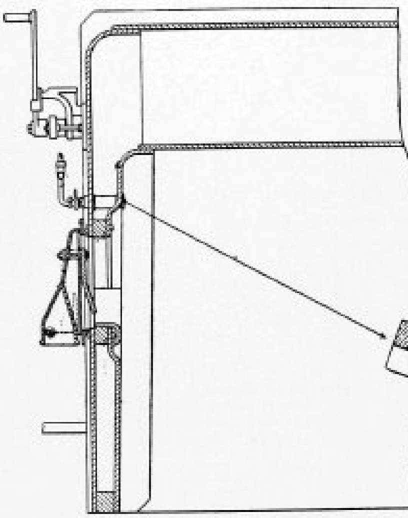
vided with a discharge opening, a valve for engaging said valve seat, said valve having an unobstructed chamber opposite the passageway of the plug, and extending outwardly from the seat engaging surface of the valve, and means for operating said valve. Thirteen claims.

1,046,074. DEVICE FOR OPERATING FURNACE DOORS. CHARLES F. KAHLER, OF CLEVELAND, OHIO.

Claim 2.—In a device for operating furnace doors, the combination with a furnace having an opening for the admission of fuel, of a horizontally arranged shaft rotatably mounted above said opening, a horizontally arranged shaft rotatably mounted below said opening, pinions rigidly secured on said shafts, a bar slidably mounted at the side of said opening and having one end extending on the inside of the pinion on one shaft and having its other end extending on the outside of the pinion on the other shaft, said bar being provided with teeth on opposite faces at opposite ends of said bar adapted to engage with the said pinions, pins arranged to support said bar, one of said pins being arranged on the outside of the bar at the end of the bar which passes on the outside of the pinion and the other pin being arranged on the inside of the bar at the end of the bar which passes on the inside of the pinion, means for reciprocating said bar and a pair of doors adapted to close said opening, the upper of said doors being provided with upwardly extending arms rigidly connected to the upper shaft and the lower door being provided with downwardly extending arms rigidly connected with the lower shaft. Two claims.

1,051,220. FIRE DOOR OF BOILER FURNACES. GUSTAV DE GRAHL, OF ZEHLENDORF, NEAR BERLIN, GERMANY.

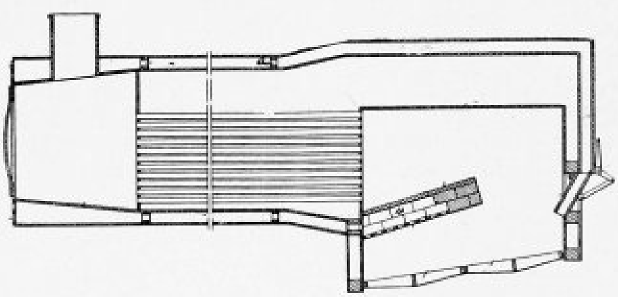
Claim 1.—In a furnace the combination with the fire-box, having a fire-door opening, of a horizontally opening fire door, having one or more air-conduits somewhat inclined to the vertical, and limited by walls, having an unchangeable position with regard to the fire-door, one or more steam-nozzles, situated above said air conduits, and connected with a steam-pipe being provided with a closure member for controlling



the steam-admission to the said steam nozzles, said air conduits being provided with ribs, for heating the air passing through the air-conduits, and connected below with the external air and opening above parallel to the side walls into the fire-box, and co-operating with said steam nozzles, said air conduits being provided with non-return valves adapted to be opened automatically under the influence of the draft in the fire-box. Two claims.

1,051,546. STEAM-BOILER FURNACE. ERNEST BUCKLEY, OF PHILADELPHIA, PA., ASSIGNOR OF ONE-HALF TO SAVILLE SMITH, OF PHILADELPHIA, PA.

Claim.—The combination, in a steam boiler furnace, of a fire-box having therein a deflecting arch containing a chamber discharging into the fire-box, a fire door with passage therethrough also discharging into



the fire-box, a casing outside of the shell of the boiler and forming between the two an air heating and circulating chamber which communicates both with the hollow arch and with the passage through the fire door, whereby a secondary supply of air heated by contact with the shell of the boiler is directed into the fire-box partly through the hollow arch and partly through the fire door. One claim.

1,048,245. SMOKE PREVENTER. OSCAR G. WARNKE, OF CLEVELAND, OHIO.

Claim 1.—The combination with a furnace having a combustion chamber, of means for supplying air and steam to the combustion chamber, valves for controlling said supply and an oscillating shaft having connections with the valves, means for rotating the shaft in one direction to open the valves, a detent engaging a shaft to hold the shaft in such position and a rod moving in one direction so as to allow the detent to engage the shaft whereby the valves will be held open, said rod moving slowly in the opposite direction to engage the detent to release the shaft whereby the valves are closed. Five claims.

1,048,356. MECHANICAL STOKER. WILLIAM SEATON, JR., OF NEW YORK, N. Y.; JEANNETTE NEILSON SEATON, ADMINISTRATRIX OF SAID WILLIAM SEATON, JR., DECEASED.

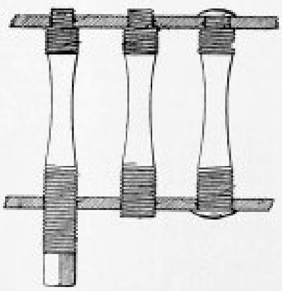
Claim 4.—In an apparatus the combination of grate bars, a support for one end of said grate bars adapted to impart movement to said grate bars, a feeding and coking plate integral with said support and inclined toward the grate bars in its normal position, means for imparting movement to said support and a hopper adapted to discharge on said plate, one side of said hopper forming means for closing said hopper. Eleven claims.

1,048,739. BOILER ECONOMIZER. FREDERICK SARGENT, OF CHICAGO, ILL., AND DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNORS TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim.—A boiler unit comprising two boilers spaced apart, an economizer for each boiler placed above and spanning the boilers, and flues for conducting the gases from the boilers to the economizers, and from the economizers to a common stack. Eight claims.

1,052,282. STAY-BOLT. JULIUS SCHMITT, OF MINNEAPOLIS, MINN.

Claim 1.—A stay-bolt having screw-threaded end portions adapted to be screwed into screw-threaded openings in the inner and outer sheets of a fire-box, and also having near its inner end a stop shoulder for



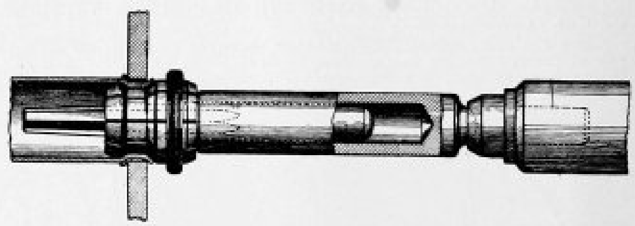
engagement with the said inner sheet, the intermediate portion of said stay-bolt being tapered in reverse directions inward toward the axis of the stay-bolt, and the outer projecting ends of said stay-bolt being upset against the said two sheets to form rivet heads. Three claims.

1,049,357. MECHANICAL STOKER. DAVID F. HERVEY, OF LOGANSPORT, IND.

Claim 2.—In a mechanical stoker, a rotary distributer comprising a shaft and blades disposed substantially lengthwise of the shaft, each blade having its ends bent in opposite directions whereby said ends extend upon opposite sides of the axis of the shaft, and provided with means for preventing sliding movement of the fuel longitudinally of the blades. Nineteen claims.

1,053,372. MANDREL-EXTRACTOR FOR BOILER TUBE OR FLUE EXPANDERS. JOHN W. FAESSLER, OF MOBERLY, MO.

Claim 1.—A mandrel extractor for sectional boiler tube-expanders, comprising a tool constructed with a blunt circular impact surface at one end and a blunt hammering surface at its opposite end, to be inter-



posed between the ring of sections of said tube-expander and a hammer, to simultaneously drive upon all the sections of said expander and by the inertia of the mandrel loosen the same. Two claims.

1,050,451. LOCOMOTIVE FEED-WATER HEATER. FRANK J. GILROY, OF BUFFALO, N. Y.

Claim 1.—The combination with the smoke-box of a locomotive, of a water-heating jacket concentric with the smoke-box wall, contiguous thereto, and provided with steam conduits for heating water therein, means for at will forcing water through said jacket to the boiler, and means for at will causing exhaust steam to pass through said conduits. Seven claims.

1,051,105. WATER GAGE. GEORGE J. HATZ, OF OMAHA, NEB., ASSIGNOR OF ONE-HALF TO CHARLES E. FULLER, OF OMAHA, NEB.

Claim 1.—A water gage comprising a casing having a chamber to receive the sight glass, a sight glass within said chamber, said chamber being provided with a wall extending around said sight glass at a distance therefrom to form a space for packing and having an inner wall extending from said surrounding wall across said packing space and inwardly beyond the edge of said sight glass, packing interposed between the edges of the sight glass and said surrounding wall of the chamber, a retaining cover arranged to extend over said surrounding wall and across the edge of the sight glass, said cover being provided with a compression gland adapted to enter the space between the sight glass and said surrounding wall, the compression of the packing being resisted by said inner wall, and means for connecting said cover to the casing. Two claims.

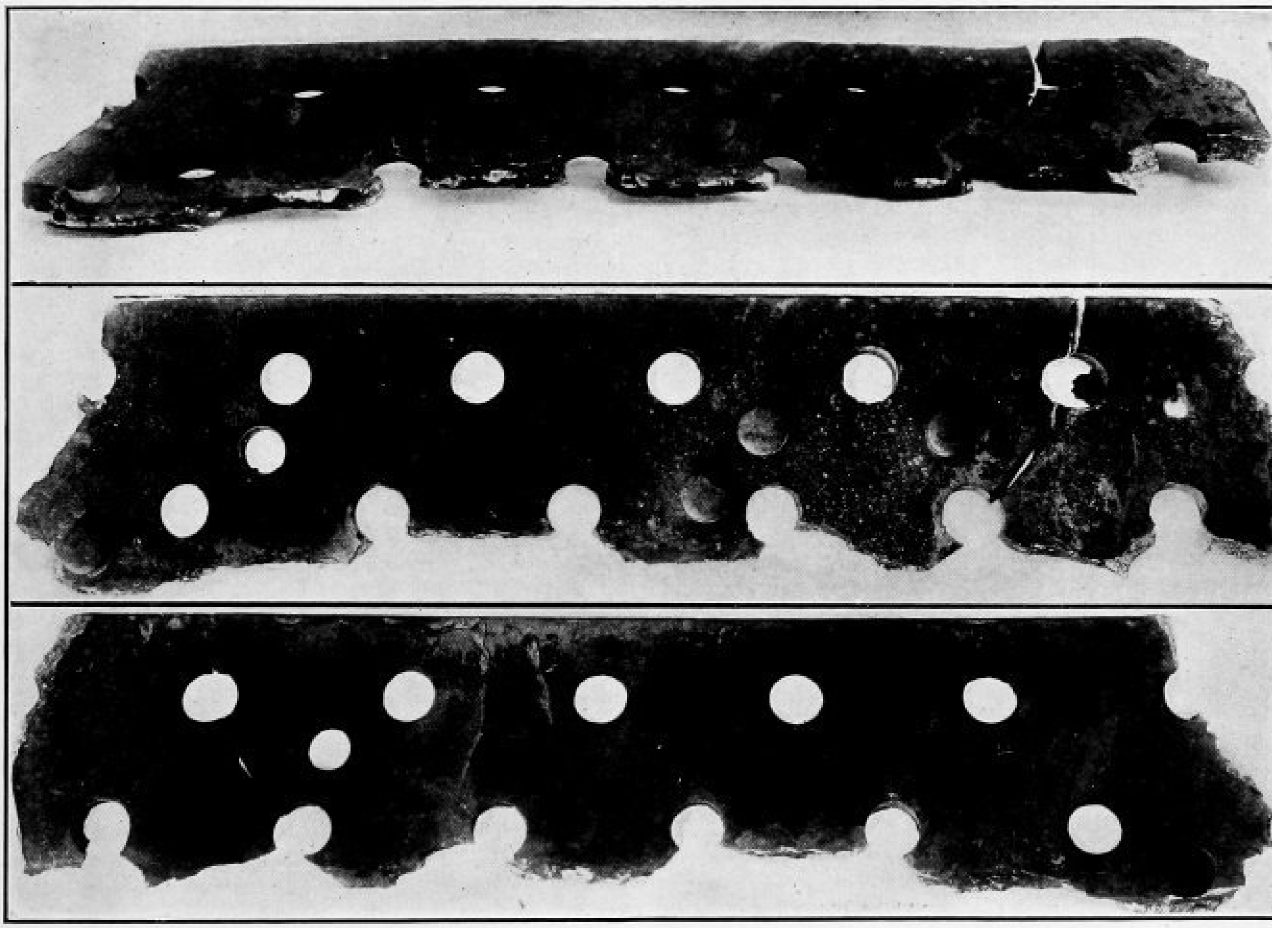
THE BOILER MAKER

JUNE, 1913

A Defective Double Butt Strap Joint

BY J. O. B. LATOUR*

On Oct. 12, 1909, a horizontal return tubular boiler installed at a combined municipal electric and water works plant in Canada exploded with terrific force, killing the operator, who was the only person near the boiler at the time, and completely demolishing the municipal plant, as well as an adjoining factory. The explosion was of such force that the front part of the boiler was thrown over the top of the water tower, which is over a hundred feet high above the location of the boiler.



VIEWS OF STRIP OF RUPTURED PLATE TAKEN FROM EXPLODED BOILER

The boiler which exploded was built in 1904. The shell was 72 inches diameter and 18 feet long, with a vertical dome 34 inches diameter and 32 inches high located in the center of the boiler and flanged to the shell and double riveted. The boiler contained 78 4-inch tubes, 18 feet long, and there was a hand hole below the tubes at the bottom of both heads.

The shell of the boiler was made up of one plate in the bottom 8 feet wide and three plates in the top, forming three part courses. Longitudinal seams joining the single lower course to the three upper courses were double butt strap joints, triple riveted with the outer row of rivets in single shear and spaced twice the pitch of the two inner rows. The rivets were ¾ inch diameter, the pitch of the inner rows being

* Chief Engineer of the Canadian Casualty and Boiler Insurance Company, Toronto, Ontario, Canada.

3 inches and of the outer row 6 inches. The riveted holes were punched before bending the plates and reamed fair after assembling, a point which was verified when the joint was taken apart after the explosion. The efficiency of the joint figured out at 86.46 percent, and as the tensile strength of the material by the stamp on the plate was 60,000 pounds per square inch of section, the safe working pressure of the shell, allowing a factor of safety of five, equaled 126 pounds per square inch. The boiler was insured for 125 pounds. The top segments of the boiler heads were stayed by four steel plate gussets, securely riveted to double angles, which in turn were securely riveted to the heads and shell and were not disturbed after the explosion.

The initial rupture occurred in the front end of the longitudinal seam of the bottom plate, through the outer row of rivets in the outside strap. After the explosion the writer had the outside strap at the back end of the boiler on the same side as the rupture removed. There was positively no outside indication of anything being wrong, but upon examining the three views of this piece shown herewith some idea of the condition of the plate can be obtained.

The upper illustration on page 161 shows the cracked edges of the plate. The piece shown is 18 inches long and was cracked almost continuously from hole to hole except at the bright spots which are clearly shown. The bright spots are the only parts of the ligament of the plate which were whole at the time of the explosion. The dark parts were broken and were all black, showing that they had probably been broken for a long time. One complete crack between two holes of the two inner rows of rivet holes should be noted in this view, as well as several other cracks. It should also be noted that some extra holes have been punched in this piece for testing purposes, and in some cases the burrs have been inserted. One burr is shown in which the crack opened about 1/16th of an inch. This plate was made by one of the largest and most reputable steel makers and was fully stamped.

The middle illustration is a view showing the side of the plate which was the outside of the boiler. In this picture the different cracks will be observed and also the extra holes which were punched after the explosion for testing purposes. All of these extra holes excepting one have the burrs inserted in them. The crack shown was expanded at the time of punching but was plainly visible before punching.

The lower illustration is a view of the side of the plate which was inside the boiler. Numerous cracks can be seen in this view also, as well as the holes which were punched for testing purposes. It is regrettable that no chemical or physical tests of the material were made, as undoubtedly such tests might have furnished some very instructive information as to the cause of the explosion.

The actual strength of the joint after the plate is cracked is the strength of the rivets in single shear plus the small parts of the plate ligaments that still held (in the crack) between the center row of rivet holes. The strength of the unbroken parts was taken up by the rivets in double shear. Allowing the rivets in single shear 45,000 pounds per square inch of section, which is the highest that can be safely allowed, the efficiency of the joint works out as only 14.81 percent, making the bursting strength of the boiler 108 pounds per square inch, or practically 100 pounds if only 42,000 pounds per square inch of section is taken as the shearing strength in single shear.

The general working pressure on the boiler varied between 80 pounds and 100 pounds per square inch, the last evidence of the pressure a few minutes before the explosion being 85 pounds per square inch. There is, therefore, no doubt whatever that the strength of the plate in this joint was reduced to such an extent that it could not withstand even the low working pressure which resulted in this terrible disaster.

The plant was carefully operated and the load on the boilers was always very light. There were two boilers, operating alternately, and the cleanliness on both sides was all that could be desired. The boilers were insured by the company with which the writer is connected and were regularly inspected, internally and externally, by highly experienced inspectors from the time they were placed in operation. The boiler was only about five years old.

While such accidents as these do not happen very often, nevertheless the writer has been shown plates that have developed similar cracks in this type of joint. It would be very instructive and helpful to everyone interested in boilers if others who have known of such failures would describe their experiences in such cases.

Advantages of Low Ratio of Heating Surface to Grate Area in Boilers

Boiler specifications usually call for a ratio of heating surface to grate area of upwards of 30 to 1, and even as high as 45 or 50 to 1 where forced draft is used. This high ratio of heating surface to grate area naturally means the incorporation into the boiler of a large amount of material, the manufacturing and assembling of which increases the amount of labor involved in building the boiler. It is, therefore, self-evident that the higher the ratio of heating surface to grate area in any given boiler the greater will be the amount of material and labor that goes into the boiler, and as these represent practically all the cost of construction, the first cost or price of the boiler increases almost directly in proportion. In view of the above facts, therefore, it must be accepted as a good policy to keep down the ratio of heating surface to grate area as much as possible consistent with low stack temperatures and the proper absorption of heat by the heating surfaces. This policy has even greater force in the case of marine boilers, as a large amount of heating surface in proportion to the grate area means an increase in the size and weight of the boiler, two factors which it is advantageous to reduce to a minimum in a marine boiler.

The possibility of obtaining better results—that is, the transmission of more heat units from the fuel to the water in the boiler and better evaporation per pound of coal—with a boiler in which the ratio of heating surface to grate area is less than that in the ordinarily accepted type of shell boiler does not seem to be realized by many engineers. By subdividing the heating surface of a boiler into various systems, so that comparatively cool water is brought directly over the fire in the primary generating system and by interposing in the path of the gases a secondary section of heating surface containing water at a temperature of the feed water, the gases of combustion as they proceed toward the stack can be brought in contact repeatedly with heating surfaces containing water at nearly the temperature of the feed water, so that when finally delivered to the stack the temperature of the gases can be reduced to a point far below the temperature due to the pressure on the boiler. In other words, more heat will have been transmitted from a given amount of fuel to the water in the boiler than would be possible in the ordinary type of shell boiler where the temperature of the gases cannot be lowered to a point anywhere near the temperature due to the pressure on the boiler, no matter how great the amount of heating surface put into the boiler. All this can be obtained, moreover, as has been proved by tests and practical experience, with boilers which have smaller ratios of heating surface to grate area than 30 to 1. In fact, a boiler with a ratio of 25 to 1 has shown greater economy, besides occupying less space, having less weight and with a lower center of gravity than boilers with a larger ratio of heating surface to grate area. Furthermore, the boiler of small ratio requires less material and labor and, consequently, less first cost for its construction and smaller maintenance costs for its upkeep.

Best Methods of Welding Superheating Tubes and Tools Used for Same*

All safe ending should be done at the firebox end, on account of the necessity of always having good and new material at the location where it is needed the most. This is the location of the extreme heat, as well as the stresses that have to be taken care of on account of the great amount of expansion and contraction, as well as the amount of work that has to be done on these flues, at this particular location, to keep the same tight and in good working condition. It is the experience of the roads that have operated these superheating engines the longest that it is absolutely necessary to keep the flues tight at all times to run them successfully. It is also the experience, in bad water districts, that these large tubes give considerable trouble; this necessitates a great deal of work being done on them. Therefore the committee would recommend that the safe end be applied on the firebox end of tubes at all times.

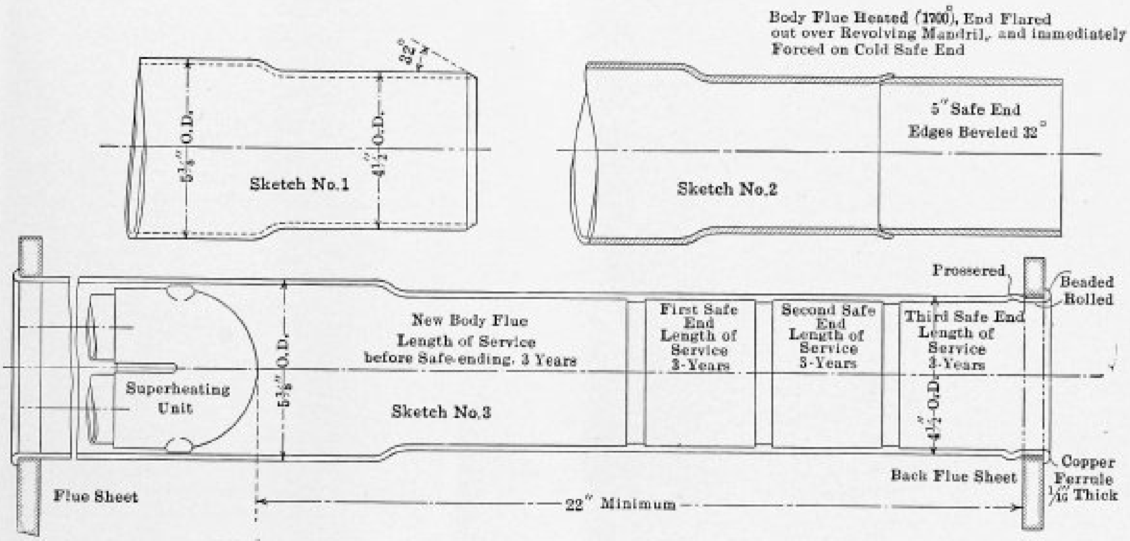


FIG. 1.—STANDARD PRACTICE FOR WELDING SAFE ENDS ON SUPERHEATING FLUES

To cut the burrs off the end of the flues and use the body of the flue in the firebox end for a bead, in our opinion, would not give satisfactory results. We all know the body flue deteriorates rapidly in bad water districts when in these boilers and in hard service. Very few, if any, of our roads would think of applying our ordinary 2-inch or 2¼-inch flues in this manner. This being the case, there is no good reason why we should apply our superheating flues with any less care and with material which has been in the boiler as a body flue for some time, under the above-mentioned conditions, which is not as good as a new safe end. The duties of a superheating flue in the firebox are as hard, if not harder, than any ordinary flue, and under some conditions, such as bad water and failure to keep same absolutely clean, they are very liable to give trouble and require considerable work to keep them tight. This being the case they should be safe ended in the firebox end, at all times, with the very best material obtainable.

It is the opinion of some of the committee that there should not be more than one weld in these flues at any time, on account of old welds giving trouble after flues have been in service, removed from boiler, cleaned and replaced again. If the welds are reduced to one in each flue you reduce the liability of having more than one leak from this source in each flue. This also adds to the safety of those who come in contact with and make repairs to this class of work.

To apply the safe end at the firebox end, at all times, it will be necessary to cut your flue as close to the front sheet as possible to avoid any additional waste of the body flue, and reduce the necessity of applying long safe ends. The average life of a body flue of this dimension, in this particular service, would not exceed four safe endings. The average flue welding machines are built so they can weld a safe end 14½ inches long. This can be done by first welding on a 5-inch piece, second an 8-inch piece, third an 11-inch piece and fourth a 14-inch piece. At the expiration of this time unquestionably the body flue will be about worn out. To do this it will be necessary to cut your flue close to the front flue sheet, as well as close to the old weld in the back end. In repairing your flue in this manner you will always have a new safe end at the firebox end, as well as a flue with only one weld at any time.

This will give an almost perfect flue in the locality where it is required to do the greater part of the work; also, where it needs all the strength and durability it is possible to have at all times. In some localities these flues are prepared and welded in the following manner:

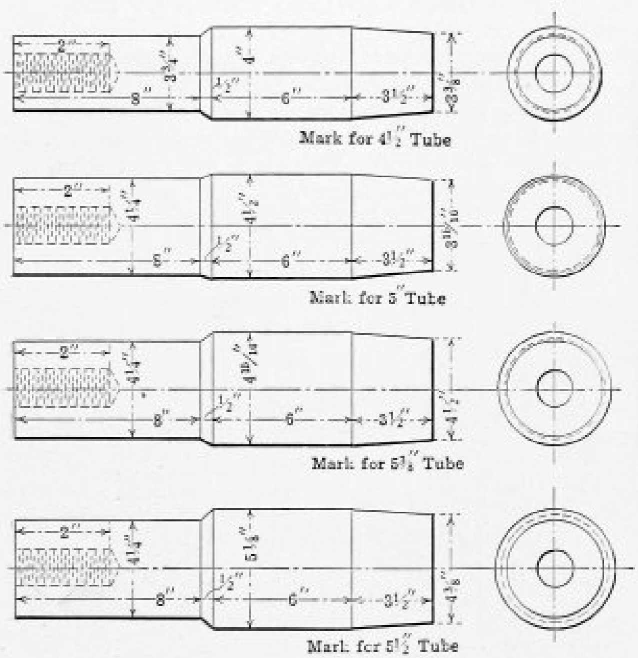
The rough end of the flue at the firebox is cut off on the cutting-off machine by beveled cutters, which leaves the end of the body flue beveled to an angle of 32 degrees. The flue

* Abstract of a committee report presented before the Master Boiler Makers' Association at Chicago, May, 1913, by B. F. Sarver, J. J. Orr and J. P. Malley.

is then heated and flared out on a revolving mandril sufficiently to admit of the insertion of a (cold) standard safe end. The safe ends are cut off 5 inches long with the same type cutters as previously noted, thereby giving a sufficient angle for scarfing (32 degrees) without any additional preparation.

The 5-inch safe ends are placed on a mandril, and, after the body flue is heated and flared out, it is forced by hand over this (cold) safe end from ⅜-inch to ½-inch. This process gives a good scarfing edge, as both pieces have been beveled to the same angle, 32 degrees, and when the body flue "cools" it obtains a positive grip on the safe end, due to its contraction; this also positions the safe end, so that a good welding heat is obtained.

The flue with safe end attached is then heated in a furnace, especially prepared so as to give a narrow flame heat on the joint to be welded. The flue is heated to a welding heat, but



All Tapped 1⅝" Std. Left Hand Thread

FIG. 2.—MANDRILS

before being removed from the furnace, and when the heat is proper for welding, they are forcibly bumped up against a water-cooled iron block, inserted in the rear wall of the furnace, or, more technically speaking, the block is located in the rear hearth opening of the furnace.

This bumping action practically welds the flue while in the fire, and the narrow flame eliminates the danger of "heating up" previous welds. The flue is now removed from the furnace and welded on a welding machine, which revolves around the flue, and is specially equipped for this purpose. This completes the operation of applying the safe end.

Since the firebox ends of these flues are swedged down from 5⅜ inches to 4½ inches it is most economical, from any point of view, to apply the safe ends to the firebox end of the body flue, and at the same time it renews this end of the flue, which is subject to the greatest strains from cold air and heat. In some localities it is permissible to have more than one weld in these superheating flues, as shown in the illustrations.

The best tools for welding these flues is a question that is in about the same position at the present time as the welding of the flue. In a great many localities the dimensions of the old welding machines have been increased regardless of the type, and it is claimed by all those who are concerned that they are getting satisfactory results.

At a great many places a welding machine is used that revolves around the flue, and, from reports, successfully; but, like others, some fault is found with them. Fig. 2 shows the proper measurements of different size mandrils to be used in this type of welding machine for different size flues.

Several questions are debatable relative to these machines. They are as follows: Whether the flue should revolve around on the roller in the machine, or whether the machine should revolve around the flue. To revolve the flue around on the roller it requires some time for the flue to travel this distance, and being of light material it is very likely to become cooled off some before the entire weld is made. It also requires a great deal of power and labor to operate and weld these flues successfully with a machine of this type.

With a machine that revolves around the flue the weld is made a great deal quicker and with less power and labor, but this machine also has its faults. First, it is claimed that it does not make a smooth job on the inside, but leaves an obstruction in the flue that is likely to cause the flue to clog rapidly. This is a very serious objection, as it is the opinion of almost all that it is necessary to have these flues clean at all times. It is also claimed that it is hard to weld the safe end on these large flues and keep them straight with this machine.

After taking into consideration the above-mentioned conditions your committee does not feel at this time that it would be doing justice to itself or any of the machines used for doing this work at the present time to make a complete report on this subject.

In summing up this question, there are three or four points which should receive careful consideration.

First—At which end of body flue should the safe end be applied?

Second—How many welds in a flue are permissible at any one time?

Third—Should welding machines revolve around the flue, or should the flue revolve around the machine?

Fourth—Flues should be annealed at the firebox end at all times.

New Enterprise in the Boiler Making Field

No doubt our subscribers will be interested to learn of a new enterprise in the boiler making field. The latest is the Downingtown Iron Works, Inc., of Downingtown, Pa. The three young men back of this enterprise are all practical boiler makers and know the business from A to Z, having had a wide experience. Mr. Louis C. Zimmerman is president and general manager, Mr. Harold T. Abele is vice-president and Mr. Park L. Plank is secretary and treasurer. The works are splendidly located on the main line of the Pennsylvania Railroad within easy reach of Philadelphia, and a short distance from the steel plate mills at Coatesville, Pa., where supplies necessary for all kinds of boiler work can be had at short notice. The present shop is 90 feet long, 40 feet wide and 18 feet high, constructed of brick throughout. The machines are all operated by electricity. Overhead cranes are provided for handling all material, finished or unfinished, and all work is done off the ground floor. The working capacity is exceedingly well provided for with plenty of extra space to make additions to the building when necessity requires same. As we are personally acquainted with these gentlemen and know that they are endowed with push and energy, we feel sure that this enterprise will be a complete success.

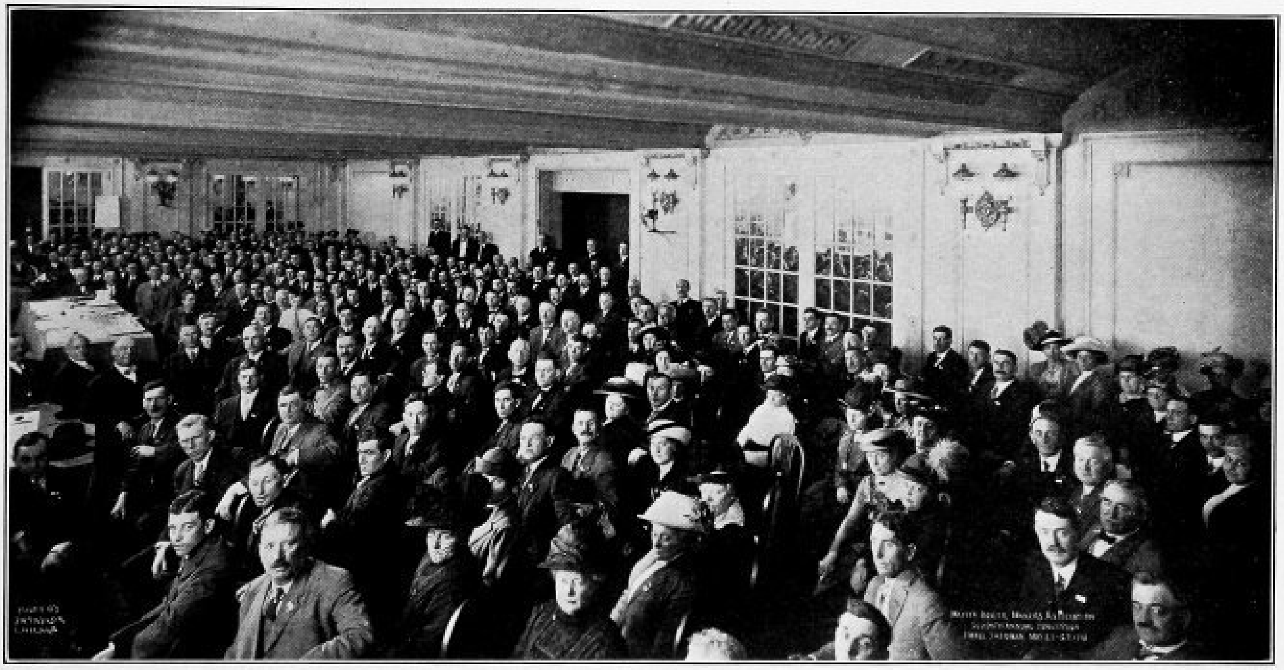
Master Boiler Makers' Annual Convention

The seventh annual convention of the Master Boiler Makers' Association was opened on Monday morning, May 26, at the Sherman Hotel, Chicago, Ill., with the president, Mr. M. O'Connor, general foreman boiler maker of the Chicago & Northwestern Railroad, in the chair. Prayer was offered by Mr. John H. Smythe, and after the invocation an address of welcome was delivered by Mr. W. L. Park, vice-president and general manager of the Illinois Central Railroad.

ABSTRACT OF MR. PARK'S ADDRESS

After cordially welcoming the members and guests of the association to the convention city, Mr. Park paid a compliment to the railway boiler makers by stating that a mechanic who can lay out a modern locomotive boiler, with all its complications and supervise its construction with the various arrangements which go into the finished product, can build any kind of boiler. He urged the members of the association to assist the operating departments of the railroads in correcting certain abuses that are insidiously creeping into National and State jurisprudence. Commenting on these conditions, he said in part: There is confronting the railroads to-day a very critical situation. Numerous laws, rules and regulations have been imposed, some of which have real merit, but many are ill-considered, ill-advised, inconsistent, unnecessary, unreasonable and impossible of compliance. Such rules and regulations were born of ignorance, and are not always sincerely in the interests of safety of the public or employees, and, furthermore, many of them show a taint of commercialism or self-interest.

Mr. Park emphasized the fact that laws once made must be enforced, and that the proper time to correct them is before they become a law. Reviewing, briefly, some of the laws and regulations, he ventured to analyze their effect upon the railroads with a view of ascertaining if they are out of line, and if so of enlisting the offices of the association in correcting conditions before they become onerous or economically burdensome. No attempt at boiler regulation was made in this country until 1870, when a boiler inspection law was passed in New York and afterwards in one or two other States. In February, 1911, the present law was passed and became effective in July of that year. There has, therefore, been an opportunity to watch the results for a period of two years. In the report of the chief inspector for the first year there were an apparent lack of instructions and failure to make systematic tests on the part of the railroads. The law as it stands can work little hardship if reasonably applied. It is supervisory in character; and while many of the so-called defects in locomotive boilers are trivial, there is little cause for criticism of the law in its application as a whole.



SEVENTH ANNUAL CONVENTION OF THE MASTER BOILER MAKERS' ASSOCIATION

The total number of defects on a number of the representative roads indicates a fair distribution of the supervision. The great bulk of the defects are broken staybolts, tell-tale holes stopped up, plugged flues and unclassified steam leaks, few of which would make the locomotive unserviceable or unsafe. The inspectors should be met with a co-operative spirit, for the intelligence, knowledge and ability of the railroad master boiler maker are at least equal to those of the Federal inspector. The additional supervision and duplication of labor entailed by the enforcement of the law, however, adds to the financial burden of the railroads.

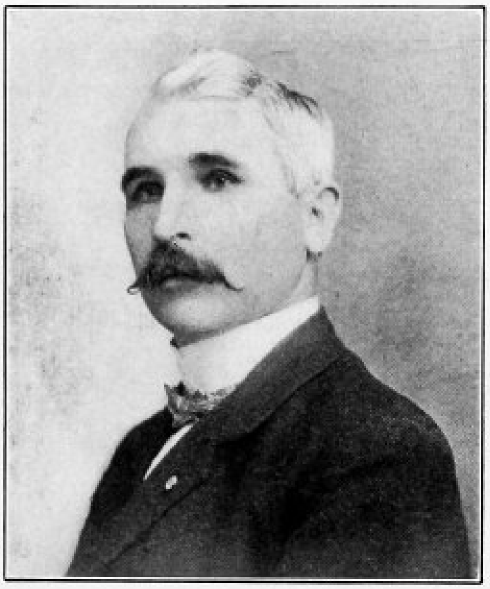
Mr. A. N. Lucas, general foreman boiler maker of the Chicago, Milwaukee & St. Paul Railroad, responded to Mr. Park's address.

The next speaker introduced was Mr. John F. Ensign, chief Federal boiler inspector, of Washington, D. C.

ABSTRACT OF MR. ENSIGN'S ADDRESS

Your position as master boiler makers is one that has great responsibility. The employees directly under you who inspect the boilers should be chosen with the greatest of care. Only those in whom you have the most absolute confidence should be placed in the position of inspecting locomotive boilers.

They should be given to understand that each part that they inspect should not only be inspected but should be repaired, and you, as masters of the situation, should see to it personally that the inspections and repairs are properly made before the locomotive is sent out. I believe the boiler maker at each division terminal should have absolute jurisdiction over those who are engaged in boiler work. It should be not only just the boiler makers that you have charge of, but also the boiler washer, and those machinists who do certain work, such as setting the safety valves or overhauling the injectors or trying the gage cocks and water glasses. During the last nine months there have been over 4,000 locomotives ordered from service by the Government inspectors. There should not have been a single locomotive taken from service by the Government inspectors; the work should have been so carefully done and the repairs so carefully made that the inspectors



M. O'CONNOR, RETIRING PRESIDENT

would not be able to find any engines to take from service. Such action should not be necessary.

Mr. Charles L. Hempel, general boiler inspector of the Union Pacific Railroad, responded to Mr. Ensign's address.

THE PRESIDENT'S ADDRESS

In his presidential address, Mr. M. O'Connor declared that the wonderful progress made by the organization during its brief existence was due to the diligence and conscientious efforts of the individual members in working together harmoniously in promoting the betterment of their standing along mechanical lines. He urged all members to contribute freely their share to the advancement of the association. A point of special importance which he emphasized was the necessity for careful consideration in promoting the welfare of apprentices. He stated: "We should, after a careful selection of these men whom we enlist as apprentices, do everything we can to encourage and help them, and by their examples they will lead other young men who are selected to fill their places, if only they are taught to show that mental culture on moral and mechanical ideas is a pleasure to them as well as a duty."

REPORTS FROM THE SECRETARY AND TREASURER

According to the secretary's report the association has a total membership of 415, of which 313 are in good standing. During the present convention about 100 new members were elected. The treasurer's report showed total receipts of $1,253.65 and total disbursements of $811.98, leaving a balance of $441.67.

TUESDAY MORNING SESSION

The second session of the convention convened Tuesday morning at nine o'clock with the president, Mr. M. O'Connor, in the chair. Mr. C. A. Seley, president of the American Flexible Bolt Company (until recently chief mechanical engineer of the Chicago & Rock Island Railroad) addressed the convention, referring at first to the subject of railway legislation. Amplifying what had been said on this subject on the day before, he said that it is the duty of every good citizen to keep his political representatives straight in regard to matters of legislation with which this representative might have little or no personal acquaintance, as is frequently the case in railway legislation. The railroads are the only corporations that are regulated by the Government that are not permitted to name the price of their product, consequently any legislation regulating the railroad bears on one side of the financial end of the railroads. The Government does not say how much a ton of steel shall cost, but it does say that the hauling of a ton of freight on a railroad shall cost only so much. The speaker then emphasized the importance which devolves upon the association in making a good record for itself at its conventions, giving some valuable suggestions from his own extensive experience in responsible positions in the major mechanical associations.

Mr. J. A. Doarnberger responded to the address of Mr. Seley.

How Many Rows of Expansion Stays is it Advisable to Apply to Crown Sheets to Secure Most Efficient Service, considering Wear and Tear of Boilers?

No report on this topic was presented.

Is There Any Limit to the Length of a Tube in a Boiler Without a Support Midway of Boiler, and will a Support Prove Objectionable in Circulation?

(An abstract of this report will be found on page 193.)

The report was accepted, the committee discharged, and the topic opened for discussion.

Mr. A. N. Lucas: As the report reads, we have got flues now in service 24 feet long, and we have a combustion chamber in our Mallet engines 76 inches long; still they have a flue 24 feet long. The paper reads, "Is there any ill effect upon a flue by reason of unequal expansion?" Not so much so long as you allow the fire to go through all the flues. If you allow your flue to stop up and your bottom flue and the bottom of your combustion chamber to become clogged, those flues go to pieces very rapidly and will give you lots of trouble. The fires going through the flue do get the expansion, and the flue if stopped up anywhere does not get the expansion and there cannot help be a seesaw there. In any case, it is a very important thing to keep your flues open at all times.

Mr. Doarnberger: I would just like to state that in making that report up, just prior to getting the report together, the Norfolk & Western got ten of what is known as 1-X-1 type engines, sixteen-wheel couple Mallet, and in those engines there was the Baldwin type of reheater, and we decided to take the 5-X ones in and cut out the old flue sheets and equip it with superheated, which necessitated the renewing of the flue sheets. Those flues, while they are known as Z-1 type engines, have about a 6-foot combustion chamber. The boiler is a much longer boiler in the last Mallets than the first, and it happened that the sixteen-wheel couple engine is 24¾ feet between the sheets, and the Z ones with combustion chamber are much longer and they are 24¾ feet. We decided on account of the trouble we had with the support sheet to omit it, and I believe that that support sheet was never put in there for the purpose of supporting the flue at all; but we could gather from the Baldwin Locomotive Company that it was put in there simply to cause the circulation of the water in flowing over it, and on account of the flues being 24 feet long in both types of engines. We have had them running since April, 1912, and we have not renewed a flue in them yet. We work them on the mountains and get 55,000 or 60,000 miles from them, and due to the last engines having 24-foot flues, and not having a support sheet, we have omitted the engines with the superheater.

Mr. D. A. Lucas: We have engines running with flues from lengths of 12 feet to 21 feet 2 inches, and we have a class of engines that takes a 19-foot 1-inch flue—2¼ inches. For an experiment we took two of these engines and renewed the flue sheets and put in a 2-inch flue, and in putting in the 2-inch flue, after the flues were set, I got in the box to look through them and found that the flue would sag so that you could just see through about one-third of the flue, and when the engine went into actual service we found it was lacking in the steaming qualities and efficiency that it had with the 2¼-inch flue, so that, from my experience, I think that the limit for a 2-inch flue is not over 17 feet. When you go any longer than that you get a sluggish action of your gases and things in the front part of your flue and don't get the full benefit of them. Now we have the Mallet compound with two separate boilers. In the back boiler we have 16-foot 8-inch flues, in the front boiler a 9-foot flue; and this front boiler was used with a pre-heater; the water was charged into the front of the boiler and forced back into the back boiler, and we found that the circulation was very poor in the front boiler, and to get good results it was necessary to put a steam connection from the back boiler to the top of the front boiler and two water connections on the back to cause the circulation, and in doing that we are getting good results and a good deal better engine. Now we have a Mallet engine of the smaller type run with a 21-foot flue. We get good results out of them. As for the length being any detriment to the flue, we have a class of engine that takes a 21-foot 1-inch flue, 2¼ inches, and we get an average of 100,000 miles out of those flues, and that's just as well as the short flues have done. That 2¼-inch flue is 16 feet and 17 feet long.

Mr. Frank Gray: On the Chicago & Alton we have had 20-foot flues in service for nearly eleven years. The oldest ones are 2¼ inches. We have about forty engines with 2-inch flues 20 feet long. We have also recently received some new engines with 22-foot flues 2¼ inches in diameter. Our flues run from 10 feet 6 inches to 22 feet. As far as mileage or leaking is concerned we have found that the long flue is no detriment whatever; in fact, we have a set of Pacific type engines and a set of Atlantic type engines that are identical with the exception that Atlantic type engines have 2¼-inch flues 16 feet long and the Pacific type has 20-foot flues. Those engines are all about eleven years old. We have always got better mileage out of the 20-foot flues on the Pacific type than we have ever been able to get out of the Atlantic type with a flue 4 feet shorter, and the Pacific type engine with the 2-inch flues 20 feet long is giving just as good service as the engines with the 2¼-inch flues 20 feet long. Our 22-foot flues we have not had long enough to know whether they are going to give the same results or not, but from a service of about a month they have been perfectly tight and given us no trouble whatever.

Mr. D. M. Yale: My idea in asking the question at the Pittsburg Convention as to the limit of the length of flues was not for finding out whether we could use a 20 or a 30 or a 16-foot flue, for the simple reason that we use them; but to find out if we could get as efficient service out of a 20 or a 24-foot flue as out of a 16-foot flue.

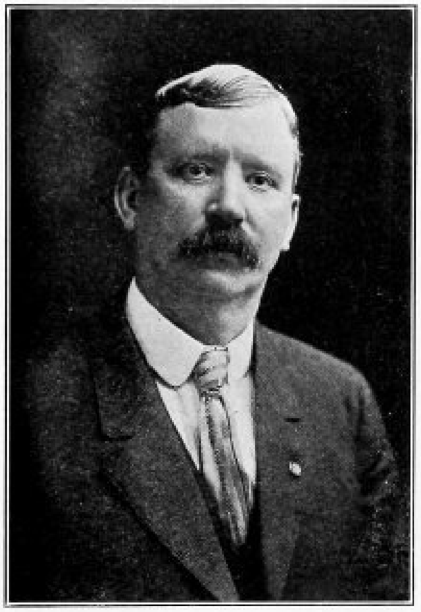
Mr. J. H. Optenberg: To answer the question of the gentleman who just spoke in regard to the efficiency of heating service in the longer tube as compared with the smaller one, I will say that it is considerably less when you get beyond a certain limit; we all know that. To be brief, with reference to the durability as between a long and a short flue, I will say this, that my experience is, as Brother Lucas has already stated, that the difference in expansion and contraction on a longer flue is greater as compared with a short one, and unless you see to it that your heat is distributed or your gases are distributed more uniformly, just as uniformly as possible through the tubes, you will find great difficulty in keeping a long flue tight as compared with a short one. If I am not mistaken, the question of bracing a long tube in the center

T. W. LOWE, PRESIDENT

was not necessarily due to the water. If that is true it appears to me, and I assume that a locomotive will have a vibration of water to contend with, if that is true, you will find that the vibration of water—in other words, the movement of the water—will have a great power, more so on a long tube than a short one; there will be more tendency to spring on a long tube than on a short one. I build boilers, and it was suggested to me when I was younger that it was necessary to put a supporting plate in the center of a long tube boiler on a steamboat, but I found that the circulation was impaired, and it will be in all cases, and they find that the most efficient and durable boiler is a boiler with a tube of limited length—not too long. Keep out of your boiler the plate to support the tube, because it will impair circulation, and along those lines I have an idea that they get more service out of a reasonable length tube, one that is not too long, than out of a long tube.

Mr. Bezant: Under this discussion of flues we are including steam pressure. In my experience with shorter flues we run those locomotives with less steam pressure, and here of late we have had engines in our district that have the same length of flues and have the steam pressure reduced to 175 pounds, and with those flues we are not experiencing half the trouble as with the same length of flues of 200 pounds.

Mr. George Austin: In all the statements that have been made here relative to the performance of the long or short tubes, it has not been specifically stated whether or not the agencies of comparison were operated under precisely the same conditions, and any data that do not set that out are not of any great value. Now it seems to me that there is a question of whether or not a long flue possesses any advantage in reference to heating surface. I note the report states that the last two or three feet evaporate 4 percent of the water as compared with 77 percent in the first part of the flue. Well, now, then, that 4 percent is a gain, isn't it? The prime cause of flue leaks, in my opinion, whether on long or short flues, is the difference in expansion, which has been stated, and the longer the flue is the greater difference of expansion we get between the different flues and boilers, different parts; consequently, long flues are more liable to leak, and I think that is the principal cause, and if flues can be maintained at an even temperature or anywhere near it, we will have very



JAMES T. JOHNSTON, FIRST VICE-PRESIDENT

little difficulty in regard to leakage, regardless of their length, and I believe that a longer flue is a decided advantage in a locomotive.

Mr. Hempel: I disagree with Mr. Austin relative to the long flue being a disadvantage to the locomotive. It strikes me that the longer the tube the more value we would receive from it, so long as the temperature is kept up to possibly 700 or 800 degrees. If the flue, for example, were 30 feet long and we still had 800 degrees in the smoke box, we would still receive some benefit from the long flues, so far as the steam-making qualities are concerned, so far as heating surface is concerned. If the flue is so long that the gases have so far to travel that they are of no value in transmitting heat, then the flue becomes useless. We have flues 22 feet long, and if I remember correctly the temperature in the smoke box was 1,100 degrees. If that is a fact, of course the flue 22 feet long is very valuable. These engines are superheaters, and the superheating tubes extend back a considerable length and they take their heat from the gases next to the front end. Therefore the gases are being absorbed in two ways, especially in superheated engines; one in the flue itself and the other by the superheated tubes—that is, the tubes that go inside of the larger tubes.

So far as the necessity of a plate in the center of the boiler to stay the flue is concerned, I would say that would be detrimental. I don't think it is necessary. I think that we should give the flue a chance to move according to the expansion of the boiler. I hold that there is no vibration in a locomotive boiler at the flue. I don't think that you can vibrate a flue in water or anything which is solid, but the flue will move up and down as the water surges. If the boiler is empty, then you have the vibration. Strike the flue with a hammer and it will vibrate; or move it any way by striking it, then you have the vibration. Otherwise, you have the movement of the flue caused by the surge of the water.

If the flue is properly applied, I believe that we will get just as good service from the 22-foot flue as we do from the 16-foot flue, so far as leakage is concerned. I know of engines that make over 100,000 miles with 20-foot flues, and I cannot see any good reason why we should say that that is too long. It may be possible that, by the surge of the water, it worked the flue to such an extent that there is some difference, but not sufficient difference to advocate the shortening up of flues and to throw away the enormous amount of heat that we get from the increased length of flues. My point of view is this, that in the long flue we get more value from our fuel.

Mr. A. N. Lucas: I do not suppose there is a member here in the room this morning that has not had experience with flues up to 19 feet long, at least; this due to the fact that the power has been increasing, and I don't know where we come in whereby we can regulate the length of flue and still increase the size of our power all the time. We know that when they adopted a 21-foot flue they thought it was an awful long flue, and the manufacturers and mechanical engineers conceived the idea that a combustion chamber would be the proper thing; so a great many roads to-day have in operation a great many combustion chamber boilers and are naturally shortening up their flues 3 or 4 feet, which I believe a good thing. I believe the combustion chamber boiler is showing good results wherever it is in use, and is shown to be a benefit, a saving in coal and a saving in the life of the flues. They are going a step further and build a Mallet type. You could not regulate the length as long as they wanted it 24 feet long or longer, so they put in a 24-foot flue and still have a 76-inch combustion chamber.

The first Mallets we got had a reinforcement plate or stiffener 7 feet back from the front flue sheet. In a short time after it was put in service we found our flues cut in two, due to the fact that in this reinforcement plate the manufacturer put in a tube about 2½ inches long in the hole and did not roll them in very tight, and some worked out, allowing the flue poor chance to move in the longer hole, and consequently cut through the tube. We had a failure on that account, so just as fast as these engines have been going through the shop we have taken that sheet out, and the next lot of Mallet engines we bought were bought without the reinforcement plate, and we are getting better results. We have had them two years in service and experienced very little trouble with the flues.

Mr. T. W. Lowe: It appears to me that there is a greater tendency for pitting and corrosion to go on when we get into this extreme length of 22 and 24 feet. Our Pacific types of engine do more pitting than any other type with a shorter flue; that is, the Pacific types have a longer flue, but with reference to the middle support, we have not found that it is advantageous with reference to anything that would come under our notice, not as regards steaming purposes or any other. However, we do think that if we were applying an intermediate plate in the long flue, that we would aggravate the trouble of pitting and corrosion which is now occurring on the 21-foot flue.

Mr. J. L. Eagan: Every boiler maker or any practical boiler maker is opposed to the long tube or the back combustion chamber. I agree that the intermediate combustion chamber is the proper thing. We all know that the expansion and contraction of the long tube is what has caused the trouble. I do not believe myself that we have any trouble from the vibration of the long tube. I think it is all in the expansion and contraction; that gives the trouble, and we will have to admit that the shorter the tube the better, and I do not believe in the center support, but the intermediate combustion chamber and the short tube is the only thing that will overcome the trouble.

Mr. D. A. Lucas: I am satisfied in my own mind that, by actual experience, I have seen that limit reached in a 2-inch flue, in the 2¼-inch flue I am not able to state; but if you've got an engine with a 2¼-inch flue 19 feet 2 inches long handling her train and her tonnage in good shape, and you'd remove those flues and put in a 2-inch flue, and she was deficient and couldn't do her business, to what would you attribute the cause? In the amount of heating surface you had reduced, in the diameter of the flue or the action of the gases in a 2-inch flue in preference to a 2¼-inch flue? Now we talk about this intermediate combustion chamber. That is what we have on our Mallet engines with the back boiler and the front boiler, and those boilers do very well as far as the flues are concerned, but the front boiler did not perform its duty until we connected the two boilers together and made the water level the same in the front boiler as the other, and created a circulation in the front boiler; then we got some results.

Mr. A. N. Lucas: How about the mud in the front boiler?

Mr. D. A. Lucas: Before we made this change the front boiler would fill solid full of mud; in fact, about four weeks would fill the front boiler, and after we made the connections in the front boiler we practically did away with that condition and also with the pitting. Now, before we made this connection the pitting of the flues—I have seen forty flues pitted the same as if somebody had taken a shot at them with a shotgun—due to no circulation and pitting, and after we made this connection and created the circulation in the front boiler we practically did away with the pitting. Now I state, if I understand this subject correctly, it is the advisability of the length of flues, and I think that when you reach a 17-foot 2-inch flue for a 2-inch flue you have reached the limit, and I am not here to state how long a 2¼-inch flue could be used, but we have got good results from 21-foot flues.

Mr. Green: A man claims he can get three-years' service in a bad water district, and in regard to the limit of the length of flue I don't see how we can do that at all. If you can put flues in and get three-years' service out of them, there is no use bothering about the limit of the flues in regard to the leakage.

Mr. Frank Gray: I would like to make a little statement for the benefit of Mr. Lucas. As you stated a while ago, we had several Pacific type engines with 2¼ and 2-inch flues, 20 feet, both the same length. We have had the 2-inch 20-foot flues five years and the others longer. We have never found any difference in our mileage between the 2-inch flue and the 2¼-inch; we got just as good mileage out of one as the other, and as far as pitting is concerned we are not bothered with that very much, but we find no more of it in the 2¼-inch flue than we do in the 2-inch, and no more in the 20-foot than in the 16-foot flue.

In regard to the length of flues, that is very largely determined not to get the increased benefit of the heating surface, but to get a larger and more powerful engine and to get the distribution of weight in this greater length of engine, that more largely determines the length of the flue of the boiler.

I might add another thing. Several members have spoken about the difference in the contraction and expansion of the shorter and longer flues. I don't think that has anything to do with keeping the flue tight at all, because the relative expansion of the outside shell is just the same in the long boiler as in the short boiler, and increases in proportion to the length of boiler just the same as the length of the flue; so I don't think that a long flue puts any more stress upon the flue sheet—a 20-foot flue than a 10-foot flue.

Mr. Fagan: I would like to ask what becomes of the expansion on a 24-foot flue and a 10-foot flue?

Mr. Bennett (of the Inter-State Commerce Commission): From tests made a few years ago to determine the expansion of flues in fireboxes, it was ascertained that flues get shorter when they are using steam, also the fireboxes. We made a test with set frames in the firebox and on the outside put center-punch marks and fired up the boiler to 200 pounds pressure, and before we kicked the fire out, trammed the outside of the fire sheets, knocked the fire out and got in the firebox immediately and ascertained that the inside side sheets were one-eighth inch longer than the outside. Now the conclusion arrived at from that test was that the cold water is attracted to the hot surface, consequently when the boiler is using steam the flues and the firebox sheets are shorter than the outside, and due to that test the superintendent of motive power at the present time has got a patent on pulling out the flue sheets on each end one-eighth inch; that is, they want to be straight when they are applied to the boiler, but he puts a bar across there and pulls them out an eighth inch and then applies the flue so there will be that eighth inch compression on each end of the flue.

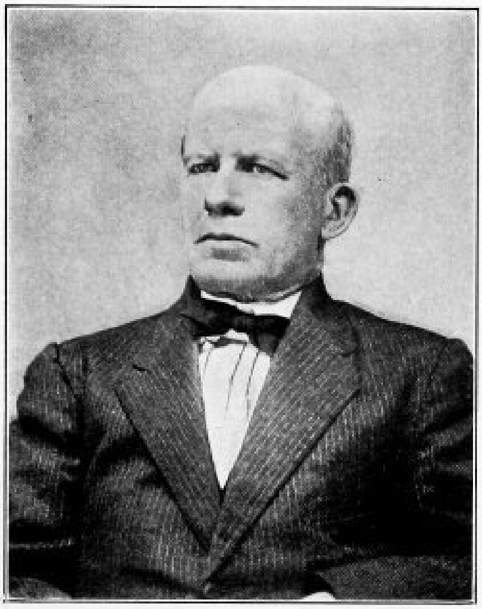
ANDREW GREENE, SECOND VICE-PRESIDENT

Personally I do not think there is anything in that, because those of us who built stationary boilers, I remember, used to have a bulge flue sheet or head, and we would pull it in in some cases an inch or more and then put the flues in to hold the flue sheets, but when you'd take the flues out again you would find that that sheet would not come out the same as before; it had received a permanent set.

Also you have all heard about the effect of leaving a staybolt a sixteenth of an inch away from the sleeve on the first row and a thirty-second on the next row. I don't believe that amounts to anything, because just as soon as pressure is applied to the boiler it will press the sheet against that sleeve, and the benefit of leaving that breathing space, as you call it, does not amount to much.

When is a Boiler in a Weak and Unsafe Condition?*

A general answer is that a boiler is in a weak and unsafe condition when the internal pressure approaches the rupture point of its weakest part. This really is a concise and complete answer. It can be simplified by naming each of the component parts that enter into the construction of a boiler and the ratio between the highest allowable steam pressure and the lowest permissible tensile strength of any boiler part. Still, as correct as it is, it really sheds no light upon the subject under discussion. A boiler explosion is never an accident and is always preventable, because it proceeds from a cause



JOHN B. TATE, FOURTH VICE-PRESIDENT

which might have been foreseen. The defect could have been remedied and the explosion prevented. The principal causes of weakness are: Weakness and defect in the design, construction or workmanship, improper treatment, carelessness, neglect, or ignorance on the part of the boiler attendant, wasting from wear, tear and corrosion, over-pressure, worn-out condition and overheating from lack of water, defective condition of safety valves and other mountings, exposure to conditions which cause development of defects, or a general deterioration of the boiler. Contributory causes of explosions are in part the following: Rigidity of construction. This restrains the necessary movement of the parts under expansion and contraction and may produce cracks, ripping of plates and leakage. Rigid staying neutralizes expansion and is very detrimental to the boiler. Improper disposition of the stays causes inequality in the distribution of strains, thus producing distortions, leaky seams, ruptured stays, cracks and ripping of the plates. Lack of provision for expansion is a frequent cause of trouble.

The above named causes of boiler trouble may be summarized under several clear headings:

1. Faulty and defective design.
2. Poor material.
3. Poor and careless workmanship.
4. Improperly made repairs.
5. Bad water.
6. Improper care.

The first, the designing of a boiler, in some respects takes greater care than is needed for many other iron and steel structures; because the variations of temperature and the consequent contraction and expansion are greater than in those where the changes only vary between the extreme temperatures of summer and winter. A disproportionately strong or heavy member, placed in a boiler through a superabundance of ill-advised caution to have that part strong enough, may mean a weakening of the entire boiler by wearing and tearing away the stronger from the weaker portion during the changes of temperature.

A well designed boiler should have every part of the same strength at all temperatures, so placed that adjacent parts will expand and contract together under all conditions and will not work against each other, thus producing strains in the structure that will ultimately tend to wreck it. All material should be uniform throughout, strong enough to carry its individual load; but not so strong as to fail to give and exert an injurious force on any other member of the boiler.

When your designer of boilers has accomplished the elimination of the weakest spot, and has arranged to have all parts in contact with the fire to be constantly under water, he has done all that one can ask of him to keep the boiler in a safe and strong condition.

It is then up to the workmen in the boiler shop to carry out the designs when properly made. A poor and careless workman may cause many defects. First in allowing poor plates containing glisters and laminations to be used. Then by careless handling in the forge fires he may burn the material. Good metal may become burnt in flanging, bending and welding. The sheets may be scored along the seams by sharp calking tools. The rivets may be burnt or imperfectly upset, and other troubles may be brought about by poor work in the boiler shop.

Improperly made repairs with too strong or the wrong grade of material where the expansion and contraction of the patch plate does not correspond with the old material of the boiler, may work great injury. Patching is a very important job, especially on the firebox and barrel.

Bad water is probably the chief cause of corrosion, pitting and grooving. These may very much weaken the shell. In some boiler explosions the plates have been found wasted to less than one-sixteenth of an inch. The scaling of a boiler may cause an uneven heating of the sheets and thus cause them to be burned through, bent or buckled.

Bad management is the chief source of boilers getting into a weak and unsafe condition. All troubles can be discovered before the danger line is reached by careful, painstaking and competent examinations. A well constructed boiler, properly repaired, with proper and frequent cleaning out, may become weak and unsafe because it is not completely taken care of. The steam may be allowed to rise above the normal pressure by neglect or mismanagement. The safety valve may stick fast to its seat. The crown sheet may become overheated to such an extent that the stays pull through and thus cause an explosion, or the explosion may result from putting water on the sheet while red hot. In this latter case the excessive pressure will be suddenly generated that may force the crown sheet or cause the crown sheet to contract to such an extent as to produce rupture.

A good general rule is when any defect is discovered that may mean danger, immediately allow the boiler to cool down, then make the necessary repairs.

For a special case I would like to mention the course of action here; that is, when the crown sheet should become overheated. Close the dampers, smother the fire with fine wet coal and open the fire door a little. Do not start the injector. Do not stop or start the engine or touch the safety valves, as any changes might cause a sudden increase of pressure that would force the crown sheet down and cause the explosion. Simply smother the fire and allow the crown sheet to cool down gradually until it will be safe to feed slowly.

* Abstract of committee report, by E. W. Young and J. H. King.

The only proper and safe way to keep your boiler from becoming weak and unsafe is to have it properly inspected from time to time; study the construction of your boiler. Know its component parts, so that you can detect signs of approaching weakness before the danger line is reached.

Mr. Optenberg: A boiler that never had a fire in it is in the weakest condition, and nobody knows better than the man who worked at the boiler to build it. Let me tell you right here, and bear this in mind, some of the older boiler makers will remember that in former years and to-day you will find the bottom rollers are a distance apart before the plate reaches that point it leaves a space on your straight seam. There was a day, gentlemen, as you well know, that we fellows used to have a sledge across the roller and bend that straight seam, and that is something that is well worth discussing here to-day on the strength of boilers, that very point, and it is about time, if such a thing still exists in any boiler shop, that it ought to be done away with, and it ought to be a strict law that no straight seam should ever be attempted to be hammered except through a roll and bottom form plate to get the proper sweep before it passes the other roller. I tell you this very point ought to be inserted in that report, and every boiler maker that has the interest of human life and property at heart should see that a law is passed in the United States and the whole world that no man is ever allowed to form up a straight seam in that way.

Mr. D. M. Yale: Was it the committee's intention to repair the firebox or barrel of the boiler with the same heft of material or reduce the material one-sixteenth in making those repairs? I have heard some parties make the remark that they put heavier material, and others that they put on lighter material. My practice has been where I used half-inch on the flue sheet and put a patch on the top flange I always put on three-eighths. I would like to know what the committee's intention was in regard to that?

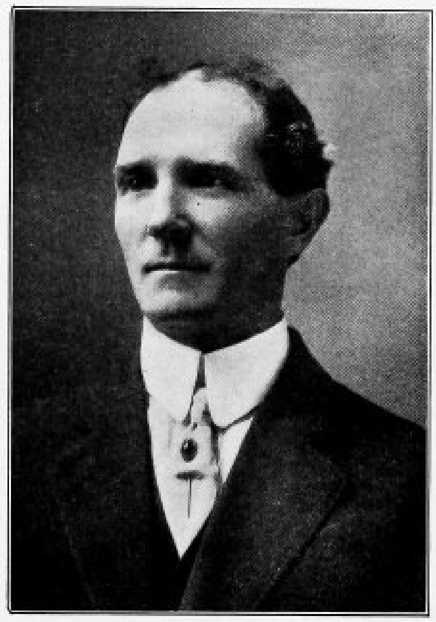
Mr. Bennett: The paper says: "The crown sheet may become overheated to such an extent that the stays will pull through and cause an explosion, or explosion may result from putting water on the sheet while red hot." What you want to get on the sheet is water right away, and the water is not going on the sheet directly, it is going through the injector checks, and the boiler is carrying 200 pounds of steam; the water is crawling up on the sides of the side sheet at about 388 degrees temperature, and if you get water on there there would not be any explosion, and from tests made by the United States some years ago they took and squirted cold water directly on top of the crown sheets and there wasn't any explosion. That old theory about flashing a body of water into steam and causing overpressure is proven not true. I claim that when the water is let into the boiler, that what you want to do is to get water into it right away.

You take a piece of iron and heat it hot and hold it in your hand and you can bend it; put a little water on it and it stiffens up right away, and that is what the crown sheet wants, it wants water on there to strengthen the sheet; the heat weakens it, and if you put water on there would not be any explosion.

Mr. J. L. Fahey: I just want to answer this gentleman's question in regard to putting water on patches. I find that some time ago we put on two patches in conjunction, together. We used to put on two patches, one on each side of the flue sheet on each side of the center, but I did away with that and put on one long patch clear across the top, 24 or 36 inches long, and I get from two to three years' service out of that patch on top of the flue sheet, which is the life of a flue sheet, you might say, and I also put 15 pounds copper under the patch an eighth of an inch away from the hole, and that sheet runs well from two to three years. I get from 18,000 to 22,000 miles out of an engine with that patch. It's the back flue sheet that I am talking about.

Mr. C. E. Fourness: The ordinances and rules of the city of Chicago provide that there shall be a factor of safety of five for shells not over ten years old, 5.5 for shells over ten and not over fifteen, 5.75 for shells over fifteen and not over twenty, 6 for shells over twenty years old. I think that is a good point for looking after when the boilers are weak and unsafe, as we allow a good factor of safety to cover, like charity, a multitude of sins.

Mr. D. A. Lucas: When you put water on a crown sheet that is red hot, you want to put it on and keep it coming on to overcome the hardening of the sheet. Where I think the boiler is exploded from water hitting the crown sheet is when an engine is in that condition with a hot crown sheet and tips over a little, and that causes a light sheet of water to get on the crown sheet and form into steam so quick that



C. P. PATRICK, FIFTH VICE-PRESIDENT

there is an excess of pressure that causes the trouble; but if water is put on in such quantity as to carry on the hardening of the sheet, I think it is a good thing to do.

The Best Methods of Welding Superheating Tubes, and Tools Used for Same

(An abstract of this report is published on page 163.)

Mr. Optenberg: If you want a good weld, you must weld while the material is welding hot; if you don't, you will not get a weld. I have succeeded in designing a flue welding roller in my own works in which I found that the minute we inserted the mandril in the tube to weld it, that mandril is cooled to a certain extent, and the moment you get that tube in contact with the mandril you are going to chill the tube below the welding heat, and in order to overcome that I took a machine and made two rollers and the outer roller is adjustable; the minute the tube is hot it butts up against it and I place the tube on the bottom roller and press the roller and it revolves, and I give it three or four turns and it is welded and the tube expands while you are welding it, and I have found that that method is the best way to weld to get a good, sound weld.

Mr. Fagan: My experience has been limited, excepting the last twelve months, in superheated tubes, and I believe that any man who is successful in welding a 2-inch tube will successfully weld a superheated tube, and there is no question in my mind but what the proper way is to revolve the rolls around the tube regardless of what size it may be.

First, at which end of the body of flue should safe end be applied? For a number of years, I believe, all practical boiler makers understand and agree that we put them at the firebox end, which is the proper place. We first began with a short safe end. We put on another short, then we cut off the two shorts and put on one long. Then, in removing the flues we saved as much of that flue as possible and put on another short and another long, and at the end of four or five welds

FRANK GRAY, TREASURER

we'd certainly worn out the body of the flue, especially in my territory, where we have everything from pure melted snow water to evaporated alkali to use, and I believe that the proper place to put on the safe end is at the back end at the firebox.

Second, how many welds in the flue are permissible at any time? There's very few parts of the country that we can get on more, if it's carried on in the proper way, than four or five welds. I don't believe there is any question but what the roller should revolve around the flue; that is something we have always done for years, and I believe it will always be done. Flues should be renewed at firebox end at all times. I believe we all agree on that.

Mr. John McKeown: We have been welding superheated flues right along and are using the Hart machine, made in Cleveland, and we have not made any change whatever in regard to handling superheated flues; we weld them the same as 2-inch flues with good results, all the difference is that the flues take a little longer to handle.

Mr. D. A. Lucas: I have now been welding the 5-inch flues for the last two years, handling in the neighborhood of 125 to 150 a month, and I find by actual service that it is necessary to weld on both ends of the flue. Now the flue is reduced as shown, and that reduced part is to give you a chance to get them into the sheets, which are an inch smaller than the body of the flue, and that extends back till it meets the steam unit pipe, and if you weld on one end continuously you will butt up against them. I have to turn them and weld on both ends after the flue is ready for the third weld, and I have welded now for over two years, as I stated, on the Hart welding machine, and I weld them the same as a 2-inch flue and have not had a failure in one weld.

Mr. Gray: We have had superheated engines now for nearly four years, and we have not welded any of our flues over once; we have not exactly decided on whether we would weld on one end continuously or on both ends, but I will say, as Mr. McKeown said, we have handled them just the same as we have the 2-inch flues, except that we take two heats for welding on the superheated flues. The superheater flues are three-sixteenths thick and we use two heats at a weld.

Mr. John Harthill: I have done a great deal of welding on superheated flues with an automatic hammer. We buy our superheated flue and swage it on the large end, and haven't had a failure on welding with a hammer.

Effect of Superheaters on the Life of Fireboxes and Flues

The committee on this subject reported having gathered information from several railroads having engines equipped with superheaters of the Baldwin, Vaughn-Harset and Schmidt type, the steam pressure ranging from 165 to 200 pounds; that they were unable to find any well founded claim to show that superheating of steam has a detrimental effect upon the fireboxes or flues, but, to the contrary, it is shown that the life of the fireboxes and flues is prolonged considerably, from the fact that where steam is superheated the working pressure is reduced. However, there are many large engines carrying 200 pounds working pressure with superheaters that show no ill effect on fireboxes or flues.

Mr. A. N. Lucas: We have had the superheater in service for the past two years in all classes of engines, combustion chamber and straight firebox, and we believe that we are getting first-class results; but the question is what condition it brings about to your firebox or flues due to superheat? We believe, or I do, that the front damper is of little use to us and does much harm in use, due to the fact that it is open a great many times when it ought to be shut and is shut a great many times when it ought to be open, and I have advocated, for the last twelve or fourteen months and longer, that the damper ought to be removed entirely to increase the life of our flues and to allow the heat to pass through all the flues, which it should. The only claim for the damper is that it might save the engine superheater unit, but I don't think we will have any bad results by removing the damper entirely; we will get much better results and less calking.

Mr. William Lindner: We've got a combustion chamber built of fire brick in such a way that there is an increased length in the firebox, and they've got a hollow arch that admits the oxygen from the atmosphere and causes a complete combustion. With this arch we get a complete combustion and an almost absolutely smokeless engine, and with the Schmidt superheater and this arch I speak of we are saving over the same type of engine—that is, the same weight engine —over 40 percent of fuel. I think that is something worth while for all of us to consider.

Mr. Frank Gray: We have had some superheated engines for over three years, going on four years, and we have a Pacific type saturated steam engine, identically the same boilers except they have those superheater boilers, the same size and everything. The fireboxes in these superheater engines are in better condition after over three years of service than the Pacific type was in ten months, because we had to commence patching some of the Pacific type engines four months after they were received. Of course, the superheater engines are freight engines with a tonnage capacity of 4,000 tons, but only carry 160 pounds of steam, while the saturated steam engines carry 200 pounds. With the reduced pressure and high capacity engine the life of the fireboxes is in the neighborhood of 400 percent now above the saturated Pacific type engine.

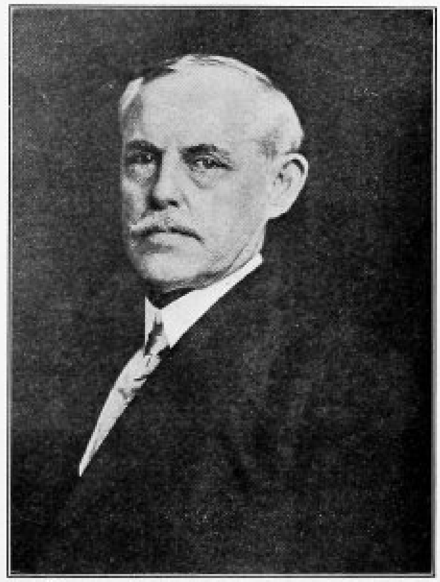
Mr. John Harthill: On the Lake Shore we have about 400 superheater engines. In my judgment I think the superheater extends the life of the firebox. In our superheaters in the last eight months—we started eight months ago to weld our superheater flues—the beads to the sheet and those flues have had no work done on the large flues whatever since the time they were welded. Keeping the prosser out of the flue is certainly prolonging the life of the flue sheet and reducing the amount of coal 25 percent or 35 percent, which makes less water evaporated and less strain on the firebox, and I think I am safe in saying that on the Lake Shore we are prolonging the life of the fireboxes in superheater engines by welding the beads to the flues, and we figure that we can get three years' service without wrecking those flues, because we have got engines in service eight months without having a prosser tool or beading tool applied to the flues and by keeping any prosser tools and beading tool out of the flue you are saving the life of the firebox. These engines have been constantly in service and up to about three weeks ago had given us no trouble at all. They have made about 50,000 miles and we are welding the same old flues into the sheets and getting good results. We expect to get a good deal more mileage out of them yet.

Mr. Fagan: In regard to the life of the firebox, I believe its life would be lengthened by the superheater in about the same proportion as we reduce the steam pressure. It is nothing but natural that the superheater does away with 40 pounds of steam. Say we are carrying 160 pounds of steam on an engine; we would be carrying 200 pounds on it to get the same result if we did not have the superheater.

Mr. George Austin: I wanted to say something in reference to the use of the damper on the superheater tube. That is a little bit aside from the subject of what effect it has on the cocks, but I believe a couple of the members are advocating what I consider good practice, the opening of the dampers in superheater tubes. With regard to the superheater tube, it is certainly obvious that, when you are trying to get up steam on a locomotive by the use of the blower, that you are producing a tremendous heat in these tubes in the fireboxes, and there is no steam in those superheater pipes to keep them cool; consequently they sustain a very high degree of heat and we have had some burst from that cause. You may have those superheater pipes up to a temperature of 800 or 900 degrees, and you open your throttle and start your engine and you throw in steam at a temperature of 50 or 60 degrees, then the contraction in a case of that kind is, to my mind, destructive, not only to the pipes, but to the joints, and is the cause of weakening, and I should think we should go very slowly in giving our approval to a practice that the superheater people themselves absolutely condemn. They are really the people interested, and it seems to me their grounds are reasonable grounds and we can operate and do operate those engines successfully and handle the superheater according to the rule.

Mr. Harthill: We carry a 200-pound pressure, and for the last year and a half we have removed all dampers and use no damper in front of our superheater engine whatever. We get better results than with the damper.

Mr. Ryder: The points I had in mind when I was listening to the discussion have been brought out. You use your firebox, one side of it, to burn coal in, and the other side to evaporate water, and the use of the firebox wears it out. If you burn less coal and evaporate less water your firebox will last longer, that is self-evident, and that is the condition that exists in a superheater locomotive. Now, the superheater makes possible lower boiler pressure, which also reduces the firebox maintenance cost. I heard Mr. Codd, of the Wabash, Pittsburg Terminal Railway make a comparison between the cost of locomotive maintenance which would include not only the boiler but the whole locomotive, and he said on an engine mileage basis and considering the superheater locomotive as 100 percent, it cost him 121 percent to maintain the saturated steam locomotive. Now he was carrying 160 pounds pressure in the superheater locomotive and 200 pounds pressure in the saturated locomotive. It would not be possible for him to operate a saturated locomotive of that size with 160 pounds pressure and get the same tractive power out of it, because he would have to go to cylinder sizes that would be prohibitive, so the superheater in that case made it possible to use the lower boiler pressure and reduce the maintenance cost. I think that is the experience of nearly all railroads, that the maintenance costs are reduced in superheater locomotives. Now with reference to the use of the dampers, there are only a few cases where the damper is being left off, and I understand that one of those roads has recently ordered twenty engines with the dampers installed. The damper is put on there to protect the units when there is no steam in them, and it does not affect the larger tubes or the leaking of the larger tubes.


HARRY D. VOUGHT, SECRETARY

Mr. J. H. Noonan: The superheater flue is a new thing with us. My first experience began in October, 1911. A short time before that we got a number of new freight locomotives, and I notice from our records that in about ten or eleven months they began breaking staybolts pretty rapidly. In the superheater locomotives we have broken scarcely any, practically none at all. I think that matter would demonstrate that we may expect a longer life from the superheater.

Mr. McKeown: We have got quite a number of superheater engines, and I think you will all agree that the superheater is a benefit to the engine. In one case it reduces the steam pressure and you have got dry steam for the cylinder, you are not pumping water all the time and I think it increases the life of the firebox.

Mr. D. A. Lucas: I would like to say that we have got a good many superheaters, and from actual examination of the different boxes I would say that the superheater engine is a benefit. We find the firebox of our superheater engines in a good deal better condition than the firebox of the saturated steam engine.

WEDNESDAY MORNING SESSION

At the opening of the third session of the convention on Wednesday morning at 9 o'clock, President O'Connor introduced Mr. Robert Quayle, superintendent of motive power and machinery, C. & N. W. Railway System.

Abstract from Mr. Quale's Address

It is a pleasant thing to get together once a year to renew acquaintanceship. It is a pleasant thing to shake each other by the hand and say, "Hello, how do you do, Tom?" and use those old, familiar names that you used to use in other parts of this great country and again express to each other your friendship and fondness for each other. After all, that is the bulk of life, isn't it?

Life is made up of friendship; it is made up of how we stand toward each other and what our attitude is toward each other. Some of you may perchance get just a little better job than some other fellow, and you may begin to feel sometimes that you are a little bit better, perhaps, than you used to be, but you have just got the same heart, man, that you had twenty years ago. You are just the same fellow that you were twenty-five years ago, if you are not too proud, and you are always glad to get back where the fellow was, even in the first shop you ever worked in, and you find one fellow there doing the same job he did twenty years ago, and you are glad to go up and hit him on the back and say, "Hello, Jim! I'm awful glad to see you," and you mean it; if you don't you should never say it. I don't believe in men saying they are glad to see other men if they are not glad to see them. Just tell them why you are not glad to see them, and maybe the argument will bring both of you closer together.

Now, you get together once a year for another purpose, and that other purpose is to bring your experience, to bring your intellectual powers, to enable you to do things better than you did yesterday, to enable you to do the work more cheaply and better than you did last year, and this is the way it ought to be.

Here you are, perhaps 450 strong, members of this association. Now just take this thought: suppose that everyone, each member of this association, should come from your respective shops to this meeting, and each one of you should have just one little shop kink that has bettered the condition in your shop and has reduced your cost, and has reduced perhaps the labor for the man in the shop, you would then have 450 kinks; and I leave it to you, gentlemen, if you don't think that if those 450 improvements were brought here and distributed, and every man should take the 450 home and use what he could of them, it would be worth while? Why, most assuredly it would.

But you know there is a tremendous tendency on the part of a man everywhere to belittle the little things that he has in his shop. Not by running them down at all, but he first gets this conception of himself: He will fold his arms complacently and look out upon the members that are here, and in his modesty say, "I am just a little bit less intelligent than some other fellow here, and I am not able to get up on the floor and express myself as some other fellow can express himself, and while I know of something that this convention would like to know, and they ought to know, that is being done in the shop I come from, yet I feel that I am not the fellow to get up and tell about it, therefore I will keep my seat."

Now, gentlemen, when you do that something is lost that we ought to know, and something is lost that every man here ought to know. It is the little things that count. There are very few men in the world that do great things, the giant things in life. You can note them here and there, just like the burning mountains in this world of ours; you see the flames rise up, and they tell you, "I am here." But after all it's the myriads and myriads of people that do the little things that count in life, so I want to bring a word of encouragement to you along this line. Don't be afraid; don't be too modest to get up and speak your piece, and while you may not say more than ten words, it may strike this convention in such a way that they will say, "That's the best thing said to-day." Say it modestly, if you wan't to, but say it, anyway, and tell these people what you've got in that cranium of yours, because you will find, sometimes, that the men that say the least are the men that know the most.

I said a minute ago that you were the men who construct locomotive boilers. We ought to use care in the construction. First, you must know something about the material, and while you may have a laboratory, and the laboratory may make the physical tests of the material as well as the chemical tests, I want to say to you men that it is within your province and, better than that, it is your duty to know just what the physical and chemical tests show. If you won't do it for any other reason do it to make yourselves strong men. Do it that you may have that information and that knowledge and know just what it is, what are the component parts, too, if you please, chemically, so that you may know what effect the various component parts of the material that you are using have upon such material, and thereby you will add to your store of knowledge, and that added knowledge is wisdom; it makes you wise in these affairs that you ought to know, and the only way you can know is by seeking this information, by looking, inquiring and going to the proper place to get the information, and then asking all the questions you want to find out just what the effect is of the various things that you put into steel to make it.

We are getting to a point in boiler construction where we must eliminate all punching of holes, because when you punch a hole and you begin to analyze that very carefully under a microscope, you will find that the hole is fractured quite a considerable distance, and you will have to drill that hole anywhere from 3/16 to ¼ inch larger before you eliminate the entire fracture, and in some instances, where you have got ¾-inch sheets, you have only got 26 percent of the original strength of that sheet, and if that is right then we must eliminate the factors that bring about the destruction of the metal, as that weakens the whole structure of the boiler.

Another thing: we are a little bit careless in laying up our boilers. In the years gone by, when we'd lay up our boilers, and not only in the years gone by, but, in fact, throughout the country to-day we see how it is being done, they roll up the sheets, and when they do we will find that perhaps the sheet is a little long, and as the man lays it up he will put in a bolt here on the circumference and another there on the circumference, and by the time he gets his rivets in, the sheet don't line up right; then a fellow gets a drift and begins to drive that drift home. What is he doing? Improving the metal? No, he is injuring the metal. He is getting things out of line; putting a strain in there that ought not to be there. When a boiler is constructed it ought to be laid up in such a manner, bolt after bolt and rivet after rivet, that you eliminate all those strains, and when you use the bolt be careful not to use it in such a way that it leaves a deep impression in your sheet, and whenever you see that throw that sheet out, because you have brought a strain on that sheet that is unnatural, and unnatural strains make for danger, and danger in the sheet makes for—you know. Let's not have those disasters; work them out.

The wise man is the fellow who stops trouble before it begins. That is true everywhere, and you men can do that, because I am not telling you anything you don't know; you know better than I do; you ought to, and I believe you do.

We talk a good deal about factors of safety. We must have factors of safety, because if we don't have them we don't know

SEVENTH ANNUAL BANQUET OF THE MASTER BOILER MAKERS' ASSOCIATION AT THE WHITE CITY CASINO, CHICAGO, MAY 28 what we are working to, and that must mean, necessarily, what is the load on that boiler, what will be the strain upon it? You must know that before you can figure out your factor of safety. You must know your steam pressure. You must know your material; its strength, its thickness and what these plates will stand and what your boiler as a whole will stand, including its longitudinal and transverse seams, and your bracing and everything else has to be taken into consideration.

I believe in a large factor of safety. I believe in it virulently. I believe in it not only for the safety of the men on the boilers, running the locomotives and the employees round about them, but I believe in it because it is an economical measure, because, in the years to come, if you have got a boiler with a large factor of safety you don't have to be reducing your pressure, you have got the factor there, and you had a surplus factor to begin with, and as you come down to the latter end you've got your pressure and can maintain it.

I do not know what the common practice is, but on the road I am connected with all the boilers we get to-day don't carry more than 170 pounds of steam, because they are all superheated, and if you are not having superheaters in your boilers to-day on the roads with which you are connected you are back numbers and had better wake up and get to the front, so that you can economize and do your work more efficiently and more proficiently than you have ever done it before.

One other point; we don't know what the Government will do after a while. We know what they have already said to us. They said: "Here are certain laws; live up to them and be good." And you'd better be good by showing a willingness to do it than be good per force. When the law came into effect, I looked upon it and thought about it, and I said, "Well, that might be all right for the other fellow, but I don't believe that's all right for me." You know we are always willing to shout the preacher's advice over our shoulders to the other fellow. "That hits Billy So-and-So good, but it never hits you or me." It's all right for the other fellow.

Our experience with the law is this: that it has made for better conditions; it has improved the conditions so far as our local boilers are concerned, so much that if we were to-day asked about the law and had this experience in some other place, and you didn't have the law here, I should say, men, by all means get the law; it's all right; it's helpful; it's really a necessity.

Now let us dig, and whenever we have a law, and the superintendent of motive power or the master mechanic gives out instructions, let us not try to evade the law. Let us try as carefully as we can and as honestly as we can to live up to the law. The best way in the world to kill a bad law is to live up to it; but let us, with all the intelligence and energy we have, endeavor to follow the law just as it is.

Now I found this some years ago: I found on one division of the Northwestern road, I think it was nineteen years ago, we put into effect some woodcuts showing the boilers, an elevation of the boilers, an end view of the boilers and a front view of them, and then we showed the side sheets and flue sheets and the door sheets and the crown sheet, and we had every staybolt marked there for the largest boilers we had, and the men were required to draw a little red line around it, giving the size of the boiler and then locate the staybolts that were broken.

Now my object in doing that was this, that if we had a locomotive or any type of locomotives that were weak in breaking staybolts, I wanted to know wherein that weakness was, and if you had some C-3 boilers that were coming in, and they were all breaking in the same location every time, I necessarily knew that there was something there that was holding those sheets rigid, and that the bolts did not have more room for expansion; they were hide-bound somewhere and consequently were breaking.

Therefore, when that went to the mechanical engineer's office and they were taken out and an investigation was made, we said, "Now we have got to see what the trouble is here; we can't stand for so many staybolts being broken there," and then, too, we had to have on these reports every staybolt that was broken. The man that made the inspection had to sign his name and locate them; then we had another report; the man that put them in had to sign his name to it; that "I have this day replaced this broken staybolt," and put his name on it, and then the foreman certified to it. In one division that I refer to I found a condition that rather annoyed me, and I went to that place and made an inspection with some boiler makers in whom I trusted, and I think I tied up eighteen boilers at that roundhouse that day for broken staybolts.

Now they may not have thought that there was any element of danger; but I tell you I did, and you men have got a tremendous responsibility upon you. I don't know anybody that has greater responsibility, and it is up to you men to know that these men who are under you are doing their work, and doing it right. It is an easy matter for you or for me to issue a circular letter and stipulate in the letter that so and so must be done. What good on earth does that circular letter do unless somebody in authority knows that it is being done? Circular letters don't do things; it's men that do things, and you are the men in connection with the boiler, and the boiler is the foundation of the whole locomotive, because without it the locomotive could not be used.

I know that I may be a crank on boiler work. I know that I may be pumping this kind of stuff into our men constantly, and notwithstanding that, gentlemen, you will find every time that you make a close investigation you will find men who are not doing what you want them to do. You know it. You have found them; but my message to you this morning is simply this: Be honest to the charge and trust that is yours. Be honest to yourself. It is up to you men to do the very best you can to make the best record for the company you are standing for, and, then, when you are doing that you are making a great record for yourself, because when you are boosting the man you are working for you are boosting yourself in the proper way.

I find this: Love begets love and like begets like and friendship begets friendship. Now just stick that into your cranium and think about it when you get away from here. When the Government inspector comes around, somebody says, "Oh, the Federal inspector is here!" and he's got a chip on his shoulder right off. Now a chip on your shoulder begets a chip on the other fellow's shoulder, just the same as like begets like every time.

Now when inspectors come around, listen to what they have got to say. You will find that they are intelligent, they know what they are talking about. Now I know this, and when they come to me and tell me, "So and so is wrong," there is a reason for it or they wouldn't be there telling me. Wouldn't I be a pretty fellow if I were to go off half cocked and say, "You don't know what you are talking about!" Do you suppose the Northwestern road would stand for anything of that kind? It don't make any difference whether we stand for it or not: it's there and I must trust the men, and all I can do is to say, "Well, you must know; and if you know, we are going to find out; and if you think you know, we are going to find out, anyway; and if you are wrong, we will correct it." If you do that and meet the fellow pleasantly and treat him pleasantly, what will be the result? He will go away with a good taste in his mouth; he will go away feeling "that fellow treated me right and I'm going to treat him right; he is square with me and I am going to be square with him."

I am not going to touch upon your subjects, but there is one subject here this morning that I think follows what I am saying now, and it is the acetylene and electric welding. There is one thing about that I like—you say "the advantages and disadvantages." I sometimes think we are too prone to talk about the advantages, the good to be derived, and don't look sufficiently at the other side of it and show up the other side and the disadvantages.

We have been using the oxy-acetylene system for quite a number of years and have got a good deal of good to say for it. We used it not only on boilers, but on castings of all kinds, and where castings are worn we weld in a piece, and even where castings are cracked we weld them up and where cylinders are cracked we weld them up, and do a great deal of work along that line.

We have not been quite so fortunate with our electric welding, because we have been experimenting and it has, up to the present time, been very largely in the experimental stage, but everything that we have to-day was experimental some time ago, and the fact that to-day we are not doing things perfectly by electric welding does not indicate that we will not to-morrow, because the American mechanic has got such peristency and such intelligent effort that he is going to make it win, and I will say to you now, men, that I am satisfied that with the machine that we have now we can do work that will be entirely satisfactory to you and to me and to the United States Government.

Be careful in your overhead welds in your crown sheet that when you cut them there, and are commencing to build up the metal and weld it in, that you weld it and build it up thoroughly from the top and get a body of metal there that will increase the tensile strength of that sheet rather than have it reduced.

Now there are a good many other things that I might say to you, but in closing I will just say a word of encouragement to you as an association. Seven years ago you started, I see by your programmes here, and seven, in the Hebrew language, is the number of perfection. This may be your perfect year—we hope it is—but you were an infant seven years ago, and I want to tell you that you are a pretty strong, sturdy boy now of only seven years. My thought is that the general managers of the railroads you represent, the motive power men of the railroads that you represent, ought to give you every encouragement they can, because when they give you encouragement and you come together and exchange ideas and go home filled with the splendid thoughts that have been expressed here, it is going to be reflected in the work on the railway that you come from or go back to. The man that stands in the way of an organization of this kind, stands in the way of progress; he stands in the way of that which we are all speaking for—namely, better work done by better workmen, higher efficiency at lower cost, and, better than that, as I look into your faces here, you men appeal to me as being men of character; and after all, men, if your association will not do anything else than to build good boilers and build up the character of men, make men stalwart and strong, so that they can look men in the face and say, as Roosevelt did yesterday, "I never was drunk in the slightest degree in all of my life," that means, gentlemen, so much for the railroads and so much for the traveling public, that I haven't language enough or language adequate to express it.

Mr. J. H. Smythe responded to Mr. Quayle's address.

The next speaker was Mr. Frank McManamy, Assistant Chief Inspector of Locomotive Boilers.

Abstract of Mr. McManamy's Address

In connection with the Federal boiler inspection law, or any other law, we have got to remember just one thing—laws were never passed and were never necessary to govern the fellow who wants to do right. Laws were passed and are necessary for the fellow who wants to do the wrong thing or do it his own way, regardless of the right way. There has been a great deal said about the severity of the law, about the officiousness of the law, about ill-considered or inadvisable laws. There never has been a law passed by the Federal Government governing railroad equipment that was not modeled and has not followed the best practice which was in use at that time. Laws do not go ahead of the best practice and say, "You must do something that is impossible"; they follow the practices which railroads have experimented with and know to be the proper ones.

Our two years in the boiler inspection work has convinced us very thoroughly that the difficulty with the boilers did not lay at the door of the master boiler makers. Every master boiler maker worthy of the name wants to turn out the very best work of which he is capable; he wants good work from his shop, because good work means a good reputation and a good reputation means a good job. That is what we are all looking for, but if he was handicapped by lack of men or facilities or material, lack of getting his power, when he knew it needed inspection and repairs and he could not get it from the powers that be who are in charge of the operation of these railroads, the law steps in behind him and says, "This locomotive is due for inspection; you have men who are competent to make that inspection; they are waiting for that locomotive. Get it into them." Is that a help or hindrance to the master boiler makers?

Mr. Quayle is not having trouble on the Northwestern for the very reason that he mentioned here. He is awake, his force is awake; they are making every effort to comply with the law. They are furnished reasonable facilities and material to comply with the law and they are coming just about as near doing it as anybody. Therefore he is having no trouble. When other railroads and other officials take the same position that Mr. Quayle has taken and furnish their master boiler makers with the same facilities and the same encouragement to do good work, you will find that everybody will say that the boiler inspection law was one of the best things ever passed, and it was the only thing that got in behind the master boiler maker when he couldn't get what he wanted and knew was necessary and said to somebody else, "Give that man the facilities to meet the conditions he has got to handle."

The Advantages and Disadvantages of Using Oxy-Acetylene and Electric Welding Process for Boiler Maintenance and Repairs*

The chairman of the committee has visited many of the railroad shops throughout the country and found from the boiler maker foreman to the superintendent of motive power all were very much enthused with the progress that is being made by both the oxyacetylene and electric welding. Much work is being done for the car departments in reclaiming steel castings, repairing and cutting of all steel cars and cutting off steel rivet heads. In the line of blacksmithing, many forgings of all kinds are being reclaimed, worn and defective parts filled in, machined over and put back on the engine as good as new.

On the machine side, cracked and broken cylinders are being repaired successfully. Steel driving boxes are made as good as new; broken and cracked castings are welded up; worn castings are filled in; odd holes are filled up; worn, cracked and broken frames are repaired and welded up; the flat spots in driving wheel tires are being welded up successfully and with but little cost.

In the boiler line the cutting out of all old parts in making all kinds of repairs is one of the big savings for a plant of

* Abstract of committee report, by A. N. Lucas, J. B. Tynan, R. W. Clark, D. A. Lucas, W. M. Wilson, M. Geary and T. Dettrick.

this kind; also welding up cracked flue sheets, patches on top flange of flue sheets, side sheets and three-quarter door sheets, broken mud rings, patches on front flue sheet, pitted spots in bottom of shell, pitted flues (there is much saving in this line), smoke arch bottoms, washout holes that have become too large at the mud ring corners or at washholes in front flue sheets, fire hole in door sheet on to back head, doing away with all rivets, patch bolts or plugs that are generally used, sunflowers in front and back flue sheet, doing away with stay rod and other plugs that may be applied in boiler shell.

The chairman is in accord with some of the committee who reported that it was about impossible to weld up vertical cracks and guarantee results at all times. Ordinarily when applying a patch it was put on rectangular or square, and where there was no trouble whatever with the longitudinal welding the vertical weld at both ends of patch could not be depended upon at all times.

But the men, the boiler maker foremen, who have had these plants during the past three and four years, have been finding out things and learning what is the best method for welding up patches in side sheets. That method now is to apply round, oval or oblong patches, in all cases doing away with the vertical welding on side sheets, and they all report getting good results at this time.

Like the superheat applied to locomotives to-day, oxyacetylene welding has come to stay. Some of the railroads are cutting their superheat unit pipes and welding them up with oxyacetylene, then welding the guard over same to protect the end of the unit and doing away with the cast steel or malleable returns.

Much of this same class of work is being done with the electric process, and while it is not as fast it does very good welding on firebox sheets and a great many other places. With it you are unable to do the cutting, which is one of the big items of the oxyacetylene process. With the electric welder the operator has to be placed behind a screen. This is to protect all other men employed in the shop. This process is hard on the eyes, and you are warned not to look at it without a glass. The operator has only one hand to work with, the other being used constantly to hold up a board about 10 inches by 14 inches with glass at center. A piece of canvas is tacked at the bottom of the board. This is for the protection of his face and hands.

A number of sets of flues have been welded up with this process, and after beads have been reduced with a tool made for that purpose the job looks very good. Several good patch jobs have been done with this process, both on firebox sheets and mud ring.

In addition to the committee report six individual reports were presented on this subject.

Mr. Chas. P. Patrick: On the Erie Railroad, welding by oxy-acetylene, as well as electricity, is no experiment. We now have eleven electric welding machines, and three, if I am correctly informed, oxy-acetylene machines, and each machine has its usefulness. We weld in cracks and patches from the very smallest size up to 36 inches square, and ¼-inch to quarter side sheets, half side sheets and full side sheets. We have better results from the electric machine, for the reason that preheating is unnecessary. We weld in full sets of flues, part sets of flues, and a few, one or two scattering half a dozen or more, beads. We weld up button head stays. Take a button head stay that is calked like a door knob; you have seen them, and, strange to say, the more severely the crown butt has been calked, the better the job can be done with the welding machine, because it leaves a greater space for the amalgamating of the material. For cutting, oxy-acetylene is the machine, and for filling up castings and pits in castings. It is against our standard practice to fill in pits. It is also the machine for boiler shells or shells of air drums or steam drums of any kind.

We have failures in welds by both processes, but it is mostly due to the operator. It is important that the operator hammer the weld while it is hot, because molten metal has a kind of a porous body, as we have in cast steel. It is also necessary that the voltage and amperes are properly adjusted to suit the thickness of the material. It is also necessary that the flux, as applied to the welding steel, be kept on the steel.

In the case of welded flues I will say that we have, possibly, on the entire system between thirty and fifty full sets of locomotive flues. That includes superheater engines as well as as our saturated steam engines. We get better results, naturally, in good water districts than we do in bad water, and there, too, the operator plays the largest part. We have welds that the bead will crack and break off. In welding in flues our standard practice is to apply the flue in an ordinary manner; put in the copper, extend the small flues through the sheets 3/16 inch—our superheated flues ¼ inch—set the copper back in the sheet a thirty-second, some apply it a sixteenth, because the metal does not mix with copper so well as it does with iron or steel. We do not flare the tubes at all; they project straight through the flue sheet and we fill it up, cementing it over, you might say, with the welder; then we go along and have a machine or tool that has a lead in there and cutters in it that revolve with an air motor and dress this flue down smooth, in order that the honeycomb won't gather around the flue and prevent the engine from steaming. After that we go over it lightly with a beading tool.

Mr. D. A. Lucas: In 1910 I started out with the first oxy-acetylene welding appliance and at the present day I have six plants in operation. The oxy-acetylene we use is past its experimental stage and a new field opens up every day, or some job turns up every day that we find we can do successfully and at a big saving with the oxy-acetylene. I have not riveted in a half side sheet nor a two-thirds side sheet since September, 1910, and I have not had a failure in a longitudinal seam.

In welding the perpendicular seams or patches in, the boiler maker, nine-tenths of us, will follow the old rule; we used to cut out a patch, rivet it on, come up here, turn a pretty near quarter corner and turn down the other side. When we first started to welding in patches we started along the same line and found that the longitudinal part of the patch never gave us any trouble, while the perpendicular sides would open up in sixty or ninety days.

Now I am welding in patches, both circular and oblong or oval, and I had an engine in the shop last month that had two patches welded in the center of her side sheets, where they gave out first, 44 inches long on one side and 19 inches wide, with the rounded ends, and that engine was in service thirteen months and the patches were just as good as the day they were welded, and in our worst water district, on our Sterling Division in Colorado. Now we have welded in side sheets and half side sheets in September, 1910, and had no bad effect. Last year I welded in 265 corner patches at the mud ring, where we had to cut them out before and offset them and put them in with patch bolts. In the 265 patches we had 15 failures, and out of the 15 failures one division got 18 patches and had all the failures; that was a chance for investigation.

I have had jobs where I could not make a weld with our Swedish iron wire or our prepared casting metal for that purpose, when I took copper and welded it and got results. I do not do any preheating at all and I don't leave my sheet out of shape at all. I don't drop them down 1½ inches at the end, as is suggested by some. In doing a heavy job of welding, if it is possible to get two welders on the job, you will make a better success. We have welded several frames successfully. We also hammer our welds. If the operator is welding a half side sheet alone he can lower his torch and pick up the hammer and hammer the weld alone, which is a good thing, for by doing so you force the metal together, taking up the biggest part of the strain that the contraction would put on there. We have welded all our superheater units for over two years.

Mr. Young: I understand that the Government is taking exception to the welding of staybolts, for it is impossible to test such bolts. Another thing they are going to take exception to is welding the pitted spots in the barrel of the boiler.

Mr. Bayard: I have, in the last three years, had considerable experience with oxy-acetylene welding; also with electric welding. What we want is the best. As to the question of welding flues, there are conditions. In a Western road, where we have bad water and where flues have got to be removed frequently, it does not pay to weld flues. I am making from 12,000 to 15,000 welds of different kinds every thirty days. I have fifteen torches at work in the main shops all the time. Patches of all kinds in fireboxes can be satisfactorily welded with oxy-acetylene apparatus; there is no question about that; we have gone beyond the experimental stage and any failure from torch welding is from the fact of inexperience in the operator.

Our flue work you put in your copper, roll your copper, drift in your tube, roll it slightly, then prosser it, then bead it, and you've got the old familiar job. Then you go to work and you spend fifty hours at $1 an hour to apply that little scab around the weld. Well, you take that scab away; either electric welding or torch welding, you will find that there are crevices that have opened up from the expansion and contraction of the closing of the tube under heat, and there is no such thing as trying to get a solid plate made in a flue sheet in the locomotive firebox or any other that you are going to have, last forever.

When you think you are going to put in flues and make them run forever because they are electrically welded, you will find that it has faults just the same as the old prossering we all know about from all the years we went through it.

The Proper Inspection of a Boiler While in Service

No report was presented and the subject was carried over for another year.

Best Form of Grate to be Used to Insure Removing of Fire at Terminals with Least Abuse of Firebox and Flues, Insuring Most Economy as Well as High Efficiency*

My past experience with bituminous coal-burning engines warrants me in stating that I have seen no form of grate that will give the results to be had with the rocking finger grate, both on the road and the dump.

On the Black Hills division of the Chicago & Northwestern Railway they are using a coal called lignite, which is mined in Nebraska and South Dakota. It burns down to a white ash similar to wood, and does not clinker. For burning this coal the company uses a close-meshed grate, similar to what is used on the D., L. & W. for burning hard coal; that is, a table grate on the rocker form. This grate is identical with the old-fashioned wood grate of years ago. This coal is of such a light body that it is necessary to fit up the front end of locomotives with a system of spark arresters similar to the old wood-burning stacks of years gone by.

Grates are not used in oil-burning engines, nor under stationary boilers burning oil. What is practically an ash pan is used, but this is called a brick pan. It has to be absolutely water or air tight to burn oil. It is bricked up with fire brick in a manner to get the very best results from the combustion of oil. Of course this has been tested out by the Southern Pacific until it is almost perfect. In fact, the Southern Pacific has reduced oil burning to a science and is reaping its reward in the large saving made over coal.

* Abstract of committee report, presented by C. J. Murray.

Additional Report by F. D. Timms

Until recently I have been altogether on roads using bituminous coal and both the table and finger rocker grates. My experience has been that for efficiency and economy, and also speed in cleaning and dumping the fire with least abuse to firebox and flues, the finger rocker grates (fingers six inches in length), with the dump grates at rear of firebox, are the best. My preference for them is because a good, steady fire can be kept while the engine is in service without continued shaking of the grates, thereby utilizing fuel that would otherwise go into the ash pan.

In cleaning or dumping the fire the fingers will crush the clinkers, at the same time forcing them into the ash pan with speed, according to the energy of the man using the shaker bar.

Mr. D. A. Lucas: I have worked on several different railroads, and from my own personal experience I think the C. B. & Q. has got the best system of grates for the purpose. I think I'd put the subject "The Best Method of Removing the Fire at Terminals with the Least Abuse to the Boiler and Maintenance." Now, we know that our boiler receives the worst kind of treatment in general at our clinker pits. I know that the biggest percentage of our flues is started to leak at the clinker pits after the engine has pulled its tonnage and done its work. The flues start to leak after the man gets through digging the grate out when he's got a poor system of grates, and with the blower on hard enough to pull your hat off and sucking cold air up through the flues. Now the flue is nothing but ⅛-inch thick, made of the best pliable metal we can get, and as I understand it the cold air hits it and produces contraction in the sheet and the leak is between the flue and the copper, due to contraction caused by cold air passing up through the flue. Now the best we can do to eliminate that is to get something in there that you can dump your fire out without even opening the fire door, only on rare occasions where you have an awful poor grade of coal that would form clinkers as big as a man's body. Now for the purpose of handling bituminous coal, the C. B. & Q. has what we call the dump frame and shaker. We have a dump 18 inches wide on a center trunnion on each end, and when that lever is given the proper throw and you come up on your lever and open up the gates, you will get 9 inches up and 9 inches down, so that a man can fall down through the grate or a clinker or anything else, and when you throw them up in that condition and pin them there, which we have provisions made for pinning them in service to hold them level and pinning them after they are thrown up in this condition and stick your shaker boiler on your connections, which work in the dump frame, you can clean your fire out with the least possible trouble and to the least detriment to the boiler and its flues.

Mr. C. L. Wilson: Different roads use a grate according to conditions that exist in that particular territory or district. Some of the roads where I go use the table grate, because they have used such a fine grade of coal that if they used the single grate there would be an awful waste of coal in firing up. Other roads use a very long fingered grate on account of the coal they use. There are others that use the short finger grate on account of the different coal they use. Now some of the coal down there won't clinker at all; you can take it out in any condition. With other coals they get a bed of fire in the box that will be from two to four feet deep, and clinkers in there that—well, the whole box is a clinker, they've just got to break it up and smash it any way to get it out.

If you went over as many different roads as I did and saw the condition of some of the grates, you'd think they needed a little instruction, and one of the biggest things I find, in handling their fires, is the way their grates are applied. They may have a good class of grates, but you go along and you will see a ⅝ pin stuck in a 1⅛-inch hole. You get up on the back head, take the shaker lever and the shaker lever will travel, maybe, the end of it, 15 or 20 inches before it will start to shake the grate at all.

Now there is a big expense when it comes down to cleaning a fire. I know one place they have down here where they have to clean fires on switch engines right along, and they have so many switch engines—they work about thirty or thirty-five switch engines in the daytime. Those engines have all got to come in there and their fires be cleaned at noon time, when they have practically got from an hour to an hour and a half to get those engines over the cinder pits. They have a long, narrow firebox, and there they found it advisable to put the dump grate in the middle of the firebox, so they can clean one end of the box, shove the good fire to the other end and knock that all out; then they've got fire in there to spread over their grate and go on about their business, and they could clean those fires with the dump in the middle of that box in about half the time they could if they had that dump in one end or the other.

In regard to the dump grate, I find, in going over the road, that there's a number of the dump grates that are used still in the front part of the firebox. Personally, I do not believe that is good practice. Of course, if we take the deep firebox, that is so deep down you cannot get at the back end of it, and you've got a dump grate in there, you've got to have it in front, but you take to-day on the wide and shallow fireboxes they have, and I think that in every instance the dump grates should be placed in the back or under the fire door, which I believe is a good deal handier and a good deal quicker cleaned than by putting it in front.

Mr. A. N. Lucas: I believe this grate subject is a good topic and it ought to interest each and every one of us, and when we go home we ought to go and look up our grate situation. Another thing, we ought to time and see how long it is taking to get the fire out at the clinker pit. Another point, check up your engineer's report at the coal shift, see how many engines come there reported O. K. by the engineer, and then check them up after they go over the fire into the round house, and make a report to your superior officer showing how many flues were calked during the month that were not reported by the engineer, but leaked due to the condition and poor care they had over the clinker pit. It will open their eyes to a considerable extent. Where you are handling 150 engines a day over the turntable, check up how many come in reported leaking, how many come in O. K., and show how many flues you have got to calk each day due to other conditions. I believe it will wake up our officers in regard to getting the best grate possible into our engines.

Mr. D. A. Lucas: When Mr. Wilson was speaking about the dump grate, we don't have one individual dump grate; our dumps take the entire length of the box; in our 9-foot fireboxes we have five dump frames and five shakers in the dump frames. In some cases, where the box is a little longer, it is necessary to place a small plate across at the back. The side bar is cast with cavities for this little 6-inch plate to fit in, and we put that under the fire door.

Now the dump grate, the idea of this subject is to get the fire out of the engine with the least possible abuse after the fire is absolutely no more use to you. When it comes to the clinker pit, it's done and you want it out of there. Now a dump grate is used for that purpose. When the fireman is going over the road and wants to clean up or liven up his fire a little from the bottom, the dump frame is pinned stationary and he works the shaker in the dump grate, which gives you this zigzag finger motion, just as half the roads have for a grate to shake the whole fire through.

We have two styles of grates on the road; one is for lignite and one for bituminous, and the opening on the grate can be governed according to the class of coal the roads use in that district; the opening can be made three-quarters or half an inch, and we have them even down to a quarter of an inch between the fingers.

The Best Method of Applying and Caring for Flues while Engines Are on the Road and at Terminals

The report of the committee was accepted and the subject closed.

Steel versus Iron Tubes—What Advantages and What Success in Welding Them and Advantages of Either in Maintenance, Mileage, etc.?

No report was presented, so the subject was passed over.

What Benefit Has Been Derived from Treating Water for Locomotives Chemically, etc.?*

The committee on the above subject sent out to parties concerned a list of questions bearing directly on the subject and from replies received the committee has arrived at the following conclusions:

The practice of treating feed water is not general; it is used by a number of railroads, particularly where water conditions are bad. The usual treatment consists of mixing a solution of soda ash and lime, the relative proportions having been determined locally by chemists.

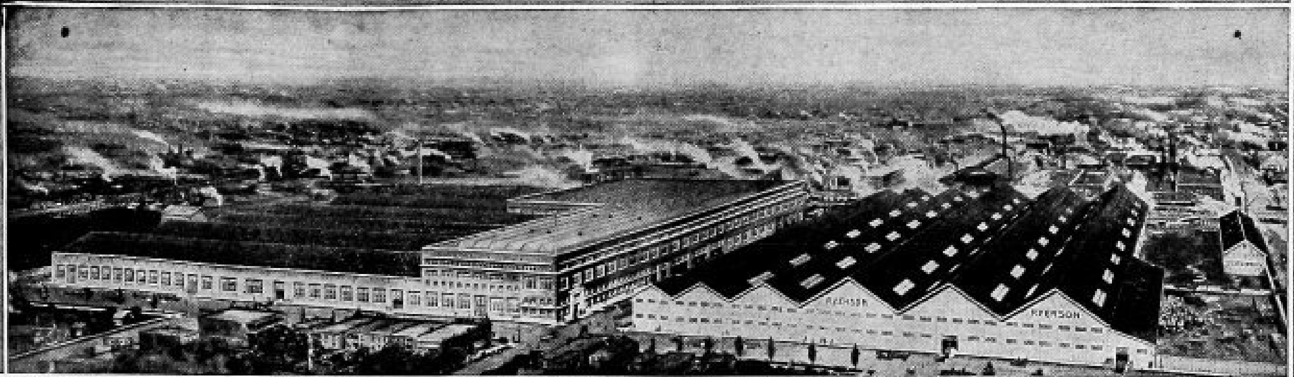
Water is treated to prevent the formation of scale and foaming. Reports indicate good results from the use of soda ash and caustic soda. There is some difference of opinion to benefits derived from treated water as a preventive of corrosion. One member reports the use of a polarized metallic preparation, applied direct to the boilers in bars distributed over crown sheet and tubes before closing the boiler and after each washout. This produces an effect more mechanical than chemical; it has an affinity for the material the boiler is made of and forms an amalgam over the boiler plates and tubes which prevents scale forming, also in the case of dirty or scaly boiler the fissures in the scale render it susceptible to removal because the material gets access to the plates and tubes through them, resulting in the scale becoming rapidly loosened and removed, falling to the mud ring or to the bottom of the boiler under the tubes, where it is blown or washed out.

In regards to application of the treatment the local conditions govern this matter.

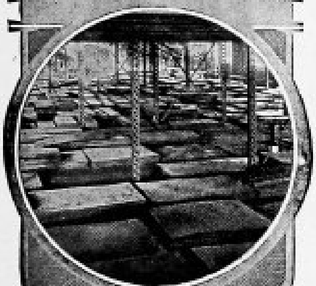
Investigation shows increased mileage between washouts from the use of treated feed water. Although complete or accurate data are not available, reports indicate that the life of flues and fireboxes has been lengthened from 150 to 500 percent by the treatment of feed water. Also it shows a substantial decrease in cost of maintenance and running repairs. It is generally conceded that treated feed water reduces pitting or corrosion of boiler plates. Reports indicate that a very large decrease in the amount of incrustation and also show a reduction in fuel consumption.

When soda ash is used as directed it shows beneficial effects

* Abstract of committee report, by A. E. Shaule, George Austin, T. W. Lowe and G. C. Wehling.

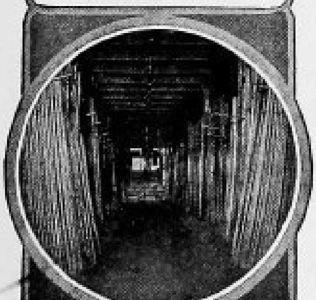


EVERYTHING IN IRON AND STEEL


Plates


Rivets


Boiler Lugs and Hangers


Bars

BARS
Bars, Bands, Hoops, Twisted and Cold Drawn.

SHAPES
Beams, Channels, Angles, Tees, Rails, Girder Sections.

PLATES
Universal, Tank, Flange, Firebox Steel, Floor.

SHEETS
Black, Galvanized, Corrugated, Stamping, Special.

TUBES
Lapweld, Charcoal, Seamless, Locomotive.

RIVETS AND BOLTS
Burden's Iron, Boiler Tank, Structural, Tinner's, Patch, Boiler, Carriage, Machine, Lag Screws.

BOILER SHOP SPECIALTIES
Ulster and Ulster Special Staybolt Iron, Staybolts, Staybolt Taps, Crabs, Crayons, Plugs, Nozzles, Manholes and Covers, Hangers, Lugs, Flanges, Furnaces, Drills, Rivet Sets.

BOILER SHOP TOOLS
Ryerson Flue Cleaning Machines, Otto Flue Cleaning Machines, Ryerson Combination Hot Saw and Tube Expander, McGrath Safe-End Machine, Hartz Super-heater and Tube-Welding Machine, Ryerson Pneumatic Flue Welding Machine, Ryerson Flue Cutter, Mathews Combination Tube Cutting and Cleaning Machine, Expanders, Forges, etc.

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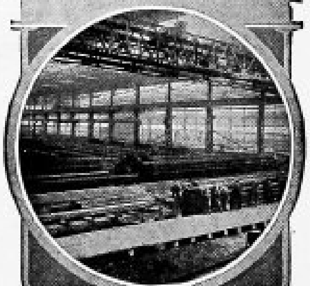
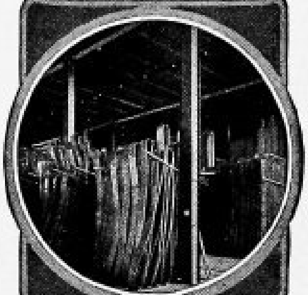
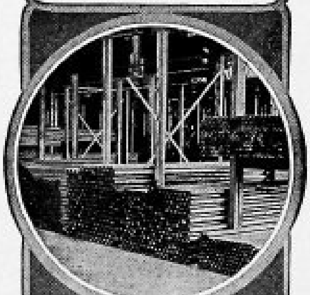
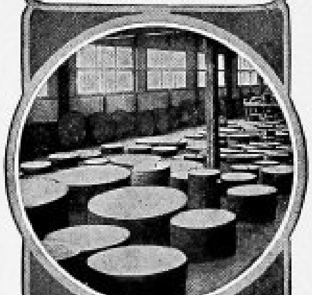

Structural Shapes


Bands


Boiler Tubes


Boiler Heads

THE LARGEST IRON AND STEEL SUPPLY HOUSE IN THE WORLD

in the matter of preventing incrustation, especially on heating surfaces; the injurious effects are trouble with and damage to injectors, discharge pipes, check valves. It has been found to add to the foaming tendency of the water, also increase lubrication, although such expense is offset by reduced cost of boiler maintenance.

The Santa Fe reports a cost of 4 cents per thousand gallons for treating feed water; the Canadian Pacific advises cost ranges from 2 cents to 5 cents, according to conditions. The polarized treatment costs about 3 cents per thousand gallons. Other roads have no figures available (roads represented by this committee). The general opinion is that considerable saving is made in the shape of improved locomotive operation, decreased cost of boiler repairs, reduced fuel consumption, etc.

The general practice is to have a blow-off cock on each side of the firebox.

Enginemen should use the blow-off cock at every opportunity. Blow-off cocks are used while on the road and at terminals. The general practice is to keep blow-off cocks open for, say, five seconds at a time until the desired quantity of water is blown out; the use of the blow-off cock is not advocated while injectors are working or the engine is being worked. Blow-off cocks are so arranged that they can be conveniently operated from the cabs of locomotives.

The use of treated water increases injector troubles to some extent, mostly due to foaming conditions brought about by treated feed water.

THURSDAY MORNING SESSION

The first speaker who addressed the convention on Thursday morning was Mr. J. F. DeVoy, Assistant Superintendent of Motive Power of the C. M. & St. P. R. R.

Abstract of Mr. De Voy's Address

The most important fact that has been brought to us of late is the Federal boiler inspection law. In reviewing the method of handling the work, which has been brought about by the adoption of the Federal law, which we have now been working on for the past two years, and in so far as its general requirements affect our methods I am rather inclined to believe that it has brought about a better condition of affairs. Shortly before it was in force, my thought was that the railroads were up against a proposition involving a serious operation which might tend to work much harm. The operation has been performed, we have accustomed ourselves to the general conditions and are trying to live up to them in a manner which will obtain for us the least amount of criticism by those who are designated to enforce the law.

I am prepared to say that, so far as my own personal opinion is concerned, the general condition of handling the work would be much less interfered with if governed by Federal Commission rather than by State laws which might be enforced by State courts, railroad and warehouse commissions or other governing State bodies. The principal reason for making this statement is the fact that in discussing legislative matters pertaining directly to railroads, I have found arguments presented which I believed were given in the interest of special crafts or organizations, and presented to men who had not been sufficiently trained along lines which would permit them to intelligently pass upon the right and wrong of the legislation which they as representatives were designated to pass upon.

I do know that in so far as the present condition of locomotive boilers in this country is concerned, it is largely due to the life work, best thought and energy of men especially equipped with brains, testing appliances, physical research, actual practice and skill, or, in other words, the development of the locomotive boiler has been more of a constructive policy rather than to pull apart some of the methods which long terms of service by men who ought to and do know have made them feel was best so far as safety and economy are concerned.

Looking back over a period of twenty-five years, and referring to men who have been engaged in this work, at least little criticism can be made as to the sincerity of purpose of these men. Mr. Vauclain, of the Baldwin Locomotive Works, has given his life work almost entirely to the thought. John Player, of the American Locomotive Company, perhaps one of the greatest locomotive boiler designers the world has ever seen, and who brought about the first workable Belpaire construction, must be given credit for the constructive ability which there is no question he possessed. The Bennetts, representing two entirely different types of boiler makers, brought about many ideas of a constructive order. E. J. Hennessey, of the New York Central, who was the first man I ever saw put over 200 flues in a boiler, made it his life work. J. N. Boone, for fifty years connected with the Wabash, Northwestern and New York Central lines, was, I believe, the first man to demonstrate in a practical way whether there was a movement in a back flue sheet which would necessitate the use of a sling stay. Myron Wells, in his great work as to the question of circulation, whether of water or gases, seemed to me to be one of the most important factors in boiler efficiency. David Van Alstine probably made an earlier and better success of combustion chambers when using Western fuel. J. W. Kelly, formerly of the C. & N. W., who demonstrated beyond a doubt that a crack in a door sheet was not a necessity. The Lucases, Goodwin, Wagstaff, Flavin, Conrath, O'Connor, Laughridge and Doarnberger, who gave the best thought of their lives to maintain and operate a locomotive boiler, justifies me in making the statement that the policy has been absolutely constructive, and it is to the credit of many men in this association that there has never been a backward step in the bettering of conditions which would tend to minimize the loss of life and accidents and at the same time maintain the high efficiency which modern conditions have demanded.

It is true that the increased size of locomotive boilers brought about by ever increasing demand for greater power has tended to magnify the faults which were always thought to have been of minor importance in the older types as compared with the boiler of to-day. Any man will tell you that the boiler of to-day has ten times more faults than it did twenty-five years ago. I absolutely deny that that is so, if condition for condition is taken into consideration.

I believe it can be justly claimed that, due to the work which the men I have mentioned have outlined and the advent of the superheater, has not only made the boiler fully as safe to operate, but has made it 25 percent more efficient in so far as economy is concerned. The questions of drop grates, water and air circulation and combustion chambers, heretofore mentioned, have brought about a life of the construction parts of locomotive boilers even greater than that of the older type. It is not an unusual condition, even under moderately bad water conditions, to get a life of five years for even the longest flue, and I will say that the long flue, approximately 22 feet, is not generally harder to maintain than was the old flue of half its length, providing that the capacity of the boilers is taken into consideration. The modern boiler, with high pressure, forced draft and high evaporation qualities, makes its work performed fully five times over the boilers of twenty years ago, and it is not an unusual thing for a modern high-pressure boiler in passenger service to be called upon to furnish anywhere from 1,200 to 1,800 horsepower for a considerable length of time.

I go at length to mention some of these conditions, for the reason that it is uppermost in my mind that no lasting good and benefits will ever come to public service corporations until the laws governing their operation are passed upon by associations similar to the Master Boiler Makers' Association, in order that the best and greatest thought, work and requirements shall be passed upon by such organizations rather than by putting it to the decision of legislatures on the advice of men who cannot possibly have given the thought which can be given by this body. Therefore I say that the demands for safer, better and cheaper service in the past five years have been made under difficulty, and that the methods have furnished opportunities in their application and development for all the energy, genius and skill obtainable, and that the best efforts of those engaged in this work had to be met with material which goes with the building, maintaining and operating of railroads, constantly increasing prices. The wages of the vast army of employees advancing nearly fifty percent, and the requirements of municipal, State and Federal authorities adding further to the cost of operation, the task has been one which can be met only by the continuous work of this and other conventions, and fully justifies your meeting and discussing ways and means which ought to be placed before governing bodies, commissions and others in authority in a way which will impress upon them what is really needed in the further advancement and requirements for the progress of the country, and which will not tend to make it more burdensome for the common carriers to serve the people at a cost which will be fair to all communities, and will at the same time allow the corporations to earn a fair return on not only the investment of their money, but the brains and skill of the greatest thinking body of mechanics in the world. I regret that I cannot say that this has always been done with a view to fair treatment to all concerned, and until such time as the work of this and other organizations can be taken as the last word in settling matters pertaining directly to that which you represent, I feel that no good will come, and that, instead of lessening the ever-increasing burden, we either cause the absolute failure of public service corporations or make their operations so difficult as to be harmful to the entire country.

I cannot, in the time at my command, discuss facts which I know are true, principally that the mileage of flues, side and flue sheets is even better with the large increase which has been put upon them, but to bring more fully to your mind that it is true, I would like to mention the performance in our first experience with Mikado engines. In April, 1909, twenty class L-1, Mikado type engines, with combustion chambers, were built at the Milwaukee shops. These engines are equipped with oil burners and are used on the extension. The life of flues in this class of engine was two and a half to three and a half years.

I have more data which I would like to present to you, but it is on the eve of one of your most successful conventions, and I do not propose to inflict my time on men who have taught me in the past that which I know about boiler making. When I want to know anything about particular cases, I pick up your addition to this library of the world, that is, your reports of your different conventions, and I there furnish myself with the information which has been given by your reports.

The increase in size of locomotive boilers as brought about by ever-increasing demands for greater power, has tended to magnify faults of this type of construction, which, though always having been present in boiler construction, was of minor importance on old types as compared with the boiler of to-day. This condition of affairs can be attributed to the fact that original boiler design had to be modified to meet present-day conditions. The old type boiler of ten feet in length is now supplanted by those from 18 to 22 feet, while the diameter has been increased from 45 to 80 inches. The grate, in order to be of size sufficient to handle this increased capacity, had to be put on top of the frame, thus eliminating the long deep water legs and low grate, which I think was one of the good points of the old type of boiler. As we all know, most of our failures in service are directly due to variation in temperature in the different parts of the boiler, and the stresses set up by these temperature variations are much greater in our modern boilers, due to the design of the firebox and the increased length of the barrel.

Topics for the Next Convention

The committee on topics submitted the following topics in addition to those carried over from this convention:

1. What can the association do to get a uniform rule regarding the load allowed on staybolts and boiler braces?

2. The advantages or disadvantages of flexible staybolts to be used in crown sheets to take the place of sling stays.

3. The advantages or disadvantages of combustion chambers in large Mallet or Pacific type engines.

4. What shape and size head of a radial staybolt in crown sheet of oil-burning engines give the most efficient service?

5. Does the method of flue cleaning or "rattling" have any effect on the further scaling up of flues?

6. Combustion and fuel economy with reference to the length of flues.

Election of Officers

The following officers were elected for the ensuing year:

President—Mr. T. W. Lowe, Winnipeg, Manitoba.

First Vice-President—Mr. James T. Johnston, Los Angeles, Cal.

Second Vice-President—Mr. Andrew Greene, Indianapolis, Ind.

Third Vice-President—Mr. D. A. Lucas, Havelock, Neb.

Fourth Vice-President—Mr. John B. Tate, Altoona, Pa.

Fifth Vice-President—Mr. Charles P. Patrick, Cleveland, Ohio.

Treasurer—Mr. Frank Gray, Bloomington, Ill.

Secretary—Mr. Harry D. Vought, New York.

New members of the executive committee elected for a term of three years:

Mr. William Lindner, Savannah, Ga.

Mr. C. N. Nau, Hammond, Ind.

Boiler Makers' Supply Men's Association

At the annual meeting of the Boiler Makers' Supply Men's Association the following officers were elected for the ensuing year: President, Edward T. Hendee, Joseph T. Ryerson & Son, Chicago, Ill.; vice-president, J. C. Campbell, Chicago Pneumatic Tool Company, Chicago, Ill.; secretary-treasurer, George Slate, The Boiler Maker, New York, N. Y.

A resolution was passed expressing the deep regret and sorrow of the members of the association at the death of their esteemed friend, Harry B. Hare.

The appreciation of the association was expressed in a fitting manner to the hotel management for the efficient and helpful way in which they looked after the arrangements for the convention, and also to the officers and chairmen of the various committees who carried out the plans for the entertainment at the convention, and in particular a vote of thanks was tendered to the entertainment committee in Chicago for the very able and efficient manner in which they conducted the convention.

In voting to reimburse the secretary-treasurer for all expenses incurred in transacting the business of the association, the occasion was taken to express the appreciation of the association for the able and efficient manner in which the secretary has performed his duties ever since the association was organized.

Registration at the Convention

A. E. Adams, U. S. Inspector, Columbia, S. C.
A. A. Akins, F. B. M., Chicago Greatwestern, Oelwein, Ia.
C. J. Albert, Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Mrs. A. Albert, Hammond, Ind.
Thos. Aldcorn, Chicago Pneumatic Tool Co., New York City.
Geo. F. Allen, The Railway Materials Co., Chicago, Ill.
W. L. Alleson, American Arch Co., Chicago, Ill.
Mrs. Verne Alexander, Chicago, Ill.
A. C. Andersen, Chicago Pneumatic Tool Co., Chicago, Ill.
Mrs. A. C. Andersen, Chicago, Ill.
Ernest Anderson, F. B. M., Kroeschell Bros. Co., Chicago, Ill.
J. G. Anthony, American Arch Co., New York City.
Edward Aplin, Chicago Pneumatic Tool Co., Chicago, Ill.
Mrs. Edward Aplin, Chicago, Ill.
F. W. Armstrong, Chicago Association Commerce, Chicago, Ill.
Joseph Ashback, G. B. M. F., Spokane, Portland & Seattle Ry. Co., Vancouver, Wash.
W. B. Atkinson, B. F. M., M. & N. A. R. R., Eureka Springs, Ark.
Mrs. W. B. Atkinson, Eureka Springs, Ark.
Geo. Austin, G. B. I., A. T. & S. F., Topeka, Kan.
Mrs. Geo. Austin, Topeka, Kan.
E. A. Averill, American Engineer, New York City.
A. M. Baird, G. F., A. T. & S. F. Ry. Co., Topeka, Kan.
Frank Bannin, F. B., Big Four, Urbana, Ill.
Mrs. Frank Bannin, Champaign, Ill.
Miss Kathleen Bannin, Champaign, Ill.
Jno. Barnes, Bird Archer Co., New York City.
W. G. Barnes, Cleveland Steel Tool Co., Cleveland, Ohio.
Mrs. Geo. Barnes, New York City.
Wm. Barton, Chicago, Ill.
Mrs. Barton, Chicago, Ill.
F. A. Batchman, F. B. M., N. Y. C. Lines, Elkhart, Ind.
W. H. S. Bateman, Parkesburg Iron Co., Champion Rivet Co., Philadelphia, Pa.
Mrs. W. H. S. Bateman, Philadelphia, Pa.
G. W. Bauer, F. B. M., Toledo Terminal R. R., Toledo, Ohio.
Chas. J. Baumann, F. B. M., N. Y. N. H. & H. R. R., New Haven, Conn.
Mrs. Chas. J. Baumann, New Haven, Conn.
G. M. Bean, American Arch Co., Los Angeles, Cal.
Mrs. G. M. Bean, Los Angeles, Cal.
W. L. Bean, Jacobs-Schupert U. S. Firebox Co., Chicago, Ill.
Mrs. W. L. Bean, Chicago, Ill.
John F. Beck, F. B. M., G. R. & I. R. R., Grand Rapids, Mich.
Miss Carrie Beck, Grand Rapids, Mich.
F. W. Behring, Chicago.
A. J. Beland, F. B. M., Chicago Junction Ry. Co., Chicago, Ill.
Mrs. A. J. Beland, Chicago, Ill.
G. W. Beland, F. B. M., Grand Crossing Boiler Works, Chicago, Ill.
Mrs. Geo. Beland, Chicago, Ill.
R. W. Bell, Supt. of Machinery, I. C. R. R., Chicago, Ill.
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Mrs. M. H. Newgerg, Boone, Ia.
G. G. Nichol, Asst. G. B. M., Santa Fe, Albuquerque, N. M.
C. A. Nicholson, F. B. M., Southern R. R., Atlanta, Ga.
Edward J. Nicholson, F. B. M., C. & N. W., Milwaukee, Wis.
J. L. Nicholson, Oxweld Service, Chicago, Ill.
J. H. Noonan, F. B. M., Southern, Knoxville, Tenn.
Wm. Norton, F. B. M., I. C. R. R., Indianapolis, Ind.
F. J. O'Brien, Globe Seamless Steel Tubes Co., Milwaukee, Wis.
Mrs. F. J. O'Brien, Milwaukee, Wis.
Arthur J. O'Connor, Missouri Valley, Ia.
M. O'Connor, Chicago Pneumatic Tool Co., Chicago, Ill.
Mrs. M. O'Connor, Missouri Valley, Ia.
Miss Bessie K. O'Connor, Missouri Valley, Ia.
Thos. A. O'Neill, F. B. M., A. L. Co., Schenectady, N. Y.
Mrs. Thos. A. O'Neill, Schenectady, N. Y.
Thos. R. Oliver, F. M., Detroit & Macinac, East Tawas, Mich.
Mrs. Thomas Oliver, East Tawas, Mich.
O. M. Olson, Spencer Otis Co., Chicago, Ill.
Mrs. O. M. Olson, Chicago, Ill.
J. W. Optenberg, president, Optenberg Iron Works, Sheboygan, Wis.
Mrs. J. W. Optenberg, Sheboygan, Wis.
J. J. Otto, G. B. F., D. L. & W. R. R., Scranton, Pa.
F. E. Owen, B. M. F., C. H. & D., Indianapolis, Ind.
J. W. Owens, Des Moines Mfg. & Sup. Co., Des Moines, Ia.
C. F. Palmer, Faessler Mfg. Co., St. Louis, Mo.
E. E. Palmer, Faessler Mfg. Co., St. Louis, Mo.
Mrs. Etta Palmer, Chicago, Ill.
LeGrand Paris, American Arch Co., New York City.
F. J. Passino, Ind. Pneumatic Tool Co., Chicago, Ill.
Mrs. F. J. Passino, Chicago, Ill.
Chas. P. Patrick, G. F. B. M., Erie R. R., Cleveland, Ohio.
Paul T. Payne, Dearborn Chemical Co., Chicago, Ill.
G. H. Pearsall, Burden Iron Co., Troy, N. Y.
J. W. Faessler, Faessler Mfg. Co., Moberly, Mo.
C. R. Phillips, Pittsburg Steel Products Co., Pittsburg, Pa.
L. R. Phillips, National Tube Co., Chicago, Ill.
R. H. Phillips, Detroit Seamless Steel Tubes Co., Detroit, Mich.
H. E. Pierce, Ewald Iron Co., Louisville, Ky.
Mrs. Pierce, Chicago, Ill.
O. F. Pittman, F. B. M., C. & C. R. R., Gassaway, W. Va.
C. F. Pitzinger, F. B. M., Ga. Ry., Macon, Ga.
Mrs. C. F. Pitzinger, Macon, Ga.
Thos. Plunkett, Revere Rubber Co., Chicago, Ill.
J. L. Ponic, Revere Rubber Co., Chicago, Ill.
C. D. Powell, G. B. Insp'r, B. & O., Baltimore, Md.
J. A. Powell, F. B. M., Ga., Columbus, Ga.
T. F. Powers, Sys. Gen. Fore. Boiler Dpt., Chicago & Northwestern, Chicago, Ill.
Mrs. T. F. Powers, Chicago, Ill.
E. W. Pratt, Asst. G. M. P. & M., C. & N. W. Ry. Co., Oak Park, Ill.
Mrs. E. W. Pratt, Oak Park, Ill.
Jas. F. Pritchard, M. B. M., G. S. & F. R. R., Macon, Ga.
J. D. Purcell, Dearborn Chemical Co., Chicago, Ill.
C. E. Pynchon, J. T. Ryerson & Son, Chicago, Ill.
Mrs. Frank J. Rahle, Chillicothe, Ohio.
T. J. Rahrle, B. F., B. & O. S. W. R. R., Chillicothe, Ohio.
J. F. Raps, G. B. Insp'r, I. C. R. R., Chicago, Ill.
Mrs. J. F. Raps, Chicago, Ill.
Henry J. Raps, G. F. B. M., I. C. R. R., Chicago, Ill.
Mrs. Henry J. Raps, Chicago, Ill.
Miss Esther M. Raps, Chicago, Ill.
Miss Mabel L. Raps, Chicago, Ill.
Miss Sadie L. Raps, Chicago, Ill.
E. E. Rapp, Ch. B. Insp'r, Toledo, St. Louis & Western, Frankfort, Ind.
Edward J. Reardon, B. Insp'r, Interstate Commerce Commission, Chicago, Ill.
Miss Julia Reardon, Chicago, Ill.
Miss M. Reardon, Chicago, Ill.
Miss Nellie Reardon, Chicago, Ill.
Miss Nonie Reardon, Chicago, Ill.
George M. Rearick, G. B. Insp'r, Buffalo & Susquehanna R. R.
Mrs. Geo. M. Rearick, Galeton, Pa.
Miss Margarite Rearick, Galeton, Pa.
T. J. Reddy, G. B. F., C. & E. I., Danville, Ill.
Mrs. T. J. Reddy, Danville, Ill.
Richard Reddy, Danville, Ill.
G. C. Reed, Oxweld Ry. Service Co., Chicago, Ill.
Miss Alice Reed, Chicago, Ill.
Miss M. Rew, Chicago, Ill.
Daniel S. Rice, F. of B. M., Penna. Pittsburg, Pa.
E. S. Richardson, Oxweld Co., Chicago, Ill.
Mrs. E. S. Richardson, Oak Park, Ill.
Geo. N. Riley, National Tube Co., Pittsburg, Pa.
Mrs. Geo. N. Riley, Pittsburg, Pa.
E. H. Ritter, B. F., B. & O., Newark, Ohio.
Jos. M. Robb, Bird Archer Co., New York City.
Mrs. Jos. M. Robb, Chicago, Ill.
E. W. Rogers, G. F. B. M., Amer. Loco. Wks., Schenectady, N. Y.
Thos. Robinson, Draper Mfg. Co., Port Huron, Mich.
Samuel D. Rosenfelt, Mech. Dept., Franklin Ry. Supply Co., New York City.
C. C. Rosser, Detroit Seamless Steel Tubes Co., Detroit, Mich.
C. H. Rutledge, Asst. F. B. M., P. R. R., Lines East.
Clement Ryan, F. B. M., Union Pacific, Omaha, Neb.
J. J. Ryan, F. B. M., L. & N., Covington, Ky.
Mrs. J. J. Ryan, Covington, Ky.
J. Ryan, B. M., C. I. & S., Hammond, Ind.
Mrs. J. Ryan, Hammond, Ind.
G. E. Ryder, Loco. Superheater Co., New York City.
Oscar Rydman, B. M. F., C. & N. W. Ry., Huron, S. D.
Mrs. Oscar Rydman, Huron, S. D.
B. T. Sarver, G. B. M. F., Penna R. R., Ft. Wayne, Ind.
Mrs. B. F. Sarver, Fort Wayne, Ind.
W. C. Sayle, Cleveland Punch & Shear Works, Cleveland, Ohio.
Mr. A. H. Scannell, Scannell Boiler Works, Lowell, Mass.
Frederick A. Schaff, Loco. Superheater Co., Chicago, Ill.
Mrs. Frederick A. Schaff, Chicago, Ill.
H. F. Scherping, F. B. M., C. & N. W., Norfolk, Neb.
Mrs. H. F. Scherping, Norfolk, Neb.
Robt. F. Scott, Ind. Pneumatic Tool Co., Chicago, Ill.
Mrs. Robt. F. Scott, Chicago, Ill.
Chas. J. Scudder, Interstate Commerce Insp'r, Milwaukee, Wis.
C. A. Seley, American Flexible Bolt Co., Pittsburg, Pa.
F. W. Severance, S. Severance Mfg. Co., Glassport, Pa.
Geo. E. Sevey, Otis Steel Co., Chicago, Ill.
Mrs. Geo. E. Sevey, Chicago, Ill.
E. V. Shackleford, Ewald Iron Co., Louisville, Ky.
C. W. Shaffer, Asst. G. B. Insp'r, I. C. R. R., Chicago, Ill.
Mrs. C. W. Shaffer, Chicago, Ill.
William J. Shank, F. B. M., C. & N. W. Ry., Butler, Wis.
Wm. Shoemaker, Supt., Hibben & Co., Chicago, Ill.
Edward G. Simms, Dist. Insp'r of Loco. Boilers, Interstate Commerce Commission, Chicago, Ill.
Mrs. Edw. G. Simms, Chicago, Ill.
Miss Elizabeth Simms, Chicago, Ill.
George Slate, The Boiler Maker, New York City.
Mrs. George Slate, Summit, N. J.
Miss Margaret Slate, Summit, N. J.
T. G. Smallwood, Chicago Pneumatic Tool Co., Chicago, Ill.
C. E. Smith, Asst. F. B. M., C. & E. R. R., Huntington, Ind.
F. L. Smith, Seimund Wenzel Elec. Welding Co., New York City.
F. M. Smith, B. F., Southern, Princeton, Ind.
H. S. Smith, Jos. T. Ryerson & Son, Chicago, Ill.
John B. Smith, F. B. M., P. & L. E. R. R., Pittsburg, Pa.
Hugh Smith, F. B. M., Erie, Jersey City, N. J.
Miss L. Smith, Chicago, Ill.
J. H. Smythe, B. E., Parkesburg Iron Co., Parkesburg, Pa.
Mrs. J. H. Smythe, Parkesburg, Pa.
James W. Spencer, B. I., Chicago Great Western, Oelwein, Ia.
Mrs. James W. Spencer, Oelwein, Ia.
B. E. D. Stafford, Flannery Bolt Co., Pittsburg, Pa.
W. F. Stauch, G. B. Insp'r, B. & O., Newark, Ohio.
C. E. Steward, G. B. M. F., Ft. Worth & Denver City & Wichita Valley, Childress, Texas.
Wm. Strensky, F. B. M., C. M. & P. S. Lines, Tacoma, Wash.
Geo. S. Stuart, Siemund Wenzel Elec. Welding Co., Chicago, Ill.
Mrs. D. F. Sullivan, Freeport, Ill.
F. J. Sullivan, B. M. F., I. C. R. R., Freeport, Ill.
Mrs. F. J. Sullivan, Freeport, Ill.
Joseph Sullivan, B. F., N. Y. C., E. Buffalo, N. Y.
Mrs. Joseph Sullivan, Buffalo, N. Y.
Morris Sullivan, F. B. M., Big Four, Indianapolis, Ind.
S. F. Sullivan, Ewald Iron Co., Louisville, Ky.
Thos. J. Sullivan, F. B. M., C. St. P. M. & O., Sioux City, Ia.
A. E. Swanson, Chicago Pneumatic Tool Co., Chicago, Ill.
Mrs. A. E. Swanson, Chicago, Ill.
J. G. Talmage, The Talmage Mfg. Co., Cleveland, Ohio.
Chas. G. Tate, M. E.
Mrs. C. G. Tate.
Miss Isabel Tate, Altoona, Pa.
J. B. Tate, F., P. R. R. Lines East.
M. K. Tate, American Arch Co., New York City.
Mrs. Maggie M. Tate, Altoona, Pa.
Mrs. F. D. Timms, Buffalo, N. Y.
Miss May Timms, East Buffalo, N. Y.
Master John Timms, East Buffalo, N. Y.
J. F. D. Timins, B. M. F., Delaware, Lackawanna & W., Buffalo, N. Y.
J. H. Tinker, Supt. Motive Power, C. & E. I. R. R., Danville, Ill.
Robt. E. Thayer, Assoc. Mech. Ed., Railway Age Gazette, Chicago, Ill.
Geo. W. Thomas, Asst. F., Baltimore & Ohio, W. Newark, Ohio.
Geo. Thomas, 3d, Parkesburg Iron Co., Parkesburg, Pa.
Miss E. Thomas, Chicago, Ill.
J. R. Thomas, Parkesburg Iron Co., Whitford, Pa.
C. N. Thulin, Chicago Pneumatic Tool Co., Chicago, Ill.
Mrs. C. N. Thulin, St. Paul, Minn.
G. J. Thust, Globe Seamless Tubes Co., Milwaukee, Wis.
John J. Turner, B. M. F., B. O. E. T. R. R., East Chicago, Ind.
Mrs. J. J. Turner, East Chicago, Ind.
Miss L. Turner, Chicago, Ill.
Mrs. G. S. Turner, Chicago, Ill.
Miss G. S. Turner, Chicago, Ill.
G. A. Troutman, F. B. M., H. & B. T. R. R., Saxton, Pa.
E. C. Umlauf, B. M. F., Erie, R. R., Susquehanna, Pa.
Geo. B. Underwood, Super. of Boilers, N. Y. C. & H. R. R., Syracuse, N. Y.
Mrs. Geo. B. Underwood, Syracuse, N. Y.
H. A. Varney, National Boiler Washer Co., Chicago, Ill.
Mrs. H. A. Varney, Chicago, Ill.
R. J. Venning, Cleveland Steel Tool Co., Cleveland, Ohio.
A. Verschmer, Scully Steel & Iron Co., Chicago, Ill.
Mrs. A. Verschmer, Oak Park, Ill.
Gus. Vogt, Layer Out, C. & E. I., Danville, Ill.
Mrs. Gus Vogt, Danville, Ill.
Wm. Voitlein, Monarch Pneumatic Tool Co., St. Louis, Mo.
Mrs. Otto C. Voss, Chicago, Ill.
Miss Rose Voss, Chicago, Ill.
Miss Votruba, Chicago, Ill.
Harry D. Vought, Sec., M. B. M. Association, New York City.
Mrs. E. I. Wagner, Chicago, Ill.
Geo. Wagstaff, American Arch Co., New York City.
J. F. Walker, The Talmage Mfg. Co., Cleveland, Ohio.
Mrs. Walker, Cincinnati, Ohio.
C. E. Walker, Chicago Pneumatic Tool Co., Chicago, Ill.
Mrs. C. E. Walker, Chicago, Ill.
Jas. T. Walsh, F. B. M., 'Frisco System, Springfield, Mo.
Mrs. Jas. T. Walsh, Springfield, Mo.
H. J. Wandberg, F. B. M., C. M. & St. P., Minneapolis, Minn.
Mrs. H. J. Wandberg, Minneapolis, Minn.
E. C. Washburn, B. M. F., B. & O., Keyser, W. Va.
Irvine Washington, J. T. Ryerson & Son, Chicago, Ill.
Mrs. Albert Weeghman, Chicago, Ill.
Harry F. Weldin, F. B. M., Pennsylvania R. R., Philadelphia, Pa.
Mrs. H. F. Weldin, Philadelphia, Pa.
Stephen E. Westover, G. B. M. F., O. W. R. R. & N. Co., Portland, Ore.
S. M. Wetmore, manager of sales, Carbon Steel Company, Pittsburg, Pa.
M. C. Wharton, F. B. M., P. R. R., Renova, Pa.
W. White, National Boiler Washing Co., Chicago, Ill.
Mrs. W. White, Chicago, Ill.
E. B. White, National Boiler Washing Co., Chicago, Ill.

A. W. Whiteford, Jacobs-Shupert Firebox Co., New York City.
Geo. Whiting, Geo. Whiting Co., Chicago, Ill.
Mrs. Geo. Whiting, Chicago, Ill.
J. P. Williams, Carbon Steel Co., Chicago, Ill.
Mrs. J. P. Williams, Chicago, Ill.
Miss Harriet Williams, Chicago, Ill.
J. W. Williams, Brown & Co., St. Louis, Mo.
Wm. Williams, Asst. F. B. M., Erie, R. R., Meadville, Pa.
H. C. Williamson, J. T. Ryerson & Son, Chicago, Ill.
J. I. Winchell, Mudge & Co., Chicago, Ill.
John Wintersteen, Dist. Insp'r, Loco., Boilers, Interstate Commerce Commission, Philadelphia, Pa.
Mrs. John Wintersteen, Philadelphia, Pa.
C. L. Wilson, Dist. Insp'r, Loco. Boilers, Interstate Commerce Commission, Memphis, Tenn.
Mrs. C. L. Wilson, Memphis, Tenn.
Frank E. Wilson, Asst. F. B. M., F. E. C. Ry., Ft. Pierce, Fla.
G. C. Wilson, Independent Pneumatic Tool Co., Chicago, Ill.
Mrs. G. C. Wilson, Chicago, Ill.
Joe Wilson, F. B. M., Fort Worth & Denver City, Amarillo, Texas.
Mrs. J. P. Wilson, Chicago, Ill.
J. T. Wilson, B. Insp'r, Chicago Milwaukee & St. Paul, Sumatra, Mont.
Mrs. J. T. Wilson, Sumatra, Mont.
W. M. Wilson, G. F. B. S., Rock Island R. R., Moline, Ill.
Mrs. W. M. Wilson, Moline, Ill.
G. A. Woodman, Spencer Otis Co., Chicago, Ill.
Mrs. G. A. Woodman, Chicago, Ill.
Marie Woodman, Chicago, Ill.
W. C. Wortman, F. B. M., C. & N. W., Fond du Lac, Wis.
Mrs. H. L. Wratten, Racine, Wis.
Bernard Wulle, Asst. B. F., Big Four, Indianapolis, Ind.
T. Yochem, F. B. M., Mo. Pac., Ft. Scott, Kan.
Alex. Young, Asst. Foreman, C. M. & St. P. Ry.
E. W. Young, Dist. Insp'r, Loco. Boilers, Interstate Commerce Commission.
Mrs. E. W. Young, Dubuque, Ia.
Miss Annie Young, Dubuque, Ia.
Reynold C. Young, F. B. M., C. & N. W., Baraboo, Wis.
Marie Zanders, Norfolk, Va.
Charles Zietz, F. B. M., D. & R. G.

Supply Men's Exhibits at the Convention

One of the interesting features of the convention was the extensive display of boiler makers' supplies, made in a very attractive and instructive manner by the members of the Boiler Makers' Supply Men's Association. Exhibits were made by the following firms:

American Arch Company, New York.
American Flexible Bolt Co., Pittsburg, Pa.
Burden Iron Co., Troy, N. Y.
Brown & Company, Pittsburg, Pa.
Bethlehem Steel Company, South Bethlehem, Pa.
Bird Archer Co., New York City.
Champion Rivet Co., Cleveland, Ohio
A. M. Castle Company, Chicago, Ill.
Christopher Murphy & Co., Chicago, Ill.
Cleveland Steel Tool Co., Cleveland, Ohio.
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Chicago Pneumatic Tool Company, Chicago, Ill.
Cleveland Punch & Shear Works, Cleveland, Ohio.
Carbon Steel Company, New York City.
Detroit Seamless Tubes Co., Detroit, Mich.
Draper Mfg. Co., Pt. Huron, Mich.
Dearborn Chemical Co., Chicago, Ill.
Ewald Iron Company, St. Louis, Mo.
J. J. Finnegan & Co., Atlanta, Ga.
Flannery Bolt Company, Pittsburg, Pa.
Globe Seamless Steel Tubes Co., Milwaukee, Wis.
George Whiting Company, Chicago, Ill.
Hilles & Jones Company, Wilmington, Del.
Independent Pneumatic Tool Co., Chicago, Ill.
Inland Steel Co., Chicago, Ill.
Ingersoll-Rand Company, New York City.
J. W. Faessler, Moberly, Mo.
Jacobs-Shupert Firebox Co., Chicago, Ill.
Joseph T. Ryerson & Son.
Lovejoy Tool Works, Chicago, Ill.
Locomotive Superheater Co., New York City.
Liberty Manufacturing Company, Pittsburg, Pa.
Mudge & Co., Chicago, Ill.
Monongahela Tube Company, Pittsburg, Pa.
Monarch Pneumatic Tool Co., East St. Louis, Ill.
George F. Marchant, Chicago, Ill.
National Tube Co., East St. Louis, Ill.
National Boiler Washing Company, Chicago, Ill.
Oxweld Railroad Service Co., New York City.
Otis Steel Company, Cleveland, Ohio.
Pittsburg Steel Products Company, Pittsburg, Pa.
The Pearsall Co., New York City.
Parkesburg Iron Co., Parkesburg, Pa.
Pittsburg Screw & Bolt Co.
Revere Rubber Co., Boston, Mass.
Ry. Materials Co., Chicago, Ill.
Ross Schofield Company, New York City.
Scully Steel & Iron Co., Chicago, Ill.
Spencer Otis Company, Chicago, Ill.
S. Severance Mfg. Co., Glassport, Pa.
Siemund & Wenzel Electric Welding Co., New York City.
Sligo Iron & Steel Company, Connellsville, Pa.
Tyler Tube & Pipe Co., Washington, Pa.
The Boiler Maker, New York City.
The American Engineer, New York City.
Vulcan Engineering Sales Co., Chicago, Ill.
Worth Brothers Company, Coatesville, Pa.
Zug Iron & Steel Co., Pittsburg, Pa.

A Notable Overload Boiler Test

A recent test of the No. 12 boiler in the plant of the Narragansett Lighting Company, Providence, R. I., produced for eight hours very nearly 250 percent of boiler-rated horsepower at an overall efficiency of boiler and grate of 73 percent. This test was for the purpose of determining the capacity of a Riley self-dumping, underfeed stoker of five retorts which had been placed under the boiler. The boiler, which was twelve years old, was a Babcock & Wilcox, 12 tubes high, 18 tubes wide and 16 tubes long. No special effort was made to prepare it for this test. An average pressure of 174.1 pounds per square inch was maintained.

The total amount of coal consumed was 25,450 pounds, or an average of 3,181 pounds per hour. The water fed amounted to 251,170 pounds, or an average of 31,396 pounds per hour, thus giving an evaporation of 9.87 pounds of water for each pound of coal. The water was fed at a temperature of 196° F., and the equivalent water evaporated per hour from and at 212° F. was 33,437 pounds per hour, or a total of 969.2 boiler horsepower developed, which was 248.5 percent of builder's rating. The equivalent evaporation per pound of coal as fired thus figures out at 10.51 pounds of water, and the factor of evaporation is 1.065.

The coal analysis showed 74.13 percent fixed carbon, 14.95 percent volatile matter, 6.52 percent ash and 4.40 percent moisture. The calorimeter test showed the heating value to be 14,600 B. t. u. when dry, or 13,957 B. t. u. as fired. The coal was thoroughly consumed, as is shown by the flue gas analysis, which gave 16 percent CO_2, 0.12 percent CO, and 2.7 percent oxygen.

The boiler was of such size that a stoker of seven retorts could have been installed under it, which would have resulted in the burning of more fuel and a considerable increase in the capacity obtained. The horsepower used by the blower was determined as 20, while 1.4 horsepower was used to operate the stoker. Separate motors were used to drive the blower and stoker.

Boiler Shop Needed in Nashville

The Nashville (Tenn.) Industrial Bureau has gathered statistics showing that there are more than 300 boilers bought annually in Nashville for enterprises that use batteries of from one to six boilers. At present these must be purchased in other markets, as there is no boiler shop in the city.

This fact, and the fact that other towns and villages within a radius of 100 miles of Nashville, use many boilers annually, and the further fact that materials for the manufacture of boilers may be shipped from the steel and iron producing fields promptly and cheaply, make Nashville an ideal spot for a boiler factory of large proportions.

Nashville and the entire State of Tennessee are noted for their friendship to home manufactories and Tennessee-made products, and with this assurance of support a big factory is sure to be a money maker from the start. That such an institution, or even two of them, would find Nashville a fertile field is the unanimous opinion of long-sighted business men who have been interviewed on the subject.

The Industrial Bureau here courts inquiry from anywhere. It assures anyone interested that its facts are authentic and that its tip that here is a splendid opportunity for a money-making investment is worthy of consideration. The bureau will gladly furnish further information to persons who care to investigate.

The field is not only one already for such an industry, but is becoming more so each year. New enterprises using steam are springing up at intervals and will continue to come here, for Nashville is rapidly adding to her greatness as a manufacturing center.

John Meets the Geometry Professor

BY JAMES F. HOBART, M. E.

"Say, John! You are acting mighty 'red-headed' this morning! Has a cyclone twisted your brain-pan, or what is all the commotion about?"

"Just geometry, Mr. Hobart! Just geometry, but it is a kind of geometry I never even dreamed about, and I feel like saying what the old farmer did the first time he ever saw a giraffe. The beast pushed eight or ten feet of neck up above the old farmer, who stared at the apparition for several minutes, then shuffled away, shaking his head and saying to himself: 'Hell, there ain't no sich thing!' Couldn't believe the evidence of his own senses, and I can't, either, when I think of what that college sharp told me."

"Well! What was it, John? I can't help you out if you don't show me what the trouble is?"

"Wait a bit, Mr. Hobart! I'll tell you all about it just as soon as I can, but I haven't yet began to even get it through my head what the professor was talking about!"

"Go to it, John, but the professor sure must have given you a socdologer to work you up like this. Go ahead as soon as you get your wits again!"

"It was this way. I was setting the large tram to a 5-foot radius to lay out a 10-foot circle, when the professor came along. I thought it was a good chance to pick up a bit more geometry from a professor of that science, so I spoke to him as he was going past and said: 'Professor, can I lay out a 10-foot circle without a tram?'"

"Certainly," said the professor. "You can lay out almost any curve, line or figure from an adequate equation by the use of co-ordinates!"

"I managed to get my breath before the professor moved along, and as soon as I could speak, after that avalanche of knowledge, I said: 'Professor, will you be so kind as to tell me how to lay out a 10-foot circle as you suggest?'

"Surely I will, John, with the greatest of pleasure! The equation of a ten-foot circle is

$$x^2 + y^2 = 25.$$

"Honestly, Mr. Hobart, I nearly fell over when the professor said that, but I managed to pull myself together so the professor wouldn't see what a confoundedly ignorant chap I was—and, honestly, Mr. Hobart, I didn't know before that there were so many things I didn't know! Why it seems as though the more I study and the more I learn the more I see which I don't know a continental about! Why is it, Mr. Hobart, and where does the thing end?"

"There is no end to it, John! You are dead right about the 'don't know' and the learning proposition, for as surely as we progress in knowledge, just as surely do we find many, many other things which we don't know about, but which we are eager to study, for the more you learn the more you will want to, and the more you can learn. There is no end to it, so go ahead with knowledge and with the professor!"

"Well, I pulled myself together as well as I could, without bolts in my seams, and thought I would get even with the professor by putting right up to him that ellipse I have been trying to lay out, so I said: 'And, professor, how shall I lay out an ellipse having axes of 6 inches and 4 inches respectively?'

"The professor had already began to move away when I asked that question, and he didn't stop to answer it! He just turned his head a bit, spoke over his shoulder, and said:

$$9y^2 + 4x^2 = 36.$$

"Now, Mr. Hobart, in the name of all that is dear to the boiler maker, where do you find 10-foot circles and 6-inch ellipses in collections of letters and figures like those? What are they good for, anyway, and what do they mean?"

"They mean a whole lot, John, and, as the professor said, you can lay out the circle and the ellipse from those equations, and do it without a tram or any other radius length at that!"

"Then, Mr. Hobart, if you don't want me to go insane, then 'show me' at once!"

"All right, John, but first I must explain a bit. You can't jump right into the middle of the professor's equations and out again with the two layouts without first getting a bit wise to certain things regarding the co-ordinates which the professor mentioned. Savey?"

"I get you! Go to it some more!"

"First, find out what the professor means by 'From an adequate equation by the use of co-ordinates.' Now, then, he has given two 'adequate equations'—we will call them adequate until we prove them otherwise. If we say $2 + 3 = 5$, then we have formed an equation. Everybody knows that 3 and 2 make 5, but if we should write $2 + x = 5$, then we have got an equation which must be worked out to find what number, added to 2, will make 5. There is a whole lot more to equations, but this is the bottom fact regarding all of them, and they are really just short cuts for finding out something you want to know. Improved, high grade tools, in fact, equations are, which help the man with the 'know-how' find his lines just as the transit helps the engineer find lines that can hardly be guessed at by the eye without the finer transit instrument."

"I see a little bit of that, Mr. Hobart, but what about that 'co-ordinate' business. That word looks a whole lot fierce to me!"

"Simple, John, simple as water, and worth as much as gold. Just make a mark at O (see Fig. 1) on a bit of boiler plate.

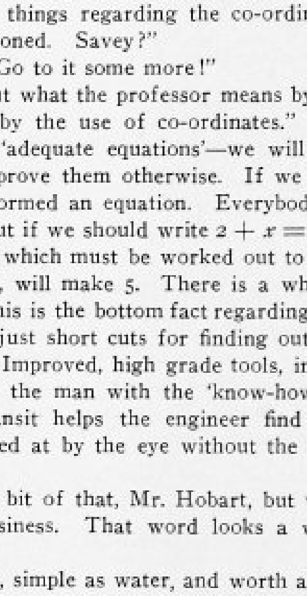

FIG. 1.—ORDINATES AND ABSCISSÆ

Draw two lines, one vertical, the other line horizontal, through the point O. Now, supposing we want to locate some other point, say P, somewhere on the plate? We measure from line N O to line P Q, and that distance, which we will call x, is the ordinate of point P. Now we will measure the distance from line O Q to line N P and call that distance y, as marked in Fig. 1. The distance y will be the abscissa of point P. And the distances x and y are the co-ordinates of point P. Co-ordinates really mean two dimensions which work together. You and Bill are co-workers, one of you is x and the other is y, and it often takes a lot of the foreman's time to figure out just what $x + y$ amounts to in your case!"

"I see it now. When we have the co-ordinates x and y given, we have located the point P, in relation to the lines crossing each other through zero point O?"

"That's a pretty good way of stating the matter, John, as fas as it goes, but there is a whole lot more than that in the ordinate business! Just let's supply different lengths for P and see how x will work out then? Here is the scheme: I will sketch it on this boiler shell just as shown by Fig. 2. We will divide up the line $X'\ X$ into equal parts, making each just one unit long long. We make them one inch, one foot, or

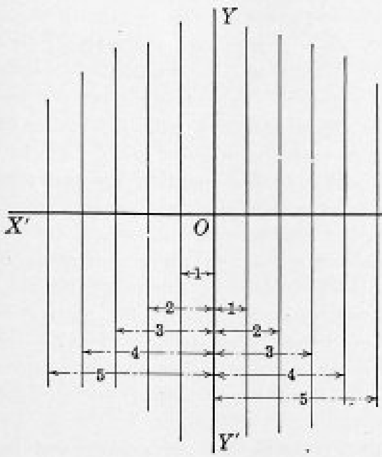

FIG. 2.—LAYING OFF THE ORDINATES

any other division of the scale that we please—it makes no difference as far as solving the problem is concerned, but if you were laying out your 10-foot circle, then we would make each division on the line $X'\ X$ one foot in length, starting from O and working 5 feet each way, drawing vertical lines as shown. These vertical lines are abscissæ of the figure we are to lay out from the equation $x^2 + y^2 = 25$, and all we have to do now is to find their length and we will have the layout of the 10-foot circle complete!"

"How do you make that out? I don't see how you get it to lay out five lines each way from O. Why are there not four, six or some number?"

"Good, John! You're catching on all right! Let's take that $x^2 + y^2 = 25$ and tear it to pieces a bit. Just supposing we put it this way, $x = O$. That means that we have measured the length of x horizontally on line $O\ X$, Fig. 2, and as there is no length to x at all, its abscissa must run right up on the line $O\ Y$, which it does. And being the case, all of the 25 must be used up and the length of line $O\ Y$, which is also the case. Now, we had better go into algebra just a little bit to find the length of line $O\ Y$. We will just take that equation $x^2 + y^2 = 25$, and put in place of x its value, which we have found to be O. As $x = O$, then $x^2 = O$, and as both $= O$, then we may drop x, or x^2, out of the equation altogether and say, $y^2 = 25$. This being the case, it don't take long to see that y must equal the square root of 25, which is just 5, therefore the length of abscissa $O\ Y$ is 5, and also we will find that the length of abscissa $O\ Y'$, and also of ordinates $O\ X$ and $O\ X'$ are also 5, therefore we have found that O is the center of a figure the radius of which extends vertically and horizontally a distance of 5 feet"

"Well, say! Of all the stunts I ever saw, that sure is the slickest. It works out just as though it was made on purpose, don't it?"

"Yes, John, it does. And it is a beautiful illustration of not only geometry, but of that highest of all branches of mathematics—the calculus!"

"Gee! Mr. Hobart, you don't mean to say that this is the calculus, do you, and that we are working in that great, high science? Why, I never could know enough to understand anything in the calculus!"

"You are working it now all the same, John, and it don't seem so very fierce either, does it? And just bear in mind that when you find the layout of that 10-foot circle by the professor's equation of $x^2 + y^2 = 25$, just realize that you are driving a tandem team consisting of geometry and calculus, hitched one ahead of the other, and both pulling out the solution of the problem for you!"

"Why, I can't realize that anything in the calculus can be so simple and that it can be used for everyday things as you have shown me! I can't begin to realize it!"

"That's the trouble all along the line, John. Show a line of algebra at a chap in the shop and he jumps up and bellows same as when a bull sees a red rag. The chap don't ever stop to see what the thing is for, or what it means, but jumps and hollers, and says bad things about the sharps who can't write for his pet paper without mixing a lot of letters with the figures—letters always look to the chap like the red rag to the bull, whereas the letters mean some simple methods which would save the chap a whole lot of hard work if he would only look to see what the letters mean and what they are good for."

"Well, Mr. Hobart, I've turned up my nose a good many times at letters mixed with figures, as you describe it, but I won't do so any more until I find out what those letters mean and what they are good for!"

"All right, John. Just find that out, and then there is no danger of your ever making faces at the letters. You couldn't pry yourself away from them with a crowbar after you once find out what mighty good tools they are. Now, then, let's find the length of the rest of the abscissæ. We have already found the lengths of $O\ Y$ and $O\ Y'$ to be 5. Let's now take the next abscissa on either side of $O\ Y$, or one foot distant from that line. We now have, substituting the value of x in the equation, which is $x = 1$, therefore $x^2 = 1$ also, we have $y^2 + 1 = 25$, or $y^2 = 24$. Taking the square root of 24 we have $y = 4.9$, which is the length of the four abscissæ on

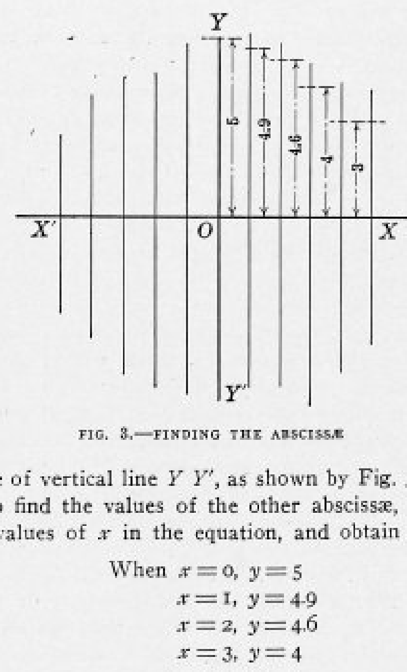

FIG. 3.—FINDING THE ABSCISSÆ

either side of vertical line $Y\ Y'$, as shown by Fig. 3. Next we proceed to find the values of the other abscissæ, substituting different values of x in the equation, and obtain as follows:

When $x = 0,\ y = 5$
$x = 1,\ y = 4.9$
$x = 2,\ y = 4.6$
$x = 3,\ y = 4$
$x = 4,\ y = 3$
$x = 5,\ y = 0$

"And what do we do with these figures, now that we have found them? Are they to be laid off on the abscissa we have spaced off in Fig. 2?"

"Sure as you live, John. Fig. 4 shows how it is done, and if you will sketch a freehand line through all the points marked between X and Y, then you will have a quarter circumference of a circle of 5 feet radius, or 10 feet in diameter. If you connect the several points with straight lines, then you will have an approximation of a circle, but if you will take pains to calculate a lot more abscissæ between those calculated one foot apart, then you may obtain as close a set of circumference curves as you please, and if you wish to spend the time you can lay out the abscissæ so close together that the eye can hardly distinguish between the many short straight lines and a true curved circumference."

"But, Mr. Hobart, we have only got one quarter of the circle laid off; how about the other three-quarters?"

"Just work back again, John, for the second angle—that is, from Y to X'. The mathematical sharps call from X to Y the first angle, from Y to X' the second angle, and from X' to Y' the third angle, while the remaining space from Y' to X

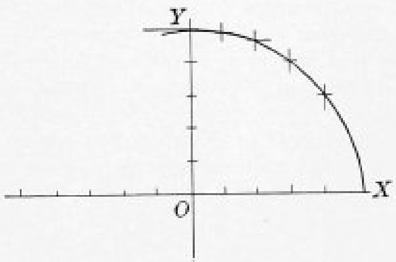

FIG. 4.—LOCATING THE CIRCUMFERENCE

is called the fourth angle. And, John, just note the fact that this is where you get the two methods of making drawings, viz.: 'First angle' and 'third angle,' or 'roll' and 'pick' projection which always bothers you so much!"

"And is that where those confounded 'angles' came from? Well, well, there is sure a whole lot in geometry dope, and I am beginning to believe that a fellow had better get busy mighty quick and have geometry with him, instead of against him in this game! But, Mr. Hobart, we have only got two of the angles filled—the first and the second; how are the others filled up?"

"That question shows that you are alive, John, and after information. If you will brush up your algebra a little you will remember that when we solve an equation like $y^2 = 25$, we can always obtain two values of y, viz.: $+ y$ and $- y$. The first, or $+ y$, is always above the line $X X'$, the second, or $-y$, is always below line $X X'$, and these minus values of y are what fill the third and fourth angles!

"See it now, John?"

"Y-e-s-s—I guess so. Takes a little time, though, to get all this new stuff stored away in a fellow's head where it won't topple over each time you try to use it. But I believe with a little more study of the matter that I will have it salted down ready for everyday use. But, tell me—how did the professor figure out that ellipse with the axes were to be 6 and 4? He gave the equation as $9y^2 + 4x^2 = 36$. Now, I can't hang my hat on any connection between 6×4, and his figures 9×4! How do you work the combination?"

"Take one-half the axis lengths, John, same as we did with the diameter of the circle. We took one-half of $10 = 5$, didn't we? And now we must take one-half of 6, or 3, and one-half of 4, or 2. Now, if we square these numbers, making $3 \times 3 = 9$ and $2 \times 2 = 4$, then we have the figures given by the professor!"

"Say, that's so, isn't it? Gee! How easy geometry and calculus are when you know how, and how devilish hard it is when you are on the outside. But tell me how to work out the values of x and y in the equation $9y^2 + 4x^2 = 36$?"

"Sure, John. Start by letting $x = 0$, as before, then we have $9y^2 + 0 = 36$, or $9y = 36$. Divide by 9 and we have $y^2 = 4$. Taking the square root of this we get $y = 2$. Then, going through the same operation with $y = 0$, we get $x = 3$. Next, going through the several operations for finding values between 0 and 3 we get as follows:

For $x = 0$, $y = 2$
$x = .5$, $y = 1.97$
$x = 1.1$, $y = 1.89$
$x = 1.5$, $y = 1.73$
$x = 2$, $y = 1.49$
$x = 2.5$, $y = 1.1$
$x = 2.75$, $y = 0.8$
$x = 2.9$, $y = 0.51$
$x = 3$, $y = 0$

"And with the plus and minus values of y thus found you can lay out that ellipse with ordinates 1½ inches apart, which should be close enough for a boiler job!"

"Oh, Mr. Hobart! Is this equation business good for anything except circles and ellipses? Can you write out other lines and curves in that way?"

"Sure, there is not a line or a curve ever made, or ever will be made, which cannot be so expressed by an algebraical equation that one who understands the matter can lay out that curve or line when or where he pleases!"

"Say! then geometry and other mathematics must be a sort of regular 'clearing house' for all sorts of mathematical work, isn't it?"

"Sure, John. Algebra in particular, and some other branches of mathematics, are pretty much like money. You have anything, you turn that thing into money, and you can carry the money around easily and turn it back again into anything you want at any time you want it! That's what money is good for. But you can do the same thing with mathematics, and more, too! Your knowledge of algebra and geometry and the calculus is so much money value, always ready for use, to be turned into work at any time you want it, but with the added good point which money never can have, viz.: they can steel your money from you, but they never can steal away your knowledge of mathematics. That will always stay with you, ready to be turned into spot cash!"

The Factor of Safety in Marine Boiler Practice

Factor of safety as applied to a steam boiler means the margin between the allowable working pressure and the actual bursting pressure, or the pressure at which the boiler would rupture. The United States Steamboat Rule fixes six as a factor of safety. No deduction, however, is made for the longitudinal seam, the efficiency of which is always less than that of the solid section of the plate. In ill-designed seams the efficiency is low, which brings the factor of safety below that which is considered good, safe practice. This clause in the rules referred to is obsolete. In no way does it apply to modern conditions, and as Mr. William S. Dawson remarked in his address on this subject before a joint meeting of two American Engineering Associations, its repeal is very necessary, and a clause founded on modern practice should be adopted.

Apart from the steamboat rules, the engineering fraternity have practically adopted five as a factor of safety in determining the safe working pressure on steam boilers. This factor is applied to the bursting strength of the weakest part of the boiler, and when applied to a cylindrical shell the weakest part would usually be the longitudinal seam. The factor of safety has to take care of the shock due to unequal expansion on the various parts of the boiler, also reactive forces due to the pulsation from the intermittent demand for steam by engines with quick opening and closing admission valves. It would seem natural, therefore, that some provision would be necessary to provide for these extra stresses over and above the steam pressure.—*Shipbuilding and Shipping Record.*

Is There Any Limit to the Length of a Tube in a Boiler Without a Support Midway of Boiler, Etc.?*

Thus far the flue 24 feet in length seems to have been the maximum length reached. Such flues have measured 2¼ inches outside diameter. Twenty-two seems to be the maximum length for the 2-inch outside diameter flue. Within these two dimensions we find lengths varying with the size, capacity and design of locomotives. In diameter they range from 1¾ to 2¼ up to 22 feet in length, but for lengths over 22 feet to 24 feet 2¼ inches outside diameter seems to prevail, some straight and some swedged, depending upon the belief of the railroad as to which is the better.

If any data have been procured to indicate the necessity for intermediate supports for the 2-inch or 2¼-inch flue, 22 feet long, the writer is not in possession of such information. Many locomotives being built to-day have 2-inch flues, 22 feet in length unsupported between flue sheets, and the results reported seem to be very satisfactory. Such being the case, it would not appear particularly necessary to introduce supports, especially since no entirely satisfactory method has yet been devised. Supports have been applied to boilers, experimentally, and probably have been used to some extent by advocates of their use; but speaking from personal experience, consider that while there is no doubt but that the support firmly holds the flue when put in place, the removal of the flues at the repair period has proven such a difficulty, as well as expensive task, the efficiency of the scheme, while plausible, remains undetermined.

As can quite readily be apprehended, the deposit of sediment and scale on the flue and around the supports practically means the stripping of the flue of such deposit for its removal from the boiler. Around the flues, at least, in the arrangement of support to which particular reference is made, a split sleeve was used, but its removal helped matters but very little.

The opinion is extensively supported that it is not necessary to provide intermediate supports for flues of reasonable length, say up to 22 feet, on the grounds that a 2-inch flue made of 1/16-inch material would be entirely supported by the buoyancy of the water, and as the thickness of a 2-inch flue is a little more than ⅛-inch, the weight for a length of 22 feet is not considered sufficient to warrant additional supports between the sheets.

On account of the difficulty entailed in any attempt to check up the relative durability of flues by lengths and diameter when there are so many factors accepted as being so powerful in their influence as to vitiate any so far discoverable effects, the belief is, so far as can be obtained, that any difference in length, with the dimensions alluded to, is inappreciable. It is, however, the opinion that the 2-inch swedged flue has advantages over the large size from a standpoint of service and durability.

A very good rule deduced from tests and experience tends to show that so long as the length of the flue does not exceed 110 diameters outside measurements, very satisfactory results are assured, and no attempt is made to hazard the statement that flues in excess of 120 diameters will not produce increased capacity and efficiency, because such might be disproven. Long experience, however, influences the belief that the above are conservative figures. On the other hand, good results have been secured from the 24-foot flues, 2¼-inch outside diameter, as far as boiler efficiency and durability are concerned; but as far as the writer's experience reaches, the flues have been supported between sheets, and it was with these of such length and so supported that so much difficulty was experienced in their removal for repairs. It has been reported that flues of this length are applied without intermediate support, but no data of interest as to their service seem to be obtainable.

There are two prime objections to the longer flue: First, their manufacture; second, the still unsettled question as to the necessity and efficiency of supports, and the friction or retardation of the gases, through the longer lengths which is considered.

The question of manufacture, while undoubtedly of some moment, has not yet been brought to us as a serious objection. Practically speaking, the longer lengths receive a very material support from the water, as already mentioned, yet if the locomotives are handled empty the flues would be very apt to spring leaks when fired, due to the sagging or vibration disturbing the joints made in the front and back flue sheets.

Taking into consideration the work a locomotive flue is required to perform, no one will venture to say the flue is not at some disadvantage, as compared with the design and improvements of other parts of a locomotive, which have received increased strength, greater capacity, and efficiency as the locomotive has advanced. As a matter of fact, the general arrangement of flues in a locomotive boiler, the methods employed in their application, and their treatment thereafter, are substantially the same now as they were twenty-five years ago.

In some of the modern high power locomotives the rate of combustion per square foot of grate or firebox areas has improved with the increased efficiency of the locomotive; still, the flue mileage has fallen off in some cases and where locomotives are operated under practically the same conditions, which would indicate that we are not getting the service out of the flues obtained a few years ago, as can be shown by statistics.

In this phase of the proposition the relative length of the flue has not been an important factor in the observation alluded to; on the contrary, the endurance of the bead or joint in the firebox flue sheet was the controlling or limiting factor, and, too, it was not due to any condition developed in the body of the flue. It is a curious fact that flues might be applied to two engines under exactly the same conditions, as far as can be observed; and one engine will go into service and give a good account of itself, while the other will make a complete failure. Oftentimes it is concluded that the flues had not been sufficiently expanded or the beads have not been sufficiently laid up, etc., still neither of these conditions could have been foretold with any degree of certainty before the engine was set out for service. There is no qustion but that there was some reason for this difference, but even among experts such conditions are hard to solve; in fact, remain undecided to a great extent; still, they might be properly classed as due in the main to inefficient workmanship.

Long and carefully prepared records show very conclusively that the service of flues in new engines is considerably better than that obtained from sets applied to the same flue sheet thereafter. In order to give a better idea of what this difference has been found to be in certain parts of the country, it might be of interest to mention that a set of flues applied to a new flue sheet might give 40,000 miles; still, it would not be expected that the next set or later sets applied to the same sheet would average more than 25,000 miles. This we might conclude is due, in part, to workmanship; and again to the distorted condition of the holes in the flue sheet or some such cause.

If there is any ill effect upon the flue, by reason of unequal expansion in the readjustment of the several parts of the

* Abstract of a committee report presented before the Master Boiler Makers' Association at Chicago, May, 1913, by J. A. Doarnberger, E. E. Stillwell, T. J. Reddy, H. J. Raps and Martin Yale.

boiler, it is reasonable to suppose that it should be more prominent during the service of the original set of flues. While such conditions are apart from the question of lengths and diameters of flues, they are mentioned to show disturbing influences met.

The question of intermediate supports is not to be regarded as set aside as impracticable or an unnecessary device; on the contrary, the idea and principle seems to be plausible, but it introduces one of interference to circulation and their removal, both of which are serious. If such a support could be devised so that the installation of flues would be separated from the top, and, furthermore, that the holes through which the flues pass were made large enough so the flue could be pulled through without difficulty, even though they be considerably coated, some advance might be regarded as having been accomplished.

While our experience seems to indicate that intermediate supports are not necessary for a 2-inch flue, 22 feet long, it cannot be said with any feeling of certainty that it will not be of some benefit. The contrary opinion is held on account of a series of experiments with two groups of engines of the same size and capacity; one having a full set of flues applied in the usual way, and the other group fitted up with a reinforcing flue sheet, held rigidly 8 inches back of the firebox flue sheet, which had the effect of holding the flue tightly for this length, relieving the joint or bead of any working or distortion due to the vibration of the body of the flue, between the reinforcing sheet and the front flue sheet. The observations referred to did not develop any material interesting data in the way of increased durability of the joint or bead itself, but advantages in other directions. While some designers are going to the above limits in lengths of flues, the adoption of the combustion chamber has materially modified the apparent wisdom of adhering to former lines.

A most interesting diagram appears in the *Railway and Engineering Review*, October 19, 1912, under heading of "Locomotive Construction," showing that about 77 percent of the water is evaporated per square foot of heating surface in the firebox plus the area in the first 4 inches of flue length. From this point forward the flues were divided into four parts of equal length. In the first section, beginning at a point 4 inches from the box, a little over 22 percent of the water evaporated; in the second, about 12 percent; in the third, about 7 percent, and in the fourth and last section, about 4 percent. The paper referred to was primarily designed to show what is derived from the flue as the length is affected. With these conclusive figures before us and the conclusions from Dr. Gross's recent tests on locomotive boilers, we might expect the combustion chamber will find more favorable consideration than in the past, especially since some of the objections, on account of incessant leaking at seams, appears to have been materially improved by reason of changes in boiler design.

In conclusion, the inference might be drawn that notwithstanding experience, while limited, has not shown that flues up to the lengths referred to have proven higher in cost to maintain, realizing, of course, the difficulties and conditions surrounding the securing of accurate information for any such purpose. Secondly, that the 24-foot flue 2¼-inch diameter observed had intermediate supports between flue sheets. Thirdly, that no observations have been made, or at least reported, where flues more than 2 inches in diameter have run over 22 feet in length, nor diameters other than 2¼ for lengths between 22 and 24 feet, the latter being the limit so far attempted. Fourth, that it seems to be the opinion that the 2-inch flue, swedged to 1⅞-inch for the rear flue sheet, gives much better results than the larger flues from a point of service, as well as maintenance.

The advocates of the longer flue are many; but if there is any change in sentiment taking place, it seems to be for the shorter lengths and larger firebox areas, with a view of obtaining more effective heating surfaces.

Inspection Service Rendered During 1912*

Tables 1 and 2 give the total number of visits of inspection, the total number of boilers inspected and other similar statistics gathered from the inspection records by the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., for the year 1912. These figures are worthy of consideration, inasmuch as they show something of the frequency with which one may expect to find the various defects listed among any representative number of American boilers. These results are gathered from so many boilers, and these so distributed over the country that the effects of local conditions largely disappear in the totals.

A glance at Table 2 will yield some interesting information. For example, in 17/18 of all the visits made a defect was found which was deemed of sufficient importance to report. Further, of the 164,924 defects reported, 18,932, or just over 11 percent, were considered dangerous at the time of the inspector's visit. As has been shown many times before, by far the most frequent troubles have their origin in the feed water or the method of using it, a fact which is evidenced by the large number of instances in which scale or sediment and corrosion are found.

TABLE I.—SUMMARY OF INSPECTOR'S WORK FOR 1912

Number of visits of inspection made	183,519
Total number of boilers examined	337,178
Number inspected internally	132,984
Number tested by hydrostatic pressure	8,024
Number of boilers found to be uninsurable	977
Number of shop boilers inspected	10,098

TABLE II.—SUMMARY OF DEFECTS DISCOVERED

Nature of Defects	Whole Number	Dangerous
Cases of sediment or loose scale	26,299	1,553
Cases of adhering scale	40,336	1,436
Cases of grooving	2,700	252
Cases of internal corrosion	15,403	823
Cases of external corrosion	10,411	895
Cases of defective bracing	1,391	331
Cases of defective staybolting	1,712	345
Settings defective	8,119	768
Fractured plates and heads	3,288	510
Burned plates	4,965	517
Laminated plates	445	55
Cases of defective riveting	1,816	405
Cases of leakage around tubes	10,159	1,607
Cases of defective tubes or flues	11,488	4,780
Cases of leakage at seams	5,304	401
Water gages defective	3,663	816
Blow-offs defective	4,429	1,398
Cases of low water	447	151
Safety valves overloaded	1,349	380
Safety valves defective	1,534	419
Pressure gages defective	6,765	568
Boilers without pressure gages	633	102
Miscellaneous defects	2,268	420
Total	164,924	18,932

* From *The Locomotive* of the Hartford Steam Boiler Inspection and Insurance Company.

Service Inspection and Repairs of Locomotive Boilers and Appurtenances

BY C. E. LESTER

The inauguration of the law governing the inspection of locomotives under the Inter-State Commerce Commission supervision has been the means of bringing about some radical changes, or rather has caused mechanical officers of railroads to inaugurate practices that previously had been given little or no attention. Previous to the supervision by Federal inspectors, on a great many railroads outside steam leaks and the inspection of boiler fixtures were passed over or taken care of in a careless and perfunctory manner. Many parts that are now considered vital were previously recognized only as a part of the locomotive, but further than that were never thought of unless forcibly brought to attention by some accident.

While in many instances it was not necessary for the Inter-State Commerce Commission to inaugurate present practices, it was necessary to have a law of this kind passed to awaken mechanical officers to the fact that keener inspections and a more systematic method of handling the work would be necessary to at least prevent a great many minor accidents. The additional expenses to railroad companies incurred by such inspections and record keeping is, the writer believes, fully met by the savings made in the reduction of damage suits and the many cases settled outside of court by conciliatory methods.

The terms "boiler inspection" and "boiler appurtenances" are broad in scope and should, the writer believes, embrace everything from the manhole cover on the back end of the tank to the netting and blower pipe in the front end—that is, practically everything on the locomotive that has to do with the generation of steam. The following embodies the writer's views on boiler inspection and embraces some things not usually connected with this subject, yet the writer advances the idea with but little fear of contradiction that each part mentioned should be considered a regular part of boiler inspection. The term "service inspection" the writer designates as an inspection at any time other than when the locomotive is in the shop, or at the hydrostatic test period.

First may be considered the matter of records, which, of course, applies to all phases of the subject. The master mechanic's office is undoubtedly the proper place for these to be kept. The work should be detailed to a clerk, and ample time given him to keep the records systematically. The records should embrace:

(*a*) Last hydrostatic test.
(*b*) Last complete removal of flues.
(*c*) Last complete removal of lagging.
(*d*) Last complete inspection of flexible staybolts.
(*e*) Date previous boiler washes.
(*f*) Date and number of staybolts renewed.
(*g*) Date previous setting of safety valves.
(*h*) Date withdrawn from service.
(*i*) Special repair report.
(*j*) Transfer of power from one division to another.

The clerk handling these records should be in touch with the train despatcher's office so that he will receive daily a report of all engines transferred. His place should also be easily accessible so that the boiler inspector can get to him without difficulty.

Each day there should be issued a statement showing engines having been washed the day previous and engines due for washout for the next ten days and distributed as per the example following:

"NEW YORK, N. Y., 5/8/13.

"MESSRS. ENGINE DESPATCHER, FOREMAN BOILERMAKER, ROUND HOUSE FOREMAN, BOILER INSPECTOR.

"*Gentlemen*: The following engines were washed yesterday:

"Blankville, 272, 416, day; 762, night.
"Overtown, 619.
"Tendercliff, none.

"The following engines are due for washout as follows: (Each engine due for ten days shown on date due).

"Yours truly,
"MASTER MECHANIC."

It is possible that at small terminals where but few locomotives are handled this part of the system would be a superfluity.

The engine despatcher, who handles the power, is the proper person to designate the boilers to be washed on certain dates, as he knows what power is needed and can arrange it best. The other men interested checking the sheet daily to see that no engines run over and that too many engines are not held at one time. It is better to wash boilers before due than run the chance of having a congestion or have several run over due. A daily transfer sheet should be supplied showing all engines that have been transferred to other divisions for service or to any point for shopping.

In addition to these sheets an additional sheet should be issued monthly showing engines due within the next two months for hydrostatic test, complete removal of tubes, or lagging, or inspection of flexible staybolts. This enables all concerned to gage their repairs accordingly, and should an engine be in shop for light repairs that would be due for test within the next two months it would be policy to make the test while the engine is shopped so that it would not have to be held again in a short time.

The front end and ash pan inspector should preferably be stationed at the ash pit, so that all engines going over the pit may be inspected whether or not they go to the engine house. The inspector should obtain each day a list of engines to be washed out, and after making his inspection he should fasten the front door only temporarily, so that there need be no repetition of work when the engines get in the house. The front end should be examined carefully to see that there are no openings any place larger than the mesh of netting, to see if any holes are in the pump exhaust or in the blower pipe that would interfere with these parts properly performing their functions. The ash pan slides and grates should be examined to see that there are no large holes that would drop fire. If any defects are found they should be reported promptly and an entry to that effect placed in the "fire appliance book," and when repairs have been completed an entry should be made showing the kind of repairs, date and name of person making repairs, so that in case of a "fire claim" accurate information can be furnished. It is a well-known fact that practically all fires that happen anywhere near a railroad track are invariably traced to some locomotive, regardless of the facts in the case. Fire claims against railroads in the United States aggregate millions of dollars yearly and it behooves the foreman boiler maker to have a careful and responsible man inspecting ash pans and front ends.

It is hardly to be expected that the boiler inspector with his manifold duties will have time or opportunity to inspect tanks, so it should be made a part of some man's duties to see to the tanks and appurtenances, and at each boiler inspection the tank lid should be made to fit properly. The manhole screen should be put in condition so that there is no hole larger than the mesh. The top of the tank should be examined from the interior to see that there are no holes where coal or cinders can work through. All braces and splash plates should be rebolted in place so that they cannot interfere with the proper working of the tank valves. Tank and tank wells should be swept clean of scale, sediment, etc., and tank valves and rods examined to see that they open and close properly. The tank hose should be dropped and screens removed and hose flushed to remove all sediment. Where it is necessary to use rubber gaskets in hose connections the gaskets should be cut with a forming tool, so that they will have the proper contour and no ragged pieces left to pull off and be carried up into the injectors.

The inspection of the boiler fixtures should be made before the steam is blown down on the boiler. Leaky cab fixtures, or, in fact, anything "that would obscure the vision of the engineer," should be given careful attention.

Studs in expansion plates, running board brackets, or, in fact, any stud accessible should be given a hammer test. The report of the chief boiler inspection department of locomotive inspection, Inter-State Commerce Commission, shows squirt hose to be the most prolific source of accident of any one part covered by boiler inspection. The hose connection should preferably be behind some obstruction, or where this is not possible it should be faced downward and securely clamped in place. Lubricator glass breaking is also a source of a great many accidents. The shield should be of substantial make and should fit so securely around the glass that it will protect a person no matter what his position may be in the cab.

The greater number of accidents to lubricator glasses happen immediately after applying a new glass or after filling the lubricator, when the engineer or workman is very liable to be directly over the lubricator, so that it is important that the glass be amply protected in this direction. This also applies to the common tubular water glass. The Klingertype reflex glass is rapidly taking the place of the tubular glass, this type being practically unbreakable in service and consequently requires no guard.

The writer has noted that several railroads are doing away with steam chest relief valves, whether for the uprpose of economy or on account of steam leaks is not known, but it certainly makes a marked improvement in "steam leaks."

Injectors should be put to work and feed and branch pipes examined for leaks that frequently mean hard-working injectors. It is presumed that inspections are usually made at the boiler-washing periods. After the boiler is cooled down and during the washout period the injector valves and checks should be reseated and the checks given the proper lift. When all gage cocks or spindles, water glass mounting and steam gage and siphon are removed, a reamer of the nominal size of holes should be used and all holes in the boiler reamed free of scale to proper size.

A simple steam-testing apparatus can be erected at small cost for testing gage cocks and water glass mountings, to the end that when they are applied they are in good order. The steam gage siphon should be given a water test to discover any possible obstructions. The gage cock and water glass mountings should be ground in to make a tight joint.

It may be well to add that at the time of hydrostatic test the safety valves should be removed before the test and the boiler openings capped. This practice will eliminate excessive tension on the safety valve springs. The repair of safety valves should be intrusted to a skilled mechanic only, as the valve is one of the most delicate as well as important parts of a locomotive, and to register correctly must be in perfect condition.

Standard gages for the valve seats, disks, etc., should be used in repairs and care be exercised to see that all parts conform to the gages. In grinding in seats care should be exercised to see that the bearing surface is not too great. In setting the valves the "blow down" should be adjusted so that it will be between three and four pounds. The washing of the boiler should be thorough at all times and every washout plug, arch plug or cap removed. The inspector should examine such of the interior as can be seen with a light through the washout holes. The firebox side sheets along the mud ring should be carefully examined for pitting or grooving, and before the washout plugs are reapplied there should be an inspection of the threads of the plugs and also the holes to see that each is well threaded. In making the firebox inspection a magnifying glass and an electric flashlight are of great assistance, frequently disclosing defects not discernible to the naked eye with a torch or lamp. In inspecting the flues examine them closely to see that there are no beads off or broken or no beads formed by drawing the sheet up to the flue with a beading tool. All such flues should be immediately removed.

The plugging of flues or the rolling of thimbles or ferrules inside the flues is a dangerous practice and should not be countenanced. Pocket or blind flues are also a source of danger, and where it is necessary that they be used they should be securely beaded and also expanded inside the sheet. It is preferred, however, that such holes should be plugged, and in every case the plug should be applied from the water side to eliminate any possibility of the plug blowing out.

Examine each sheet carefully for cracks, bulges or laminations. Where arch tubes are used they should be carefully examined in the firebox for any evidence of pulling, laminations, pockets or cracks, and on the outer ends to see that they are free from scale or evidences of pulling, and that each tube extends through the sheet far enough to be belled over or beaded, and that this work is properly done. The writer has found a light hammer for staybolts and a heavy one for radial stays to give the greatest satisfaction. Should broken bolts develop under the hammer test, it is well to have the lagging and jacket stripped, as an ocular test of the exterior will undoubtedly develop more when lagging is off. It is a pretty good plan to try.

The detector holes in the staybolts should be gaged, as it is very frequently found that the holes are filled with sediment or not drilled a sufficient depth to perform their required duties. Many railroads are adopting electric or oxy-acetylene welding, and it is not an infrequent occurrence to find staybolts with the heads covered over with a slab of welded metal. This practice is a dangerous one, due principally to the fact that it is impossible to detect a broken bolt or one that is pulling in the sheet. In all such cases the boiler should be kept out of service until proper repairs are made. Belly braces fastened with flexible staybolts have been adopted by some companies, and as this type of brace is practically a new one, but few boilers are so equipped. Being familiar with them, the writer can vouch for the statement that under the hammer test the bolts sound like broken brace bolts, especially when the boiler is cold and with no particular tension on them. The inspector should familiarize himself with boilers in which these braces are, and are not, applied, and keep a record of same so that he will not become confused and allow a boiler in service with broken belly braces laboring under the impression that the boiler has flexible stays. Flexible staybolts and radial stays are confusing under the hammer test, and the inspector should have a record of the location of these bolts in each boiler in his territory.

In making inspections and ordering repairs it should always be borne in mind that the inspector swears "to the best of your knowledge and belief the statement of inspection is true." It certainly does not pay to falsify any report, which is, of course, dishonest, and with the liability of serious consequences, of which disqualification as an inspector may be well considered, as well as the possibility of a serious accident with resultant loss of life.

A paper on inspection of locomotive boilers by John F. Ensign, Chief Inspector, Department of Locomotive Boiler Inspection, Inter-State Commerce Commission, read before the St. Louis Railway Club and published in the April issue of THE BOILER MAKER, deals with several phases of the subject that have been the source of much misunderstanding and discussion. The attitude of the department along these lines is explained so clearly that there can be scarcely any doubt as to what is desired and required.

It is undoubtedly a fact that even at this late day there are points where the force making inspections and following up the work caused thereby is no better than previous to the enactment of the law. The labor and responsibility have been increased greatly and no provisions made to cover this. However, each day brings a clearer understanding of the requirements, and with it a more reasonable attitude on the part of some who delay it. When it is taken into account that during the year of 1912 the total number of accidents reported were 35, with 3 killed and 40 injured as the result in the State of New York alone, it can be seen that there is yet a great opportunity for improvement and education in the inspection and maintenance of locomotive boilers.

Firebox Roof Girder Formula

BY F. A. GARRETT

It is common knowledge that where a considerable number of calculations have to be made from any one formula, but with varying factors, a great deal of time may be saved by the application of graphical methods for solving various problems. The chart shown herewith was designed by the writer some two years ago for rapidly solving problems in connection with the Board of Trade formula for firebox roof girders. As it has answered its purpose admirably, it may possibly be of interest to readers of THE BOILER MAKER.

The same principle may be applied to a great variety of formulæ, and a detailed description of the principles involved will enable readers to construct charts for a good many formulæ which they may be interested in. The chart is plotted from the formula

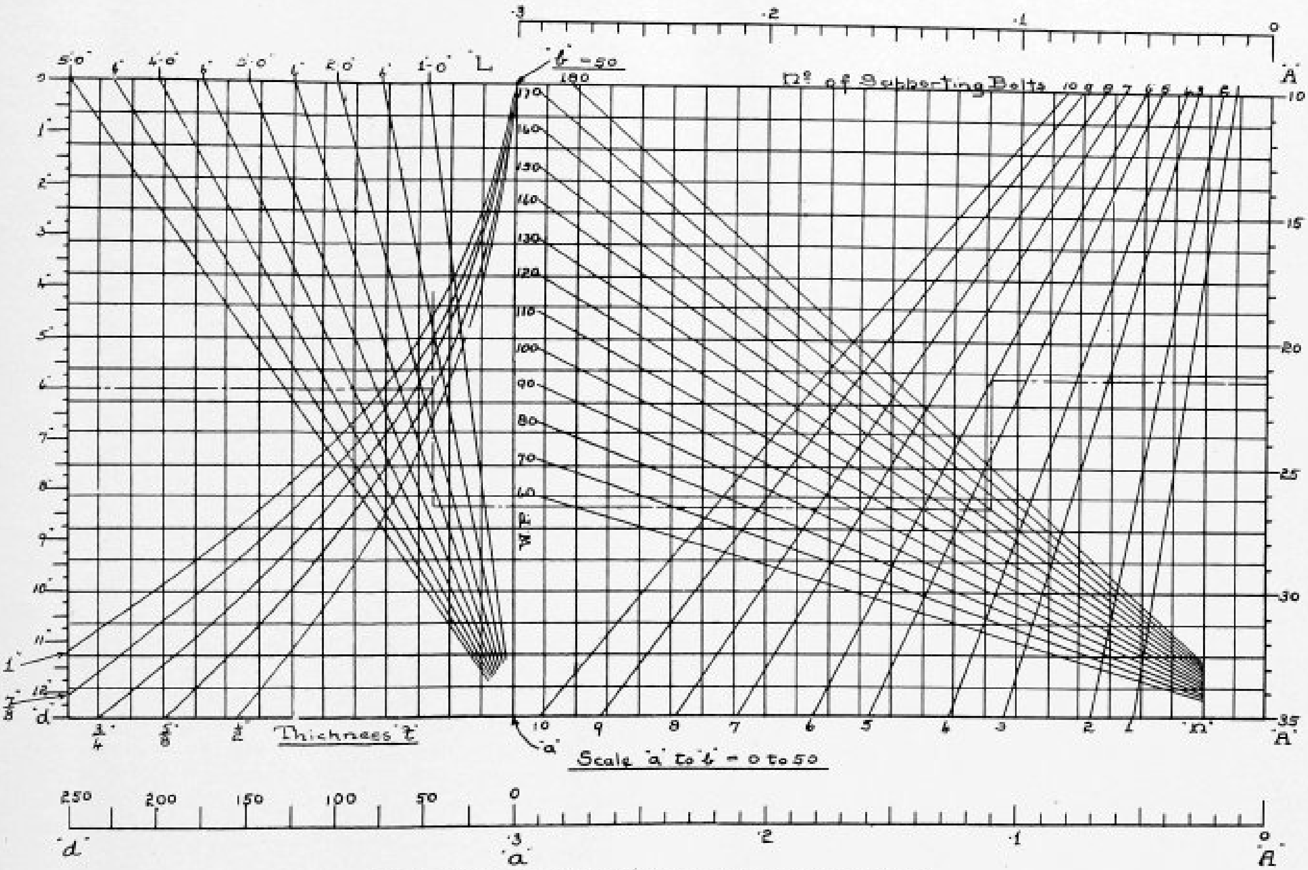

FIG. 1.—GRAPHICAL SOLUTION OF FIREBOX ROOF GIRDER FORMULA

$$d = \sqrt{\frac{(W - P)\, D \times L \times WP}{C \times T}} \qquad (1)$$

Where d = depth of girder at center in inches.

T = total thickness of one girder in inches.

t = thickness of each plate in girder in inches $= \frac{T}{2}$

W = length inside plates of combustion box in inches.

L = length inside plates of combustion box in feet.

P = pitch of supporting bolts in inches.

D = distance apart of girders in inches.

n = numberof supporting bolts in each girder.

WP = working pressure in pounds per square inch.

C = constant, which varies with the number of bolts in each girder. (See Table I.)

$A = P\ D =$ area supported by one bolt in square inches.

Fig. 1 shows how the chart will appear when completed, but it will be much easier to read accurately if it is plotted on paper ruled in millimeters. The detached scales at top and bottom of the figure show how the chart is scaled off, so as to enable the calculated values to be plotted, but these may be left off the chart when inking it in.

We shall have to rearrange the formula somewhat so as to put in workable order for plotting.

TABLE 1

No. of supporting bolts	Value for C	$\frac{n}{C}$	Values of $\frac{A\ n}{C}$ when $A = 10$	$A = 35$
1	660	.001515	.01515	.053
2	990	.00202	.0202	.0707
3		.00303	.0303	.106
4	1100	.003635	.03635	.1271
5		.00454	.0454	.159
6	1155	.00519	.0519	.1819
7		.00606	.0606	.212
8	1188	.00674	.0674	.236
9		.00758	.0758	.2655
10	1210	.00826	.0826	.289

After a little thought it will be evident that $(W - P)\ D = P\ D\ n$ and $P\ D = A$, so that the formula (1) becomes

$$d = \sqrt{\frac{A \times n \times L \times W\ P}{C \times T}} \qquad (2)$$

If we consider the factors $\frac{A\ n}{C}$, we see that with a particular number of bolts in each girder, the value of $\frac{n}{C}$ will remain constant, while A will vary. So that we may write:

$\frac{A\ n}{C}$ = a constant $\times A$ square inches = values for scales $A\ a$ and $A\ b$. The values for $\frac{n}{C}$ will be found in the table, together with calculated values for $\frac{A\ n}{C}$, when $A = 10$ and when $A = 35$ square inches. Now plot the former values along the scale $A\ b$ and the latter values along the scale $A\ a$, and connect up the points by straight lines, as shown in the figure. Calling any particular value of $\frac{A\ n}{C}$ which we may choose a constant, and multiply it by the working pressure, we get $\frac{A\ n}{C} \times W\ P$ = a constant $\times W\ P$ = values for scale $a\ b$. These curves will commence at the origin O in the right-hand bottom corner. Since the maximum value of $\frac{A\ n}{C} = .3$ nearly, we need only calculate the values of $.3\ W\ P$ to enable us to plot the second set of curves seen on the right-hand side of chart.

When $W\ P$	= 60	70	80	90	100	110	120
Value for scale $a\ b$	= 18	21	24	27	30	33	36
When $W\ P$	= 130	140	150	160	170	180	
Value for scale $a\ b$	= 39	42	45	48	51	54	

Again, calling any value of $\frac{A\ n\ W\ P}{C}$ which we may choose another constant, and multiplying it by the length of box in feet, we shall get values for the straight line "curves" shown on the left-hand side of the chart for $\frac{A\ n\ W\ P}{C} \times L$ = a constant $\times L$ in feet = values for scale L.

Assuming lengths of box up to 5 feet, and calculating for intervals in length of box of 6 inches, we get the following values for scale L:

Length of box L	= 1′	1′ 6″	2′	2′ 6″	3′	3′ 6″	4′	4′ 6″	5′
$L \times 50$	= 50	75	100	125	150	175	200	225	250

These curves will commence at the origin O, and will terminate on scale L. It now remains to take varying values from scale $a\ d$, divide by the varying thicknesses of girders and extract the square root of the answer for

$$\sqrt{\frac{A \times n \times W\ P \times L}{C \times T}} = d = \text{values for scale } d.$$

Calculating, we get

When value on scale $a\ d$	= 50	100	150	200	250
Thickness of girder T = 1″	7.07″	10.00″	12.25″	.....	.....
" " " = 1¼″	6.32″	8.94″	10.95″	.....	.....
" " " = 1½″	5.77″	8.17″	10.00″	11.54″	.....
" " " = 1¾″	5.34″	7.56″	9.26″	10.72″	11.95″
" " " = 2″	5.00″	7.07″	8.66″	10.00″	11.18″

For the sake of simplicity, the curves plotted from these values are marked with figures which represent the thickness of plate used in making up the girder, or $\frac{T}{2} = t$.

It now remains to work out an example so as to make clear the principles of reading the chart.

The length inside plates of a firebox is 2 feet 9¼ inches. P = 4 feet 75 inches, D = 4.5 inches, $W\ P$ = 150, t = ⅝ inch and n = 6. From this we get $A = P \times D = 21.375$ square inches.

Referring to the figure, enter the scale A at 21.375, and follow the "dot and dash" line across horizontally until we get to the n line marked 6, then run down the ordinate so found until we come to the line of working pressure, and from this point run across the chart horizontally until we come to a point which represents the length of box in feet. (In our case 2 feet 9¼ inches is practically midway between the 2-foot 6-inch and 3-foot lines.) Then where the ordinate from this point cuts the ⅝-inch t line we read off on the left-hand vertical scale of chart the depth of girder, which is seen to be a little over 6 inches. Incidentally, on this same ordinate we can read the various depths for other thicknesses of girder bar.

It will be noted that if we want to find any other factors of the formula, such as the working pressure allowable for a given depth and thickness, it is only necessary to reverse the above operation. Checking over the above result by the formula (C = 1155)

$$d = \sqrt{\frac{(33.25 - 4.75)\ 4.5 \times 2.76 \times 150}{1155 \times 1.25}} = 6.06 \text{ ins.} = 6\ 1/16 \text{ ins.}$$

This figure practically agrees with that obtained by means of the chart, there being really an error of 1/32 inch by chart reading, as the ruling is not absolutely accurate.

SUMMARY OF BOILER EXPLOSIONS FOR 1912.—According to statistics gathered by the Hartford Steam Boiler Inspection and Insurance Company, Hartford, Conn., there were 537 boiler explosions in the United States during the year 1912, resulting in the death of 278 persons and injury to 392 others, making the total number of persons killed and injured from boiler explosions during the year 670.

Tools for Boiler Makers and Their Uses—V

BY W. D. FORBES

The operation of the machine* is as follows: The motor is started, the first clutch thrown in, which, of course, drives the pinion engaging with the hub of the large spur gear; when the sheet is in position the operator presses the lever on the floor, and in so doing throws in the clutch on the long shaft which sets in motion the shaft and the punch is forced down through the plate. How is the rotary motion of the shaft turned into a reciprocating motion, which is necessary in order that the punch will act? The revolving shaft has a pin turned on it eccentrically—that is, the center of the pin is not in the center of the revolving shaft, but offset from it. Fig. 39† will make this clearer. Here *B* is the center of the revolving shaft, *A* is the center of the pin and the distance *D* is the offset, and this distance multiplied by two will give the length of the

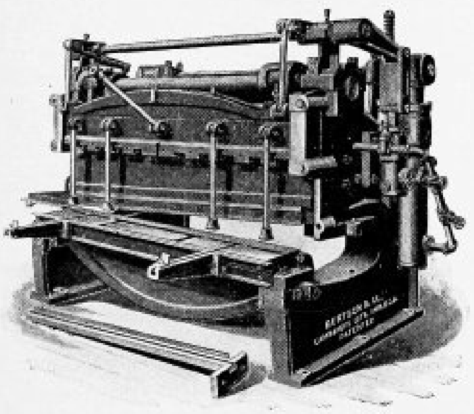

FIG. 41.—HYDRAULIC PLATE SHEAR

stroke of the punch carrying reciprocating head. This pin moves in a slot in a plunger *C*, which in turn carries the punch. Guides are provided at *E* and *E*. This is the general idea of the construction, and of course means have to be provided for the wear which will take place in any machine. An eccentric is sometimes used instead of an eccentric pin. In so large a punch as the one illustrated the punch carrying head is very heavy, and in order to make some compensation for the weight a spring is used, which relieves the machine.

In the throat of the machine will be seen a lever which is forked, and the punch is between the forks. This lever can be raised or lowered by turning the little adjusting wheel shown at the extreme left of the lever. The use of this fork is to prevent the plate after being punched from being lifted up with the punch, and the forked piece is called a "stripper." It might be supposed that this stripper was not necessary, as if a punch has punched a hole the punch should be drawn out of it without any friction, but this is not the case. The fact is that the punched hole is only the size of the punch, and if the plate is canted the least little bit the punch cramps and sticks in the hole. The stripper therefore obviates any trouble from cramping.

Now why so many gears? Why not connect direct with the long shaft? The reason is this, there would be no trouble in doing this if room and money was available, but to get the power required by direct drive would demand a motor of very great size, turning at a very slow rate, and such a motor could hardly be built. It must be remembered that the punch does not move fast, but requires great power, while the motor shown in the illustration runs at a high rate of speed. Now all these gears are nothing more or less than levers; the long end is the circumference of the gear wheels and the short ends are the shafts. It comes down to power and distance. The motor makes, we will say, 3,000 revolutions, while the long shaft turns but ten turns a minute, each stroke of the punch is 300 times as powerful as one revolution of the motor, but it must be borne in mind that the distance traveled by the punch is 300 times less than that traveled by the motor. There is no power gained, but there is great convenience obtained. No friction has been considered in these statements.

It is, of course, evident that instead of an electric drive a belt drive could be employed as shown in Fig. 40.** Here the clutch and foot rod are clearly shown and a flywheel is again provided. We referred to a flywheel a little earlier and said we would remark on it later, and we now say that the value of a flywheel lies in the fact that it is a storage of power, or energy. It will be clear on a moment's thought that were no stored energy available, very much more applied power would be required, but with the flywheel as the punch comes in contact with the sheet and begins to do its work, the stored energy is given out and the punching is accomplished with ease.

In Fig. 40 the belt is run on a "tight and loose" pulley and the operator shifts the belt from the loose pulley to the tight one when he starts the machine, and applies the clutch when he has the plate in position. When a plate is to be sheared the same system is used, only the punch is replaced by shears.

In Fig. 41 is shown a special type of shears. It is special only, however, because the shear blades allow a very much longer cut to be made than is possible with a standard tool. Of course any length of cut can be made by shifting the plate at each stroke with any shears, but the tool shown allows a longer single cut to be made in a way which at times is most advantageous.

The frame of these shears, instead of being single or throated is double, strongly braced by a connecting girder, a lower girder acting as a table on which the sheet rests. This lower girder is fixed, but the upper one is made to move up and down and carries with it one of the shear blades. The other blade is fixed to the lower stationary table.

The motion of the upper girder is obtained as in the punch, only instead of a single pin two connecting levers are used to apply the power at each end.

In Fig. 40 is shown clearly a feature not before referred to, that is, a counterweight on the ram. The reason for using this counterweight is to take the weight off the eccentric or driving pin. In this design it will be noticed that the flywheel is not large in diameter, but it is very thick across its face or rim. This would indicate that the shaft which carries the flywheel is run at a high speed, but the storage of energy would be just as effective.

Referring again to Fig. 41 it will be noticed that the shear blade on the moving girder is not set parallel to the table, and this is most always done except in very small shears for light metal. The reason for setting the blade at an angle is this: It is evident that if the shear blades were parallel the entire length of the blades would come together at the same

* See Fig. 38 and description in May issue.
† See May issue, page 146.
** See May issue, page 146.

time and a very great force would be required in order to make the cut, while with the blade set at an angle only one point is cut at a time; thus the power required is very much reduced. This may be made clearer by calling attention to an ordinary pair of hand shears. When used to cut a piece of paper the two edges of the blades cut the paper only at one point.

In Fig. 41, just in front of the moving blade, can be seen rods on the lower ends of which are round bases or feet, the rods being made fast to a stationary girder. These rods are called "gag holddowns," and they act as do the strippers on a punch and prevent the plate from rising after the cut is taken. These gags swing towards the front of the tool when the plate is withdrawn, thereby preventing any binding. Gags of this type are patented, we understand.

Now this wide-bladed tool is not made to work by an electric drive or steam power, but by hydraulic pressure. A cylinder is used and one can be seen at the right-hand end of the illustration. In this and the other cylinders on the other end not shown, water or some other liquid is used; quite often glycerine is employed, as it does not freeze. In these cylinders are pistons on which the liquid under pressure acts, and they are forced forward when required.

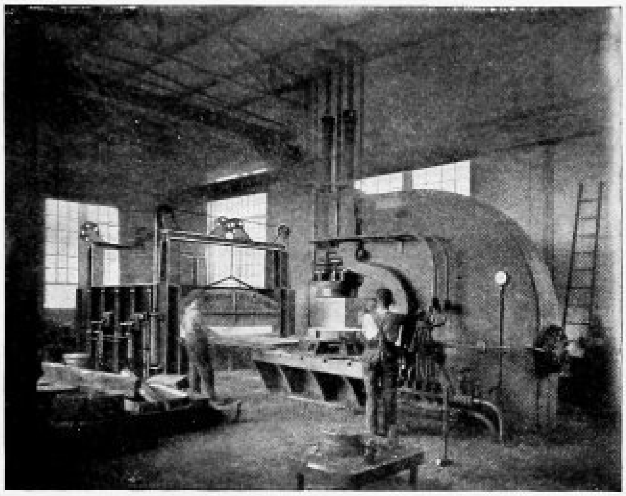

FIG. 42.—HYDRAULIC FLANGING PRESS

Fig. 42 shows a vertical hydraulic flanging press in which this very satisfactory system is used. In many cases having the work stand vertical is an advantage. The shell of a boiler can be punched at one handling in such a tool, as the shell is raised by means of an overhead crane or hoist and it can be turned for the pitch of the rivet at its ends and raised for the vertical seam.

It was not mentioned in describing deep-throated punches that to make the tool stiffer when only edge work is being done tie bolts are used.

They can be put in place or taken out in a few moments, and of course add to the stiffness of the punch if heavy work has to be done.

In the punches and shears, and in fact in all the tools on the market, there are many very clever devices, such as clutches, die blocks, etc., which are mostly patented, and which it would be impossible to describe even if only the leading ones of each class were chosen. Some parts of the punches are made to standard, and the punches and dies are so made. Figs. 43, 44 and 45 show a few examples of punches and a die. The punch is held in the machine as follows: In the sliding head or ram a hole is drilled into which fits a piece of steel held in place by a set screw. On the end of this piece of steel or holder is cut a thread on which fits a nut. This nut is so made as to allow the punch to pass entirely through except the head. By screwing up the nut on the holder after the punch is passed through it, the punch is firmly held in place. The threads are made to standard sizes, which is a great convenience to the users of punches.

Each manufacturer of boiler-making tools has his own designs, and he is very glad to send to those interested a full description of any part, or the entire machine if asked, and no man should run a tool any length of time without understanding all its working parts. The men who try to know more than just pull a lever or shift a belt are the ones who advance in their trade.

The action of punching a hole tears the metal around it to some extent, and it is usual to ream punched holes, especially if the plate is heavy, for on thin material this tearing effect is of little moment. To overcome this difficulty drilling is at times resorted to. In fact, on plates in boilers for high pressures drilled holes are demanded, and after the holes are drilled in a flat plate and the plate is rolled up the holes in the second plate have to be drilled from the holes in the first. It is usual to hear that drilling is a very much more expensive process, but when it is remembered that reaming has to be resorted to after punching this idea will be found not to be true. With a multiple drill press or a machine where a gang of drills is used the cost of drilling is perhaps

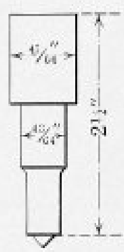

FIG. 43

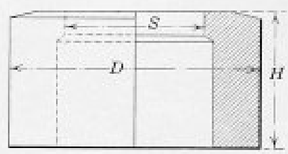

FIG. 44

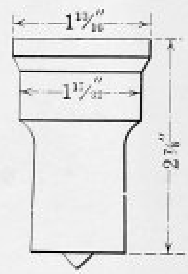

FIG. 45

less than punching and reaming. It will be seen that it would not be possible to get the heads of the drills close enough together to drill the holes in the plate close enough for ordinary boiler work, so every third or fourth hole is drilled and the sheet is then shifted and another lot of holes are drilled, which finally results in the holes being properly pitched.

When holes are drilled their diameters need not be considered, as is the case in punching. It is usually thought that a hole cannot be punched smaller than the thickness of the plate; but this is not strictly true, as now the better quality of steels allows punching to be done that disproves this idea. As far back as 1876, in Philadelphia, nuts 2 inches thick were punched with a quarter-inch punch, but this was only as an exhibition and not an every-day possibility.

Attention was directed to the shearing effect when the blades were set at an angle. Some punches are made on the same idea—that is, the face of the punch is not left square, but two spirals are filed, each starting from the face on opposite sides and running back half around the punch very much as if a partial thread was cut. This, therefore, shears two points of the plate at a time, and therefore makes the punch drive with greater ease and gives a cleaner hole.

There are, of course, many modifications of punches and many tools for boiler makers which may be called special for the class of work which the shop has taken up. We have given some illustrations of such tools, and when well provided with work they are great money savers.

(To be continued.)

The Boiler Maker

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CIRCULATION STATEMENT.

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

NOTICE TO ADVERTISERS.

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

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of THE BOILER MAKER, published monthly at New York, required by the act of August 24, 1912.

Editor, Howard H. Brown; managing editor, H. L. Aldrich; business manager, H. L. Aldrich, all of 17 Battery place, New York.

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ALDRICH PUBLISHING COMPANY,
H. L. Aldrich, President and Treasurer.

Sworn to and subscribed before me this 2d day of October, 1912.

(Seal) GEORGE E. MULLER,
Notary Public.
(My commission expires March 30, 1915.)

Owing to an unexpected delay in the delivery of the convention report, we must ask the indulgence of our readers for the late appearance of this issue of THE BOILER MAKER. As the delay was caused by circumstances over which we have no control, we trust that due allowance will be made for any inconveniences arising from the delay.

The Master Boiler Makers' Convention was an unqualified success in every respect. The attendance was the largest ever recorded. The membership showed a substantial increase; the work of the association was carried out with vigor and enthusiasm, and much information that is of value to the boilermaking craft was brought out and thoroughly discussed. With such evidences of sturdy growth as have been manifested by this association during its brief existence, we hope that every progressive master boiler maker in the country will become impressed with the mutual benefits to be derived from immediate affiliation with the association.

If any adverse criticism of the Master Boiler Makers' Association were to be made, it would probably be this: The association is devoted almost wholly to railway work, and offers little inducement to the contract or marine boiler maker.

It will be recalled that the present association was formed seven years ago by the amalgamation of the Master Steam Boiler Makers' Association and the International Railway Master Boiler Makers' Association. Among the active members of one of these associations were many influential men engaged in other branches of boilermaking than railway work, while the other association was devoted almost entirely to railway work. The amalgamation was brought about after due consideration of the claims of the various classes of boiler makers, with the object of forming a society which would cover thoroughly every phase of the boilermaking industry.

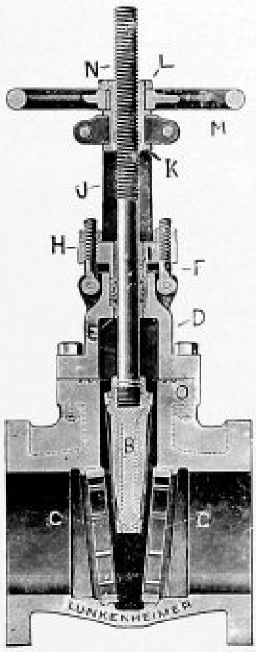
It is the opinion of many at the present time, therefore, that in covering only the railway branch of boilermaking the association is not fulfilling its purpose.

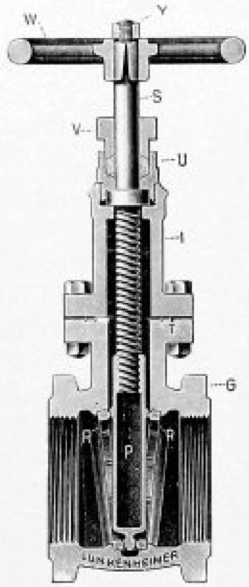
The subjects which were discussed most thoroughly at the convention related to the effect of superheaters on firebox and flue maintenance; the probable limit for the length of locomotive boiler tubes, and the advantages and disadvantages of oxy-acetylene and electric welding. The superheater apparently has proved a benefit in almost every case, prolonging the life of fireboxes, decreasing the cost of maintenance, and reducing appreciably the fuel consumption. The reduction of maintenance cost is due primarily to the fact that a steam pressure of only about 170 pounds can be carried on a superheated locomotive as against 200 pounds on an engine of similar power using saturated steam. Opinions varied as to the value of long boiler tubes; but, taking into consideration the increased size and power of modern locomotives, the long flue does not seem to be a detriment. A midway support for long flues, however, has proved detrimental. As far as autogenous welding is concerned, both the oxy-acetylene and electric processes have proved successful for the special kind of work to which they are adapted. Failures with both types of apparatus have been experienced, of course, but usually the failure has been due to poor operation, a difficulty which can be readily overcome.

Engineering Specialties for Boiler Making

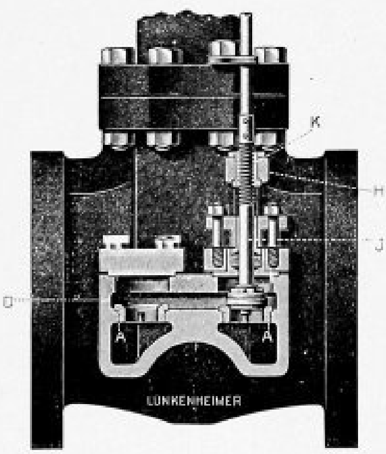
An Improved Gate Valve

The improved gate valve illustrated herewith, which is manufactured by the Lunkenheimer Company, Cincinnati, Ohio, is made either entirely of brass or iron body, brass mounted, or in "puddled" semi-steel, and also cast steel. It is also made in practically all sizes and patterns and for all pres-





sures and temperatures for which such valves are necessary. As can be seen from the illustrations the valves are made in two forms, one with a stationary stem and the other with outside screw and yoke. The seat rings, as well as the wedge disk, can be removed when worn, thus making the valve as



good as new. A very desirable feature in the construction of the valves is the fact that when finishing the interior of the valve body, that portion which receives the seat rings is threaded to the correct angle of the tapers of the valve disk. The seat rings are threaded and faced off straight, and when screwed in place they fit accurately to the tapers of the disk. This consequently makes it possible to easily renew the seat rings when they become worn or broken, hence prolonging the life of the valve. As the valves are double-seated they will take pressure from either side. Either pattern of the gate valve can be packed under pressure when wide open. The stuffing-box in the valve with stationary stem is made of bronze and is tightly screwed into the hub. In the valves with outside screw and yoke, both the gland and stuffing-box are lined with bronze bushings, which form a perfect bearing surface for the stems. The disks are accurately guided in the bodies, and by means of the guides the stems are relieved of all side strains. It is claimed that the valves are not affected to any extent by expansion or contraction. The joint between the body and hub is worthy of attention, for the reason that it is practically indestructible. It consists of grooves cut in the top surface of the valve body, in which are placed seamless copper gaskets. A joint made in this manner, it is claimed, will never leak and cannot wear out.

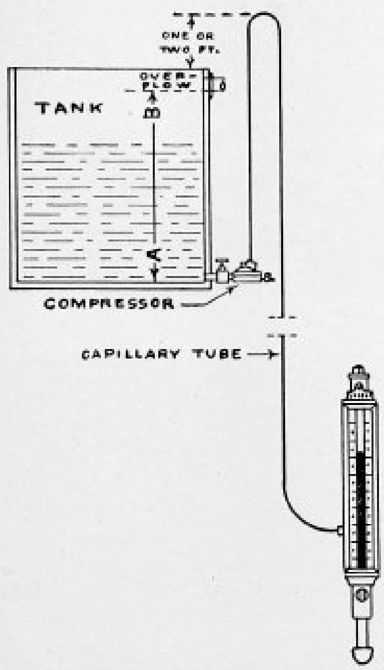
The valve can also be had with an exterior by-pass, a detailed view of which is also shown herewith. The by-pass used on the Lunkenheimer "Victor" valves is not separate from the valve proper but is cast integral with the body. The additional metal required for the by-pass tends to strengthen the valve body, and being self-contained it is not affected by extremes of expansion or contraction. The stuffing-box is made of bronze, and has a flange on the bottom, which prevents the iron flange above it from touching the iron body, and hence prevents the corrosion between these surfaces. Referring to the illustration, the outside screw and yoke *H* increases the durability of the thread on the stem *J*, owing to the fact that they do not come in contact with steam. The bushing *K*, which is threaded to receive the threads of the stem *J*, not only prevents corrosion but also makes it possible to renew the same should the threads become worn. The areas of the by-passes of these valves are sufficiently large to admit enough steam around the disk to quickly equalize the pressure on both sides.

The Hydro-Cator

A new hydraulic indicator called the Hydro-Cator is manufactured by the Sterling Gauge Company, Detroit, Mich. This instrument is used for indicating the depth of water or other liquids, and can be located any distance above, below or from the liquid to be indicated. It is adapted for tanks of all kinds, such as water, fuel oil, settling tanks and water compartments in floating dry docks and cranes, also ballast tanks, etc. The instrument itself is very simple, being free from any mechanism or moving parts, it shows at all times the exact amount of water in the tanks of compartments, in feet and inches or gallons.

The contents of the tank is shown by a brilliant red liquid or mercury in a glass tube, the scale reading is ten inches high for the standard instruments, which represents the full depth of tank, whether it is 2 feet or 100 feet, as each gage is specially calibrated for the depth of tank and the specific gravity of the liquid to be indicated. The manufacturers make them up with longer glasses up to 72-inch readings if desired.

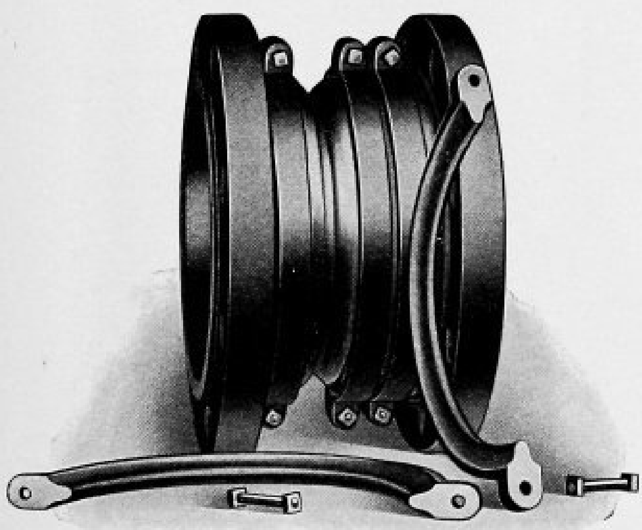
The instrument is fastened to a wall or bulkhead, and a ⅛-inch outside diameter capillary copper tube, annealed and very flexible, is run to the tank. The tube contains only air and can never freeze or stop up. One end of this hollow wire is attached to the top of a casting 6 inches in diameter, which is called the compressor, and is attached to the bottom and outside of the tank as shown, or may be simply lowered through the top to the bottom on the inside. The static pressure of the liquid in the tank forces the trapped air in the compressor and tube line against the indicating liquid in the instrument and causes it to rise in the glass tube in exact proportion to that in the tank. The apparatus can be installed without emptying the tanks of their contents, and it is charged



any time by attaching a standard bicycle tire pump to the cap on top of the instrument. One valuable feature is that the readings of the instrument are not changed or disturbed by any listing or racing of the boat in a heavy sea. The United States Navy are now specifying and have a large number in use.

The Badger Self-Equalizing Expansion Joint

The Badger self-equalizing expansion joint, made by E. P. Badger & Sons Company, Boston, Mass., is a corrugated



copper joint having external rings. It is designed to take up changes in length in pipe lines, whether these pipe lines convey steam, water or air. The well-known corrugated form, such as used for furnaces of internally-fired marine boilers, is adopted because of its strength and flexibility. External rings on the corrugations, besides adding to the strength of the joint, distribute the strains among several corrugations, and by thus bringing many corrugations into service no one of them is called upon to take more than its share of the work. The number of corrugations depend upon the pressure and upon the length of the joint. For high-pressure and superheated steam the change in length is considerable, therefore more corrugations are used. For very low pressures, as in exhaust piping, two or three corrugations are sufficient for the slight alteration in length.

New Drill Speeders

The Graham Manufacturing Company, Providence, R. I., has just brought out a new line of drill speeders, or high-speed drilling attachments, for use in drill presses of the larger class where small holes are to be made. The device increases the speed of the drill three times, and thus converts a slow-running drill press into one of high speed, thereby

saving the cost as well as the space required for an extra high-speed machine. The general type is shown in the illustration. The shank is made in standard sizes to suit the holes in ordinary drill presses. On the bottom is fastened a regular drill chuck, which revolves three times to once of the spindle of the main machine. Instead of the chuck the spindle may be extended and made to accommodate taper shank drills. The driving mechanism that increases the speed consists of gears and pinions arranged in double, so that side strains are eliminated. No end thrust is conveyed through the case. A ball-bearing between the bottom of the slow-revolving shank and the top of the fast-running spindle relieves all end strain. The alinement, which is quite important, is accomplished by extending the lower end of the shank downward inside the hollow chuck spindle until it is nearly as low as the bottom of the case itself. The spindle is further supported by a bronze sleeve on its outside.

Welding and Cutting with Oxy-Acetylene Apparatus

Within a few years the use of oxy-acetylene welding and cutting has made such rapid progress in England, France, and especially in Germany and Switzerland, that in these countries there is hardly a boiler shop to be found without an equipment of this kind. The United States have heretofore held back, awaiting to see the result of developments abroad, but indications are that progress in this country will soon overtake the lead of Europe.

FIG. 1

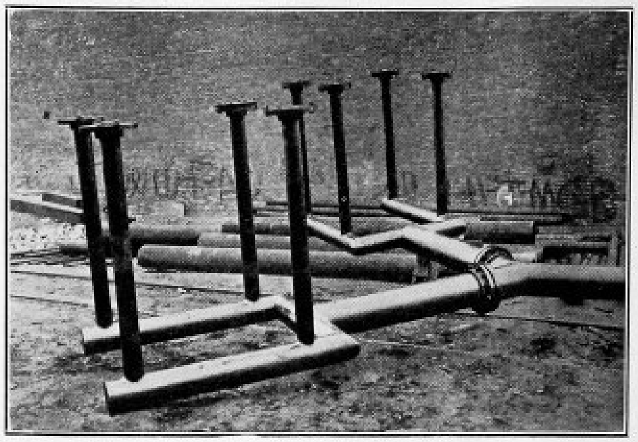


FIG. 2

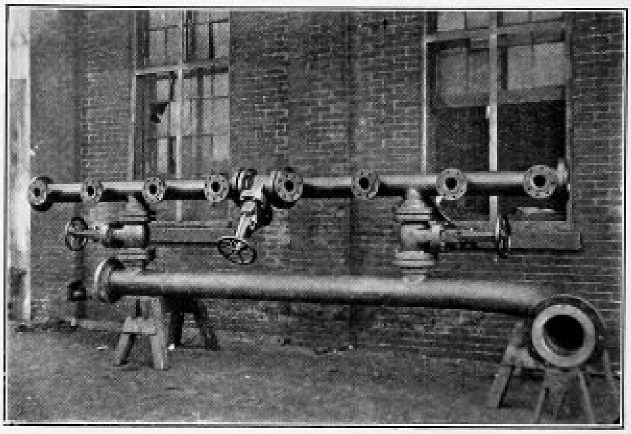


FIG. 3

The reason for skepticism in this country was a string of initial failures, due to inefficient machines and inexperienced operators, which cast an undeserved stigma on the process itself.

Cutting of all kinds of iron and steel may be done by any good mechanic after short instruction, provided a first-class apparatus is used, but it must be stated that reliable welding in boiler work requires experience and should be executed only by men who understand the action of the process on the metal to be welded. Under guidance of a competent teacher this art may be learned in a few weeks.

The following photographs of work done by Dougherty & Bachran, Philadelphia, with the apparatus of Messer & Co.,

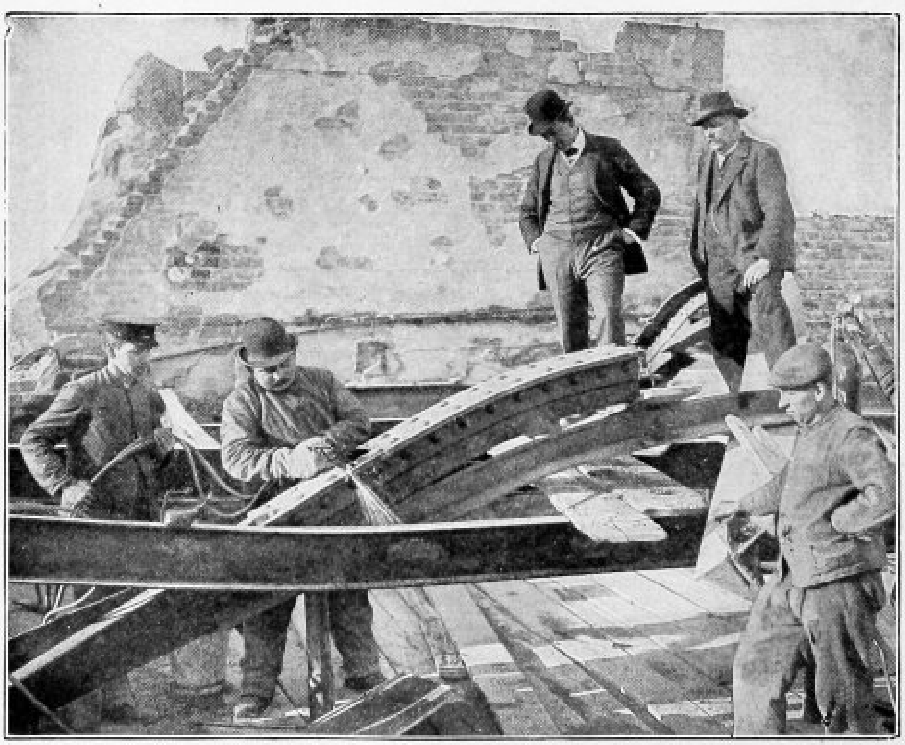


FIG. 4

Philadelphia, Pa., will be of special interest to boiler makers. Fig. 1 shows one fitting for the exhaust connection for two condensers, made for the Salts Textile Manufacturing Company, Bridgeport, Conn. It is made of 24-inch steel pipe with two 20-inch and one 12-inch necks, welded together. The weight is 1,110 pounds. Fig. 2 shows 4-inch, 7-inch and 10-inch welded pipes furnished the Merrimac Chemical Company, North Woburn, Mass. It is evident that the elimination of many joints means a great saving and considerably increases the safety. Fig. 3 shows a brine header of 6-inch pipe with eight 3-inch necks, and two 6-inch necks. The joints are all vanstoned and the necks welded to the pipe. Attention is called to the fact that by the use of the oxy-acetylene process the greater part of the work may be done in the shop, whereby the expensive operation of mounting is reduced to a minimum. The welded pieces are being tested in the shop to the required pressure, and absolute assurance of strength and reliability is obtained. In Fig. 4 is shown how iron tanks, girders, boilers, etc., may be removed from buildings without tearing down walls or other obstructions.

The use of the cutting torch in erecting new constructions is manifold. In the manufacture of sheet steel and iron of any thickness the oxy-acetylene machine finds innumerable uses, such as cutting ends to any shape, cutting out manholes, frames, socket holes and other apertures in any kind of tanks and boilers.

Technical Publications

MODERN STEAM BOILERS (THE LANCASHIRE BOILER). By W. D. Wansbrough. Size, 5½ by 8½ inches. Illustrations, 117. London, 1913: Crosby Lockwood & Son. Price, 4s. 6d. net.

American boiler makers are by no means as familiar with the Lancashire type of boiler as are their fellow craftsmen across the water, for the Lancashire boiler is little used in the United States, its place being taken by the horizontal return tubular boiler. In Great Britain, however, the Lancashire boiler has been for many years the standard stationary boiler, and for over seventy years it has been manufactured with but little variation in its outward appearance, although the details of construction have been vastly improved over the early types.

A striking contrast between the early boilers and the present type is pointed out by the author when he states that it is not so very many years ago since a 7-foot boiler would have its end plates in two parts and its shell made up of from ten to sixteen pieces. Now a boiler 9 feet 6 inches diameter by 30 feet long is made with its huge shell in three plates only, so vastly have the means of production developed. The author adds that the Lancashire boiler of 1912 is a piece of workmanship as nearly perfect as hands can make it, and also that construction, even down to the minute details, has been so standardized that practically all first-class boilers of this type are built not merely upon the same lines, but to an almost identical specification.

This remarkable unanimity is something sadly lacking in American boiler practice; and in the production of the cylindrical return tube boiler, which is the American counterpart of the English Lancashire boiler, it seems rather strange that standardized designs should not have been adopted, as has been done in England with the Lancashire boiler. We could never see the advantage of varying the minor details of horizontal return tubular boilers where the boilers are of practically the same size and power, when a single standard design would serve the purpose equally well and save trouble in the original manufacture and subsequent repairs, if any were necessary. The author of this book states that this remarkable unanimity in the construction of Lancashire boilers in England has been brought about mainly by the influence of the various boiler insurance companies, and in particular by the efforts of the Manchester Steam Users' Association. A very wise step would have been accomplished if the boiler insurance companies in America performed a similar service for the boiler making industry there.

The first chapter of the book deals with the evolution of the Lancashire boiler. The second discusses the structural strength, taking up in detail the strength of the shell, the heads, braces, furnaces, etc. An interesting chapter, well illustrated with photographs, describes the manufacture of this type of boiler, and the procedure of inspection during construction is outlined in full. Other parts of the book deal with efficiency tests, advice to boiler attendants, the causes of explosion and legislation preventing the same.

Some interesting facts are brought out by the author regarding the durability of this type of boiler, and in one case he shows on good authority that repairs to the Lancashire boilers cost on an average only about 6d. a boiler per annum. This is a striking testimony to the lasting qualities of these boilers, and instances are not lacking of boilers which have been in service over half a century and have as yet shown no signs of weakness, although carefully examined for deterioration.

WATER: ITS PURIFICATION AND USE IN THE INDUSTRIES. By William Wallace Christie. Size, 5¼ by 7¾ inches. Pages, 219. Illustrations, 79. New York, 1912: D. Van Nostrand Company. Price, $2.00 net.

We have emphasized repeatedly in the columns of this journal the necessity of paying strict attention to the treatment of water for use in steam boilers, as many of the difficulties in boiler operation can be laid to the impurities in the feed water, most of which might be prevented by proper feed-water treatment. Especially is this true in railroad service. Locomotives using hard water with clean boilers have required calking at the end of three weeks, and have required thirty-three calkings in seven months, while with soft water in the same locomotives calking was required but six times during fifteen and one-half months. The requirements of locomotive boilers in the matter of feed water do not differ materially from those of stationary boilers, except that the locomotive boiler is always in a constant condition of agitation, and that it is not always possible to supply even on a single section of a railroad a uniform quality of water to the locomotive. For these reasons bad water will make more trouble in the locomotive than the same water would in a stationary boiler. In discussing boiler troubles, boiler makers usually modify their statements with some reference to the kind of water that was used in the boiler. Proper methods of treating boiler water is a matter which has been left largely to the chemists and specialists, and the average boiler maker or boiler attendant knows too little about it for successful service. It may seem rather far fetched to expect a boiler maker who has no jurisdiction over the boiler after its construction to concern himself very much over the subject of the purification of boiler feed water, but in a great many cases, and particularly in railroad work, the boiler maker has to supervise and carry out the boiler repairs, which are due to the disastrous effects of bad water, and so an intimate knowledge of feed-water treatment is practically a necessity for men employed in this work. The book under review is not confined to the treatment of boiler feed water. In fact, only a small part of it, hardly more than a single chapter, deals with this subject. In writing the book, the author had in mind the use of water in various branches of industry, such as in mixing concrete, brewing, dyeing, bleaching, tanning, ice making, laundries, soap making, paper making, sugar refining, etc., and the book was prepared to cover all of these cases.

HANDBOOK OF ENGLISH FOR ENGINEERS. By Professor Wilbur Owen Sypherd. Size, 4½ inches by 6¾ inches. Pages, 314. Chicago and New York, 1913: Scott, Foresman & Company. Price, $1.50.

This book is designed primarily, as stated in the preface, to meet the needs of advanced engineering students and of young engineers in actual practice. In the preparation of the book the author has also kept in mind its usefulness to engineers already actively engaged in the practice of their profession. The scope of the book can be seen from the chapter headings, which are: Chapter I., The General Problems of Engineering Writing; Chapter II., Mechanical Details Common to the Various Forms of Engineering Writing; Chapter III., Business Letters; Chapter IV., Reports, and Chapter V., Articles for Technical Journals. The nature of the material in the book is such that the specimens of different forms of writing will not only serve as useful models for the inexperienced man, but they are also suggestive in a general way and will lead the reader to a true appreciation of the underlying principles established by custom and expediency which should govern all good engineering writing. The models of letters, reports and articles for technical journals illustrate the forms generally approved for such compositions, and should furnish useful suggestions for most of the writing required from engineers. The mechanical details common to the various forms of technical writing involve certain rules regarding punctuation, abbreviations, numbers, capitals, etc., which should be familiar to engineers in order to avoid confusion in important written documents. While the ability to speak and write English correctly and convincingly on almost any subject depends largely upon clear thinking and a thorough knowledge of the subject under discussion, yet the failure to master the ordinary technique of engineering writing imposes a serious and needless handicap upon an engineer, even if he is a man of exceptional technical ability. For overcoming such a handicap the book under review will be found in many ways a valuable aid.

THE STEAM CONSUMPTION OF LOCOMOTIVE ENGINES FROM THE INDICATOR DIAGRAMS, by J. Paul Clayton, has just been issued as Bulletin No. 65 of the Engineering Experiment Station of the University of Illinois. This bulletin applies to locomotive engines the logarithmic analysis developed in Bulletin No. 58 of the Engineering Experiment Station by the same author. In Bulletin No. 58 it was shown that expansion curves of all steam engine indicator diagrams obey substantially the polytropic law $P V^n = C$, and that the value of n is controlled directly by the quality of the steam mixture in the cylinder at cut-off. It was further shown that each distinct type of engine possesses a series of definite relations between the values of n and steam quality at cut-off, and that, by determining their relations, the actual steam consumption of engines can be closely determined from the indicator diagrams alone. This present bulletin gives the relations of n and steam quality at cut-off as determined from the tests of twelve locomotive engines, and shows that the steam consumption of these locomotives may be determined by this means on within 4 percent of the steam consumption as measured on test plants. Methods are developed for measuring valve leakage, the proportion of steam used for heating the train in winter, the spring in valve gears, cylinder clearance, cylinder leakage and the cyclic events. Copies of Bulletin No. 65 may be obtained upon application to W. F. M. Goss, director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

REMOVAL.—Edw. Renneburg & Sons Company (Machine and Boiler Works) recently removed their plant to new and larger works at Atlantic Wharf, Boston street and Lakewood avenue, Baltimore, Md.

Personal

P. J. DONOHUE has been appointed foreman boiler maker of the Chicago, Rock Island & Pacific at Biddle, Ark.

JOHN P. BOURKE has been appointed third vice-president of the Hauck Manufacturing Company, Brooklyn, N. Y.

CHARLES BEARD, formerly with the Madeira-Mancore Railway, Porto Velho, Brazil, has again taken the position of foreman boiler maker with the Guayaquil & Quito Railway Company, Duran, Ecuador.

WILLIAM STOBBARD, of Portland, Ore., is credited by the *Boiler Makers' Journal* as being the oldest boiler maker now working at the trade. He was born in England in 1825 and served his time under George Stephenson, the inventor and builder of the first locomotive. Mr. Stobbard is a flange turner, and, although now eighty-eight years old, says he is capable of doing good work in that line yet and that he can drive a good rivet, too. He has a son, George Stobbard, who is a boiler maker also, and has worked at the trade for fifty years.

C. A. SELEY, mechanical engineer of the Chicago, Rock Island & Pacific Railroad, has resigned to become president of the American Flexible Bolt Company, of Pittsburg, Pa. Mr. Seley has long been regarded as among the ablest mechanical engineers in the country. He has always taken a leading part in the major technical associations, and for several years was a member of the executive committee of the Railway Master Mechanics' Association. The honors that have come to him during his busy career in the railway field have been won through sheer merit, and have been bestowed by men keenly alive to the value of his work and well able to appreciate his abilities.

JOHN B. TATE, who has just been elected fourth vice-president of the Master Boiler Makers' Association, is general foreman boiler maker of the Pennsylvania Railroad at Altoona, Pa. Mr. Tate began work with the Pennsylvania Railroad in 1874. About twelve years later he was placed in charge of all boiler repairs and firebox renewals. In 1897 he yas appointed assistant to the general foreman boiler maker, who at that time was Mr. Morris Davis, a man who is undoubtedly well known to many readers of THE BOILER MAKER. Mr. Tate held the position of assistant to the general foreman boiler maker until the retirement of Mr. Morris in 1909, when he was advanced to his present position. This brief outline of the advance of a man from the ranks of the apprentices to the head of one of the most important departments of a large railroad gives some idea of the sterling quality of his abilities for which he is justly honored.

Obituary

BERNARD SCHUCHARDT, of the German machine tool house of Schuchardt & Schutte, died June 2 in Berlin after a short illness. The firm has a New York office at 90 West street.

JOHN H. HOWARD, of Howard Bros. Boiler Works, Buffalo, N. Y., died suddenly of heart disease May 1, aged 54 years. He had been connected with the boiler-making business for thirty-eight years. He was the senior member of the company, which makes a specialty of marine work.

INTERNATIONAL ENGINEERING CONGRESS, 1915.—Engineers throughout the world will be invited to participate in an International Engineering Congress to be held at the Panama-Pacific International Exposition, San Francisco, in 1915, under the auspices of the five leading American engineering societies.

Letters from Practical Boiler Makers

Action of Rust

Water in the presence of iron decomposes, its oxygen combining with the iron forming oxide of iron, or rust. Its hydrogen is set free at the rate of about 44 cubic inches for each grain of rust developed. Rust occupies about twice the volume of the iron contained in it, and it absorbs from 18 to 28 percent by weight of moisture, so this moisture, if rust is not stopped, will attack other parts of the metal and form more rust. Rust once developed, if not cleaned off thoroughly before painting, will continue to develop under the paint. It will develop very fast under poor paint, but only slowly under good paint. Rust thus developed will gradually force the paint away from the metal and cause it to crack or peel off. The best way to overcome this action is to clean the metal as thoroughly as possible and then paint it with a good graphite paint. A. B. E.

Rolling a Cone

To roll a straight course is a very simple and quick operation. To do this it is only necessary to tighten up on the rolls while the plate is run through them until the ends of the plate finally meet, forming a perfect circle. But when it comes to rolling a cone piece, trouble is at once experienced.

An old style of bending or forming a cone piece was to draw the bending lines on the plate, then follow up the diagonal lines with a heavy handle fuller and sledge hammer until the cone got its proper shape.

Another method of doing this that the writer has seen old-time boiler makers use was to roll the cone along the bending lines, then shifting intermittently on to the next diagonal line until the cone was shaped into its proper and even form.

The foregoing are probably not the only methods used for rolling a cone. Some of the readers of this article may know of better methods or quicker methods, and if so the writer will be very glad to see such methods published in the next issue of The Boiler Maker. E. Eaton.

Jersey City Heights, N. J.

Care of Superheater Tubes

It is to be regretted that more time could not be allowed to the question of care of superheater tubes in the recent convention of the Master Boiler Makers' Association, held at the Sherman House, at Chicago, as, due to the heavy rush of business, it was almost impossible to get the floor to bring out questions which, in my opinion, would be beneficial to all master boiler makers as well as all railroads that were represented by their boiler makers.

I take the liberty of informing you through your valuable journal as to the methods we use in the care of our large 4½-inch tubes in our superheater engines on the Missouri Pacific lines. We have experienced some trouble on different parts of our line on the large tubes leaking, and while it is contrary to the instructions of our superintendent of machinery for the boiler makers to use the flue rollers, in some cases those instructions have been disregarded and the flue rollers have been used to such an extent that some of our large tubes have been rolled until they are from ¼ to 5/16 inch larger in diameter than the original size.

I happened to be on a certain point on the system when one of our large passenger engines had an engine failure due to the 4½-inch tubes leaking. On making an inspection of this firebox and tubes I found that the expanders that were intended to be used on this class of work were entirely too small, due to the heavy rolling that those tubes had had, and in applying the rollers in those large tubes mentioned I found after the rolls had passed over a certain portion of the tube that the material in the tube had become so hard that it would pull from the sheet. In other words, the flue rolls would not make the flues tight in the hole. The flues had become so hard from the constant rolling of it, it was almost the same as trying to expand a piece of spring steel with a pair of flue rolls.

To overcome this I made a casing out of scrap tank steel, rolled it around the seam of rivets of flanges on the flue sheet and packed between this casing and the rivet heads magnesia lagging; then plugged up all the large flues as well as the small ones with magnesia, shoving this magnesia back into the flue about 4 or 5 inches; then sheared out a plate ¼-inch scrap tank steel, 12 inches wide, and put this across the face of the tube sheet two rows of flues below the large flues, shoving a couple of bolts on each side to hold this plate; then bent a piece of our standard netting around the edge of this plate 10 inches wide, forming a basket, which was filled with charcoal.

A fire was started in this charcoal and in about two hours' time the flues all became a cherry red, and will say that it was astonishing to see the amount of scale that was loosened from those tubes while in this condition.

When those flues became cherry red the expansion forced all tubes into the firebox about 1/16-inch. This, you will understand, loosened all the minerals between the tubes and the copper, and it also softens the copper.

The flues were allowed to cool off, and after they did so went back into their original place. I had a larger expander pin made for these tubes, giving the tubes a good expanding and a good beading, and will say that the flues after being heated in this manner worked as soft as any new tubes I have ever worked.

The engine was put in service and has been running constantly for the past sixty days without giving any further trouble. We have had such good results from this engine that we have adopted this practice on the system.

T. P. Madden, General Traveling Boiler Inspector.
Missouri Pacific Railway System,
St. Louis, Mo.

Long Flues

Has the limit in the length of flues been reached? The tendency to-day is towards larger and longer boilers, and this means longer and heavier flues, with the attendant evil of sagging in the middle, and increased strain on flue ends causing leakage, especially at the firebox end, and to try to overcome this evil the middle flue sheet has been tried, with very indifferent success.

Some twenty years ago, while discussing flues with one of the officials of the road on which I then worked, the long flue and how to support it was one of the subjects. Flues of 16 feet and 17 feet, and 2¼ inches and 2½ inches O. S. D. and No. 11, and 12 B. W. G. were used to try and overcome the sag, thinking that the heavier gage flue would be stiff enough to effect that end, but to no purpose. Then one of our local roads tried the middle flue sheet, as an experiment on one of their fast passenger engines. All went along splendidly for a while. Flues did not leak and the motive power department were congratulating themselves that their troubles were at an end, when one day the engine was hauled in dead.

Upon examination nothing was found wrong with either end of the flues, but upon applying the water test water was found coming from away inside the flues past the weld. When the flue was removed it was found completely worn through where the bottom of the flue had rested on the support, and this trouble continued at short intervals until the middle flue sheet was finally removed, and for a number of years this road did not bother with supporting the sagging flue until some eleven or twelve years ago the same thing was again tried, and to show your reader what this means to the road, and incidentally to the boiler maker who is given the job of renewing a set of flues installed in this way, I will tell you of the experience of two boiler makers, whom I know well, who were given such a job.

George and Jack, two good flue men, were sent to the back shop to change flues in Engine 1157. The job was to be done in a hurry, for the road was hard pressed for power on account of bad water and leaky boilers. They had been working away just as hard as two strong men could work, but did not show the results expected of them, for they found that the accumulation of scale on the flues prevented them being driven through the middle flue sheet, and some of them were worn so thin they would break in two at this support, making it impossible to remove them in the usual way.

The master mechanic wanted to know why the flues were not coming out faster, and if they could not do better than they had done. George, a very plain and outspoken man, told the master mechanic that there was a way to take them out much more quickly.

"Well," said the master mechanic, "if there is a way to take them out quicker than you are doing, why not do so and get the job done, for we want the engine back in service."

George then told him that the quickest way to do the job was to put about fifteen sticks of dynamite in the boiler and blow them out, as that was the only way to do so quickly. This made the master mechanic mad, and being a a very fluent swearer, he let loose on George and Jack and chased them out of shop and yard.

Now, sir, if we are to have long flues and use the middle support, the holes in it should be fitted with copper ferrules and the fit made as neat as possible, so that the vibration in the flue would be overcome. This, of course, would do well where pure water is used, or we would find ourselves in the same trouble that George and Jack were in when it comes to renewing flues. Therefore we must look for another solution of the problem, and I think it can be done another way, for I am of the opinion that we have not reached the limit in long boilers.

Some twenty-five years ago there was published in the *American Engineer and Railroad Journal* a drawing of a locomotive designed and built by the London & North Western Railway of England, of the smoke-burning type with long boiler. In the middle of barrel of the boiler there was a combustion chamber about 36 inches long, access to which was obtained through a manhole in the bottom of the shell, thus giving the boiler two sets of flues of much shorter length and at the same time allowed the use of a flue of lighter gage. Now if this type of boiler was used the length could be much greater than those in use at present, and still keep the length of flue down to a reasonable length, and boilers in service could be greatly improved, for in my experience I have found that for boiler pressures up to 200 pounds per square inch and for flues of 2 inches O. S. D. and 126 inches long 13 B. W. G. are most effective.

Pittsburg, Pa. FLEX IBLE.

Laying Out Irregular Cones

In an article on the above subject which I contributed to the December number of THE BOILER MAKER, I promised to continue the article in a future issue; the following, therefore, is a continuation of the article published in the December number. In the former article I described the method of laying out irregular cones with circular ends. The article this month deals with irregular cones much like those in the previous article, except that the ends are elliptical instead of circular.

Figs. 1, 2 and 3 show the method of laying out such a cone. Both elliptical ends are divided into the same number of equal spaces, in this instance 10. After numbering the points, as in

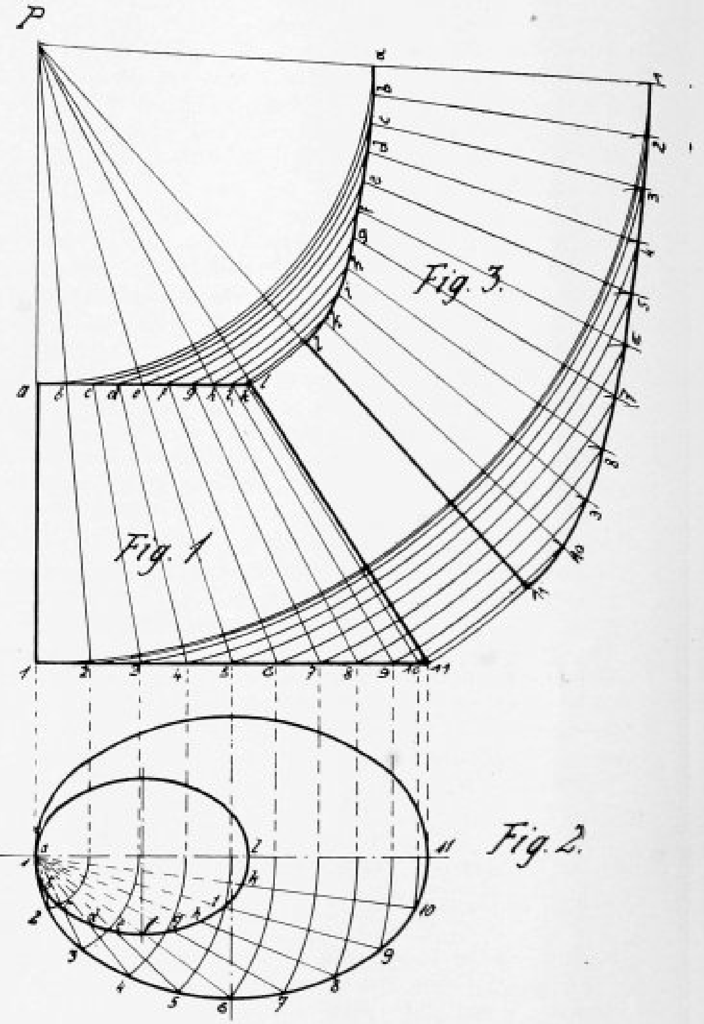


Fig. 2, draw the lines 2-*b*, 3-*c*, 4-*d*, etc. All these lines intersect the point 1 in Fig. 2. With 1 as a center draw the arcs shown with radii 1-2, 1-3, 1-4, etc. These arcs intersect the line 1-11, and the points of intersection are projected to the line 1-11 in Fig. 1. Connect the points thus found in Fig. 1 with the point *P*, and at the intersection of these connecting lines with the line *a*-*l* in Fig. 1 lay out the points *b*, *c*, *d*, etc., to *l*.

Now using *P* as a center draw the arcs shown with the radii *P*-11, *P*-10, *P*-9, *P*-8, etc., and then the arcs with radii *P*-*a*, *P*-*b*, *P*-*c*, etc. Through the point *P* draw the line *P*-11 intersecting all these arcs, as shown in Fig. 3. Then with the dividers set to the length of one of the spaces in the large ellipse, Fig. 2, and with point 11, Fig. 3, as a center, strike an arc intersecting the arc from point 10, thus locating the point 10 in Fig. 3. Continue in this manner to locate the points

9, 8, etc., to 1. The same process should be followed, locating the points *k*, *i*, *h*, etc., to *a* in Fig. 3, except that the dividers should be set to the length of one of the equal spaces on the small ellipse for locating these points.

Connecting the points thus found with a curve, the layout of half of the cone is completed, as shown in Fig. 3.

For laying out the irregular cone in the manner just described, the ratio of both axes of the two ellipses, the small one and the large one, must be the same. If the ratios are not the same the method shown in Figs. 4, 5 and 6 must be used. In this case first draw the plan, Fig. 5, and the side view, Fig. 4. Now divide the large ellipse into any number of equal spaces and draw tangents at each of these points of division.

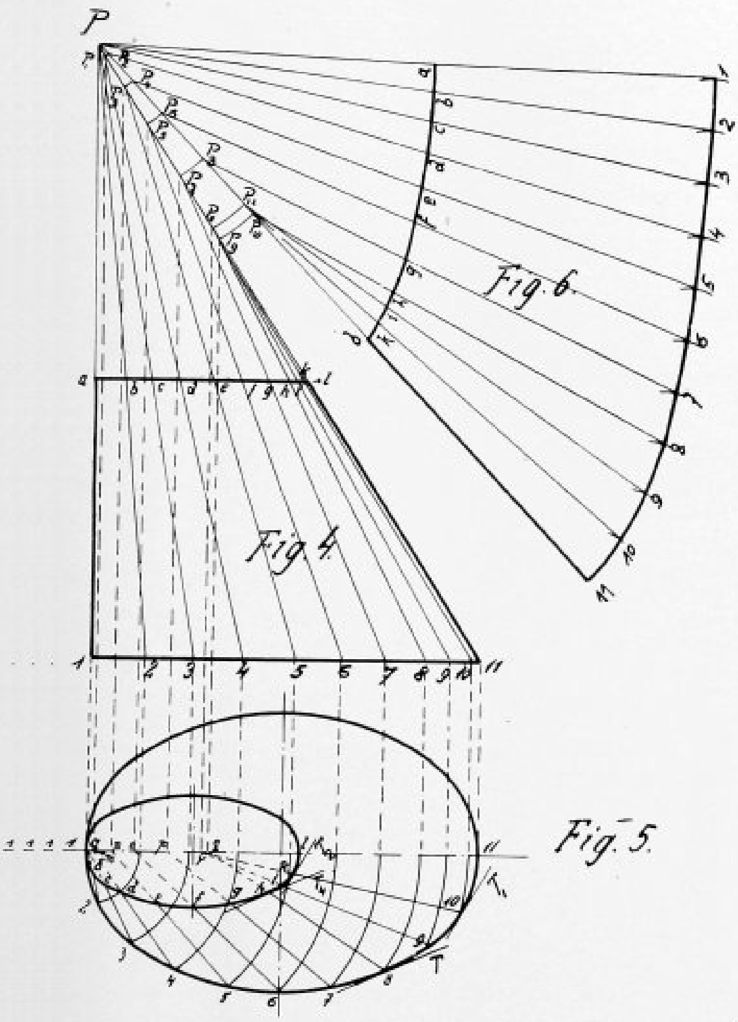


Fig. 6. Fig. 4. Fig. 5.

Parallel to these tangent lines draw new tangents on the small ellipse. The points of division on the large ellipse may be numbered 1, 2, etc., to 11, and the points where the tangents touch the small ellipse may be designated *a*, *b*, etc., to *l*. Now draw lines connecting the points 2 and *b*, 3 and *c*, 4 and *d*, 5 and *e*, and so on *to* line 11 and *l*. These lines in Fig. 5 intersect the line 11-*l*, Fig. 5, at the points *m*, *n*, *p*, etc., to *r*. With these points as centers draw arcs to the line 11-*l*, and project points *m*, *n*, etc., to *r* to the line 11-*P*, thus locating the points P_1, P_3, P_5, and so on in Fig. 4. Using *P* as a center draw arcs with the radii P-P_1, P-P_2, and so on to P-P_{11}. These arcs intersect the line *P*-11, Fig. 6, at points P_2, P_4, P_6, and so on to P_{12}.

With P_{12} as a center, draw an arc with the radius P_{11}-P_{10}, in Fig. 4, and with 11 as a center draw an arc with the radius 10-11; that is, one space from the large ellipse, Fig. 5, intersecting the first arc at the point 10. In this manner locate the points 9, 8, 7 and so on to 1. Points *a*, *b*, *c* and so on in Fig. 6 are found in the same manner. The length *P*-11 in Fig. 6 is the same as the length of *P*-11 in Fig. 4. Also the length *P*-1 is the same in both figures. The layout shown in Fig. 6 is only half of the pattern, but as the figure is symmetrical the other half will be a duplicate of this.

Fig. 7 shows how to construct an ellipse by drawing arcs. On the line *a*-*c* lay off the major axis of the ellipse, divided into two parts at point *b*. On a line through point *b* perpendicular to the line *a*-*c*, lay off the minor axis of the ellipse, locating the points *d* and *e*. Draw a line through *a* and *d*, and space from *d* to *f* the difference of the halves of the two

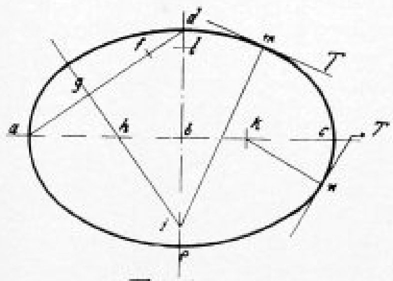


Fig. 7.

axes. The length *a*-*f* is bisected at the point *g*, and through *g* draw a line at right angles to *a*-*f*, intersecting both axes of ellipse at the points *h* and *i*. These points will be the centers of the arcs forming the ellipse. One radius is *i*-*d* and the other *h*-*a*. The length of *b*-*l* is the same as *b*-*i*, and *b*-*k* is the same as *b*-*h*.

For finding the point where the tangent touches the ellipse it is only necessary to draw a line perpendicular to the tangent *T*, cutting through the center of the arc.

The construction of an ellipse in this manner is very simple, and the ellipse is as nearly a true ellipse as if it had been constructed exactly according to the rules of geometry. All the lines drawn in Fig. 4, as, for instance, *P*-1, are rolling lines, and the true length of the line is found accurately

Graz, Austria. JOHN JASHKY.

Repairing Boiler Shells

The proper repairing of boiler shells—that is, the repairing of shells and maintaining the maximum efficiency—has been a problem on railroads for years past, and it has taken the agitation of comparatively recent date to awaken some of the slumberers to the fact that they were running boilers unfit and unsafe for service.

It is a notorious fact that a great percentage of foreman boiler makers in the past had not the faintest conception of joint efficiency, brace strains, shearing strength of rivets, safety valve area, etc.

A glance over the reports of inspectors from State commissions, insurance companies and other records of boiler accidents that were caused by faulty design, poor workmanship and improper repairs is sufficient evidence that the right men have not always been in the position of supervisors. Technical papers that follow the mechanical field are full of such reports, and the fact that Federal, State and municipal governments are appointing commissions with great powers in the boiler field shows plainly that the writer's statement in reference to incompetent foremen (though a pretty broad statement) is well worth a second thought.

The following extracts from a set of rules on care and maintenance of boilers, formulated by mechanical officials of a leading railroad, proves that they could see the need of competent men:

"An intelligent and practical understanding is considered of the very highest importance, and close compliance therewith is an essential detail of safe operation.

"Every officer and employee who is concerned either directly or indirectly in the performance of any duty or detail of work defined in this book is required to be provided with a copy and understand it.

"Foreman boiler makers, their assistants, boiler inspectors or their subordinates, responsible for the care, repairs, maintenance or construction of steam boilers are required to possess suitable qualifications and attainments. In addition to these requirements, applicants for such positions are required to be men of judgment.

"The qualifications and fitness of any applicant or prospective appointee to perform the required duties are to be determined by the general foreman boiler maker having jurisdiction before any appointment is made permanent."

When the writer was first appointed general foreman boiler maker for a large railroad system he found some very peculiar repairs being made to boilers, the following being one of several that certainly was a dangerous procedure:

An old stationary boiler had a bottom third of a course extending from one circumferential seam to another cut out and a patch was being applied. The patch was of $\frac{3}{8}$-inch plate and was being applied with a single riveted lap joint with $\frac{3}{4}$-inch rivets spaced $1\frac{3}{4}$ inches apart. The original longitudinal seam in this course was double riveted with a double strapped butt joint of about 67 percent efficiency. I do not recall the details of the joint, only that the original plate was $\frac{5}{8}$ inch thick.

The foreman appeared to think the job all right in every respect, and when questioned about it among other questions he was asked why he would space rivets so closely in any seam, and the reply was that it would be stronger. This man was generally considered a very competent foreman.

From the many dangerous practices discovered it is the opinion of the writer that a general or traveling boiler inspector who is thoroughly familiar with the construction and repair of all types of boilers and can calculate efficiency of joints, braces, etc., is holding a much more responsible position than is generally considered.

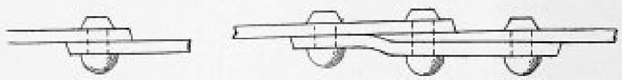
The case cited with numerous other bad practices brought out by the writer, his predecessor and colleague led to the appointment of a committee consisting of the writer and two others to formulate, among other things, a standard practice for patching boiler shells. The instructions were that the proposed practices were to be so simple that they could be understood by the common workman, and the number of rules or practices to be cut to a minimum. It will be noted in the practices, if carefully read, that it is impossible for improper repairs to be made if the simple instructions be followed.

The provision that the circumferential seam patches be made round or diamond shape at the ends eliminates the possibility of making a weak net section of plate by eliminating more than one hole in a direct line with the axis of the boiler.

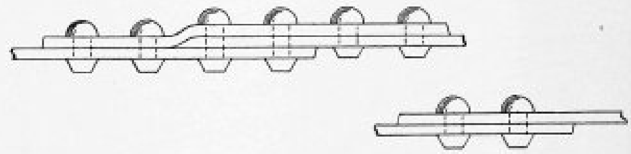
No. 1. Cracks.—Plugging cracks in back heads or in any part of roof, wagon top or dome sheet or in any position of the shell courses is prohibited.

No. 2. Patches (Longitudinal Seams).—When it is required that a patch extend from one circumferential seam to another the thickness of the plate shall be the same as the shell sheet and the size and spacing of the rivets and thickness of the welt plates, if any, in any patch shall be the same as the original longitudinal seam in that course of the shell. The section removed shall extend to the original longitudinal seam in one direction, so that no more than two longitudinal seams shall exist in any one course.

No. 3. Patches (Circumferential Seams) Single.—A patch over a single-riveted circumferential seam shall extend both sides of the seam and be single riveted, using the same thickness of plate as the shell with rivets same size and spacing as the original seam. See Sketch below.



No. 4. Patches (Circumferential Seams) Double.—When a patch is applied to a double riveted circumferential seam the patch shall be of the same thickness as the original plate and double riveted, using rivets the same size and spacing as in the original seams. See sketch below.



Circumferential seam patches, both single and double riveted, shall be made round or diamond shape at ends.

CONE HEAD.

Steam Economy

It is a well-known fact that in burning coal to make steam only about one-tenth of the heat produced is converted into mechanical effect. If a superficial thinker should build a dam across a river and make one-half of one-tenth of the running water effective in turning a water wheel, he would think he had done great things. He would think of that small amount of water going through the mill and congratulate himself on 90 percent of useful effect, never giving a thought to the large amount of water going directly over the dam which had cost him so much to build. But that is waste water, and cannot be held back and controlled; he did not build the dam high for that purpose, but to get an effective height for the water above the wheel.

High temperature is the height which the engineer seeks in making steam, and his waste way for the heat, which he cannot control, is the smokestack. The boiler might be made long enough to absorb nine-tenths of the heat instead of one-tenth, and let the products of combustion go into the smokestack at blood heat, but that would leave the water in the back end of the boiler only blood warm—96 degrees—regardless of the volume of heat units, if they lack temperature.

Two hundred and twelve degrees is the lowest temperature at which steam will form under atmospheric pressure. A heat unit is that amount of heat which will raise the temperature of one pound of water one degree. Temperature is the intensity of the heat, and is the result of a larger volume of heat units being crowded closely together. The blacksmith does not want a large open fire to make a welding heat; he wants a small hot fire, and to get this he confines the heat units by covering his fire with fine coal. A smokestack that is too large for the furnace acts the same as would an open fire for the blacksmith; it lets large volumes of heat units escape without intensifying the heat. If all the heat produced by perfect combustion of coal could be confined and intensified to proper temperature, and then applied wholly to the water in the boiler, it would greatly reduce the expense of steam making. But perfect combustion requires that the products of combustion shall pass off quickly and give room for a further supply of fresh air, and this keeps a large current of heat passing swiftly up the chimney.

Albany, N. Y. CHARLES MILLER.

Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

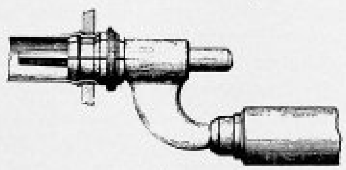
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,051,829. SUPERHEATER BOILER. JOHN E. BELL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—In a superheater boiler, the combination with a plurality of steam and water drums, a transverse mud drum, and two spaced banks of tubes connecting the same, of a baffle located longitudinally in front of the advance bank, a superheater located in the space between the banks of tubes, a continuous baffle also located in said space and separating the rear bank of tubes from the superheater and the bank in advance thereof, to cause the gases to first pass substantially the full length of said advance bank of tubes and also heat the superheater, and afterward pass to the rear bank of tubes, and a baffle located in front of the advance bank of tubes. Six claims.

1,053,373. MANDREL-EXTRACTOR FOR BOILER TUBE OR FLUE EXPANDERS. JOHN W. FAESSLER, OF MOBILE, MO.

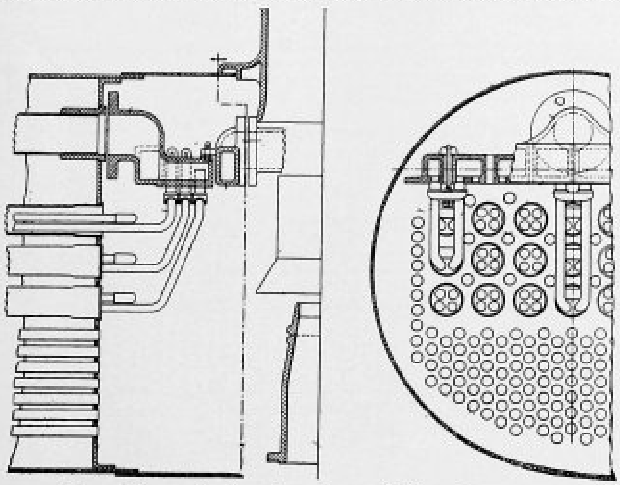
Claim 2.—In combination with a flue expander and a mandrel, an



extractor for the mandrel comprising a sleeve loosely fitting over said mandrel, and an integral arm carried by the sleeve. Four claims.

1,054,676. STEAM COLLECTOR FOR SUPERHEATERS. FRANCIS J. COLE, OF SCHENECTADY, AND SIMON HOFFMANN, OF NEW YORK, N. Y., ASSIGNORS TO LOCOMOTIVE SUPERHEATER CO., OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 1.—In a locomotive provided with a superheater, a steam collector in the upper part of the smoke box comprising alternate header branches for saturated and superheated steam respectively separated by air spaces, a plurality of superheater units, each of which has its ends



connected to adjacent header branches, and fastening means passing through said air spaces for detachably securing said units in place. Ten claims.

1,054,420. METHOD OF FORMING FIRE-BOXES. HENRY W. JACOBS, OF TOPEKA, KAN., ASSIGNOR, BY MESNE ASSIGNMENTS, TO JACOBS-SHUPERT UNITED STATES FIRE BOX COMPANY, OF COATEVILLE, PA., A CORPORATION OF PENNSYLVANIA.

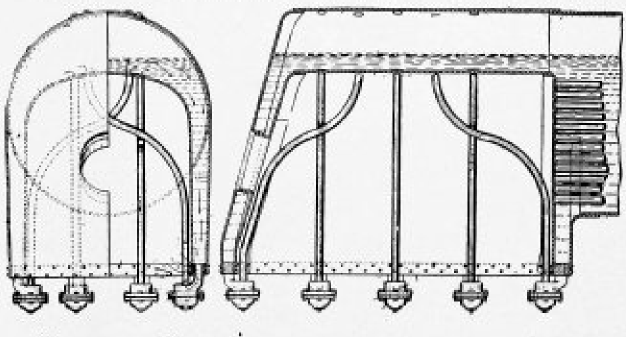
Claim 1.—The method of forming fire-boxes comprising plates forming U-shaped inner and outer channel sections having outwardly extended flanges, forming stay sheets adapted to lie between and connect corresponding pairs of flanges of said inner and outer sections, and assembling such fire-boxes by first securing said inner sections and stay sheets together alternately, and afterward placing said outer sections between said stay sheets and securing their flanges and said stay sheets together. Six claims.

1,051,890. WATER-TUBE BOILER. DAVID S. JACOBUS, OF JERSEY CITY, N. J., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—In a watertube boiler, the combination of two units, each comprising a bank of inclined watertubes, upper and lower headers into which said tubes are expanded, said units being so disposed that the upper headers converge toward each other downwardly, whereby there is formed an A-shaped combustion chamber between the units, two steam and water drums above each unit, all of the steam passing into one of the drums of a unit and from thence to the other drum, steam circulators and separating tubes and water circulators connecting said drums, connections from the upper headers to one of the drums of each set, and a centrally disposed fuel chamber common to said units. Five claims.

1,057,666. LOCOMOTIVE BOILER. JAMES PELLINGTON, OF PATTERSON, N. J.

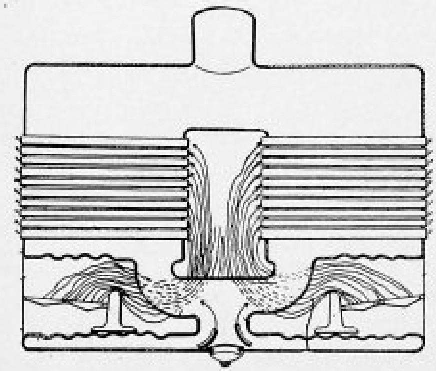
Claim 1.—In combination, with a boiler having a firebox space, a water jacket flanking said space and a mud ring forming the bottom of the water jacket and arranged substantially coincident with the fire level



in said space, a sediment receptacle arranged below the mud ring and having its interior communicating upwardly through the mud ring with the interior of the water jacket, said receptacle having means to withdraw therefrom the sediment collecting therein. Four claims.

1,057,062. MARINE BOILER. EDWARD KING, OF ZURICH, SWITZERLAND.

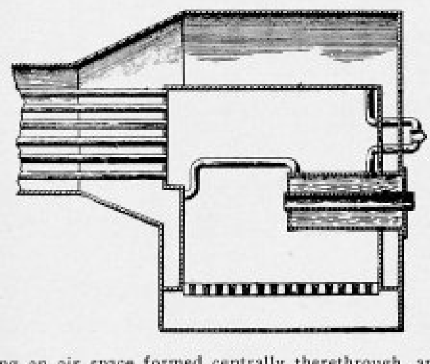
Claim 1.—In a fire-tube marine double boiler, having a furnace tube fired from both ends and a common combustion chamber wherein the direction of the gases is changed, the combination of water circulating



tubes extending from the water space of each half of the boiler at either end of the common combustion chamber and at the upper part of the furnace tube, and a tube common to said water circulating tubes extending through the lower part of said furnace tube. Three claims.

1,057,361. SUPPLEMENTAL BOILER FOR LOCOMOTIVES. EDWIN C. SHAW, OF WILMINGTON, DEL.

Claim.—The combination with a locomotive boiler, firebox, grate bars and fire tubes located within the boiler; of a jacketed supplemental



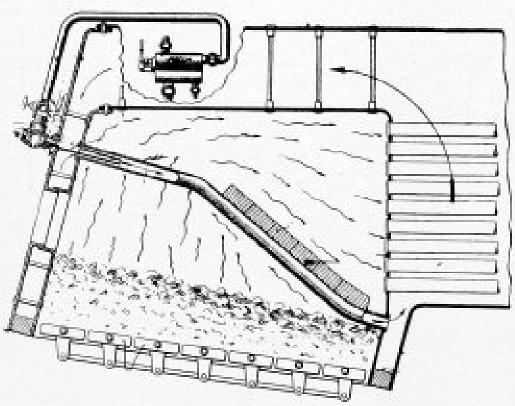
boiler having an air space formed centrally therethrough, and inlet and outlet pipes, the outlet pipe having a valve connected thereto, all constructed and operated. One claim.

1,051,913. WATERTUBE BAILER. ARTHUR D. PRATT, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, N. J., A CORPORATION OF NEW JERSEY.

Claim 1.—In a watertube boiler, the combination of two units, each comprising a bank of inclined watertubes, lower and upper headers into which said tubes are expanded, said units being so disposed that the upper headers converge toward each other downwardly, pipes connecting said upper headers with each other, drums located above and connected with the lower and upper headers of the corresponding unit, and a central combustion chamber common to said units. Five claims.

1,057,566. FEED-WATER CIRCULATING SYSTEM FOR BOILERS. FRANKLIN MARSH, OF MILWAUKEE, AND JOHN G. PHILLIPS, OF GREEN BAY, WIS.

Claim 2.—A fitting for feed-water circulating systems comprising a sectional header pipe, the sections being connected by crosses, one series of branches of which crosses are provided with header nipples and the



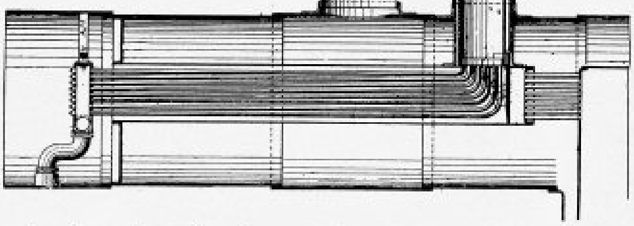
corrèsponding alined series of branches provided with end closures, a series of plugs having threaded apertures in union with the header nipples, a series of tapered discharge nozzles in threaded union with the apertured plugs, and a feed pipe in communication with the header. Two claims.

1,057,690. SMOKE-BOX SUPERHEATER. SAMUEL M. VAUCLAIN, OF PHILADELPHIA, PA., ASSIGNOR, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, A CORPORATION OF NEW JERSEY.

Claim 2.—The combination of a locomotive boiler having a smoke box at one end, a superheated section at each side of the smoke box, a cylindrical shell extending longitudinally in the box and open at its underside and having a closed conical rear end and a screen within the cylindrical shell and in line downwardly and rearwardly, whereby the products of combustion after passing the superheated return through the center of the shell and the cinders are directed downwardly through the open bottom of the shell. Two claims.

1,057,691. SUPERHEATER. JACQUES L. VAUCLAIN, OF PHILADELPHIA, PA., ASSIGNOR TO LOCOMOTIVE SUPERHEATER COMPANY, A CORPORATION OF NEW JERSEY.

Claim 1.—The combination of a steam boiler, a flue, a steam dome receiving steam at its top and having a tube sheet at its lower end, a



series of superheater pipes bent upwardly at their rear ends and secured in said tube sheet, and a header to which the superheater pipes are secured at their forward ends. Eleven claims.

1,057,705. SUPERHEATER FOR STEAM BOILERS. CHARLES CAILLE, OF LEPERREUX, FRANCE.

Claim 1.—In combination, a firebox, a smoke box, fire tubes extending between and communicating with said boxes, a heater within said smoke box and comprising a casing and a tube communicating with said casing and extending within one of said fire tubes, said second mentioned tube being open at both of its ends whereby hot gases from the firebox will pass through said second mentioned tube and into said casing. Four claims.

1,057,389. FURNACE AND DRUM THEREFOR. JOHN BOLGIANO, OF BALTIMORE, MD., ASSIGNOR TO THE AMERICAN FURNACE DEVICE CO., OF BALTIMORE, MD., A CORPORATION OF DELAWARE.

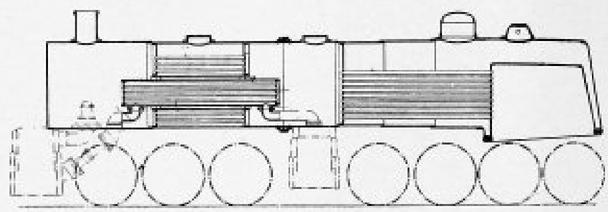
Claim 2.—In a furnace, a bridge wall having a recess in its front face between its ends and extending from the top to near the bottom of the wall, a drum arranged in the recess above the bottom thereof and having lateral projections providing a flue between the projections and the drum within the recess, and a damper arranged at the lower end of the recess beneath the drum adapted to control the flow of air into the recess and the flue. Twelve claims.

1,057,707. BOILER-TUBE-CLEANER NOZZLE. HUGH CASSIDY, OF BROOKLYN, N. Y.

Claim 1.—A nozzle having a circumferentially continuous conical body, open at its large end, having outwardly disposed projections adjacent to the large end adapted to seat against the end of the tube, and a hub on the central axis of said nozzle at the forward end thereof for attaching the same to a supply pipe. Five claims.

1,057,727. REHEATER FOR LOCOMOTIVES. GRAFTON GREENOUGH, OF PHILADELPHIA, PA., ASSIGNOR, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, A CORPORATION OF NEW JERSEY.

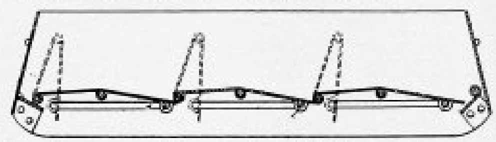
Claim 2.—The combination of a boiler having a steam space; a feed water heater located beyond the steam space in the boiler and consisting of headers with longitudinal tubes therein; and a cylindrical casing,



also attached to the headers; with a reheater located within said casing and consisting of a casing and a series of longitudinally arranged flue tubes, so that the products of combustion, as they pass through the boiler, travel through the tubes of both the feed water heater and the reheater. Seven claims.

1,057,758. ASHPAN FOR LOCOMOTIVES. CHARLES C. MATTOX, OF LAURELVILLE, OHIO.

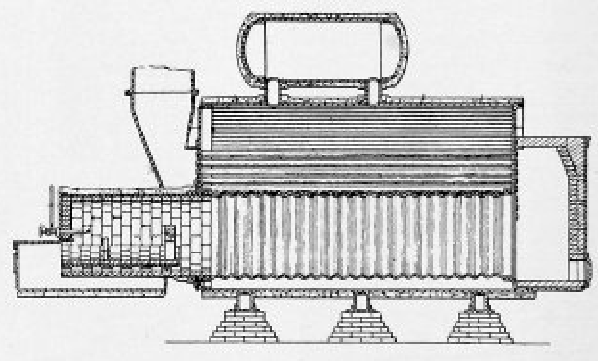
Claim 2.—A locomotive ashpan having side plates provided with slots, a bottom composed of a series of leaves, each leaf consisting of two members hinged together, a rod to which one of said members is rotatably secured, second rod secured to the other of said members pro-



jecting through corresponding slots in said side plates and means connected with the projecting ends of said rods for operating said leaves simultaneously, the parts being so arranged that the two members of the leaves fold up when moved into dumping position. Three claims.

1,057,855. EXTENSION FURNACE. ROBERT E. LE BLANC AND PIERRE P. LANDRY, OF PAINCOURTVILLE, LA.

Claim 1.—An extension furnace for fire-tube boilers comprising a cylindrical body extending outwardly from the firebox of the boiler and communicating therewith, a downwardly bowed partition arranged interiorly of the body and spaced from the bottom thereof, said partition



being extended longitudinally for the greater portion of the length of said body, an air deflector wall rising from the partition intermediate the ends thereof, a target rising from the partition at a point spaced rearwardly from the deflector wall, a supplemental body formed exteriorly of said first-named body and extended below the bottom thereof, and beyond the outer end of the same for communication with the said first-named body, a damper located at the inner end of said supplemental body and a lid on the top of said supplemental body beyond the outer end of the first-named body. Two claims.

1,057,994. SUPERHEATER BOILER. JOHN E. BELL, OF NEW YORK, N. Y., ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

Claim 2.—The combination with a boiler of the transverse drum multiple bank serial pass type, of a superheater located between a baffle at the rear of the front bank and the second bank of water tubes, and a shelf projecting from the baffle of the front bank beyond the superheater tubes, said tubes connecting an upper transverse steam receptacle above the shelf and a side-wall steam receptacle below the shelf. Six claims.

THE BOILER MAKER

JULY, 1913

Construction of Underfired Boilers

BY W. E. PINNEGAR*

Boilers of this type supply a large amount of steam compared with the space they occupy, and they are recommended for fuel economy, especially where refuse is available, as on coffee or sugar plantations. The writer has known many instances where this type of boiler has been used for burning oil, giving excellent results.

The underfired, return or multi-tubular boiler, as it is sometimes called, has its disadvantages as well as its advantages, and can only be recommended where the feed water is very good, or when great care is taken to prevent any accumulation of deposit on the bottom of the boiler over the fire. Experiments have proved that an average scale of uniform thickness of a quarter of an inch increases the fuel bill by nearly 50 percent as compared with clean iron.

To prevent this to a certain extent the writer advocates the use of a mud-drum, which should be fitted at the back end of the boiler. This allows sediment to be left behind instead of going direct into the boiler, as is the case when the feed water enters at the front or top of the boiler.

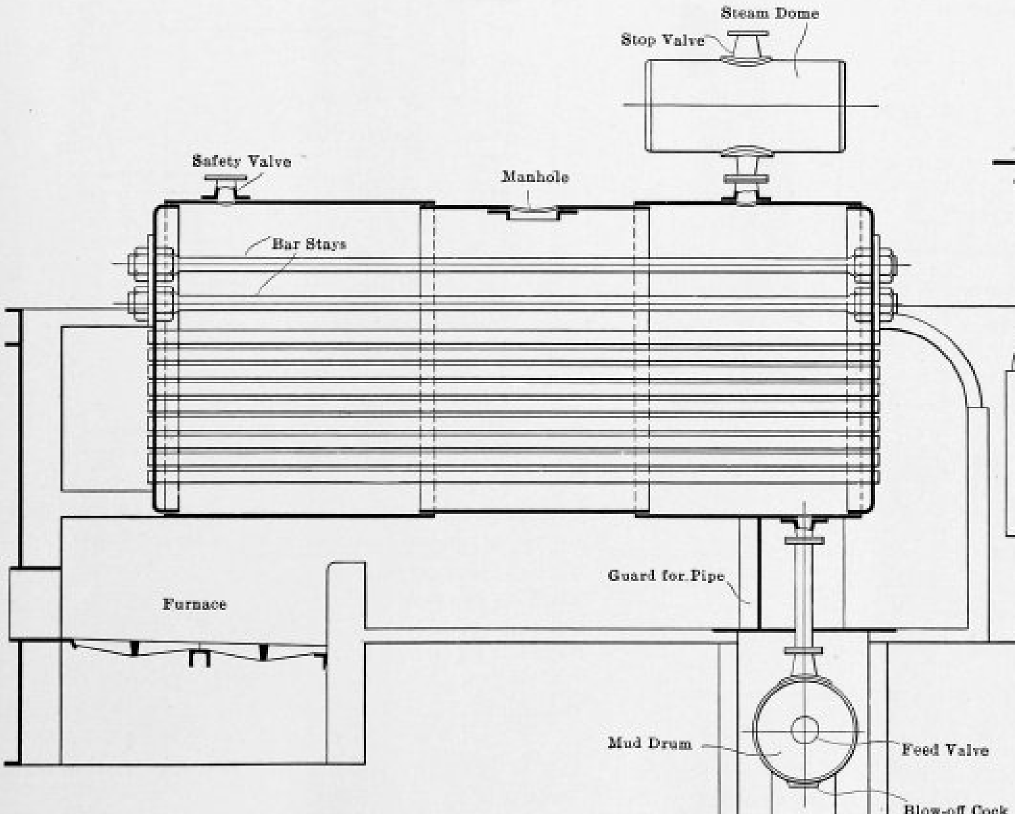


FIG. 2

FIG. 1.—LONGITUDINAL SECTION OF UNDERFIRED BOILER IN BRICKWORK, COMPLETE WITH STEAM DOME AND MUD DRUM

As the steam space is very limited in these boilers it is somewhat essential that they should be fitted with a steam dome, but should the head room be very limited, priming can be overcome by what is known as an anti-priming pipe, placed directly under the main steam stop valve. These pipes are made of cast iron, the same diameter as the valve, and about 4 feet to 5 feet long, the upper portion being perforated with slots

* Address: 33 Amner Road, Clapham Common (West Side), London, S. W., England.

about one inch and a quarter by five eighths. The total area of these slots should be about 25 percent in excess of the stop valve area. The pipe is supported to the shell plates by means of two studs riveted over.

In designing these boilers the number of parallel plates forming the shell should be composed of an odd number. This allows both the ends to be of the same diameter. The first belt or ring of shell plate should be a little longer than the other, so as to allow the circular seams to fall some dis-

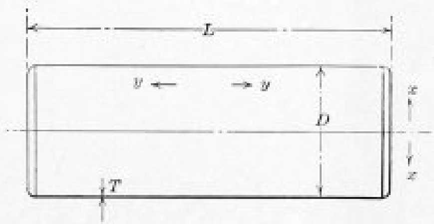


FIG. 3

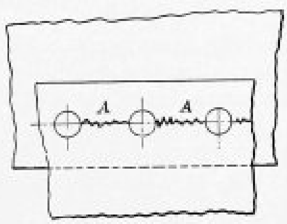


FIG. 4

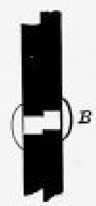


FIG. 5

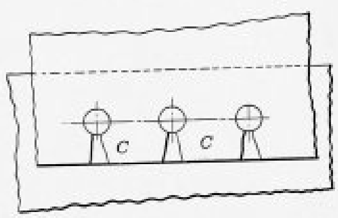


FIG. 6

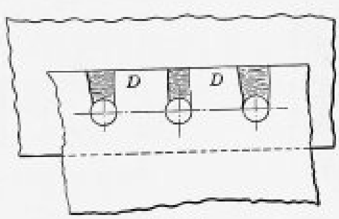


FIG. 7

FOUR WAYS IN WHICH RIVETED JOINTS MAY FAIL

tance from the fire bridge, unless the seam is protected by means of a special firebrick made for the purpose.

Fig. 1 shows a longitudinal section of an underfired boiler in brickwork, complete with steam dome, and a mud-drum. Fig. 2 shows an anti-priming pipe in lieu of the dome.

All boilers subjected to internal pressure are stressed in two directions, as shown by x, x and y, y, Fig. 3.

We will first consider the longitudinal section.

D = Internal diameter of boiler in inches.
L = Length of shell of boiler in inches.
T = Thickness of boiler plate in inches.
P = Pressure in pounds per square inch.
f = Allowable stress pounds per square inch.

For underfired boilers with double riveted butt joints at the longitudinal seams, f should equal about 10,000 pounds per square inch. If constructed with lap joints f should equal about 9,500 pounds per square inch.

Total longitudinal bursting pressure $= P \times D \times L$.
Sectional area of metal to resist this $= 2 \times T \times L$.

$$\text{Stress on metal} = \frac{P \times D \times L}{2 \times T \times L} = \frac{P \times D}{2 \times T} = f.$$

If we consider the transverse section the total bursting pres-

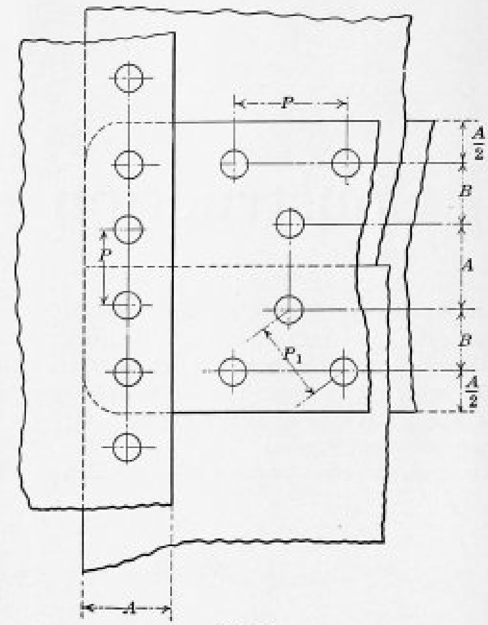


FIG. 8

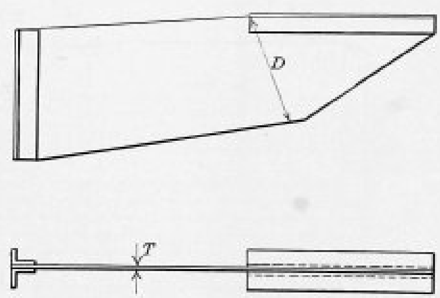


FIG. 9

sure through this section is the area of one end multiplied by the working pressure, the area being in square inches:

Area $= .7854 \times D^2$.
Working pressure $= P$.
Bursting pressure $.7854 \times D^2 \times P$.
Sectional area to resist this $= 3.1416 \times D \times T$.

$$\text{Stress on metal} = \frac{.7854 \times D^2 \times P}{\pi \times D \times T} = \frac{P \times D}{4 \times T} = f.$$

This proves that a boiler is twice as strong circumferentially as longitudinally.

In calculating the actual thickness of a boiler shell, we have to multiply the denominator in the above formula by a certain percentage, as in practice we have longitudinal butt or lap joints. This percentage or efficiency is found by the following formula:

$$E = \frac{p - d}{p}.$$

Where p = pitch of rivets in longitudinal seams.
d = diameter of rivet holes.

Therefore the thickness of the shell plates is

$$t = \frac{P \times D}{2 \times f \times E}.$$

The writer has often heard the question discussed as to the possibility of welding the shell plates of small boilers, but even in the best of workmanship there are to be found flaws

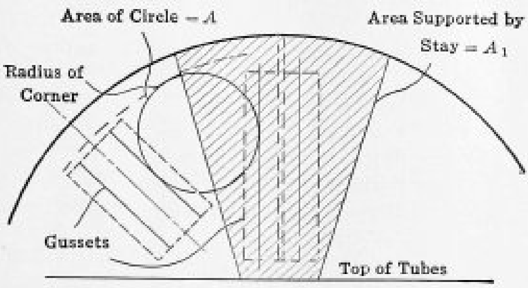


FIG. 10

which cannot be detected, and under steam pressure may lead to serious results.

Thickness of butt straps, as a rule, should be about a sixteenth inch less than the thickness of the shell plates. Another rule sometimes used by boiler makers is:

Double butt strap $T_1 = \frac{5 \times T}{8}$.

Single butt strap $T_1 = \frac{9 \times T}{8}$.

Where T = thickness of shell in inches.

T_1 = thickness of each butt strap in inches.

Double-riveted lap joints, 65 to 70 percent, average 67 percent.

Treble-riveted lap joints, 67 to 74 percent, average 72 percent.

Butt joints, double riveted, 72 to 78 percent, average 75 percent.

Professor Unwin gives a simple yet a reliable formula for finding the diameter of the rivets; thus $D_1 = 1.2 \times \sqrt{T}$ where D_1 = diameter of rivet and T = thickness of shell plates, both being in inches.

To find the number and pitch of rivets in the cirular seams we proceed as follows:

One rivet in shear $= .7854 \times D_1^2 \times f$.

Pressure on end plate $= .7854 \times D^2 \times P$.

$$\text{Therefore number of rivets} = \frac{.7854 \times D^2 \times P}{.7854 \times D_1^2 \times f}.$$

f should not be more than 9,500 pounds per square inch.

Pitch = circumference of shell divided by the number of rivets.

$$\text{Pitch} = \frac{3.1416 \times D}{N}.$$

D = diameter of boiler, 3.1416 = constant, N = number of rivets.

Longitudinal Seams

Assuming the efficiency of the joint to be 75 percent, we get $p - d = .75\ p$.

$$p - .75\ p = d = .25\ p.$$

$$\text{Therefore } p = \frac{100 \times d}{25}.$$

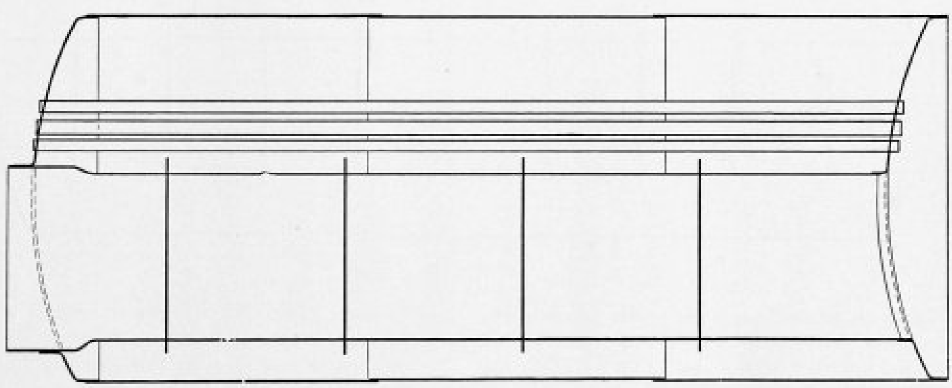


FIG. 11

Riveting

All rivet holes should be drilled and not punched (as is often the case), the holes being slightly countersunk at the rivet heads, and care being taken to remove all burr from between the plates. The rivet holes should be a sixteenth larger than the diameter of the rivet so as to allow an easy passage for the rivet. All riveting as far as practicable should be done by machine.

A riveted joint may give way in four different ways. First, by tearing the plate between the rivets, as at *A*, Fig. 4. Second, by shearing the rivets, as at *B*, Fig. 5. Third, by cross breaking, as at *C*, Fig. 6. Fourth, as at *D*, Fig. 7, by crushing.

The joints most generally used in underfired boilers are the treble-riveted lap and the double-riveted butt joint, and before calculating the thickness of the shell plates we must assume an approximate efficiency of the longitudinal joints. Below is a good average:

p = pitch of rivets.

d = diameter of rivet holes.

The following formula should be noted when designing boilers: r = percentage of plate left between the rivet holes, R = percentage of rivet section, p = pitch of rivets in inches, d = diameter of rivets in inches, N = number of rivets in one pitch, C = 1. for lap and single butts, C = 1.75 for double butts, T = thickness of plate.

$$\frac{100\ (p - d)}{p} = r. \text{ For steel plates and steel rivets.}$$

$$\frac{F \times 100 \times 23 \times d^2 \times .7854 \times N \times C}{4.5 \times p \times 28 \times T} = R. \text{ For steel plates}$$

and steel rivets.

Given C, d, F, N and T to find p so that r and R are equal, F = factor of safety for shell plates.

$$\frac{23 \times d^2 \times .7854 \times N \times C \times F}{4.5 \times 28 \times T} + d = p.$$

Fig. 8 shows in detail a longitudinal butt joint double riveted with circular seams single riveted. The spacing of the rivets should be as follows:

$$A = 3 \times d.$$

$$B = \frac{\sqrt{(11 p + 4 d)(p + 4 d)}}{10}.$$

In the design of zigzag riveting the diagonal pitch P_1 should not be less than $.65\ p + .35\ d$.

STAYING

A portion of the ends above the tubes requires staying either by means of longitudinal bar stays, shown in Fig. 1, or by gusset stays shown in Fig. 9, which is the standard method of staying in the Lancashire or Cornish boilers in England.

It must not be forgotten that the lower portion requires staying also, but not to the same extent as the upper portion. By placing ordinary bar stays we would considerably reduce the tube area, therefore in lieu of these we have what is known as stay tubes, which are about twice the thickness of the ordinary tubes, screwed into the end plates and fitted with nuts externally and internally.

The number of these stays should be such that would allow for supporting the unstayed area between the tube plates. As an example, suppose we have a boiler whose diameter is D, the lower half being fitted with a number of 3-inch tubes. This lower half, minus the total area of all the tubes, is the area which has to be supported by the stay tubes. Calling this area A, and the working pressure of the boiler in pounds per square inch P, the total load = $A \times P$. The number of stay tubes required equals the area at the bottom of the thread minus the area of the internal diameter, multiplied by the number, and the allowable stress. Putting this into a formula we get

$$A_1 \times N \times f = A \times P.$$

A = area of end plate that requires staying, P = pressure in pounds, A_1 = area at bottom of thread minus the area of the internal diameter of staying tubes, f = allowable stress in pounds per square inch, which should be about 9,500 to 10,000 pounds, N = number of stay tubes.

To find the thickness of the end plates, and also the dimensions of the stays required for supporting them, first figure the gusset stays. Taking a circle which is the largest that can be inscribed in any unstayed portion of the end (see Fig. 10), and calling this area A, then

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

P = Pressure.
C = about 100.
T = thickness in sixteenths of an inch.
A = area in square inches.

For the dimensions of stay, A_1 (Fig. 10) equals the area of the end supported by one stay in square inches, therefore,

$$A_1 \times P = D \times T \times f.$$

Number of rivets connecting the gusset to shell = $A_1 \times P = N \times A_{11} \times f$.

Number of rivets connecting the gusset to end = $A_1 \times P = N \times A_{11} \times f_1$.

A_1 = area in square inches.
P = working pressure.
D = depth of stay in inches.
T = thickness of stay in inches.
f = allowable shearing stress = 9,000 pounds per square inch.
A_{11} = area of one rivet.
f_1 = allowable tensile stress = 8,000 pounds per square inch.

For flat ends stayed by longitudinal bar stays as above:

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

C = constant for each description of staying.
A = vertical pitch $\times$ horizontal pitch.

Stays passing through the plate only with nuts externally and internally, steel plates, C = 140.

Stays with double nuts and large washers riveted to the end plates, C = 250.

If a doubling plate is fitted externally, and riveted to the end on its outer edge, and covering the whole unstayed area, being as thick, or nearly as thick, as the plate itself, C = 140.

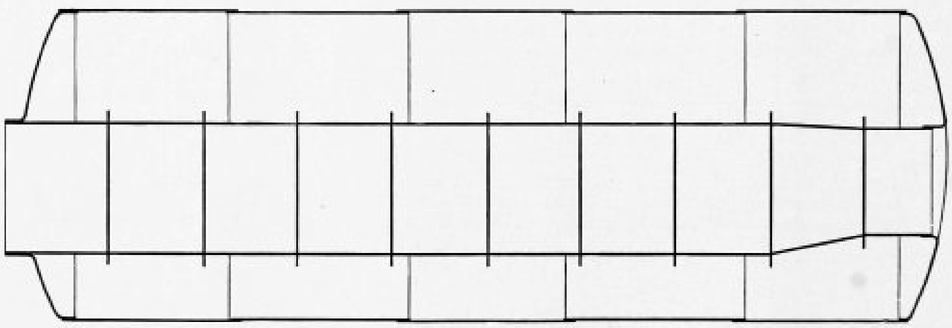


FIG. 12

The writer has seen on the English market a return tube boiler having one internal large firetube, together with a number of smoke tubes, the ends of the boiler being dished, so as to eliminate all internal gusset or bar stays. This boiler is shown in Fig. 11. But, as the reader will observe, trouble is bound to come to the tubes sooner or later, owing to the expansion of the end plates.

It was with interest that the writer read the editorial remarks in the May issue of THE BOILER MAKER dealing with the Lancashire and Cornish boilers, which are the standard types used on this side of the Atlantic, and although this short article deals only with the underfired boiler, we would like to add here that the flat ends of these boilers, which were stayed by means of internal gussets or bar stays, are now becoming obsolete, their place being taken by the "Thompson dish-ended boiler," as shown in Fig. 12. These boilers with their dish ends do not require staying, therefore there are no stay rivets to leak, no external angle ring for connecting the end plate to the shell. They allow greater freedom for expansion and contractional strains, and are also recommended for their easy cleaning.

Working Pressures of Plain Steel Flues

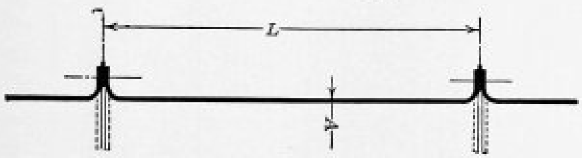
With Adamson Flanged Joints, Calculated to British Board of Trade Rules and also to Lloyd's Rules of British and Foreign Shipping

BY W. R. ALLEN

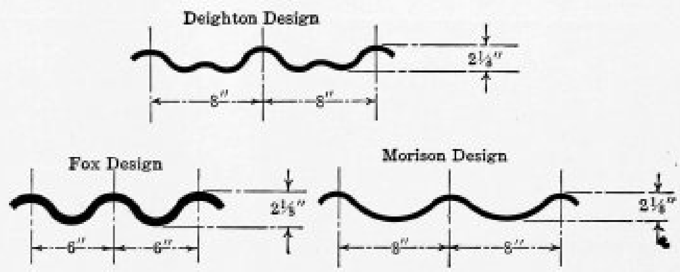
It will be noticed that the tables given herewith take into consideration the limiting lengths due to varying thicknesses. In the case of Board of Trade rules these are marked with thick lines, and in the case of Lloyds the lengths of sections for ⅜ inch thick is 3 feet 9 inches, consequently the working pressures will run right up to 3 feet 9 inches for any other thickness.

It should also be understood that the working pressures are calculated with the diameters being given as outside. This is illustrated at the head of the lists by a small sketch at the foot of the first column.

The lengths of the various sections increase by one inch from 1 foot 6 inches to 3 feet 9 inches, and the diameters



ADAMSON DESIGN



OTHER DESIGNS

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 2′ 0″ to 2′ 6″	Thickness, Inches.	Length of Sections, 1′ 6″ to 2′ 7″.													
		1′ 6″		1′ 7″		1′ 8″		1′ 9″		1′ 10″		1′ 11″		2′ 0″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2′ 0″	3/8	189	195	186	193	184	191	182	189	180	187	177	185	175	183
	13/32	208	216	206	214	204	213	201	210	199	208	197	206	194	204
	7/16	231	235	229	233	226	230	224	228	222	226	220	224	218	222
	15/32	252	254	250	252	247	249	245	248	242	245	240	243	238	241
	1/2	275	275	272	273	270	270	268	269	266	266	263	264	261	262
2′ 3″	3/8	168	173	166	172	164	170	162	168	160	166	157	164	155	162
	13/32	185	192	183	190	181	188	179	187	177	185	175	183	173	181
	7/16	206	209	203	207	201	205	199	203	197	202	195	200	193	198
	15/32	224	226	222	224	220	222	218	220	215	218	213	216	212	215
	1/2	244	244	242	242	240	240	238	238	236	237	234	235	232	233
	17/32	263	261	261	259	258	257	256	255	255	253	252	251	250	250
2′ 6″	3/8	151	156	149	155	147	153	145	151	144	150	142	148	140	146
	13/32	166	173	165	171	163	170	161	168	159	166	157	165	155	163
	7/16	185	188	183	186	181	184	179	183	177	181	175	179	174	178
	15/32	201	203	200	201	198	200	196	198	194	196	192	194	190	193
	1/2	220	220	218	218	216	216	214	215	212	213	210	211	209	210
	17/32	236	235	235	233	233	231	230	230	229	228	227	226	225	225
	9/16	253	250	250	248	249	246	247	245	246	243	244	242	242	240
	19/32	271	266	269	265	268	263	265	262	264	260	262	258	260	256

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 2′ 0″ to 2′ 6″	Thickness, Inches.	Length of Sections, 1′ 6″ to 2′ 7″.													
		2′ 1″		2′ 2″		2′ 3″		2′ 4″		2′ 5″		2′ 6″		2′ 7″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2′ 0″	3/8	173	181	170	179	168	177	166	175	163	172	161	170	159	168
	13/32	192	202	190	200	187	197	185	195	183	193	181	191	178	189
	7/16	215	220	213	218	211	216	208	214	206	212	204	210	202	208
	15/32	236	239	234	237	231	235	229	233	226	231	224	229	222	226
	1/2	259	260	256	258	254	256	252	254	249	252	247	250	245	248
2′ 3″	3/8	153	161	151	159	149	157	147	155	145	153	143	151	141	149
	13/32	171	179	169	177	167	175	165	174	163	172	160	170	158	168
	7/16	191	196	189	194	187	192	185	190	183	189	181	187	179	185
	15/32	210	213	207	210	205	209	203	207	201	205	199	203	197	202
	1/2	230	231	228	229	226	227	224	226	222	224	220	222	218	220
	17/32	248	248	246	246	244	244	242	242	240	240	238	238	236	237
2′ 6″	3/8	138	145	136	143	134	141	132	139	131	138	129	136	127	134
	13/32	154	161	152	160	150	158	148	156	146	155	144	153	145	151
	7/16	172	176	170	175	168	173	166	171	165	170	163	168	161	166
	15/32	189	191	187	190	185	188	183	186	181	185	179	183	177	181
	1/2	207	208	205	206	203	205	201	203	199	201	198	200	196	198
	17/32	223	223	221	221	220	220	218	218	216	216	214	214	212	213
	9/16	240	238	238	236	236	235	235	233	232	231	231	230	229	228
	19/32	258	255	256	253	254	251	252	250	250	248	249	247	247	245

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 2′ 0″ to 2′ 6″.	Thickness, Inches.	Length of Sections, 2′ 8″ to 3′ 9″.													
		2′ 8″		2′ 9″		2′ 10″		2′ 11″		3′ 0″		3′ 1″		3′ 2″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2′ 0″	3/8	157	166	154	164	...	162	...	160	...	158	...	156	...	154
	13/32	176	187	174	185	171	183	169	181	167	179	...	177	...	175
	7/16	199	206	197	204	194	202	192	200	190	198	188	195	185	193
	15/32	220	224	217	223	215	220	213	218	210	216	208	214	206	212
	1/2	242	245	240	244	238	241	236	239	233	237	231	235	229	233
2′ 3″	3/8	139	148	137	146	...	144	...	142	...	140	...	138	...	136
	13/32	156	166	154	164	152	162	150	161	148	159	...	157	...	155
	7/16	177	183	175	181	173	179	171	177	169	176	166	173	165	172
	15/32	195	200	193	198	191	196	189	194	187	192	185	191	183	188
	1/2	215	218	214	216	212	214	210	212	207	211	205	209	203	207
	17/32	234	235	232	233	230	231	228	229	226	227	224	226	222	224
2′ 6″	3/8	125	133	123	131	...	129	...	128	...	126	...	124	...	123
	13/32	141	150	139	148	137	146	135	144	133	143	...	141	...	140
	7/16	159	165	157	163	155	161	154	160	152	158	150	156	148	154
	15/32	176	180	174	178	172	177	170	175	168	173	166	171	164	170
	1/2	194	196	192	195	190	193	189	191	187	190	185	188	183	186
	17/32	211	211	209	209	207	208	205	206	203	205	202	203	200	201
	9/16	227	226	225	224	223	223	221	221	220	220	218	218	216	216
	19/32	245	243	244	241	242	240	240	238	238	236	236	235	234	233

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 2′ 0″ to 2′ 6″.	Thickness, Inches.	Length of Sections, 2′ 8″ to 3′ 9″.													
		3′ 3″		3′ 4″		3′ 5″		3′ 6″		3′ 7″		3′ 8″		3′ 9″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2′ 0″	3/8	...	152	...	150	...	147	...	145	...	143	...	141	...	139
	13/32	...	172	...	170	...	168	...	166	...	164	...	162	...	160
	7/16	183	191	181	189	...	187	...	185	...	183	...	181	...	179
	15/32	204	210	201	208	199	206	197	204	194	201	192	200	...	199
	1/2	227	231	224	229	222	227	220	225	217	222	215	220	213	218
2′ 3″	3/8	...	135	...	133	...	131	...	129	...	127	...	125	...	124
	13/32	...	153	...	151	...	150	...	148	...	146	...	144	...	142
	7/16	162	170	161	168	...	166	...	164	...	163	...	161	...	159
	15/32	181	186	179	185	177	183	175	181	173	179	171	177	...	176
	1/2	201	205	199	203	197	201	195	200	193	198	191	196	189	194
	17/32	220	222	218	220	216	218	214	216	211	214	209	213	208	210
2′ 6″	3/8	...	121	...	119	...	118	...	116	...	115	...	113	...	111
	13/32	...	138	...	136	...	135	...	133	...	131	...	129	...	128
	7/16	146	153	144	151	...	150	...	148	...	146	...	145	...	143
	15/32	163	168	161	166	159	165	157	163	155	161	153	160	...	158
	1/2	181	185	179	183	177	181	176	180	174	178	172	176	170	175
	17/32	198	200	196	198	194	196	193	195	190	193	188	191	187	190
	9/16	214	215	212	213	210	211	209	210	206	208	205	206	203	205
	19/32	232	232	230	230	229	228	227	226	225	225	223	223	221	222

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 2' 9" to 3' 3".	Thickness, Inches.	Length of Sections, 1' 6" to 2' 7".													
		1' 6"		1' 7"		1' 8"		1' 9"		1' 10"		1' 11"		2' 0"	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2' 9"	3/8	137	142	135	141	134	139	132	137	130	136	129	134	127	133
	13/32	151	157	150	156	148	154	146	153	145	151	143	150	141	148
	7/16	168	171	166	169	165	168	163	166	161	165	160	163	158	162
	15/32	183	185	181	183	180	181	178	180	176	178	174	177	173	175
	1/2	200	200	197	198	196	197	195	195	193	193	191	192	190	191
	17/32	215	214	213	212	211	210	210	209	208	207	206	206	205	204
	9/16	230	227	228	225	227	224	225	223	223	220	221	219	220	218
	19/32	246	242	245	240	243	239	241	238	239	236	238	234	236	233
	5/8	261	256	260	254	258	253	256	251	254	250	253	248	251	247
3' 0"	3/8	126	130	124	129	123	127	121	126	120	125	118	123	116	122
	13/32	139	144	137	143	136	141	134	140	133	138	131	137	129	135
	7/16	154	156	152	155	151	154	149	152	148	151	146	149	145	148
	15/32	168	169	166	168	165	166	163	165	162	163	160	162	158	161
	1/2	183	183	182	182	180	180	178	179	177	177	175	176	174	175
	17/32	197	196	195	194	194	193	192	191	191	190	189	188	188	187
	9/16	211	208	209	206	207	205	206	204	205	202	203	201	202	200
	19/32	226	222	225	220	223	219	221	218	219	216	218	215	216	213
	5/8	240	234	238	233	236	232	235	230	233	229	232	227	230	226
3' 3"	3/8	116	120	115	119	113	117	112	116	110	115	109	113	108	112
	13/32	128	133	127	131	125	130	124	129	122	128	121	126	120	125
	7/16	142	145	141	143	139	142	138	141	136	139	135	138	134	137
	15/32	155	156	153	155	152	153	151	152	149	151	148	149	146	148
	1/2	169	169	167	168	166	166	165	165	163	164	162	162	160	161
	17/32	182	181	180	179	179	178	177	177	176	175	174	174	173	173
	9/16	194	192	193	191	191	189	190	188	189	187	187	186	186	184
	19/32	208	205	207	203	206	202	204	201	203	200	201	198	200	197
	5/8	221	216	220	215	218	214	217	212	215	211	214	210	212	209

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 2' 9" to 3' 3".	Thickness, Inches.	Length of Sections, 1' 6" to 2' 7".													
		2' 1"		2' 2"		2' 3"		2' 4"		2' 5"		2' 6"		2' 7"	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2' 9"	3/8	125	131	124	130	122	128	120	127	119	125	117	124	115	122
	13/32	140	147	138	145	136	144	135	142	133	140	131	139	130	137
	7/16	156	160	155	159	153	157	151	156	149	154	148	153	146	151
	15/32	171	174	170	172	168	171	166	169	165	168	163	166	161	165
	1/2	188	189	186	187	184	186	183	184	181	183	180	181	178	180
	17/32	203	203	201	201	200	200	198	198	196	197	195	195	193	194
	9/16	218	216	216	215	215	214	213	212	211	210	210	209	208	207
	19/32	235	231	233	230	231	228	230	227	228	226	226	224	225	222
	5/8	250	249	248	244	246	242	245	240	243	239	242	237	240	236
3' 0"	3/8	115	120	113	119	112	118	110	116	109	115	107	113	106	112
	13/32	128	134	126	133	125	131	123	130	122	129	120	127	119	126
	7/16	143	147	142	145	140	144	139	143	137	141	136	140	134	138
	15/32	157	159	155	158	154	156	152	155	151	154	149	152	148	151
	1/2	172	173	171	172	169	170	168	169	166	168	165	166	163	165
	17/32	186	186	185	184	183	183	181	181	180	180	178	179	177	177
	9/16	200	198	198	197	197	196	135	194	194	192	192	191	191	190
	19/32	215	212	214	211	212	209	210	208	209	207	208	205	206	204
	5/8	229	225	227	223	226	222	224	220	223	219	221	218	220	216
3' 3"	3/8	106	111	105	110	103	108	102	107	100	106	99	105	98	103
	13/32	118	124	117	123	115	121	114	120	112	119	111	117	110	116
	7/16	132	136	131	134	129	133	128	132	126	130	125	129	124	128
	15/32	145	147	143	146	142	145	141	143	139	142	138	141	136	139
	1/2	159	160	158	159	156	157	155	156	153	155	152	153	151	152
	17/32	172	171	170	170	169	169	167	167	166	166	165	165	163	164
	9/16	184	183	183	182	182	181	180	179	179	178	177	177	176	175
	19/32	199	196	197	194	196	193	194	192	193	191	191	189	190	188
	5/8	211	207	210	206	208	205	207	203	206	202	204	201	203	200

increase by 3 inches from 2 feet to 3 feet 9 inches. The thicknesses vary from 3/8 inch to 1/2 inch for 2 feet diameter, 3/8 inch to 17/32 inch for 2 feet 3 inches diameter, 3/8 inch to 19/32 inch for 2 feet 6 inches diameter, and so on until the thickness 11/16 inch is reached for a diameter of 3 feet 9 inches.

The symbols B. of T. and L. at the head of each column of pressures are abbreviations for the words Board of Trade and Lloyds.

With this information and the lists it should be quite apparent to any reader how to find the working pressure applicable to any diameter, thickness and length of flue section.

Example.—We have a section 2 feet 10 inches long, 3 feet 3 inches outside diameter and 1/2 inch thick. Find the working pressure.

Refer to the table with 3 feet 3 inches diameter and 1/2 inch thickness, then under the heading of 2 feet 10 inches long the working pressure of Board of Trade will be found to be 146 pounds and Lloyds 148 pounds.

With regard to the corrugated flues, these range from 2 feet 6 inches to 4 feet 8 inches diameter and 7/16 inch to 11/16 inch thick.

The tables accompanying this article are printed on pages 217-223.

BOILER EXPLOSION.—On June 11 a Scotch boiler, which forms one of a battery of two on board the steam barge *E. M. Peck*, exploded while the barge was backing away from the dock at Racine, Wis., killing the chief engineer, first and second assistant and an oiler instantly, injuring three others fatally, who have since died, besides seriously wounding many of the crew of the barge and doing a large amount of damage. The boiler was 11 feet long over all, 132 inches in diameter, with two Adamson furnaces and one hundred and twenty-eight 3½-inch tubes. The boiler was built in 1888, and the consensus of opinion points to old age and crystalization as the main cause of the explosion.

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 2′ 9″ to 3′ 3″.	Thickness Inches.	Length of Sections, 2′ 8″ to 3′ 9″.													
		2′ 8″		2′ 9″		2′ 10″		2′ 11″		3′ 0″		3′ 1″		3′ 2″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2′ 9″	3/8	114	121	112	119	...	118	...	116	...	115	...	113	...	112
	13/32	128	136	126	134	125	133	123	131	121	130	...	128	...	127
	7/16	145	150	143	148	141	147	140	145	138	144	136	142	135	140
	15/32	160	163	158	162	156	160	154	159	153	157	151	156	150	154
	1/2	176	178	175	177	173	175	171	174	170	172	168	171	166	169
	17/32	191	192	190	191	188	189	187	187	185	186	183	184	181	183
	9/16	206	206	205	204	203	203	201	201	200	200	198	198	196	196
	19/32	223	221	221	220	220	218	218	216	216	215	214	213	213	212
	5/8	238	234	236	233	235	231	233	230	231	229	230	227	228	226
3′ 0″	3/8	104	111	103	109	...	108	...	106	...	105	...	104	...	102
	13/32	117	125	116	123	114	122	113	120	111	119	...	118	...	116
	7/16	133	137	131	136	129	134	128	133	126	132	125	130	123	129
	15/32	146	150	145	148	143	147	142	145	140	144	138	143	137	141
	1/2	161	164	160	162	158	161	157	159	155	158	154	157	152	155
	17/32	175	176	174	175	172	173	171	172	169	170	168	169	166	168
	9/16	189	188	187	187	186	186	184	184	183	183	181	181	180	180
	19/32	204	203	203	201	202	200	200	198	198	197	197	196	195	194
	5/8	218	215	216	213	215	212	214	211	212	210	210	208	209	207
3′ 3″	3/8	96	102	95	101	...	99	...	98	...	97	...	96	...	94
	13/32	108	115	107	114	105	112	104	111	102	110	...	108	...	107
	7/16	122	127	121	125	19	124	118	123	117	121	115	120	114	119
	15/32	135	138	133	137	132	136	131	134	129	133	128	132	126	130
	1/2	149	151	148	150	146	148	145	147	143	146	143	145	141	143
	17/32	162	162	161	161	159	160	158	158	156	157	155	156	153	155
	9/16	175	174	173	173	172	171	170	170	169	169	167	167	166	166
	19/32	189	187	187	186	186	184	184	183	183	182	182	180	180	179
	5/8	201	198	200	197	198	196	197	194	196	193	194	192	193	191

Transmission of Heat into Steam Boilers*

In a recent Bulletin, issued by the Bureau of Mines of the Department of the Interior, and prepared by Messrs. Henry Kreisinger and Walter T. Ray, under the direction of Dr. Joseph A. Holmes, there are given the results of a number of important experimental investigations upon the transmission of heat into steam boilers. These experiments are of such value that every engineer who devotes his efforts to the improvement of apparatus for the generation of steam should consult them in their entirety, and the following abstract of the work will indicate both the lines along which the work has been done and the nature of the results obtained:

In Bryan Donkin's book, entitled "The Practical Physics of the Modern Steam Boiler," it is stated that James Watt obtained nearly as good an evaporation per pound of coal and per square foot of heating surface as is obtained now. The remark is probably true. At any rate, about the only decided superiority of the modern steam boilers over older types is in mechanical construction, and for this superiority credit should be given to the designers of machine tools quite as much as to the boiler engineer. The main reason for tardiness in boiler improvement probably lies in the reluctance of educated engineers to do the disagreeable work involved in boiler tests.

Nearly a hundred years of practical investigation of boiler and furnace problems has resulted in little advance. Perhaps the main reason why many of the investigations failed to bring about progress was that boiler and furnace were considered a unit and were investigated together. Various combinations of boilers and furnaces have been built and tested without thoughtful planning. Many of the published results of such tests confuse the performance of the boiler and the furnace in such a way that it is difficult, if not impossible, to tell which of the two should be blamed or praised for the poor or good results obtained from the combined apparatus. Evidently, many persons have thought that the combined efficiency could be greatly increased by some mysterious manipulation.

The principles governing the combustion of fuel in boiler furnaces and the absorption of heat by boilers have been little

(*Continued on page 222.*)

* From *Cassier's Magazine*.

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 2′ 9″ to 3′ 3″.	Thickness, Inches.	Length of Sections, 2′ 8″ to 3′ 9″.													
		3′ 3″		3′ 4″		3′ 5″		3′ 6″		3′ 7″		3′ 8″		3′ 9″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2′ 9″	3/8	...	110	...	109	...	107	...	106	...	104	...	102	...	101
	13/32	...	125	...	124	...	122	...	121	...	119	...	118	...	116
	7/16	133	139	131	137	...	136	...	135	...	134	...	131	...	130
	15/32	148	152	146	151	145	150	143	148	141	146	140	145	...	143
	1/2	165	168	163	166	161	165	160	163	158	162	156	160	155	159
	17/32	180	182	178	180	176	178	175	177	173	175	171	174	170	172
	9/16	195	195	193	194	191	192	190	191	188	189	186	188	185	186
	19/32	212	210	210	209	208	207	206	206	205	204	203	202	201	201
	5/8	226	224	224	222	223	221	221	219	220	218	218	216	216	215
3′ 0″	3/8	...	101	...	100	...	98	...	97	...	95	...	94	...	93
	13/32	...	115	...	114	...	112	...	111	...	109	...	108	...	106
	7/16	122	127	120	126	...	124	...	123	...	122	...	120	...	119
	15/32	135	140	134	139	132	137	131	136	129	134	128	133	...	132
	1/2	151	154	149	152	148	151	146	150	145	148	143	147	142	145
	17/32	165	166	163	165	162	164	160	162	158	161	157	160	155	158
	9/16	178	179	177	177	176	176	174	175	172	173	171	172	169	170
	19/32	194	193	192	191	191	190	189	188	187	187	186	186	184	184
	5/8	207	205	206	204	204	202	203	201	201	200	200	198	197	197
3′ 3″	3/8	...	93	...	92	...	91	...	89	...	88	...	87	...	86
	13/32	...	106	...	105	...	103	...	102	...	101	...	100	...	98
	7/16	112	117	111	116	...	115	...	114	...	113	...	111	...	110
	15/32	125	129	124	128	122	127	121	125	119	124	118	123	...	121
	1/2	139	142	138	141	136	139	135	138	134	137	132	136	131	134
	17/32	152	154	151	152	149	151	148	150	146	148	145	147	143	146
	9/16	165	165	163	164	162	163	161	161	159	160	158	159	156	157
	19/32	179	178	177	177	176	175	174	174	173	173	172	172	170	170
	5/8	191	189	190	188	189	187	187	186	186	184	184	183	183	182

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 3′ 6″ and 3′ 9″.	Thickness, Inches.	Length of Sections, 1′ 6″ to 2′ 7″.													
		1′ 6″		1′ 7″		1′ 8″		1′ 9″		1′ 10″		1′ 11″		2′ 0″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
3′ 6″	3/8	108	111	106	110	105	109	104	108	102	107	101	105	100	104
	13/32	119	123	117	122	116	121	115	120	114	119	112	117	111	116
	7/16	132	134	131	133	129	132	128	130	127	129	125	128	124	127
	15/32	144	145	142	144	141	142	140	141	138	140	137	139	136	138
	1/2	157	157	156	156	154	154	153	153	151	152	150	151	149	149
	17/32	168	168	167	166	166	165	165	164	163	163	162	161	161	160
	9/16	180	178	179	177	178	176	176	175	175	173	174	172	173	171
	19/32	193	190	192	189	191	188	190	187	188	185	187	184	186	183
	5/8	205	201	204	199	202	198	201	197	200	196	199	195	198	194
	21/32	217	213	216	212	214	210	213	209	212	208	210	207	209	206
	11/16	230	223	229	222	228	221	226	220	225	219	224	218	222	216
3′ 9″	3/8	101	104	99	103	98	102	97	101	96	99	95	98	93	97
	13/32	111	115	110	114	108	113	107	112	106	111	105	110	103	108
	7/16	123	125	122	124	121	123	119	122	118	121	117	120	116	119
	15/32	134	135	133	134	132	133	130	132	129	131	128	129	127	128
	1/2	147	146	145	145	144	144	143	143	141	142	140	141	139	140
	17/32	157	156	156	155	155	154	154	153	152	152	151	151	150	150
	9/16	168	166	167	165	166	164	165	163	163	162	162	161	161	160
	19/32	181	177	179	176	178	175	177	174	175	173	174	172	173	171
	5/8	192	187	190	186	189	185	188	184	187	183	185	182	184	181
	21/32	202	198	201	197	200	196	199	195	198	194	196	193	195	192
	11/16	215	208	213	207	212	206	211	205	210	204	209	203	208	202

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 3′ 6″ and 3′ 9″.	Thickness, Inches.	Length of Sections, 1′ 6″ to 2′ 7″.													
		2′ 1″		2′ 2″		2′ 3″		2′ 4″		2′ 5″		2′ 6″		2′ 7″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
3′ 6″	3/8	98	103	97	102	96	101	95	100	94	98	92	97	91	96
	13/32	110	115	108	114	107	113	106	111	104	110	103	109	102	108
	7/16	123	126	121	125	120	123	119	122	117	121	116	120	115	119
	15/32	135	136	133	135	132	134	131	133	129	132	128	130	127	129
	1/2	147	148	146	147	145	146	143	145	142	144	141	142	140	141
	17/32	160	159	158	158	157	157	155	155	154	154	153	153	152	152
	9/16	171	170	170	169	169	168	167	166	166	165	165	164	163	163
	19/32	184	182	183	181	182	179	181	178	179	177	178	176	177	175
	5/8	196	192	195	191	193	190	192	189	191	188	190	187	188	185
	21/32	208	204	206	203	205	202	204	201	202	199	201	198	200	197
	11/16	221	215	220	214	218	213	217	212	216	210	214	209	213	208
3′ 9″	3/8	92	96	91	95	90	94	88	93	87	92	86	91	85	90
	13/32	102	107	101	106	100	105	99	104	97	103	96	102	95	101
	7/16	114	117	113	116	112	115	111	114	110	113	108	112	107	111
	15/32	126	127	124	126	123	125	122	124	121	123	119	122	118	121
	1/2	138	138	136	137	135	136	134	135	133	134	132	133	130	132
	17/32	149	148	147	147	146	146	145	145	144	144	143	143	142	142
	9/16	160	158	159	157	157	156	156	155	155	154	154	153	152	152
	19/32	172	170	171	168	170	167	168	166	167	165	166	164	165	163
	5/8	183	180	182	178	180	177	179	176	178	175	177	174	176	173
	21/32	194	191	193	190	191	189	190	187	189	186	188	185	187	184
	11/16	206	201	205	200	204	198	203	197	201	196	200	195	199	194

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 3′ 6″ and 3′ 9″.	Thickness Inches.	Length of Sections, 2′ 8″ to 3′ 9″.													
		2′ 8″		2′ 9″		2′ 10″		2′ 11″		3′ 0″		3′ 1″		3′ 2″	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
3′ 6″	3/8	89	95	88	94	...	92	...	91	...	90	...	89	...	88
	13/32	100	107	99	105	98	104	97	103	95	102	...	101	...	100
	7/16	114	117	112	116	111	115	110	114	108	113	107	111	106	110
	15/32	125	128	124	127	123	126	121	125	120	123	119	122	117	121
	1/2	138	140	137	139	136	138	135	136	133	135	132	134	131	133
	17/32	150	151	149	149	148	148	146	147	145	146	144	145	143	144
	9/16	162	161	161	160	159	159	158	158	157	157	156	155	154	154
	19/32	175	173	174	172	172	171	171	170	170	169	169	167	167	166
	5/8	187	184	185	183	184	182	183	180	182	179	180	178	179	177
	21/32	198	196	197	195	196	194	195	192	193	191	192	190	191	189
	11/16	212	207	210	205	209	204	208	203	207	202	205	201	204	200
3′ 9″	3/8	83	88	82	87	...	86	...	85	...	84	...	83	...	82
	13/32	94	100	93	98	91	97	90	96	89	95	...	94	...	93
	7/16	106	110	105	108	103	107	102	106	101	105	100	104	99	103
	15/32	117	119	116	118	115	117	113	116	112	115	111	114	110	113
	1/2	129	131	128	129	127	128	126	127	124	126	123	125	122	124
	17/32	140	141	139	139	138	138	137	137	135	136	134	135	133	134
	9/16	151	151	150	150	149	149	147	147	146	146	145	145	144	144
	19/32	163	162	162	161	161	160	160	159	158	158	157	156	156	155
	5/8	174	172	173	171	172	169	171	168	170	167	168	166	167	165
	21/32	185	183	184	182	183	181	182	180	181	178	179	177	178	176
	11/16	198	193	196	192	195	191	194	190	193	189	191	187	190	186

understood. The dogmas that the area of grate should have a certain ratio to the area of the heating surface, and that it takes 10 square feet of heating surface to make one boiler horsepower, seemingly had become so thoroughly fixed in the mind that they were hardly ever questioned. It is only within the last decade that a few engineers have broken away from the old rule of thumb methods, and have begun to investigate the functions of the boiler and furnace separately. Their studies seem to mark the beginning of advance in steam generating apparatus.

The boiler is the metallic vessel that contains water and steam and absorbs heat; consequently it should be studied as a heat absorber.

The furnace is that part of the steam generating apparatus in which the potential energy of the coal is changed into heat; consequently it should be studied as a heat generator.

WORKING PRESSURES OF PLAIN STEEL FLUES WITH ADAMSON JOINTS.

Diameters, 3' 6" and 3' 9".	Thickness, Inches.	Length of Sections, 2' 8" to 3' 9".													
		3' 3"		3' 4"		3' 5"		3' 6"		3' 7"		3' 8"		3' 9"	
		B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
	3/8	...	87	...	85	...	84	...	83	...	82	...	81	...	79
	13/32	...	98	...	97	...	96	...	95	...	94	...	92	...	91
	7/16	104	109	103	108	...	107	...	105	...	104	...	103	...	102
	15/32	116	120	115	119	114	118	112	116	111	115	110	114	...	113
	1/2	129	132	128	131	127	129	125	128	124	127	123	126	121	125
3' 6"	17/32	141	142	140	141	139	140	137	139	136	138	135	137	133	136
	9/16	153	153	151	152	150	151	149	149	148	148	146	147	145	146
	19/32	166	165	165	164	163	163	162	162	161	160	159	159	158	158
	5/8	178	176	176	175	175	173	174	172	172	171	171	170	170	168
	21/32	190	188	188	186	187	185	186	184	184	183	183	183	182	181
	11/16	203	198	202	197	200	196	199	195	197	193	196	192	195	191
	3/8	...	81	...	80	...	79	...	77	...	76	...	75	...	74
	13/32	...	92	...	91	...	90	...	88	...	87	...	86	...	85
	7/16	97	102	96	101	...	100	...	99	...	97	...	96	...	95
	15/32	108	112	107	111	106	110	105	108	103	107	102	106	...	105
	1/2	121	123	119	122	118	121	117	120	116	118	114	117	113	116
3' 9"	17/32	132	133	130	132	129	131	128	130	127	128	126	127	124	126
	9/16	143	143	141	142	140	141	139	140	138	138	137	137	135	136
	19/32	155	154	154	153	152	152	151	151	150	150	149	149	147	147
	5/8	166	164	165	163	163	162	162	161	161	160	160	158	159	157
	21/32	177	175	176	174	174	173	173	172	172	171	171	170	170	168
	11/16	189	185	188	184	187	183	186	182	184	181	183	179	182	178

MAXIMUM WORKING PRESSURE FOR DEIGHTON, FOX AND MORISON SECTIONS OF CORRUGATED FLUES.

Least Diameters of Furnace Inside Corrugations.	Thickness of Sections 7/16" to 11/16".																	
	7/16"		15/32"		1/2"		17/32"		9/16"		19/32"		5/8"		21/32"		11/16"	
	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.	B. of T.	L.
2' 6"	198	185	212	204	226	222	239	241	253	259	266	278	281	296	293	315	307	333
2' 7"	192	180	205	198	219	216	232	234	245	252	258	270	272	288	284	306	297	323
2' 8"	186	175	199	192	212	210	225	227	238	245	250	262	264	280	276	297	288	315
2' 9"	181	170	193	187	206	204	218	221	231	238	243	255	256	272	268	289	280	306
2' 10"	176	166	188	182	200	199	212	215	224	232	236	248	249	265	260	282	272	298
2' 11"	171	161	183	178	194	194	206	210	218	226	230	242	242	258	253	274	265	290
3' 0"	166	157	178	173	189	189	201	205	212	220	223	236	236	252	246	267	257	283
3' 1"	162	154	173	169	184	184	195	200	206	215	217	230	230	246	240	261	251	276
3' 2"	158	150	169	165	179	180	190	195	201	210	212	225	224	240	234	254	245	269
3' 3"	154	146	164	161	175	176	186	190	196	205	207	220	218	234	228	248	239	263
3' 4"	150	143	160	157	171	172	181	186	191	200	202	215	213	229	222	243	232	258
3' 5"	146	140	156	154	167	168	177	182	187	196	197	210	208	224	217	237	227	252
3' 6"	143	137	153	151	163	164	173	178	182	192	192	205	203	219	212	233	221	246
3' 7"	140	134	149	147	159	161	169	174	178	188	188	201	198	214	207	228	216	241
3' 8"	137	131	146	144	156	157	165	170	174	184	184	197	194	210	203	223	212	235
3' 9"	134	128	143	141	152	154	161	167	171	180	180	193	190	206	198	218	208	231
3' 10"	131	126	139	138	149	151	158	164	167	176	176	189	186	201	194	214	203	226
3' 11"	128	123	137	136	146	148	155	160	164	173	172	185	182	197	190	209	199	222
4' 0"	125	121	134	133	143	145	152	157	160	169	169	182	178	194	186	205	195	217
4' 1"	123	119	131	131	140	143	148	154	157	166	165	178	175	190	182	201	191	213
4' 2"	120	117	129	128	137	140	146	152	154	163	162	175	171	186	179	198	187	209
4' 3"	118	114	126	126	135	137	143	149	151	160	159	172	168	183	175	195	183	206
4' 4"	116	112	124	124	132	135	140	146	148	157	156	169	165	180	172	191	180	202
4' 5"	114	110	122	121	130	133	138	144	145	155	153	166	162	177	169	188	177	198
4' 6"	112	109	119	119	127	130	135	141	143	152	150	163	158	174	166	184	174	195
4' 7"	110	107	117	117	125	128	133	139	140	149	148	160	156	171	164	181	170	192
4' 8"	108	105	115	115	123	126	130	136	138	147	145	157	153	168	162	178	168	189

In almost all the boilers now used for generating steam only a small percentage of the heating surface is so exposed to radiation from the fuel bed, furnace walls and flames as to receive heat both by radiation and convection. By far the greater part of the surface receives heat only by convection from the moving gaseous products of combustion.

The greatest resistance to the flow of heat is met before the hot gases reach the dry surface of the heating plate. If a boiler is even moderately clean, the resistance of the plate itself to the flow of heat through it is very small indeed. The resistance to the passage of the heat from the plate into boiler water is also very small. It may be said that the heating plates transmit to the boiler water all the heat that can be imparted to their dry surfaces.

Increasing the rate at which heat is imparted to the dry surface of the heating plate increases the rate of steam production in the same proportion.

Since in most boilers the heat imparted by convection is the larger part of the total heat the boiler receives, increasing the rate at which heat is imparted to the heating surface by convection causes a nearly proportionate increase in the rate of steam production. If the initial temperature of the moving gases remains constant, increasing the velocity with which the latter pass over the heating plate increases in an almost direct ratio the rate at which heat is imparted to the dry surface of the plate, and therefore increases almost directly the rate at which steam is made.

In the future the velocity at which gases pass over the heating plates will be the factor that will be used for increasing the capacity of boilers. There is no valid reason why stationary boilers cannot be worked at two or three times the rate at which they are worked at present.

To increase the capacity of any boiler, pass more gases over its heating surfaces.

A boiler that has its heating plates arranged in such a way that the gas passages are long and of small cross-section is more efficient than a boiler in which the gas passages are short and of large cross-section.

If the same weights of gas at the same initial temperature are passed through a 2-inch and a 4-inch flue, both flues having the same length, the 2-inch flue will absorb more heat than the 4-inch flue, although the 4-inch flue has twice as much heating surface as the 2-inch flue.

Locomotive boilers are as a rule more efficient than stationary fire-tube boilers, because the tubes in the former boilers have a smaller diameter in comparison with their length than the tubes in the latter boilers.

To increase the efficiency of watertube boilers, insert baffles in such a way that the heating surfaces are arranged in series with reference to the gas flow, thus making the gas passage longer.

As the velocity of gases over the heating plates of a boiler increases, the true boiler efficiency at first drops, and then, after the gases exceed a certain velocity, it remains nearly constant.

In multi-tubular boilers the true boiler efficiency increases as the diameter of the tubes decreases. In watertube boilers the true boiler efficiency increases as the cross-section of the gas passages between individual tubes decreases.

In multi-tubular boilers the true boiler efficiency increases as the length of the flues increases, and in watertube boilers it increases as the length of the gas passages increases.

In boilers that receive the greater part of their heat by convection, the true boiler efficiency after the gases attain a certain velocity is nearly independent of the initial temperature of the gases.

Within certain limits, the true boiler efficiency depends on the shape of a boiler and not on its size nor its operation.

In the Bulletin there is given a resumé of a large number of experiments made upon small multi-tubular boilers, intended to determine the relations between the velocity of the air to the absorption of heat, also the relation between the initial temperature and the rate of heat absorption, and the influence of heating surface, tube length and tube diameter. For the detailed data and results of this work the reader must be referred to the original report, but some interesting inferences may be mentioned here.

Thus, a study of the efficiency curves indicates that for any one boiler the true boiler efficiency, after the gases have passed the critical velocity, is very nearly the same for all initial temperatures, and hence the true boiler efficiency of any one boiler is practically independent of the initial temperature of the gases.

Again, a study of various arrangements and areas of flues leads to the conclusion that it is not area, but arrangement, that makes heating surface efficient. It does not pay to increase the length of flues beyond a reasonable limit, nor to increase diameter merely to gain area of heating surface.

Broadly, the following deductions may be made from the laboratory experiments detailed in the report:

When the temperature of the air entering a boiler remains constant, the rate of heat absorption by convection by the heating surface of the boiler flues increases very nearly in direct proportion to the velocity of the gas passing over the heating plate. This is particularly true beyond the point of the critical velocity.

When the velocity of the air remains constant, the rate of heat absorption increases as the initial temperature rises, but not in direct proportion to the rise; the increase in the rate of heat absorption becomes smaller for equal rises of initial temperature as the initial temperature increases.

With air velocities greater than the critical velocity the true boiler efficiency is nearly constant for any rate of working and for any initial temperature.

The critical velocity increases when the temperature rises, and seems to drop when the diameter of the flues increases.

Increasing the diameter of the flues decreases their efficiency as heat absorbers—that is, flues of large diameter are less efficient than flues of small diameter of the same length, although the large flues have more heating surface. The higher efficiency of small tubes is due to the fact that the average distance of each particle of the gas from the flue surface is shorter, and therefore each particle of gas comes oftener in contact with the surface. It is not the total area of the heating surface that determines the efficiency of a boiler, but the cross-sectional area of the gas passage and the arrangement of the surface with respect to the flow of gas.

It seems that a large number of small flues having the same total cross-sectional area as a few flues of larger diameter require a smaller pressure drop to push the same weight of gas through than do the large flues.

Increasing the length of flues increases their efficiency, but not in direct proportion; the increase in efficiency becomes smaller with every successive addition to the length of the flue, so that to make flues larger than some definite length would not be good economy.

Most of the resistance to the passage of air through the flues of a tubular boiler is at the entrance to the tubes; adding to the length of the flues increases the resistance but little.

It has been sufficiently proven that the temperature of the gases on leaving a boiler varies almost directly as the temperature of the gases entering the boiler, both temperatures being reckoned above that of the boiler water; the lower the entering temperature the lower the leaving temperature. It is obvious that if two boilers have exactly a similar construction and baffling, the gases in the one which is so set that it receives more heat by radiation from the furnace will have the lower initial and final temperatures, and the efficiency of this boiler will be the higher. The gases themselves radiate but little heat to the boiler, but part of the heat generated by the combustion of the fuel is radiated by the hot fuel bed, the flames, and the furnace directly to the boiler, and is never absorbed by the gases. Therefore, the latter enter the boiler at a lower temperature than they would if they absorbed all the heat generated in the furnace. This means that any heat which the boiler gets directly by radiation is a clear gain. Of course, the presumption is that the combustion and air supply is the same in all cases.

When fuel burns in a boiler furnace most of the heat generated is immediately absorbed by the gases that result from combustion. These gases then pass along the heating surface of the boiler and impart the heat they contain to the boiler; this heat impartation takes place almost entirely by convection. The gases then act as a conveyor of heat; that is, they carry the heat from the burning fuel to the "dry surface" of the boiler plate. Therefore the amount of heat a boiler receives per unit of time depends to a great extent on the utilization of the heat-conveying or convecting properties of the gases.

The conductivity of the metal forming the heating plate, even though the plate has a moderate amount of coating, is so high that any quantity of heat that can be imparted to the dry surface by convection can be transmitted through the heating plate without difficulty. Water has such high heat-abstracting ability that it can absorb heat as fast as the heating plate is able to conduct it. The slowness of the process of heat transmission into a boiler is due to the slowness with which heat, in present practice, is imparted to the dry surface.

It has been shown that the rate at which the gases transfer heat to the dry surface of the boiler depends on the following factors:

(*a*) On the difference of temperature between the gas and the dry surface.

(*b*) On the density of the gas.

(*c*) On the velocity at which the gas flows over the dry surface.

As to the first factor it must be said that boiler furnaces always should be operated at the most economical temperature. Generally this is not the highest practical temperature, as the necessary reduction of the air supply may cause part of the combustible to escape unburned from the furnace; further, a very high temperature may not be desirable on account of expensive repairs on the firebrick lining in the furnace. Considering these two limitations the temperature should be as high as feasible in order to make the quantity of heat available as large as possible. In well-managed plants the furnaces are operated at the best economical temperature, and therefore there is not much chance of improvement by increasing the first factor.

The density depends on the absolute temperature of the gases, and is therefore fixed when the temperature is determined.

The velocity of gaseous products of combustion is independent of their temperature and their density, and therefore can be increased at will whenever a higher rate of steam production is desired. It is this velocity factor which enables locomotive and marine boilers to produce steam at two or three times the rate customary with stationary boilers. In the first two types of boilers double or triple capacity is obtained by forcing over their heating surface two or three times the weight of gases at two or three times the velocity. The same results can be effected in stationary boilers; their capacity can be increased several times by forcing several times the weight of gases over their heating surface at several times the velocity.

It has also been shown, both by the results of experiments and by theoretical considerations, that more heat can be abstracted from the same weight of gas if the length of the gas passage is increased or the cross-section of the passage is reduced; the second condition must always include the reduction of the "hydraulic mean depth" of the gas stream. Both of these conditions increase the number of contacts the particles of gas make with the dry surface. With any given velocity, lengthening the gas path lengthens the time during which each particle can make contacts with the dry surface; reducing the cross-section of all these "hydraulic mean depths" reduces the mean distance of each particle of gas from the dry surface of the plate so that the particle of gas can reach the surface in less time, and in the same available length of time make more contacts. Abstracting more heat from the gases means higher boiler efficiency. The length and the cross-section of a gas path is really the arrangement of the heating surface with respect to the gas stream, so that one may say that the efficiency of the boiler depends on the arrangement of the heating surface with respect to the flow of gases.

The preceding deductions can be summarized in the following brief statements:

The capacity of a boiler can be increased by forcing a greater weight of gases through the boiler.

The efficiency of a boiler as a heat absorber can be increased by arranging the heating surfaces in such a way that the gas passages are long and of small cross-section, so that they have a small "hydraulic mean depth."

The application of the principles of heat transmission offers an excellent opportunity for economic improvements in the steam boiler as well as in steam-plant designs. It seems feasible to increase the capacity of boilers several times; and at the same time, by properly arranging the heating surfaces in the boilers, to raise the efficiency perhaps several percent. Increasing the capacity of boilers would reduce the first cost of the installation, and consequently less interest would have to be paid on a smaller investment. Increasing the efficiency would reduce the coal bill. Under such conditions power could be produced much more cheaply than it is at present.

Considering the high heat conductivity of metals, there is no reason why boilers could not be made to generate steam at three or four times the rate they do at present by simply forcing about three or four times the weight of gases over their heating surfaces. This may be considered a conservative statement, as much higher rates are possible and have been attained.

It may at first seem that the power required to force such large quantities of gas through the boilers would be so great that the cost of installing and operating the "draft" appliance would offset any gain from the increased capacity of the boiler. However, such is not the case. It is true that the power required to push the gases through the boiler increases as the cube of the capacity the boiler develops, so that to triple the capacity of a boiler the power required to push the gases would have to be increased 3^3, or 27 fold; or, to quadruple the capacity the fan power would have to be 4^3, or 64 times as large as for single capacity. The one feature that makes high capacity possible is the fact that the power really consumed in ordinary cases in pushing the gases through the boiler and furnace is so small that even after it is multiplied by 64 it still remains only a small fraction of that developed in the boiler. Distrust in the possibility of working steam boilers harder rests on past experience. Engineers are accustomed to hear that the steam consumption in mechanical-draft appliances is from 1 to 2 percent of the total steam generated by the boilers which are served by the appliances. With such extravagant "draft" productions, of course large increase of boiler capacity would not be practicable. Thus, suppose that a fan producing "draft" for a boiler battery at ordinary rates of steaming consumes 2 percent of the steam generated in the battery. If the capacity is to be quadrupled, the fan would apparently have to do 4^3, or 64 times, as much work as before. Since four times the capacity is developed, the steam consumed would be $\frac{64 \times 2}{4} = 32$ percent of the total steam generated at the quadrupled capacity. This, of course, is a considerable percentage, high enough to make any commercial consideration out of question.

(*To be concluded.*)

A FATAL MISHAP.—On June 14 a workman was boiled to death while cleaning one of the boilers of the United States cruiser *Birmingham*, stationed at the League Island navy yard, Philadelphia, Pa. The workman was about to leave the boiler when the steam was suddenly turned on with such force that he was unable to escape. A thorough inquiry is to be made into this matter.

Riegel Watertube Firebox Design

BY S. S. RIEGEL*

Figs. 1 and 2 show the general arrangement of a watertube firebox adaptable to a modern type fast freight or fast passenger Pacific engine, as generally used in present service. It consists of a slight widening of the firebox at each side beyond the grates a sufficient extent to accommodate the introduction of ninety-eight 2½-inch outside diameter tubes, No. 9 BWG, of an average length between sheets of 69¼ inches, placed right and left, for nearly the full length of the firebox. This places in the region of greatest heat activity a considerable amount of the more effective heat absorbing surface, making it obviously possible to reduce the rate of combustion to a considerable extent, in view of the increased intensive circulation provided by this form of construction.

The lower ends of the tubes terminate in water-drum constructions made up in one or two forms, as in style of No. 1 (Fig. 2), consisting of a hollow form casting, or in style No. 2 (Fig. 2), consisting of a ring casting of steel in combination with a boiler plate top construction. This side ring is fastened directly to the end sections of firebox ring in one of two ways, either by a liberal sized riveted joint between the drums and mud-ring construction at the front and back junctions of these two parts, or the two parts may be welded together the same as with present rings.

The upper ends of the tubes terminate directly in the crown sheet, which with the side sheet is made in one piece, of a slightly increased thickness of metal approximating ½ inch in thickness. The top of the crown is slightly depressed to always keep the upper tube terminations flooded, as with the rapid circulation of water from the tubes and over and down the sides of the firebox it is impossible to expose them to injury. With the crown sheets elevated, to bare the top of the crown sheet is possible only in cases of extremely low water. It is found by an experimental model of this boiler construction that even though the water may be evaporated so that the barrel tubes are entirely bared or out of the water, the intensive circulation or up-draft through the watertubes will continue to flood the crown sheet. This makes it virtually impossible to burn the crown except in cases of extreme negligence.

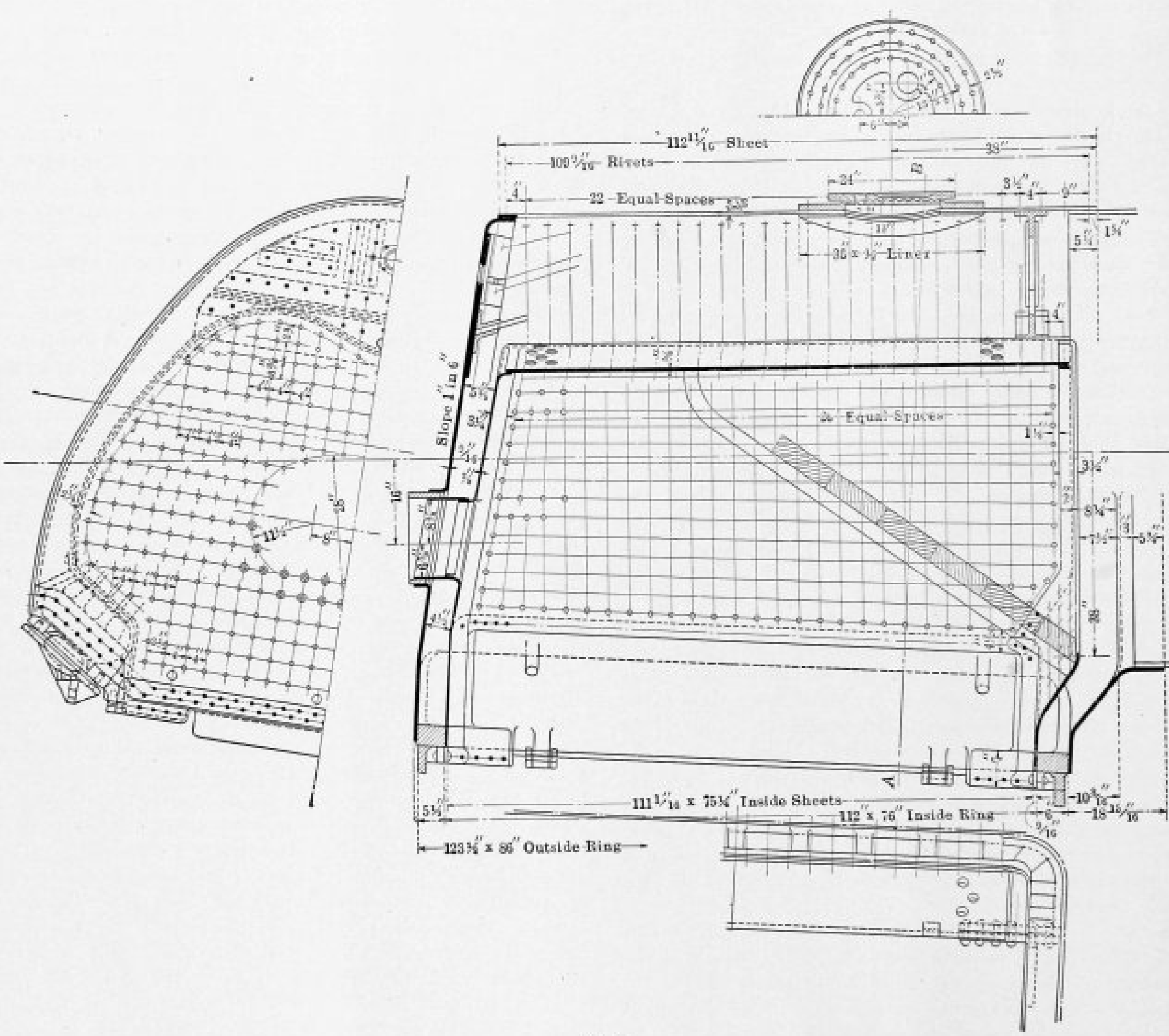


FIG. 1

* Mechanical Engineer, Delaware, Lackawanna & Western Railroad, Scranton, Pa.

This boiler is, therefore, safe to this extent, way beyond the danger line of the ordinary type of standard boiler construction.

By placing the watertubes directly in the firebox in the region of greatest heat activity, a relatively large area is in intimate contact with the region of greatest heat, and from the experiments derived from this experimental boiler, and again as recently proven in the Coatesville tests, it is established that one square foot of firebox heating surface is at least equivalent to 7 or 7.5 square feet of tube surface, so that on this basis a boiler with this limited amount of additional fire-

The side water-drums are provided with hollow removable closure plates, which serve the double purpose of closing the side openings against steam leakage and provide mud collecting or blow-off chambers for ejecting the deposits, as in style No. 1 (Fig. 2), or a manhole cover plate construction, as in style No. 2 (Fig. 2). These openings are desirable for the original admission or replacement of the side watertubes in case of renewal, and an advantage in inspecting the tubes and in keeping them clean when necessary, although they can remain closed for quite long periods of time.

This construction increases the heating surface of the fire-

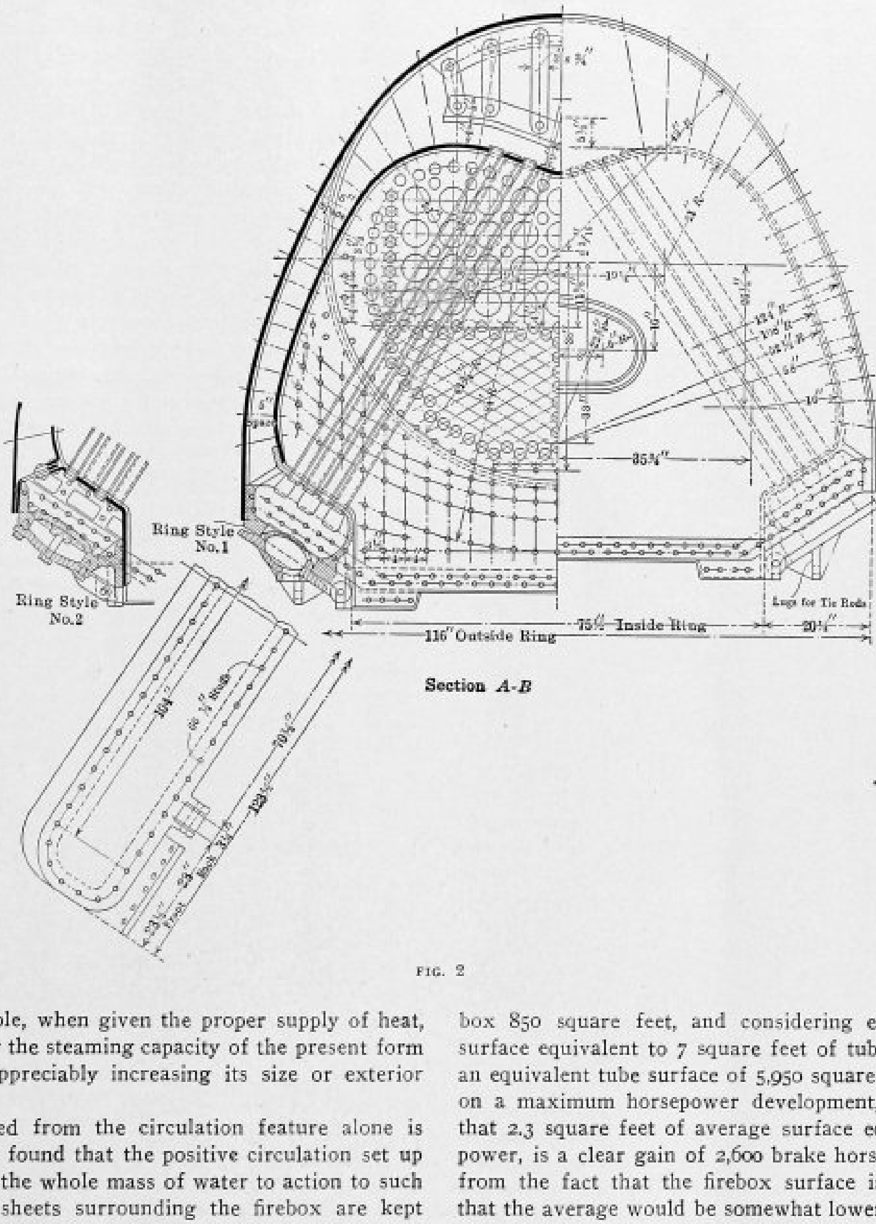


FIG. 2

box surface is capable, when given the proper supply of heat, of virtually doubling the steaming capacity of the present form of boiler without appreciably increasing its size or exterior dimensions.

The benefit derived from the circulation feature alone is considerable, as it is found that the positive circulation set up in the boiler excites the whole mass of water to action to such an extent that the sheets surrounding the firebox are kept free and clean from scale deposits.

As it is desired to prevent the direct passage of the larger volume of gases from the fire directly into the flues without directing them to contact with the watertubes, a brick arch arrangement, as shown in faint lines on the longitudinal section, is supported directly on arch tubes, the lower ends terminating in the back tube sheet in about the usual location. The upper ends attach directly to the crown sheet in holes ordinarily provided for the side arch tubes, two or more of the side arch tubes being omitted to permit the use of arch-supporting tubes.

box 850 square feet, and considering each foot of firebox surface equivalent to 7 square feet of tube surface, represents an equivalent tube surface of 5,950 square feet, or putting this on a maximum horsepower development, on the assumption that 2.3 square feet of average surface equals 1 brake horsepower, is a clear gain of 2,600 brake horsepower, or assuming from the fact that the firebox surface is so relatively large that the average would be somewhat lowered to approximately five times the value, we would have an equivalent increased surface of 4,250 square feet, or 1,848 brake horsepower.

It would not seem from a large number of recent tests that this assumption is too great, as there have been frequent examples of even better and higher average brake horsepower developments, so considering this as entirely possible to obtain, we could expect a total development of 4,273 brake horsepower.

With the selected proportions outlined on the general drawing, the boiler would have the following approximate dimensions:

Boiler pressure	200 pounds
Firebox	112 inches by 76 inches
Grate area	58 square feet
Tubes	36 5⅜ inches and 281 2 inches, 20 feet long
Heating surface, flues	4,172 square feet
Firebox sheets	114 square feet
Firebox watertubes	736 square feet
Total	5,136 square feet
Superheater	1,085 square feet
Ratio of heating to grate surface	88.6
Percentage of firebox to total heating surface	16.5
Maximum horsepower developed	4,273

It would appear from similar boilers in marine service that this estimate of boiler performance is quite proper and in line with current practice. It is found by experimenting with a model of this construction that the circulation of water, due

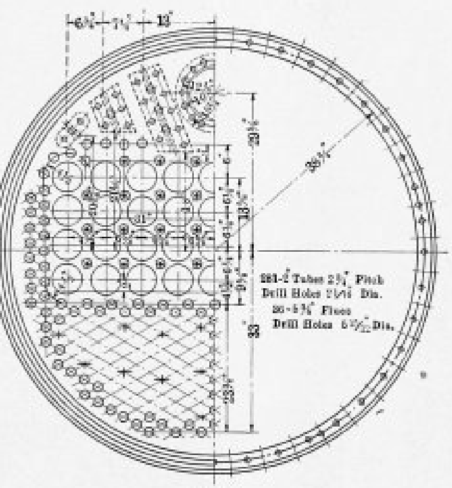


FIG. 3

to ascending streams of water in the tubes, is so considerable as to stimulate circulation through the entire boiler, to such an extent that the water is perfectly and intimately mixed in the boiler throughout its extent. This has an influence which will overcome sheet distortions due to currents of water of different temperatures. This will also overcome damaging distortions in and around the firebox, particularly about the side sheets, and should greatly prolong the life of the firebox, its benefits being two-fold—the circulation is sufficiently rapid to

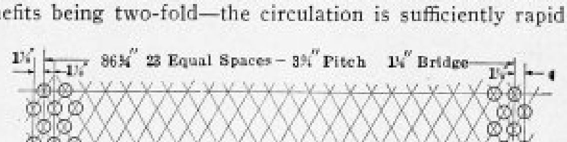


FIG. 4

keep the sheets scoured against scale formations and keeping the water of uniform temperature, the relative expansion between the outer and inner sheets is too slight to be damaging.

By the use of flexible staybolts along the sides of the firebox (a full installation being recommended), frequent heading up of the bolts will be eliminated, and by the use of angle form air tools all necessary attention to staybolts can be given initially and in repair, and the steam joints can be calked in all restricted and other places to meet all practical requirements.

With the brick arch on arch tubes, the direct flow of gases through the center is diverted through the sides, and should overcome any concentration of draft in the center to any desirable extent, depending on the height and position of the arch. The arch construction also provides a combustion chamber of sufficient volume immediately over the fire.

The construction shows a manhole placed immediately over the roof of the boiler for accessibility. The watertubes are placed in the sheets, slightly expanded on the firebox sides, so that they act as stays to support the crown sheets. Therefore, no staying is necessary over the crown sheet, and the manhole chamber admits of accessibility directly to the crown sheet and the tops of the flues, should any attention be necessary. The side water-drums and cover plates are made continuous or in sectional constructions, as desired.

Locomotive Boiler Scale

At the fifth annual convention of the International Railway Fuel Association, held in Chicago, May 21 to 24, a report was submitted on the subject of locomotive boiler scale. According to the *Railway Age Gazette,* in which a brief report of the convention is published, the committee was unable to secure much data on the subject of heat loss due to boiler scale. The committee believes that such loss is considerably over-estimated. It was pointed out that in order to keep the tubes 100 percent clean the tube borers should be educated as to the importance of doing their work in a thorough manner, and that they should be carefully watched by the foreman in charge. Convenient and accessible plugs should be supplied in order to thoroughly inspect the boiler after it has been washed out. Larger arch tubes were recommended to adequately take care of the steam generated in them. The ideal way to treat water, it was stated, is in settling tanks, so that it may be commercially pure before being put into the boiler. The adding of a boiler compound by the guess method is to be generally discouraged, and each treatment should be chemically correct, as much harm may be done otherwise. The use of pure amorphous graphite was strongly recommended, as it is purely mechanical in its action, having a tendency to break off the scale as well as prevent its formation. A simple laboratory experiment was made by applying this grade of graphite to one side of a plate and intermittently boiling. After eighty hours, extending over a period of ten days, the graphite was still as active in its protection of the plate as it was originally. The opposite side of the plate was rusty.

Boiler Manufacturers' Convention

The twenty-fifth annual convention of the American Boiler Manufacturers' Association of the United States and Canada will be held at the Hollenden Hotel, Cleveland, Ohio, Sept. 1 to 4. The convention will be opened at 2 P. M. on Monday, Sept. 1, and will continue in session until Thursday evening, or until a later date if necessary. The importance of the business to be transacted at this convention is such that the local committee which has charge of the arrangements has decided to exclude all social features which would interfere with the meetings except for a trip to Put-in-Bay on Wednesday, Sept. 3, and on this trip arrangements will be made so as to have a meeting on the boat. No attempt will be made to crowd all the business of the association into the limits set by the convention dates, but meetings will be held until such time as all present are satisfied that what has been done or arranged for will prove beneficial to the interests of the members of the association. The important question of uniform specifications is well under way, and immediate action must be taken if the members of the association wish to safeguard their interests, and it is only by united effort and assistance by the greatest number that success can be secured. During the convention various important measures will be acted upon for the mutual benefit of the members and for this reason a large attendance is urgently desired.

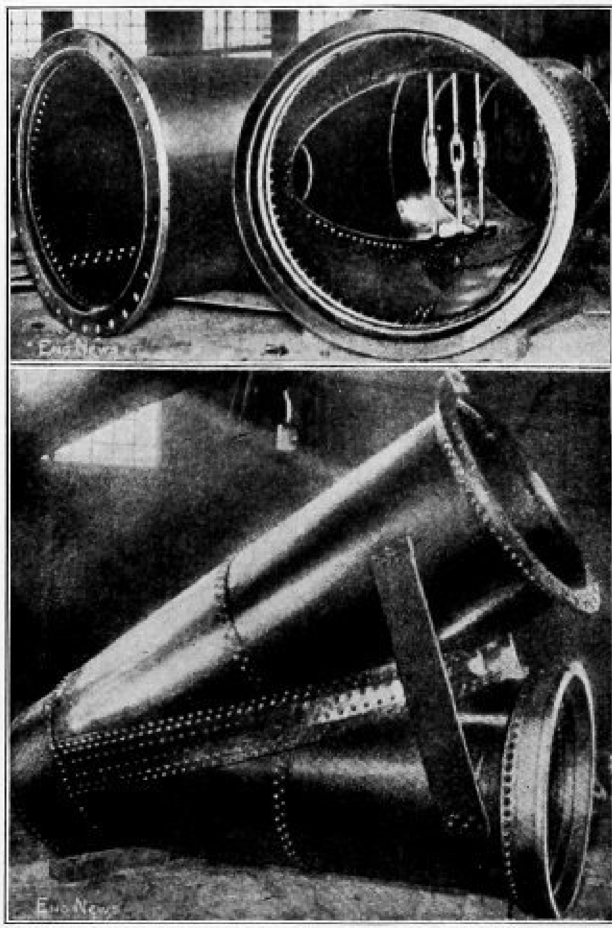
Large Riveted Steel Special Water-Pipe Joints

As a part of the 60-inch diameter riveted steel pipe for the North Side Reservoir, Pittsburg, Pa., the two types of specials illustrated herewith have recently been installed. Five 60-inch diameter Y's and one 60 by 48 by 60-inch offset T were required, and it was the original intention of the city to have them made of cast iron, about 1½ inches thick and properly reinforced. The James McNeil & Bros. Company, of Pittsburg, however, proposed to make them of plate steel, and after consideration of their submitted designs the city accepted their proposition. Accordingly five Y's of the type shown in Figs. 1 and 2, and one T, shown in Fig. 3, were built. The cost was lower than for the cast iron specials originally considered.

The Y's were made of ⅝-inch soft open-hearth flange steel plates. The two branches of each Y were united by a ¾-inch flanged plate, double riveted to the branches. Riveted on the inside of this mantle plate were two heavy angle irons with a baffle plate and three 2-inch bronze bolts with turnbuckles between. One branch of the Y's had a rolled steel flange for connection to the valve, while the other branch had a cast steel bell end for a lead joint connection.

The 60 by 48 by 60-inch T was made of ⅝-inch soft open-hearth flange steel plates, and was constructed as a 60-inch elbow with a 48-inch outlet. This 48-inch outlet was riveted to the elbow eccentrically; that is, the bottom of the 48-inch outlet was level with the bottom of the 60-inch elbow.

The shipping weight of the Y's was 14,000 pounds each, and of the T 11,000 pounds, one-third of the estimated weight of the cast iron specials. All of the specials were tested at 100 pounds per square inch internal pressure.—*Engineering News.*



FIGS. 1 AND 2.—RIVETED STEEL 60-INCH SPECIAL

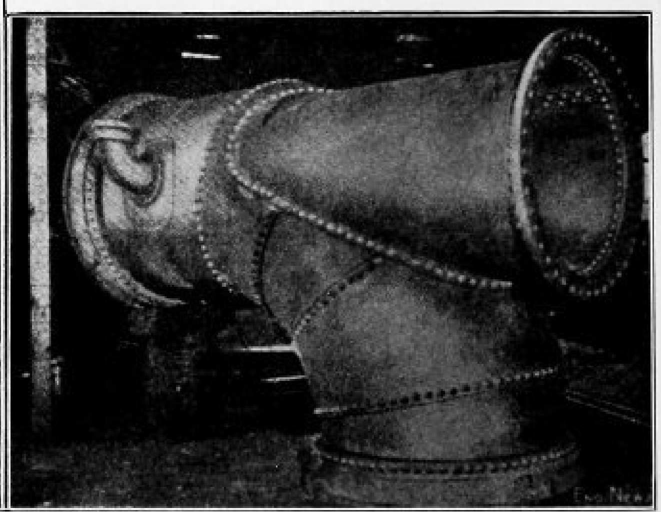


FIG. 3.—OFFSET T SPECIAL, 60 X 48 X 60 INCHES

Non-Return Stop Valves

A boiler tube in a large plant recently pulled out of the drum into which it was expanded, a number of men were seriously hurt and the service was interrupted. Had it not been for the heroism of an attendant who rushed through the steam-filled room and closed the stop valve, thereby horribly burning his hands, every boiler would have lost its pressure, hours of idleness for the entire establishment would have followed, and possibly those in the boiler room would have been killed.

It requires an iron nerve and an extraordinary sense of duty to close a stop valve under such circumstances. Hardly ten men in a thousand would risk it. The non-return stop valve in such cases allows only the one boiler to be rendered unserviceable, and the time saved thereby is an item usually in excess of the cost of the valves.

And this is not their only good feature. As with some forms of insurance policies, it is not necessary to "die to win"; with these valves it is not essential that a boiler be disabled to prove their advantages. We all know the care that must be exercised in cutting a boiler in on the line with others under pressure. The pressures must equalize before the valve is opened and if the steam gage on which the engineer solely depends for guidance is defective, disaster may follow the opening of the valve. The automatic non-return valve obviates this danger by not opening communication between the boilers until the pressures are equal.

Those who have advocated the compulsory use of non-return stop valves have met stubborn opposition. Plant owners are sometimes reluctant to believe that they will be benefited by installing such valves. It is learned that they protect the fireman in the event of a ruptured tube or seam. This is surely their paramount feature, but it is talked of so much that their other advantages are forgotten. This is unfortunate.

Railroads are liable to damages if a passenger slips on a car step not provided with an adhesive mat. This is because the mat conduces to safety and is a commodity on the market the price of which is not prohibitive. Should not owners of boilers be liable for boiler accident, the dangers of which can be minimized by the use of the non-return stop valve?—*Power.*

Heine Two-Pass Two-Drum Boilers

In larger sizes Heine boilers are built with two drums and suitable water legs. The tube surface is usually arranged in two passes.

The cut of Fig. 1 is reproduced from a photograph taken at the Ayer Mills, Massachusetts, during the erection of a number of 600-horsepower Heine boilers, built for 200 pounds working pressure. This picture shows clearly the construction of the water legs. The boilers in the foreground are upside down, and the man shown is riveting the water leg to one of the drums. The handhole openings in the water leg show the arrangement of the tubes, there being, first, the lowest row (the upper row in the photograph), on which are placed tiles forming the roof of the combustion chamber, next a bank of eight rows of tubes forming the first pass, and then a bank of seven tubes forming the second pass.

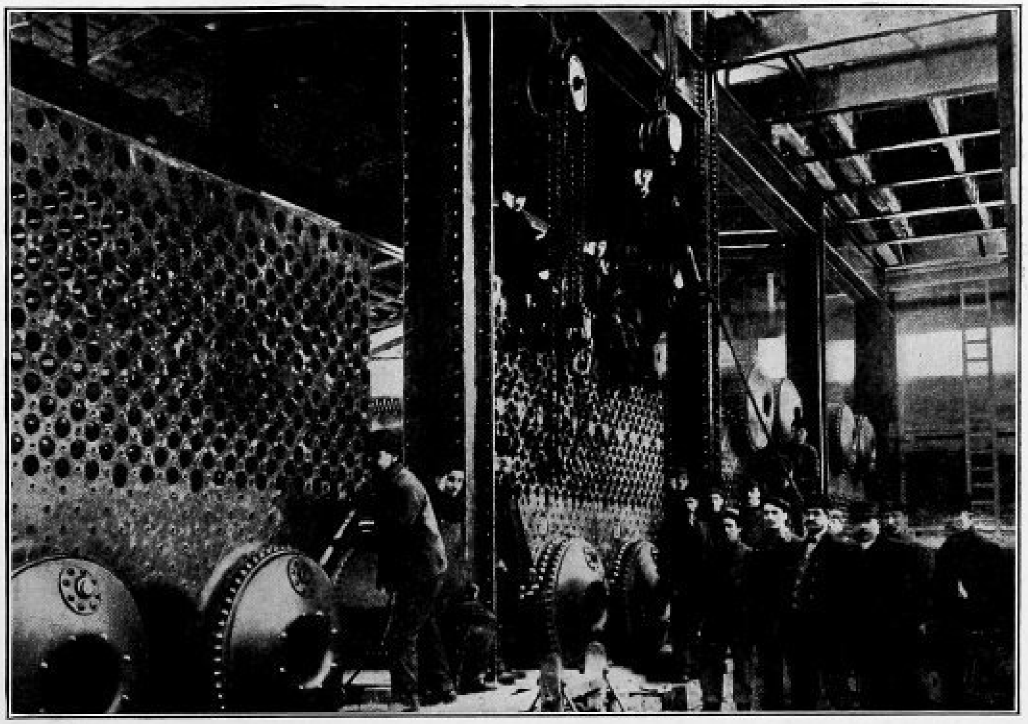


FIG. 1.—SHOWING WATER LEGS OF TWO-PASS, TWO-DRUM, HEINE BOILERS AT AYER MILLS, LAWRENCE, MASS.

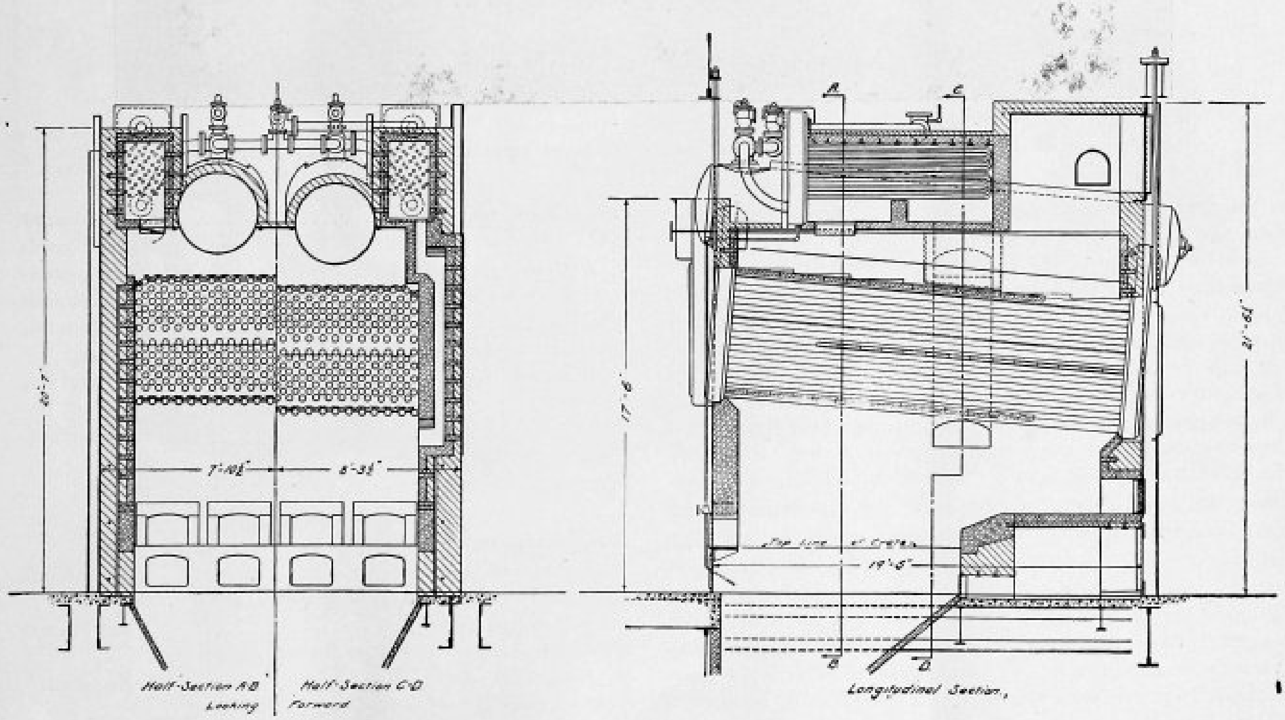


FIG. 2.—SHOWING CROSS SECTION AND LONGITUDINAL SECTION OF A 635 HORSEPOWER HEINE BOILER AND SUPERHEATER AT THE GRAND CENTRAL TERMINAL SERVICE STATION, NEW YORK

Fig. 2 is a cross section and longitudinal section of a 635-horsepower boiler, as installed at the Service Plant of the Grand Central Terminal, New York City. Fig. 3 shows these boilers in course of erection.

In Fig. 2 may be seen the horizontal baffling on the lowest row of tubes, extending over the furnace and back over the bridge wall, thus forming the roof of the combustion chamber. The middle baffle is located in this boiler on the ninth row of tubes, and consists of a special cast iron baffle, extending from the rear water leg toward the front water leg with a sufficient opening for the passage of the gases. On the top row of tubes are placed T tiles, similar to those on the bottom, extending from the front water leg to within a few feet of the rear water leg. The travel of the gases is obvious. The effective path of travel is long, and the boiler surface is compactly arranged, so that there is efficient absorption of the heat in the gases, even with comparatively high furnace temperatures resulting from the design of combustion chamber.

Another interesting point shown in this drawing is the superheater design. Two superheater units are used for each boiler, located above the waterline in a firebrick chamber formed on each side of the setting. A flue connects each chamber with the furnace, and a small percent of the furnace gases flow up these flues and supply heat for the superheater tubes. The hot gases make two passes over the superheater tubes and then flow out of the superheater chamber at the end nearest the front header, and before reaching the up-take they pass under the boiler drum. A damper in the superheater outlet gives complete control of the amount of gases flowing over the tubes, thereby permitting of temperature regulation and also of entirely cutting off the supply of hot gases when saturated steam is desired, or when there is no boiler load. No provision is made for flooding the superheater, as that operation is unnecessary. It should also be noted that since flooding is unnecessary, deposits of scale-forming impurities are not formed within the superheater tubes.

The performance of one of these 635-horsepower units at the Service Station of the Grand Central Terminal is given in the table. The tests were made with anthracite Buckwheat No. 2 and natural draft, and efficiencies considerably above 70 percent were obtained.

ACCEPTANCE TEST OF A 635-HORSEPOWER HEINE BOILER WITH SUPERHEATER AT GRAND CENTRAL STATION SERVICE PLANT, NEW YORK CITY, OCT. 30, 1912, BY WARREN & WETMORE, ARCHITECTS.

Square feet of shaking grates	125
Fuel	No. 1 Buckwheat
Coal analysis (N. Y. C. & H. R. R. R. chemist), as received	Dry coal
Moisture	5.0
Ash	17.93
British thermal units per pound coal	12,193.00
Duration of run	8.916 hours
Total weight of coal as fired	24,640.00 pounds
Total weight of water fed to boiler	165,377.00 pounds
Coal per hour as fired	2,763.00 pounds
Water per hour, actual conditions	18,546.00 pounds
Average steam pressure	179.5 gage
Temperature of feed water	62.7 deg. F.
Superheat	89.0 deg. F.
CO^2 by volume	13.8 percent
Horsepower developed	675.0
Percentage of rating	106.00
Economic Results	
Water apparent evaporated per pound coal, actual conditions	6.71 pounds
Equivalent evaporation from and at 212 per pound coal as fired	8.43 pounds
Equivalent evaporation from and at 212 per pound dry coal	8.9 pounds
Over-all efficiency of boiler superheater and furnace	70.5 percent
Over-all efficiency corrected for moisture	70.9 percent

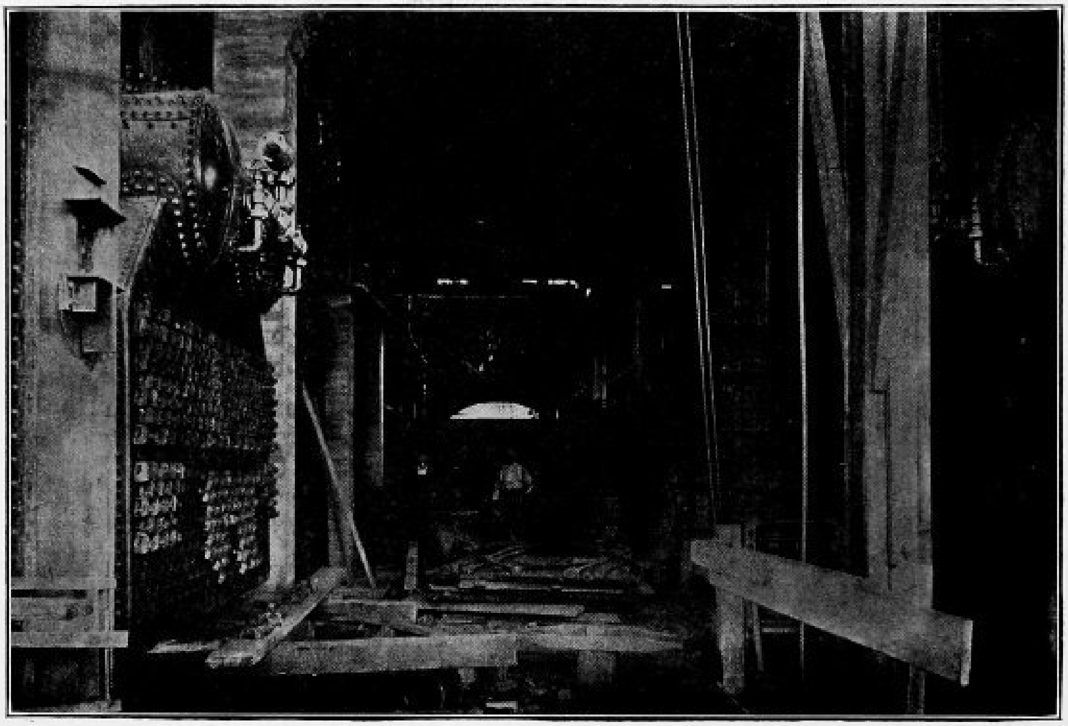


FIG. 3.—SHOWING HEINE BOILERS IN COURSE OF ERECTION AT THE GRAND CENTRAL TERMINAL SERVICE STATION, NEW YORK

Tools for Boiler Makers and Their Uses—VI

BY W. D. FORBES

The idea of the hydraulic press may be illustrated by means of Fig. 46, which shows a cylinder, *A*, and a piston, *B*. Through a pipe, *C*, the liquid is forced by means of a small pump, *D*, and as water or other fluids are non-compressible, whatever pressure is received from the small pump is exerted on the surface of the piston *B*. If, now, the area of the piston *B* is 100 square inches and the pipe *C* leading to the cylinder has 1 pound pressure in it obtained from the small pump

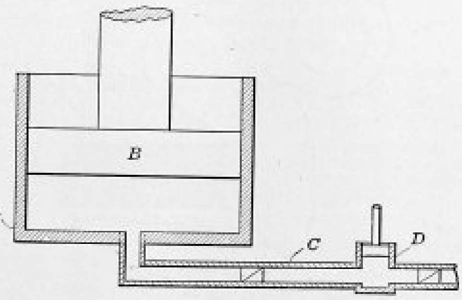


FIG. 46

D, the total pressure on the surface of the piston *B* will be 100 pounds, as the 1-pound pressure will be exerted on each square inch. This would not be so if the fluid were compressible.

The bending rolls shown in Fig. 47 are, next to the punch and shears, the most used tool of a boiler shop, excepting the

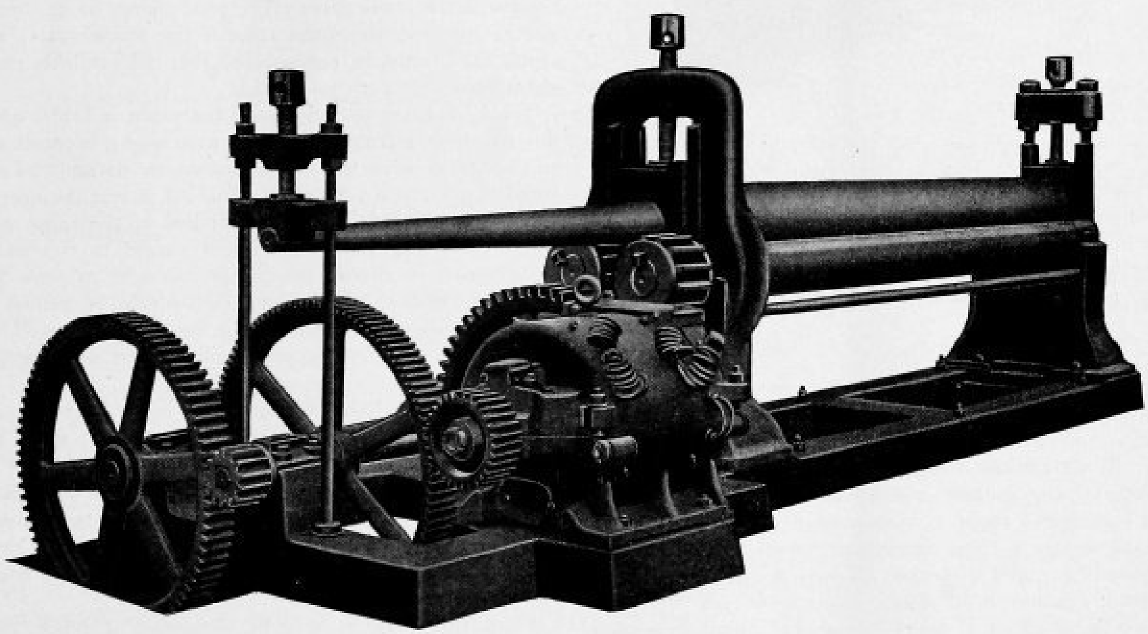


FIG. 47.—BENDING ROLLS

riveter. The flat plate, if passed through the rolls, is formed into a curved surface and a complete circle can be produced if desired. If the illustration is examined closely it will be noticed that the two lower rolls are geared so as to revolve, but the top roll has no drive and revolves only by friction when a plate is passed between the rolls. This top roll has a long extension, which shows at the left of the illustration, and at its end is a pair of rods made fast to the bed of the machine, and across the top of this frame is a cross bar through which passes a screw, which when turned will press against the long extension. At the extreme right-hand end of the top roll can be seen a loop, or perhaps it will be clearer to call this a U, in which the right-hand end of the top roll lies. Across the opening of the U is seen a bolt passing through the two lugs which form the sides of the U. This bolt can be pulled out, leaving a free opening above the end of the roll. If, now, the screw at the left of the long extension is screwed down,

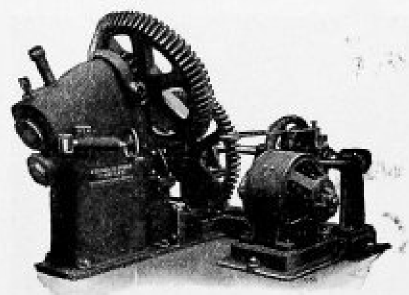


FIG. 48.—ROTARY BEVEL SHEAR

the right-hand end of the roll will be lifted out of its bearings, and if a sheet has been rolled up into a complete circle it can be drawn off the machine. The bearing to the left of the top roll swings on a pin, as shown.

When the rolls are very long, bearings are placed at the center in order to prevent their springing. Means are provided so the rolls can be adjusted—that is, made to come more or less close—as on their position depends the amount of curve which is given to the plate.

To-day, with the very thick plates used, the edges have to be planed to a bevel, and this is done in a machine especially designed for the purpose. It is a long bed on which the plate is clamped, and a tool carrying sliding head is provided which can be adjusted in the same manner as the tool post of a regular planer. The sliding head is fed along a rail, like the cross rail of a planer, by means of a quick pitched screw, the motion of the screw being reversed at the end of the stroke. This tool is not often found in any but the larger shops.

There are many special machines which can be used in a boiler shop, such as the rotary bevel shear shown in Fig. 48. Of course tools of this class are expensive and must have sufficient work to make them pay.

Proper overhead cranes or hoists are necessary with most of the machine tools. Fig. 49 illustrates a simple, inexpensive and serviceable crane and a very convenient chain hoist. In order to hoist a plate it must be gripped in some way, and Fig. 50 shows a clamp which is most convenient for lifting plates. A device of this kind saves a world of time over wrap-

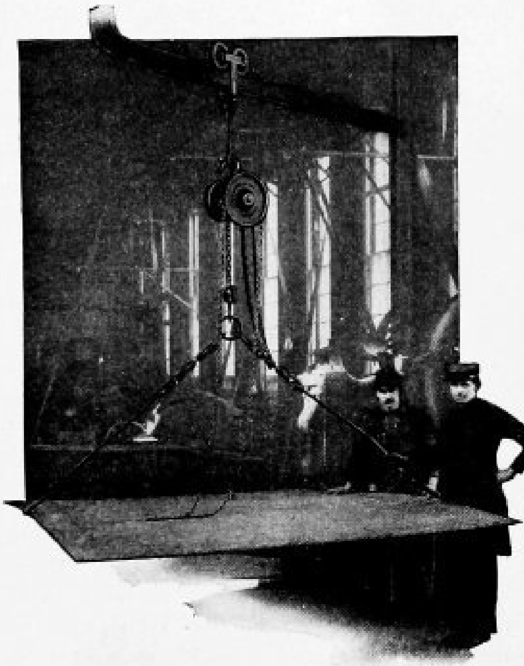


FIG. 49.—CRANE AND HOIST FOR HANDLING PLATES

ping a chain around the plate. We strongly urge those who have practical boiler shop work to do to look into the many time-saving appliances which are now on the market, as we are sure that if used more profits can be made and jobs which show no profit can be made to pay.

Compressed Air and Its Uses

The atmospheric air is a mechanical mixture and not a chemical combination—that is, it is made up of 21 parts of oxygen gas and 78 parts of nitrogen gas, when we consider its volume. By weight air has 23 parts of oxygen and 77 parts of nitrogen. Air also contains a small amount of carbonic acid gas and some water vapor.

We have to take a given temperature when we speak about the volume of air, and 32 degrees is used as a basis, at which temperature 1 pound of air equals 12.382 cubic feet.

The weight of air at 32 degrees is .080728 pound at a pressure (barometric) of 29.92 inches of mercury, equal to 14.6963 pounds per square inch, or 2116.3 pounds per square foot. It is usual to call the weight of air on a square inch area as 14.7 pounds.

Air expands by heat $\frac{1}{49.2}$ of its volume for each degree, or about one-fiftieth of its volume, and its volume increases inversely as the pressure.

When air is compressed its temperature is raised, and this is unavoidable; but it must be remembered that this development of heat is a loss of work. If a volume of air is compressed at 30 degrees to one-quarter of its original volume its temperature rises 376 degrees, if no heat of compression is radiated or lost. As the heat of compression increases small clearances become necessary in a well-designed compressor, and it is necessary to compress to a higher degree in the cylinder in order to fill a receptacle to a desired pressure.

It is somewhat perplexing to accept the assertion that all work of compressing air is turned into heat, as we are constantly trying to provide means of extracting the heat produced by compression. Were we able to do so it would seem that we are simply wasting power to compress the air if we

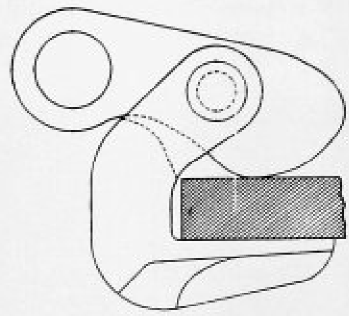


FIG. 50.—"NEVER SLIP" SAFETY CLAMP FOR HOLDING PLATE

at the same time dissipate all the heat, as without the heat we would have no energy, or only that of the air before compression. If the temperature of the air after compression is no higher than before compression this would be true, but by compression the air's energy is made more available in its form. When air is compressed its intrinsic energy is obtained through its expansion after it has reached its thermal equilibrium with the atmosphere. The total energy of uncompressed and compressed air is the same if the temperatures are the same, but it must be remembered that the available energy is much greater in compressed air.

The higher air is compressed the more it heats, and with this rise in temperature the more necessary it becomes to have quick-closing valves and small clearances. It must be remembered that air is a very elastic fluid; it is just the opposite to water, and the two cannot be handled in the same way. A water pump can be made without regard to clearances, as, since water is almost non-compressible, it at once fills all clearances with a substance (itself) which, of course, results in there being no clearance. Air can be compressed until it liquefies, but in liquefying it the temperature must be lowered to 317 degrees below zero.

We have said that air must be compressed beyond the pressure wanted, in order to be able to deliver a given amount at a given pressure; we will give a table, which Mr. F. Richards worked out some years ago, showing how much horsepower it takes to compress a cubic foot of air to a given pressure and how much horsepower it takes to deliver the same pressure; a 10 percent allowance was made for the friction in the compressor.

From this table it will be seen that it takes 7.8 times the power to deliver 1 cubic foot of air at 100 pounds than it does to compress 1 cubic foot to 100 pounds, but this proportion does not hold throughout the table, as at 5 pounds pressure it only requires about 1.34 times the power to deliver the 1 foot of air.

(To be continued.)

Loss Due to Boiler Scale.—Tests made by the engineering department of the University of Illinois show that heat losses ranging from 8 to 12.4 percent occur in steam boilers coated with scale from 1/50 to 1/16 inch in thickness.

The Boiler Maker

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Sworn to and subscribed before me this 13th day of June, 1913.
(Seal) GEORGE E. MULLER,
Notary Public.
(My commission expires March 30, 1915.)

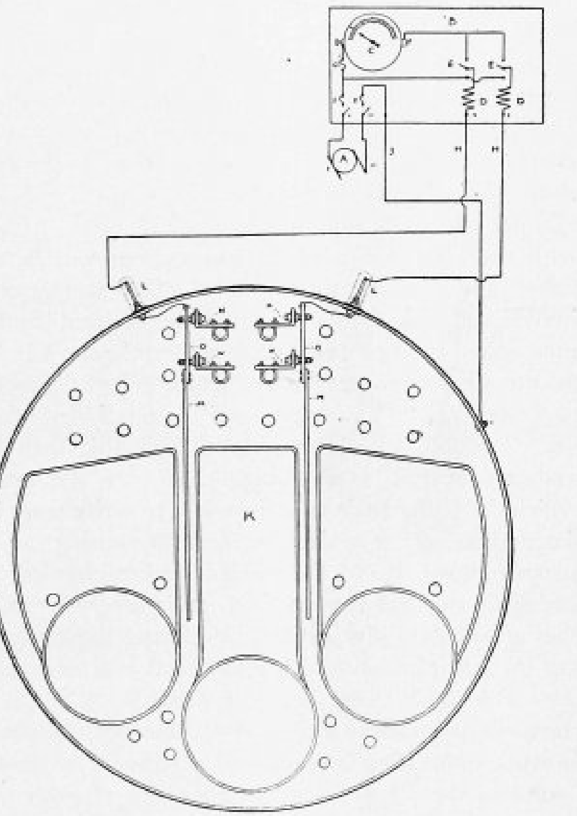
Over a year ago some of the most loyal supporters of the American Boiler Manufacturers' Association instituted a vigorous campaign in an effort to increase the membership and enlarge the usefulness of the association. This was preliminary to the twenty-fourth annual meeting of the association held at New Orleans in March of last year, but it was hardly expected that the results of the campaign would be evident at that convention. In fact, the main purpose of the campaign seemed to be to build up the organization during the year so that the full effects of the work in this direction would be evident at the twenty-fifth annual convention, or silver anniversary of the foundation of the association, which will be held at Cleveland in September of this year. How far-reaching the results of this work will be cannot be told until the convention is over, but it is to be hoped that the praiseworthy efforts of those men who have worked so loyally to bring about beneficial results will be fully rewarded. It seems strange that any so-called missionary work should be necessary concerning the growth of an organization which has been in existence for twenty-five years and exerted such an important influence over the boiler-making industry. The opportunity for active work along such lines as the establishment of uniform rules covering boiler materials and boiler construction should be apparent to everyone who has anything to do with manufacturing boilers, and it is equally obvious that little can be done in this direction without the concerted efforts of the majority of boiler manufacturers in the country. Due recognition, therefore, of the importance of the work of the Boiler Manufacturers' Association should be kept in mind, and the opening date of the twenty-fifth annual convention, September 2, should be set aside as a date already filled by every member and every prospective member of the association.

Writing for a technical journal seems to be hard work for the average boiler maker until he has tried it and found how easy it is after all. Hardly any competent boiler maker has much trouble in explaining to a visitor or to a fellow workman the details of the machine he is operating or the work he is doing in the shop; but when he is asked to sit down for a few minutes and write the same words on a piece of paper, with the idea that what he has written will be published and read by thousands of other workmen, he immediately becomes unaccountably reticent and, in nine cases out of ten, refuses to undertake the job. The most common excuses offered are: "I don't know how to write," or, "I have never written anything before," or "Somebody else knows more about this than I do and can write it better than I can." If the articles which the boiler makers were asked to write were long discussions of theoretical problems requiring an extensive knowledge of the sciences and mechanical arts, which do not form a part of their everyday work, they would be fully justified in offering these excuses, but the information which a technical journal, such as THE BOILER MAKER, is continually asking for is for the most part simply a brief description or explanation of some interesting job, piece of machinery, or method found in the shops in which they are employed. It does not require a literary genius to explain a simple matter that is thoroughly understood by the writer or speaker. All that is necessary is to get the facts down in black and white, either in the form of a letter, a few notes, or a memorandum, supplemented perhaps by a rough pencil sketch, or a blue print, or photograph showing the character of the work; then the letter should be mailed to the editor of the journal, who will arrange the notes in proper form for publication. Sending in information for publication in this way is certainly not a difficult job for any first-class boiler maker, and we hope that each one of our readers who knows of some unusual "kink" used to advantage in a boiler shop, or any other matter of interest to boiler makers, will write and tell us about it; for by so doing he will be helping the other readers of the journal, and, at the same time, will find that the others will be more willing to help him in the same way.

Engineering Specialties for Boiler Making

The Cumberland Patent Process for the Protection of Metals

The Cumberland patent process for the protection of metals, manufactured by the Cumberland Syndicate, 44 Charing Cross, London, S. W., England, is an electrical process consisting of the use of one or more electrodes installed in a boiler, or other vessel, containing water and connected to the positive terminal of the direct-current supply, the boiler itself being connected to the negative terminal and the water forming the electrolyte. The illustration shows diagrammatically the apparatus which is used in this process and its arrangement in connection with the boiler. *A* is a motor generator; *B*, a switchboard; *C*, an

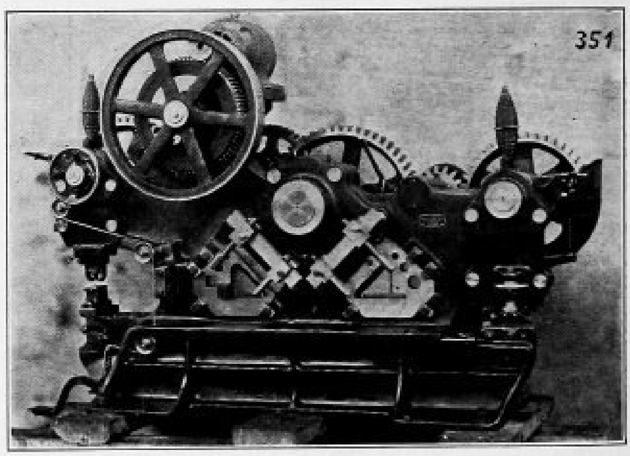


ammeter; *D*, adjustable resistances; *EE*, two-way switches; *FF*, double-pole switches and fuses; *HH* are the wires from the positive pole of the apparatus to the insulated poles, *LL*, in the shell of the boiler, which conduct the current to the detachable iron electrodes, *MM*, attached to the steam space stays, *NNN*, while *J* is the wire from the negative pole to the boiler shell. The results from experiments by competent authorities and from actual experience in service, it is claimed, show that this process stops corrosion in boilers or other metal vessels containing water; that it removes scale from the heating surface of a boiler, and also prevents scale from forming; and it is also a safe water alarm; for if an electrode is placed horizontally in a boiler just above the danger zone for low water, and lights are placed in the circuit with the current through them, the lights will go out when the electrode is not immersed in the water, and, consequently, will give a positive indication of low water in the boiler. For the operation of the apparatus only enough voltage is required to overcome the resistance through the water and to overcome any electromotive force due to the difference of potential of the metals comprising the boiler when they exist. Too high voltage, however, gives no harmful results on the boiler, but merely increases the action on the electrode, requiring it to be removed more frequently. It is claimed that the apparatus requires practically no attention after once being properly installed and started.

"Imperator" Quadruple Combination Machine

The Wiener Machinery Company, New York City, American managers for the Oeking Company, Dusseldorf, Germany, have placed on the market a quadruple combination machine under the name of the "Imperator." The design of this machine was brought about by the success achieved with the Oeking solid steel frame triple combination machines which have been on the market for some time past. Many inquiries were received for a combination machine which could miter right and left angles without any change of knives, and it is also found that a market exists for machines which, besides cutting and mitering angles, rounds and squares, would also cut beams and channels.

The new type of the Oeking solid steel frame quadruple combination machine, styled "Imperator," is therefore built to combine in one frame ready for work all the tools for almost any kind of cutting, shearing, coping, mitering and notching.



The fact that the frame is one massive piece of steel permits a compactness which will make it a most suitable and economical tool for crowded shops. It is also particularly suited for plants where driving power is limited.

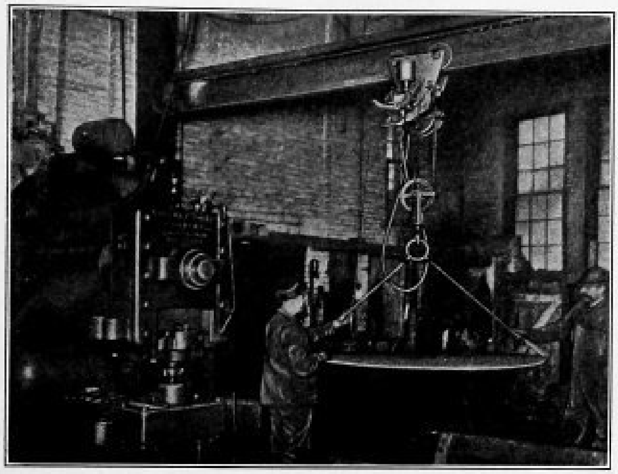
The machine illustrated is capable, without any change of tools, of splitting plates of unlimited length, or cutting flat bars, shearing off rounds and squares, cutting and mitering angles and tees, both right and left at any degree, and of punching plates and structural material, both webs and flanges. With interchangeable tools, beams and channels or any other shape can be cut. The punching tools can also be interchanged for coping, mitering, etc.

The machines are built in three sizes, and can be furnished with tight and loose pulley for belt drive or can be arranged for direct-motor drive. If it is desired the machines can be equipped on a turntable to facilitate mitering long bars of angle iron. It is claimed that these machines do not cost more than the equivalent equipment in single machines, and that they are, furthermore, very economical in operation, saving both time and labor.

Chicago Pneumatic Geared Hoist and Trolley Combined

The illustration shows a Chicago pneumatic geared hoist and trolley combined of 3 tons capacity, serving a plate punching machine in the boiler shop of Henry Pratt Company, Chicago. This combination hoist and trolley is manufactured by the Chicago Pneumatic Tool Company, Chicago.

The hoist operates by a pneumatic motor, consisting of two double oscillating cylinders set at right angles in an air-tight case. There is no movable valve mechanism. The air ports are controlled by a balance slide valve, which closes the ports when on a center and starts or reverses the motor as turned to the right or left. The valve is thrown by a lever to which chains are attached of proper length to be within easy reach from the floor. When the lever is released the valve is self-



closing. The motor operates the hoist through a chain of gears cut from solid steel. The manufacturers have recently perfected an automatic air-actuated brake, which can be applied to the hoist when it is absolutely essential to sustain the maximum load indefinitely without settling. When so fitted the hoist is particularly adapted to serve machine tools and riveting machines in boiler shops and bridge works. The brake acts on a disk, keyed to the highest speed shaft or train of gears by means of a leather diaphragm of suitable diameter to furnish the necessary frictional resistance to sustain the load. Air is admitted at the back of the diaphragm by special ports cut in the main admission valve, so arranged that when the hoist is shut off air is pressing constantly on the diaphragm, but the first movement of the slide valve tending to start the hoist releases the brakes, but it is impossible to stop the hoist without the brake taking hold.

By attaching the hoists to a trolley, as shown in the illustration, head room is saved. The trolley is built to run on the lower flange of I-beams or channels.

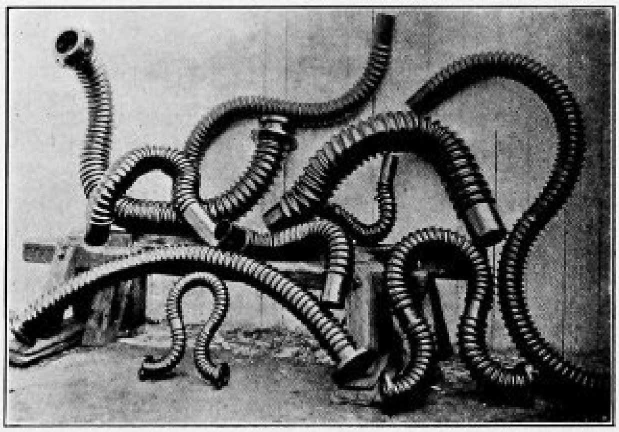
These hoists are designed and constructed to handle loads ranging from 1 to 10 tons at a speed of from 28 to 4 feet per minute. The load is handled with an easy movement, with precision and accuracy, without vibratory motion. In considering the capacity of the hoist and the range of lift the least possible head room is required.

An Improved Process for Making Corrugated Tubes

The term corrugated tubes is not new. Under this name tubes manufactured by various methods have been brought out from time to time with more or less success. Recently a process of manufacture has been patented which, on account of the excellent results secured, has been adopted for many purposes. The process has been patented in the United States and Europe by Mr. W. Maciejewski, a Polish engineer. The European patents have already been purchased and corrugated tubes made according to them by the following companies: Russia, "Compensator" Works, W. Maciejewski, Warsaw, Polna 36; Germany, Franz Seiffert & Company, Act. Ges., Berlin, SO 33; Belgium, Anciens Etablissements Louis De Naeyer, Société Anonyme, Willebroeck; France, La Compagnie des Forges D'Audincourt. The United States patents are offered for sale by Schuchardt & Schutte, of 90 West street, New York.

Either standard wrought iron or steel tubes can be corrugated by the Maciejewski process. According to the pressure and size required, small and medium-size tubes are made from ordinary steel tubing, while for large diameters lap-welded and rerolled tubes are used. The corrugations are made by an ingenious method of pressing the material together, a special machine being employed, the design and construction of which are fully covered by patents. An important feature in the present process and not found in any other is that, through shortening the tubes, the corrugations are pressed into them at equal distances apart without decreasing the original inside diameter. Furthermore, the thickness, it is claimed, remains absolutely uniform, and is the same as in the original tube. During the process of corrugating any defects in the material at once become apparent.

Interesting examples of corrugated tubes are shown in the illustration. They can be made in all sizes, from 1⅜ inches



up to 18 inches, including diameters suitable for use in boilers. Here the average length is about 12 feet, although any other length can be manufactured if required. The tubes for very long lines can be partly corrugated.

Of the many different uses to which Maciejewski's tubes can be employed to advantage the following should be particularly noted: In steam pipe lines the contraction and expansion caused by the steam, and vibrations of the engines, pumps and other units are effectively taken care of by the elastic property of the tubes. Also in firetube boilers a greater heating surface is secured, and the strain is removed to a large extent from the head plate and the combustion chamber. In superheaters the heating surface is increased, and the same is true in radiators for steam and for hot water heating systems. The greatest advantage of all is the use where the space for expansion and contraction is limited and large bends cannot be made, as is the case on steamships.

When steam is turned on or off there is a wide variation in the temperature, hence there is considerable linear movement in the line and its branches to the various units. This movement was taken up by U bends prior to 1890, and later on by expansion joints. Both, however, have their disadvantages, and have been replaced in many large installations in Europe by a length of pipe corrugated by the Maciejewski's process. Tests made by the Association of German Engineers have shown that smooth tubes when bent have a greater elasticity than they should have according to theoretical calculations. The reason for this is that during the process of bending small corrugations are made, which increase the elasticity when expanding and contracting. Thus, when the small corrugations are increased to a height of ten times the thickness of the material the flexibility of the tube is also increased, the corrugations in the throat being pressed together, while those on the periphery are pulled apart. On account of the easy bending properties of corrugated tubes very small radii can be readily obtained having a large amount of elasticity. For instance, a smooth pipe 10 inches in diameter, having a height of 108 inches and an 108-inch throat, has a maximum expansion of 2 inches. A corrugated tube of the same diameter, but only 63 inches high and a 55-inch throat, has an expansion of 5½ inches. Hence a pipe line which has an expansion of 5½ inches would require three bends of smooth pipe with a combined length of about 81 feet, or only one corrugated tube 12 feet long. The advantage in favor of the latter is at once apparent.

Personal

C. E. LESTER, formerly foreman boiler maker of the Erie Railroad, Jersey City, N. J., has accepted a position with the American Locomotive Company at Dunkirk, N. Y.

CHARLES SHUART, formerly employed by the Erie City Iron Works, Erie, Pa., has taken the position of head layerout and foreman with the Casey-Hedges Company, Chattanooga, Tenn.

E. Y. SWIFT, for many years president of the Michigan Bolt & Nut Works, Detroit, Mich., died recently. The present executive officers are L. L. Barbour, president; F. S. Bigler, vice-president and general manager, and H. MacLean, secretary and treasurer.

THOMAS STEWART, formerly shop foreman for Andrews, Phalen Company, West Twenty-fifth street, New York, and later flange turner and layerout for the San Pedro, Los Angeles & Salt Lake Railroad Company at Los Angeles, Cal., has been promoted to assistant foreman boiler maker and boiler inspector for the same railroad.

F. O. AMBROSE, a boiler maker of Janesville, Wis., is credited by *Ryerson's Monthly Journal* with being one of the pioneer Wisconsin boiler makers. Mr. Ambrose is the third of four generations of boiler makers. His grandfather conducted a well-known shop in France, while his father was the proprietor of a boiler shop in Germany. Then to continue the line, Mr. Ambrose with his three sons is carrying on the same successful business in Janesville. He has been in Wisconsin for thirty-four years, and for thirty years has conducted a shop near or in Janesville.

OWEN ROONEY, formerly superintendent of the Vance Boiler Works, Geneva, N. Y., has taken charge of the new shops of the Sims Company, manufacturers of steam specialties, Erie, Pa. Mr. Rooney was at one time foreman boiler maker with the Kelly Springfield R. R. Company, of Springfield, Ohio, severing his connection with this company to become superintendent of the Vance Boiler Works at Geneva, N. Y., a position which he held until the plant was destroyed by fire last November. Mr. Rooney will be pleased to hear from any of his old friends at his new address.

JOHN L. NICHOLSON has been elected director, vice-president and general sales manager of the Locomotive Arch Brick Company, with headquarters in the Chamber of Commerce building, Chicago, Ill. Mr. Nicholson, who was one of the inventors of the Wade-Nicholson Hall arch, has had a great deal of experience in the development of the brick arch to its present state of efficiency, having entered the employ of the American Locomotive Equipment Company in 1904, and remaining with the same company when it was taken over by the American Arch Company as its Southern sales manager, a position which he held until May 1 of this year. Early in life Mr. Nicholson was connected for many years with the Chicago and Northwestern Railroad as fireman, engineer and road foreman.

Technical Publications

STEAM BOILERS. By E. M. Shealy. Size, 6 by 9 inches. Pages, 356. Illustrations, 185. New York, 1912: McGraw-Hill Book Company. Price, $2.50 net.

The author of this book, who is an assistant professor of steam engineering at the University of Wisconsin, has had extensive experience in teaching this subject by correspondence in the Extension Division of the University. The book, therefore, is the result of well matured plans to produce a suitable text for instruction by mail as developed through actual experience. As it is written primarily for correspondence students, it is intended particularly for the use of firemen and others who may be in responsible charge of boiler rooms. With this object in view the author has dealt very sparingly with the actual construction and calculations for strength of boilers. Only about thirty pages are devoted to this subject, as only the essential details and calculations are given. The first two chapters contain comprehensive descriptions of various types of boilers. Then follows the part devoted to boiler calculations, stays and staying. The remainder of the book is devoted to the discussion of heat and work, the properties of steam, evaporation, fuels, combustion, boiler settings, piping, fittings and accessories, as well as the inspection, care and testing of boilers. The book accomplishes its purpose admirably, but evidently is not intended for the instruction of boiler makers in the details of boiler construction and design, although a knowledge of the contents would greatly broaden the mind of the average boiler maker.

MODERN ORGANIZATION. By Charles Delano Hine. Size, 5 by 7¼ inches. Pages, 110. New York, 1912: The Engineering Magazine Company. Price, $2.00.

This book forms an additional volume to the "Works Management Library," published by the Engineering Magazine Company, and is made up of a series of articles which appeared originally in *The Engineering Magazine* early in 1912. Major Hine's "Unit System," which has met with remarkable success on the Harriman Lines in promoting efficiency without causing trouble, is based on the fundamental ideas of correcting over-centralization and over-specialization by simple changes of official relation and departmental routine. The book explains exactly what this system is and how it was put into effect on the Harriman Lines. A striking feature of the system, and one which will appeal to works managers, is the fact that no elaborate system is introduced. There is no cumbersome mechanism, no changes are made affecting the rank and file, the system works by changing the relations and the viewpoint of the directing official, thus operating first upon and then through him. While the ideas and methods have been applied most widely to railway operation, they may be adapted to any situation, whether Government bureau, commercial company or manufacturing and industrial corporation, as the policies are largely mental suggestion, which creates and transforms the ideals which are the first principle of efficiency. The scope of the volume is indicated roughly by the chapter headings, which are as follows: The Unit System on the Harriman Lines; Operation of the Unit System; Broadening the Ideals of Line Supervision; Over-Specialization; Fallacies of Accounting; Supplies and Purchases; Line and Staff; Genesis and Revelation of Organization.

Letters from Practical Boiler Makers

Firing Up Device

In many shops it is customary after giving a locomotive a general overhauling to fire up the boiler before the lagging or jacket is applied. This is a practice that should commend itself to all mechanical men, as it is most beneficial, developing defects frequently not discernible under cold water test.

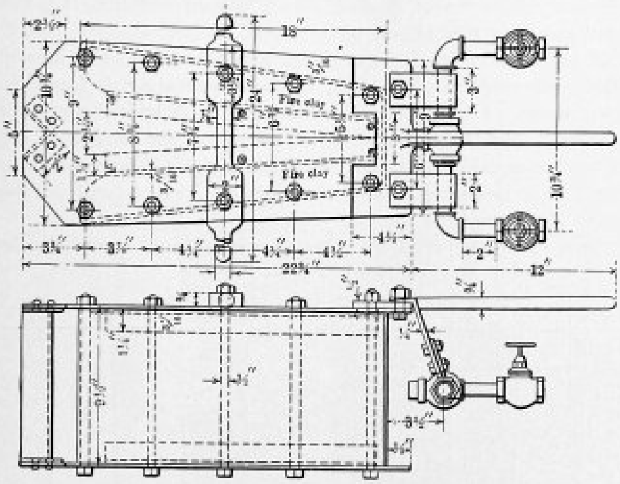


FIG. 1.—FIRING UP DEVICE

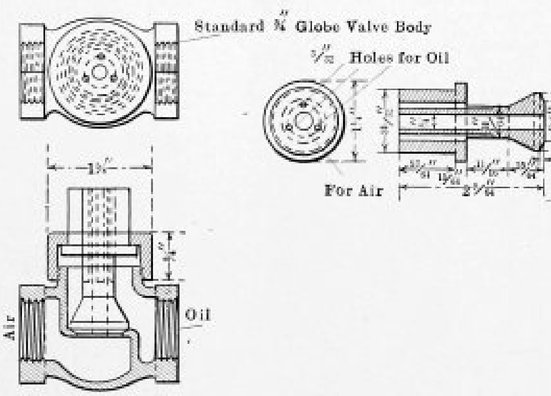


FIG. 3.—DETAILS OF BURNER

This practice has meant, however, that the foreman boiler maker had to be somewhat in the lead of the other foremen, and to have the grates, etc., applied, or to throw in a temporary set of grates or make a fire bed out of scrap flues. This

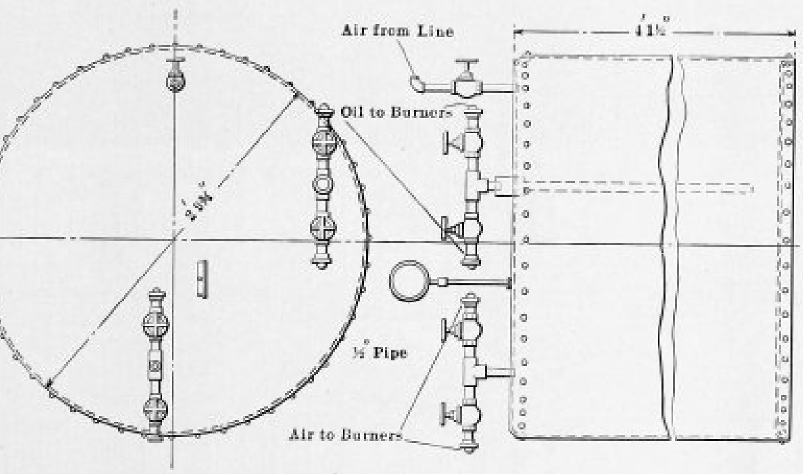


FIG. 2.—OIL RESERVOIR

entails some expense and consumes valuable time. In addition to this, when firing with wood or coal it is necessary to get a tender or a platform behind the boiler that sufficient fuel will be available for firing.

Inasmuch as numbers of shops are not equipped with smoke jacks, the locomotive would be required to be run outside the shop and several hours consumed getting up steam, taking up steam leaks, etc. As a rule the ash pan would not be up and the weather possibly bad—the fire dropping down or the elements interferring; frequently a day would be lost in this one operation.

With the device illustrated all the disagreeable features mentioned are eliminated. It is not necessary that the drum conform to the dimensions shown, as almost any old air reservoir will do that will hold a barrel or two of oil. The burner is inserted in the fire-hole, and the oil and air mixture, under pressure, is ignited, and after the firebrick get heated and the mixture right it is practically self-operative, and a high pressure of steam can be raised in from 90 to 150 minutes, depending on the size of the boiler and with no inconvenience to any workman.

The fact that the device is practically self-operating after starting makes it economical as well as practical. No fireman is needed after starting it, and there are no cinders and ashes to be disposed of. Should firebox calking be necessary a workman can go in the firebox as soon as the heater is shut off.

A boiler can be fired for 25 cents plus the cost of a barrel or two of fuel oil, the size of the boiler bearing a definite relationship to this cost. The material used in the construction of the entire device can be found in any railroad shop, making the device easily obtainable. C. E. LESTER.

Dunkirk, N. Y.

Layout of 90-Degree Elbows

In most cases where the layout of an elbow is given, the laps are shown on the throat or back of the course. This is usually shown in textbooks, but the writer does not believe there are many layerouts who would use that plan in practice, as they could not make a very neat job at either the throat or the back; for the lap in a throat would spread and at the back the holes would lap over. The throat of the large end would have to be set out half-way up each side and the back of the small course set in as shown at *A* and *B*, Fig. 1.

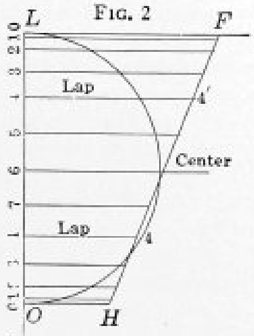


FIG. 2

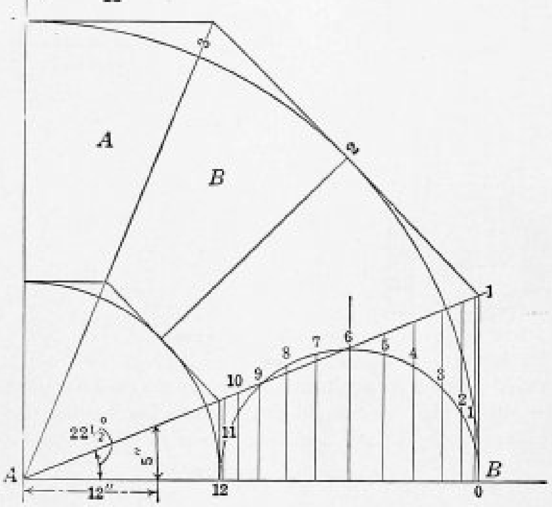


FIG. 1

The sketch shown is for a three-piece elbow with laps on one side, a construction which is generally used for land and pontoon pipes with dredging machines. The plan is equally good also for either smoke, air or water pipes. In this case a 90-degree elbow is shown. To lay out the elbow, first draw the outline and divide the curve into four equal parts, as shown; or, if it is too large to space with the dividers, divide 90 degrees by four and we get 22½ degrees. Now, if we know the offset for a 22½-degree angle in 1 foot, we can easily lay out the pipe. It is very useful to have a memorandum showing the angle offsets in 1 foot for different angles, as it saves a whole lot of trouble. Such a memorandum is given at the end of this article.

A 22½-degree angle will call for a 5-inch offset in 12 inches. The textbooks use 4⅞ inches, but by measuring it is found to be 5 inches. Lay the square on the line *A-B* with the 12-inch mark on point *A*, and mark 5 inches up on the tongue of the square; then lay the straight edge on the point *A*, just touching the 5-inch point, and draw the line *A-1*, which will be the angle for the bottom section.

Now draw the semi-circle as shown in Fig. 1, and divide

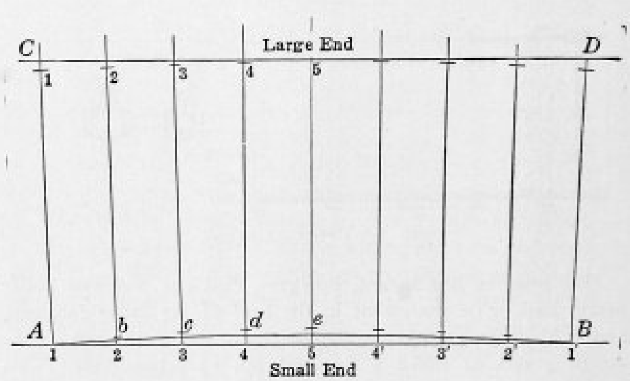


FIG. 5

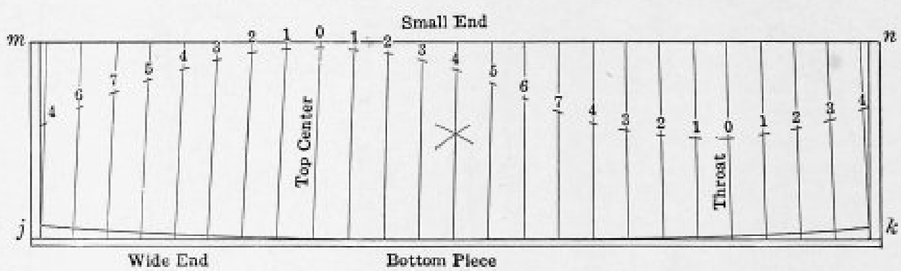


FIG. 3

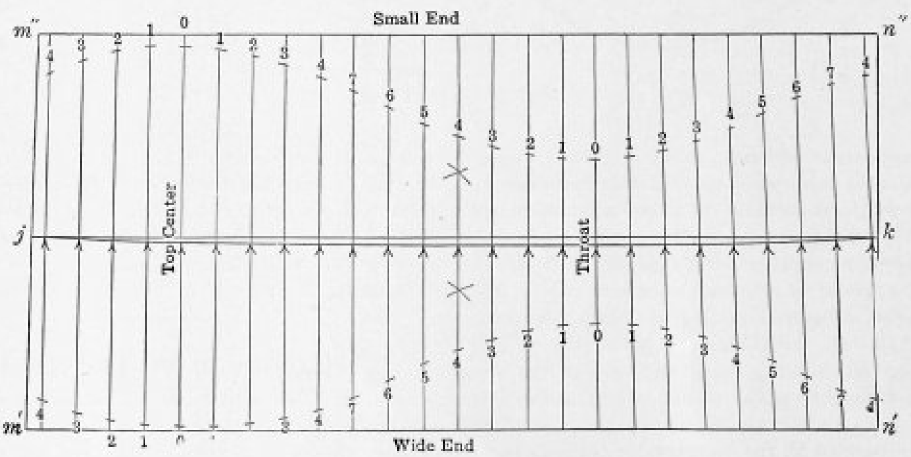


FIG. 4

it into as many spaces as required—in this case 12. Then with the square laid on the line *A-B*, draw lines through the points on the half circle to the line *A*-1. This part of the work can be laid off on any piece of scrap of sufficient size and kept for future use with the laps marked as shown in Fig. 2.

Fig. 3 represents the bottom section and Fig. 4 the middle section. Get *J-K* and *M-N* on Fig. 3, marked with the width required, and lay off the circumference of both the large and small ends, dividing the plate to get the centerline and laying off on each side of the centerline the same number of spaces as there are on the half circle, Fig. 1. Then draw lines, cutting the points on *M-N*.

In getting the camber, if the sheets are not too long, the writer uses the square, laying it on the line 4; scribing 3 and moving to 3 and scribing 2, and so on, until the centerline, marked *X*, is reached. Then reverse the square and work from the centerline. Center those points, then get a piece of hoop iron and mark the points from *O-L* to corresponding points on *H-F*, Fig. 2, and transfer to Figs. 3 and 4.

The following is a table of angle offsets in 1 foot, which may be of use to others as it has been to the writer:

2½ degrees =	9/16	inches in 1 foot
5⅝ degrees =	1 1/16	" "
10 degrees =	2⅛	" "
11¼ degrees =	2⅜	" "
15 degrees =	3¼	" "
22½ degrees =	5	" "
25 degrees =	5⅝	" "
30 degrees =	6⅞	" "
35 degrees =	8⅜	" "
40 degrees =	10	" "
45 degrees =	12	" "
50 degrees =	14¼	" "
52½ degrees =	15½	" "
55 degrees =	17¼	" "
60 degrees =	20¾	" "

Springfield, Ill. JOHN COOK.

BOILER OF MALLET COMPOUND ENGINE WHICH EXPLODED FROM LOW WATER

When the sheets are pretty long, the writer divides it into eight equal parts, as shown on Fig. 5. Lay the square on the line *A-C*, with the heel resting on the point *A*, with the straight edge resting against the tongue and extending to *e* on the centerline; mark with the scriber points *b*, *c*, *d* and *e*. Reverse the square and lay on line *B-D*, and mark the points the same as before, but be sure that the mark on *e* cuts the mark last made right on the centerline. (If it doesn't the outline of the sheet will not be right.)

Now lay the straight edge on points marked "¼," and draw a line cutting the line 4-5-4'; then move the straight edge to points just made on 4 to points on 2, and cut the line 3. Do the same on the other side of the centerline and connect these points, and the camber will be obtained as shown on Fig. 5.

Center these points and set the trams from 5 on the small end to 5 on the large end; that is, the width of the sheet, and use the center marks on all the other points of the small end, and scribe the arcs on the large end, *C-D*. If the spaces are rather large, by putting a steel straight edge edgewise, and bending to touch the points, the regular curve can be drawn, but do not fasten the two ends and pull at the middle, as that will not make a regular curve.

Another Low Water Explosion

Above is shown the exploded boiler of a Mallet compound engine. When the explosion occurred the boiler was blown off the running gear, and was thrown 150 feet ahead, turning a complete somersault, and landing on the smoke arch, tearing this off completely. The explosion is attributed to low water. F. B. M.

Mexico.

Talks to Young Boiler Makers

"It seems to me that there is a lot of money in this boiler repair business, and I am tired of working for somebody else." This idea was expressed by my friend who some time ago put up a kick about good men being underpaid and poor men overpaid. He was sitting with another young fellow on a bench in the city park, where both were smoking their evening pipes. The two were good workmen and had just come off a job of retubing a mill boiler and had made a good showing, and knowing what the boss had got for the job, and the time they had been on it with one helper, the profit looked mighty good to them. Alex, who had just given expression to my opening sentence, as I said, had been keeping time and the books, so there was no guesswork as to figures. Carl, his companion, filled his pipe again before he answered. He was rather slow in talking and was a good listener.

"I have been figuring a little, and I guess a small boiler shop would pay well if we built it up in Milltown right in the heart of the mill district. What do you think it would cost to start?"

Alex pulled out a piece of paper, the electric lights gave him light enough to see, and he began. "Let's see, we would have to have a pair of bending rolls, a punch and shears to begin with. I'll get some prices on them and perhaps we could pick up some good second-hand tools. There are good ones to be had and a big saving could be made that way. We would have to have a building about 60 feet square, I should say. Now, just for fun, let's put down the rolls at $500 and the punch and shears $500 more. There is a building at Milltown just outside the town limit. I think it was a canning factory. I heard a man say it was for rent at $20 a month."

"Well, if that building was for canning work it would have to have a new floor for boiler work," put in Carl. Alex nodded his head, and said:

"Yes, and I guess it has a second story in it which would have to be ripped out. That would cost money, and, anyway, the frame would not likely be strong enough to carry a crane, and without a crane we would be behind the times. Then we would have to have some air tools, but they don't cost such a lot. Those long-stroke hammers cost about $75, and we would not want more than two."

"Yes, but the air compressor costs a lot," said Carl. "Then we would have to have a boiler and engine to run the compressor and the punch and shears."

"The piping would cost something, but I can put that up. I have done a lot of that kind of work," put in Alex. "Then we would have to get a lot of hose and a drill press of some kind, some drills and countersinks, taps and dies, extra shear blades, some shafting and hangers and some belting. Yes, there would be a lot of chicken feed.'"

Carl pondered a few minutes and said: "You can't put up piping without fittings or run your tools without pulleys, belting and couplings for your shafting, and then there is oil needed and the punching machines are no good if we have no punches, and we would have to have ¼, ⅜, ½, ⅝, ⅞ and 1-inch, anyway, and then we would want an air tank for the air and a lot of valves for the line. I guess if we want to go into this we had better make a list of what we have around the shop and get it all down to a dot. Then come to think of it there are drifts to buy, chains and hooks for hoisting, a forge and a flange fire, turning mauls, hammers, holder-ons, bolts and nuts and laying-out horses. When we look it over we see a lot of things about the shop that don't seem to count much, but none of them grows on bushes, so we can't pick 'em like blackberries, but I am tired of journeyman's work and I want to be a boss. I have some money saved up, and a friend has often told me he would back me, and I know you've got a little pile, so we can get the money. We know our trade, and all the boiler shops I have worked in have been started just as we are preparing to start, and if one man can do it others can. Don't you think so, Alex?"

"Sure thing, but it does kind of stagger me when I get right down to what is wanted, and I guess we will find there are a lot more things wanted when we come to look it all over. How much would a traveling crane cost, do you think?"

"I don't know, but we would have to make up our minds as to what we would want to lift first, and whether we would use power or not. Then the span must make a lot of difference; the wider it is the more it will cost. Then there is the length of track and the framing to carry it and erecting it. Gee! but what a lot there is to everything!"

There was silence for a few minutes while the two men puffed away on their pipes.

"Yes, you bet there is," suddenly broke out Alex. "Here now, just look at this, we are smoking our pipes; at first all you need would seem to be some tobacco and a pipe, but then you have to have a bag for the tobacco and matches, and it is just the same all through. But I'm going to lay out a boiler shop just as if I had a big lot of money and see what it all comes to. I can draw a little. They gave us some instruction at school in drawing, but there were too many flowers and heads of old Greek fellows to my way of thinking, but I can use a tee square some and I have a drawing board. You come up to my room to-morrow night, and we will make a start."

"All right," answered Carl. "But to be up to date we will have to have a welding outfit and some high-speed drills for the drilling machine and tap wrenches and ratchet drills and some flat drills and countersinks. Then we would want some air drills or electric drills, or both.

"Say, look here," said Alex, "if we keep on we will have to rob a bank to start in the boiler making business. I begin to think that the boss does not have it all his own way in this line. Anyway, we will start in to-morrow making our list of what we want. You take the shop end and I will look over our books and we will dope it all out. Now, me for my little bed. Good night, Carl."

In the shop where Carl and Alex worked a journeyman had been working for some two months, who seemed a nice sort of fellow, and he had made some changes in the way of doing work which pleased Carl very much, so noons he used to talk with him about the tools in the shop. Most of them were old, but, much to Carl's surprise, this new man seemed to think they were pretty good. He had put them in much better shape than they were, by making the strippers over and setting up on various parts of the various tools and making the laborers clean them up. At noon Carl began making notes. The new man, whose name was Ben, watched him for some time, and at last said:

"This shop has got a good layout and a lot of good workmen, and the boss thinks he is making money. What do you think about it?"

Carl answered, "Why, yes, I know he is making money. He started here about fifteen years ago, and you can see for yourself what a nice home he has and how well he is fixed, can't you?"

"Yes, he has a nice house, and he may be fixed all right, but I was talking about his boiler business," was Ben's answer.

"Well, I don't see how you can make it out any other way," said Carl. "My uncle knew the boss when he started, and he borrowed all he had to start with, and the first five years he just coined money, as there was no competition here then."

Ben said: "Yes, but you know he bought a lot of land in the western part of the town, and that got to be the swell part of this town, and the boss got a big profit from that, and, of course, that had nothing to do with the boiler works. Then he bought stock in the fruit company here, and that went up to two hundred and over, and he cleaned up a nice little pile there.

"When the hard times came on he hardly did a tap of work in this shop for two years, and his investment made him no return, and he kept four or five men at work making stock and doing a little repairing, and those two years must have eaten up a lot of money, as his taxes and the interest on his plant went right on as well as his advertising bills. He could not cut them down much or people would think he had gone out of business, and that would never have done.

"I guess if you could look into it most of the Boss's money was made in the first five years, as far as the boiler shop went, and his big money was made on the side. Anyway, take this shop, he could not sell the tools and business for what it cost him to put in the machines and build up the trade. He doesn't know to-day that he is behind the times, and while he writes off depreciation of tools each year he doesn't put any money in the bank to make good the depreciation, and that is where he and most boiler shops, and almost any kind of a shop, make a big mistake. If he tried to sell this shop he would find out that its good will would not be considered of any value, and his plant would be the only thing considered by a sane purchaser. Why, there is not a tool in it up to date. They will do the work perhaps of the very latest, but not as quickly, and his personality gets him business which would not come to anybody who bought him out. His estate would not realize one-eighth of the inventory value."

All this Carl told Alex when they met in the evening to begin the plans for the new shop, and they talked it over all the evening and did not get at the plans at all. They made up their minds that Ben must know a lot they did not, so they decided to "pump" him and next day confided to him their ideas.

Ben seemed pleased, and asked: "Are you going to make it a partnership or a company?" Neither of them had given this a thought, and Carl asked:

"What's the difference?"

"A company," Ben answered, "has to be formed under the laws of some State. All State laws are not the same. Some do not tax a company if it manufactures in the State, but do tax them if they use the State charter and manufacture outside the State. Some ask very minute returns as to what is being done under the charter, and others ask very little. In some States the charter allows stock to be issued on almost anything, while again in others something very tangible must be owned or stock only to a certain amount may be issued. A charter costs very little in some States, and is obtained without trouble."

"What's the use of a company, anyway?" asked Alex.

"It is this," said Ben. "You have your liability limited to the amount of stock you own. Some charters make you personally liable to the full amount of your holdings, others do not make you, as a stockholder, liable for anything. You pay for your stock, and if the company goes broke you can't be called on to help make good any debts."

"Well," said Alex, "ain't that the best way?"

Ben said: "Perhaps for the fellow who got up the stock company and gets his pay for his work, but how about the fellow who puts up the money for the stock? Take yourself; I ask you to put up a thousand dollars for a new company. You think it is a good proposition, and you naturally want to know what security there is behind the company. If I am wealthy and am willing to back up the stock with my private means you feel safe and go in, although you would also have to stand back of your stock as well. Let me make it clearer. If the stock is what they call 'full-paid and non-assessable,' you pay the full value of the stock and you cannot be asked to pay in any more legally. If the stock is assessable you put in so much money and agree to put up more if the directors of the company demand it."

"Shucks!" exclaimed Carl, "I don't want any company business if that's the way things go. What's the matter with a partnership?"

"Just this," answered Ben. "If your partner comes into the office and finds from your check book there is $10,000 in the bank, he can draw it all and you can't say a word legally about it. You can do the same; that is, if you have no agreement to the contrary, or he can order anything he chooses for the firm, and you are liable for its payment to the full extent of your property. In other words, the action of one in a partnership binds all others in the pertnership. If you two started a business of boiler making as partners, and you ordered a lot of tools, and before they were paid for one ran off, the other fellow would have to foot the bills."

This rather stunned our friends, but after lengthy arguments the company idea seemed the best to work on, but the main thing they thought was to find out if they could get the money for the enterprise. Ben told them, however, that they could not do this until they had made up their minds where they were to locate, and what branch of boiler work they were going into—that is, boiler building or repair work. If boiler building, how large boilers would they provide tools for, and a plan of the building and a list of tools, etc., required would have to be made out, and the total cost figured, and then they could tell how much business they would have to do to meet their expenses, pay their own salaries, wages, etc., and make a fair profit on the investment. Then they would have to canvass to find out if they could get the business. There would be no use in building a boiler shop and have no work for it to do.

This was a "poser," as to go about hunting work while in the employ of the boss did not seem just right, and they might get fired for doing so, and small blame to the boss; but, anyway, they would get up a plan and see what the tools would cost, all set up, and then they could act.

Alex started in and wrote to a lot of punch makers, air compressor people, asking prices on several sizes of tools. He had prompt replies from all, but very much to his embarrassment two or three concerns sent men to see him, who, finding him not at home, hunted him up at the shop. The boss was out, so Alex thought it was all right, but he wrote at once to all the others to whom he had written to keep away. Somehow the trade got wind of a new shop "about to be erected," and Alex had a hard time of it for a few weeks trying to keep matters quiet.

Very much to his and Carl's surprise a man, whom they did not know at all, came to them and said if they wanted to start a boiler shop out at Milltown he would provide the money if they would agree to run it. They could pay him for the land, and whatever they were able every month with interest at 6 percent, but they would have to move quick and get out plans so he could look them over with his friend, who was a practical man. Nothing but the best of tools would be considered, and on Saturday he would take them over to see the piece of land he could get for the shop.

New York. W. D. FORBES.

(To be continued.)

How to Find the Weights of Iron or Steel Bars

To find the weights of square or flat iron or steel bars, multiply the area of the bar by 10/3, which will give the weight in pounds. For the number of pounds per lineal foot for steel, add 2 percent. Example:

To find the weight of an iron bar 1½ by ½ inches, 3/2 by ½ by 10/3 equals 5/2, or 2½ pounds per lineal foot. For steel, add 5/100, or 2.55.

To find the weight per lineal foot of round steel bars, divide the square of the quarters of an inch in the diameter by 6, which will give the weight per lineal foot. Example:

To find the weight per lineal foot of a round bar ¾ inch in diameter: Square 3 (because three-quarters) equals 9, which divided by 6 equals 1½. Weight 1½ pounds per lineal foot.

This method is useful where a man cannot have at his elbow one of the steel handbooks in which weights can be found already computed.—*Ryerson's Monthly Journal.*

OHIO BOILER RULES.—At a meeting of the Ohio Board of Boiler Rules, held at Columbus on July 7, new boiler rules were formulated in accordance with the recently amended Ohio steam boiler inspection law.

Selected Boiler Patents

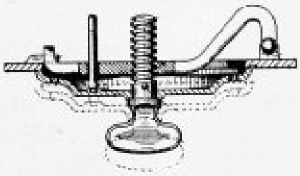
Compiled by

DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

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

1,058,025. GATE FOR DRAFT CHAMBERS OF FURNACES. MARY A. MALLOY, OF PORTLAND, ORE., ASSIGNOR, BY MESNE ASSIGNMENTS, TO GRACE HUDSON.

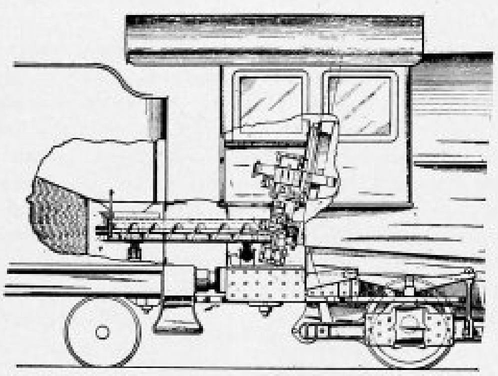
Claim 1.—The combination with a casing provided with an opening, of a gate provided with an orifice or orifices which communicate with the opening, whereby to admit a predetermined continuous volume of air through the opening though the gate be closed against the casing surrounding the opening, means for moving the gate toward or from the



opening, said means including a bar pivoted to the casing and a screw mounted in the gate and threaded in the bar, and a lug on the casing with which the bar co-operates to form a lock, the screw permitting of the gate being adjusted to admit air in the opening to mingle with the air admitted through the orifices. Five claims.

1,058,356. MECHANICAL STOKER. ALBERT G. ELVIN, OF SOMERVILLE, N. J.

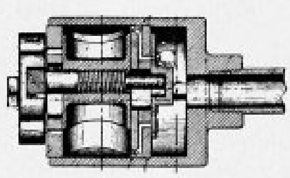
Claim 1.—In a mechanical stoker, the combination of a receptacle into which fuel is deliverable, a fuel carrying and throwing shovel adapted to traverse in said receptable, between positions in rear and in



front, respectively, of the avenue of fuel delivery thereto, said shovel being adapted to pick up and carry a charge of fuel in its forward traverse, and power actuated means for imparting horizontally swinging movements to said shovel. Twenty-one claims.

1,058,932. BOILER-TUBE CLEANER. JOHN ZILLIOX, OF BUFFALO, NEW YORK.

Claim 2.—A boiler-tube cleaner comprising a casing, a pair of opposing hammers pivoted to oscillate transversely to the axis of the casing,



each hammer being provided on opposite sides of its pivot with impact heads adapted to strike opposite portions of a boiler-tube, and means for actuating the hammers. Six claims.

1,058,293. SECTIONAL WATER-TUBE BOILER. PATRICK F. DUNDON, OF SAN FRANCISCO, CAL.

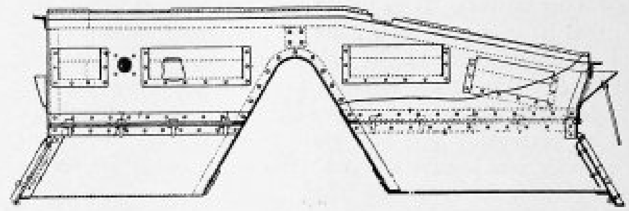
Claim 1.—In a steam boiler, circulating chambers, and clusters of concentric tubes connected to and communicating with the circulating chambers at their opposite ends. Nine claims.

1,058,298. LOCOMOTIVE FURNACE DOOR. HARRY GREGG, OF LOS ANGELES, CAL.

Claim.—A furnace door construction, comprising a frame, a door suitably mounted in said frame provided with a plurality of inclined apertures, a lining for said door provided with apertures registering with said apertures in said door, and a hopper communicating with the uppermost of said apertures, whereby communication is afforded through said door for sand in said hopper and air through the other aperture to commingle within the furnace. One claim.

1,059,059. LOCOMOTIVE ASH-PAN. WILLIAM R. McKEEN, JR., AND JAMES H. GROVE, OF OMAHA, NEB.

Claim 2.—In an ash-pan, the combination of an upper portion open at its lower side; a depending lower portion closed at its bottom and sides and making a close joint with the upper portion; separable conections



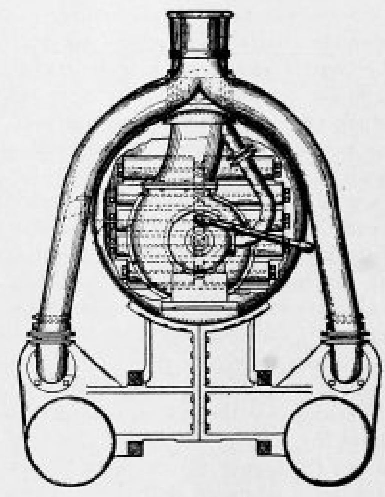
betweeen said upper and lower portions; a door in one end of said lower portions, and inlet air ducts leading the incoming air in a downward direction through the walls of said upper portion. Five claims.

1,059,479. BLOWER FOR BOILERS. JOHN MAGEE, OF DETROIT, MICH., ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

Claim 2.—The combination with the water leg of a water-tube boiler having water tubes and the inspection openings therefor together with hollow stay bolts, of a blower consisting of nozzles inserted in the hollow stay bolts, branches connecting the nozzles and clearing the openings, and a header forming connection between the branches and clearing the openings. Eleven claims.

1,059,378. LOCOMOTIVE. HELON B. MACFARLAND, OF TOPEKA, KANSAS.

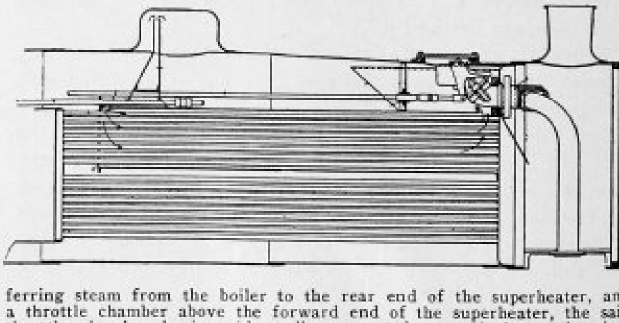
Claim 1.—In a locomotive provided with a smoke box or chamber located within the boiler shell forward of the fire flues of the boiler and provided with an exterior smoke stack, a partition or wall whereby said



smoke box is divided into separate chambers, said partition being provided with an opening therethrough, draft inducing mechanism communicating with the opening in said partition and located in alinement with the smoke stack, driving means located forward of said mechanism and directly connected thereto, and draft controlling means located intermediate of said partition and the forward ends of the fire flues of the boiler.—Nine claims.

1,061,180. SUPERHEATER FOR STEAM GENERATORS. WILLIAM F. KIESEL, JR., OF ALTOONA, PA.

Claim 2.—In a boiler of the locomotive type, a superheater chamber inclosing portions of the upper fire tubes of the boiler, a duct for trans-



ferring steam from the boiler to the rear end of the superheater, and a throttle chamber above the forward end of the superheater, the said throttle chamber having side walls connected respectively to the shell of the boiler, the front flue sheet of the boiler and the top sheet of the superheater and serving to brace the flue sheet and support the superheater casing. Two claims.

THE BOILER MAKER

AUGUST, 1913

A Bad Case of Incrustation

Not long ago a single-furnace Scotch boiler, about 9 feet diameter by 9 feet long, which formed part of the equipment of an English steamship, collapsed while in service, owing to the amount of scale formed in the boiler and the accumulation of mud, salt and lime pumped into the boiler with the water. The boiler was an old one, having seen service in another steamship which sank in the Mersey River. After removal from the sunken steamer the boiler was installed in the second vessel, where it remained in service until the furnace collapsed from the above cause.

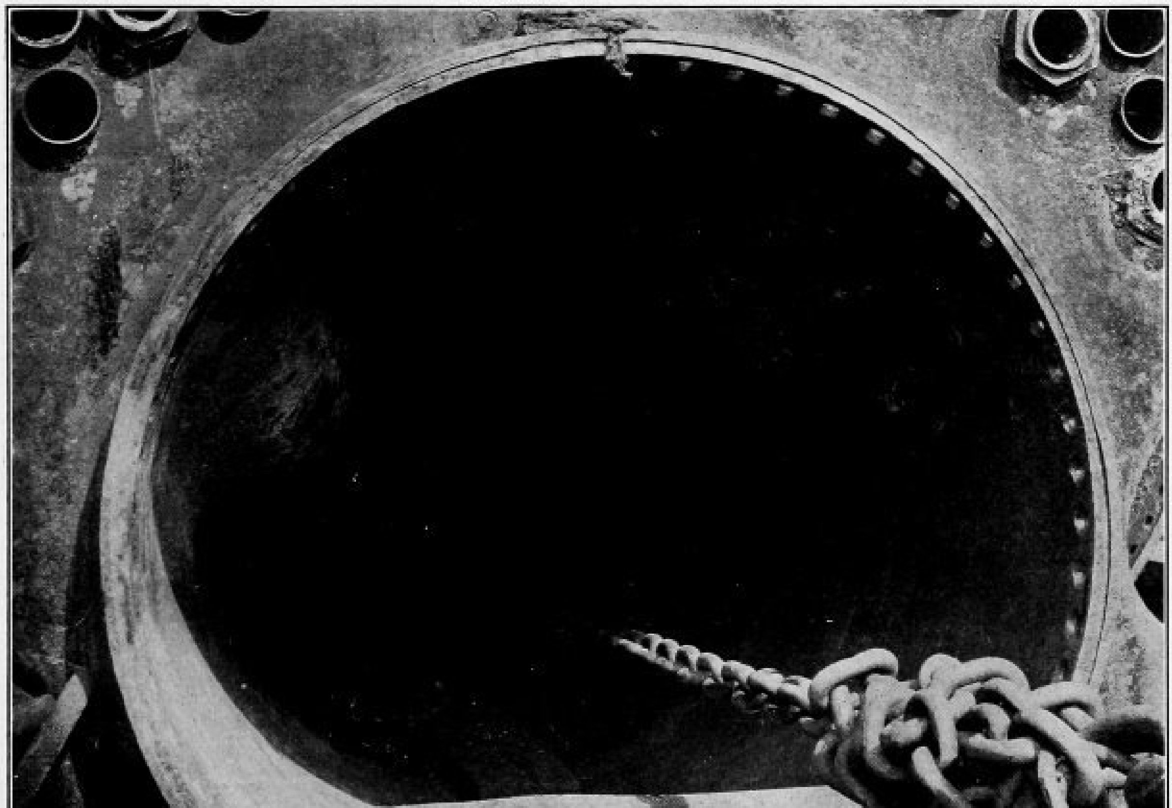


FIG. 1.—COLLAPSED FURNACE

Fig. 1 shows how the furnace crown collapsed, while Fig. 2 gives some idea of the extent of incrustation in the boiler. The photograph shown in Fig. 2 was not taken, however, until after the workmen had been busily engaged with chisels and hammers breaking up the scale, and, consequently, much of it had been demolished, but nevertheless the picture shows that the incrustation was very thick. On top of the furnace the scale was found to be about 1 to 1½ inches thick; on the sides of the shell it averaged about ½ inch thick, while on the bottom, where much of it was soft, it was 3 inches thick. In some places salt crystals were found, as the water in the river where the vessel was in service was somewhat salty. Around the tubes of the boiler in places where there should have been a clearance of about 2 inches, the space was choked up with scale until it was practically a solid mass.

At the time the furnace collapsed there were several passengers on board the boat, and when the stoker found that something was wrong with the boiler he raked out his fire but kept the gage glass half full of water. After the fires were hauled, everyone left the vessel, expecting an explosion, which, fortunately, did not occur. Besides the collapse of the furnace the back part of the combustion chamber was bent between the stays, and nearly everywhere the boiler was badly strained.

The amount of incrustation was certainly unusually large, and seems to indicate that the boiler had been badly neglected, since the formation of scale and the accumulation of mud or sediment in a boiler is to be expected where the vessel is using river water and sometimes sea water. Since the accumulation of scale was to be expected, there was no excuse for allowing it to cover the heating surface of the boiler so extensively as was the case in this boiler.

Scale formed from sea water is composed largely of calcium sulphate, which is soluble in water at a temperature of about 95 degrees F., but which becomes less soluble in water at higher or lower temperatures. Under ordinary conditions in a steam boiler carrying a pressure of 35 pounds or over, the entire amount of calcium sulphate would be deposited in the boiler. Furthermore, in river water other impurities are found, such as carbonate of lime and sulphate of lime, with a certain amount of organic matter and not infrequently mud or sand. Deposits of such impurities in boiler feed water should always be looked for and the boiler cared for carefully, for if they are neglected a serious formation of scale inside the boiler will be found, until the heating surface nearest the fire stands in immediate danger of being overheated and finally collapsing, as was the case of the boiler illustrated in this article, or a complete failure or rupture with consequent destruction of life and property may take place, as was the case more frequently in the early days of high steam pressure.

Factor of Safety

The factor of safety is for the purpose of keeping the stress on the boiler well below the elastic limit of the steel plate used in its construction. The term elastic limit here used designates the extreme stretch of the steel—the limit of elasticity is reached when all the stretch is taken out under a tensile strain. If we do not exceed this limit the steel will return to its original form after the strain is removed; however, if the elastic limit is exceeded the steel takes a permanent set and does not return to its original form. In the latter case, also, a weakening of the plate occurs by a slight separation of the molecules, causing a permanent injury to the body of the plate which cannot be remedied. In a steam boiler this means weakness permanent in its nature, and while the boiler ofttimes withstands this first shock, if it is kept in service it is liable to fail under ordinary working pressure at some future time.

The elastic limit of open hearth, flange, firebox or marine steel is usually about 50 percent of the tensile strength. For example, where the tensile strength of the steel plate is 60,000 pounds the elastic limit would be about 30,000 pounds to the square-inch cross section.

Suppose we have a boiler 40 inches in diameter constructed of open hearth plates 5/16-inch thick, 60,000 pounds tensile strength, 30,000 pounds elastic limit. Assume a well designed seam of the double-riveted lap style, at 70 percent efficiency of the solid plate (the weakest part of this seam being the plate ligament between the rivet holes). The elastic limit on the ligament of the plate between the rivet holes is reached at an internal pressure of 327 pounds to the square inch. The safe working pressure on this boiler, provided the rivet holes were drilled under the United States Steamboat Rule, would be 187 pounds; under modern rules the safe working pressure would be 156 pounds to the square inch.

FIG. 2.—FURNACE, TUBES AND COMBUSTION CHAMBER REMOVED FROM SHELL, SHOWING ACCUMULATION OF SCALE AND DISTORTION CAUSED BY IT

Transmission of Heat into Steam Boilers*

However, a little more detailed investigation will show that with present mechanical draft outfits about 90 percent of the energy that can be developed from the steam consumed in the fan engine is wasted in the crude inefficient engine, in the still cruder fan, and in the long, leaky gas or air ducts having many sharp turns; and that only about 10 percent is actually expended in pushing the gases through the furnace and boiler. The power actually needed to force the gas through the boiler can be easily figured from the volume of gas to be displaced per minute and the pressure against which the gas must be moved. This power in foot-pounds is equal to the product of the pressure in pounds per square foot and the cubic feet of air displaced; the following expression gives it in horsepower:

$$\text{Horsepower} = \frac{\text{pressure (pounds per square foot)} \times \text{cubic feet gas displaced per minute}}{33{,}000}$$

In specific cases the power expended in pushing gases from the ash pit to the base of the stack, or to the up-take, can be figured as shown in the following illustration:

Assume that in a battery of boilers ordinarily developing 1,000 boiler horsepower the equivalent evaporation is 9 pounds of water per pound of dry coal of average quality, and that it takes 15 pounds of air to burn 1 pound of dry coal, then the figures are:

Weight of coal burned per minute

$$= \frac{1{,}000 \times 34.5}{9 \times 60} = 63.9 \text{ pounds.}$$

Weight of air used per minute

$$= 63.9 \times 15 = 958.5 \text{ pounds.}$$

Volume of air per minute

$$= 958.5 \times 13 = 12{,}460 \text{ cubic feet.}$$

Ordinarily the pressure drop from ash pit to up-take seldom exceeds 0.75 inch of water, but for convenience let the pressure drop in this case be taken as 1 inch. We then have for the data in the case above given:

$$1 \text{ inch of water} = \frac{62}{12} = 5.16 \text{ pounds per square foot.}$$

$$\text{Horsepower} = \frac{12{,}460 \times 5.16}{33{,}000} = 1.95.$$

Now, according to the cube law, if the capacity of this battery is to be quadrupled the power needed to move the gases would be 4^3, or 64 times 1.95, which is approximately 125 horsepower.

Surely in a unit of this size one engine brake horsepower ought to be produced with one boiler horsepower, and fans having an efficiency of 75 percent can be built. With such outfits the consumption of steam for the quadruple capacity would then be $\frac{125}{4{,}000 \times .75} = 4.2$ percent of the total steam generated.

When one considers that in big power stations power is produced in large electrical units at about half the steam consumption assumed above, and also remembers that the fans could be driven electrically, the quadruple capacity appears commercially very feasible—especially if by proper arrangement of the heating surfaces the efficiency of the boilers is increased.

If one considers the sizes of fans usually seen in power plants at present, he may perhaps make the objection that if the capacity of boilers were quadrupled the fans would be so large that they might take up the greater part of the space saved by making the boilers do more work. There is, however, no substantial reason for fearing such conditions. The fans used at present are unduly large because of their low efficiency; in different constructions the efficiency ranges from 80 down to 10 percent, and in most is perhaps much closer to 10 than to 80 percent. Fast-running fans of large capacity and high efficiency are now being put on the market. Such fans could be easily placed under or above the boiler they were to serve without being conspicuous on account of their size.

As an example of the feasibility of increased boiler capacity, the reader is referred to United States Geological Survey Bulletin No. 403, wherein are described 21 tests made on a watertube boiler of the United States torpedo boat *Biddle*. This particular boiler had a total heating surface of 2,776 square feet. It would, therefore, be rated in land practice as a 277.8-horsepower boiler. On some of the tests as much as 915 boiler horsepower was developed—about 3.3 times its rating in land practice—and still higher capacity was possible. A blowing fan forced the air directly into the fire-room; the latter was as nearly air-tight as practicable and was kept under pressure. The wheel of the fan was 5 feet in diameter and 14 inches wide. It was placed directly on the fire-room wall and had no casing, but was protected by a wire screen. The blades were curved in the direction opposite to the rotation of the wheel. At the high boiler capacity mentioned the speed of the fan was about 850 revolutions per minute, and the power required was about 15 horsepower.

The question may be asked, Why are the fans used at present so crude and inefficient? The answer is that the manufacturer had to sell them cheaply in order to sell them at all, and cheapness and good design and efficiency in apparatus do not go together. Really, there was hardly anything to be gained by more refined and efficient mechanical draft outfits. Suppose that the steam consumption would by refined apparatus be reduced from 2 percent to ½ percent of the steam generated in the boiler, would any plant manager be willing to pay, say, double the price for the installation of a more efficient mechanical draft apparatus to save at most 1½ percent of the steam?

Another objection that can be made to forcing steam boilers to high capacity is the alleged moisture in the steam. Here, again, one can refer to locomotive and torpedo boat boilers; these types of boilers are working at about three times the rate customary in stationary boilers and work under conditions favorable to priming; still there is no particular trouble from moisture in steam. At large steam-turbine plants, where steam is highly superheated, complaints of higher moisture in steam are not heard.

In designing a steam-generating apparatus to produce steam at high rates, probably the greatest difficulties will be met in the furnace. To produce four times the weight of hot gas, four times the weight of coal must be burned in the same time. To burn coal thus rapidly without large losses through incomplete combustion of gases and tar vapors, driven off from the soft coals upon heating and losses in sparks—losses which always accompany the high capacity of the locomotive and torpedo boat boiler—the furnace would have to be the larger part of the steaming apparatus.

To prevent the escape of unburned gases and tar vapors, the principle of slow heating should be used in stoking the coal, in order to avoid the distillation of heavy hydrocarbons which are difficult to burn. Combustion space should be provided in which to burn the lighter and more quickly-burning compounds.

In the locomotive and torpedo boat boiler the grates are comparatively small, so that in order to force a large quantity of gases through the fuel bed the velocity of the gases must be high. This high velocity lifts small particles of burning coal from the fuel bed and carries them through the boiler.

* Concluded from the July issue.

To avoid the loss from sparks in stationary boilers, the velocity of the gases through the fuel bed should be kept so low as not to start the sparks on their way to the stack. This end can be attained by increasing the grate area. The increase in the grate area will aso reduce the resistance to the flow of the gases, and thereby reduce the power needed to push the gases through the fuel bed. The velocity through the boiler itself should be high, so as to carry through the boiler any solid particles that might settle on the heating surface. If the gases flow faster through the boiler than through the fuel bed, it is obvious that any solid substance that has been light enough to be lifted from the fuel bed will surely be carried through the boiler by the higher velocity. To burn four times the weight of coal on double the grate area would require much less pressure drop through the fuel bed than if it had to be done on the present small grates. Increasing the grate area would reduce the fan work considerably.

From the foregoing discussions it can be seen that the obstacles in the way of higher boiler capacities are superficial, and if the great advantage in the reduction of the first cost of a boiler plant is considered, it seems that the high-capacity boiler is bound to come in the near future. This reduction in boiler plant will give steam power a greater advantage over gas power in large central stations.

A few years ago the gas engine apparently threatened to displace the steam engine, and even the steam turbine, wherever mechanically feasible; that is, wherever real estate was cheap. It has not done so, however, and if one seeks the reason why it has not he has only to ponder some figures in a paper by William L. Abbott, chief operating engineer of the Commonwealth-Edison Company, of Chicago.

Mr. Abbott states that of the total operating revenue received by large central station companies, 50 percent goes out for "fixed charges," consisting of interest or dividends on investment, sinking fund, or depreciation, taxes and insurance; 30 percent for operating expenses of all kinds whatsoever, and 20 percent for general expenses, including salaries of general officers, advertising, rentals, etc. Of the 30 percent spent for operating expenses, 20 percent goes for coal; in other words, only 6 percent of the company's gross operating income goes for fuel.

Mr. Abbott specifically states that the fuel saving attained by a gas-engine plant would be more than overcome by the heavier fixed charges on such a plant; especially would this hold if the heavier labor costs in gas-engine plants using producers are taken into consideration. Now, it is easy to see that a gas-engine plant that would save half the coal (an improbable attainment) would save only 3 percent of the gross operating revenue, and that the increased labor costs alone might approach the saving, not to consider the added bond interest.

The following figures of the cost of installation of steam turbine plants and of producer-gas engine plants of large capacities are taken from a chart compiled by Edwin D. Dreyfus:

COST OF INSTALLATION OF STEAM TURBINE AND OF PRODUCER-GAS ENGINE PLANTS

Total Plant Capacity Installed, Kilowatts.	Cost of Steam-Turbine Plant Per Kilowatt.	Cost of Producer-Gas Engine Plant Per Kilowatt.
4,000	$75	$110.00
8,000	65	104.00
12,000	58	102.00
16,000	53	100.00
20,000	49	99.00
24,000	47	99.50
28,000	46	98.30

The cost of labor Dreyfus gives as 19 to 13 percent of the total power-plant charge in the steam plant and from 23 to 20 percent in the gas-producer plant.

The above status of the comparison is present day. It has been repeatedly pointed out in this bulletin that there are bright prospects of getting two or three and perhaps four times the amount of steam from a given boiler-house investment at a higher efficiency than is usual at present. If steam power-house builders should put as much extra money into air preheaters, fans, economizers, etc., as the advocates of gas engines desire put into gas installations, the additional equipment would work some surprises; whether the greater investment would be sound commercial economy in most cases the authors of this bulletin do not undertake to say.

It is well known that in modern turbine power plants the boiler room is the costly portion; if it be assumed (probably safely for our purpose) that only one-fourth of an electricity supply company's money is in its power houses, and that three-fifths of this latter investment is in the boiler rooms, then to reduce the boiler-room investment only one-half would reduce the total bond interest 7.5 percent, a liberal dividend on the average amount of capital stock—and it must be borne in mind that such companies always will be run for the benefit of the stockholders.

The reader will surmise by this time that the imminence of new competition was the best thing that ever happened to steam engineering; it is altogether possible that the rapid strides now being made in boiler-turbine plants will keep them commercially in advance of gas installations, so far as one can now see, except in those cases where gas is to be had for next to nothing or as a by-product.

By applying the principles of heat transmission developed in the general discussion it would be possible to design with fair accuracy a boiler for any desired efficiency. It has been shown that the efficiency of a boiler can be increased by increasing the length of gas path or by reducing the cross-section of the gas passages. By the latter is meant the cross-section of each elementary stream and not the sum of all of them, as, for example, in the locomotive boiler it is the cross-section or the size of the tubes which determines the efficiency and not the number of tubes. In other words, the reduction of cross-section must reduce the "hydraulic mean depth" if the efficiency is to be increased. The "hydraulic mean depth" is the quotient of the area of the cross-section of the gas stream divided by the perimeter formed by the heating surface of the boiler and touched by the gases. Thus, if the size of the tubes in firetube boilers is reduced, the area is decreased in proportion to the square of the diameter of the tubes, whereas the perimeter is reduced only in proportion to the first power of the diameter; therefore the quotient, or the hydraulic mean depth, decreases in proportion to the diameter of the tube. If, however, the size of tubes is kept the same but their number is reduced, then the area decreases at the same rate as the perimeter, and therefore the "hydraulic mean depth" remains constant.

In a similar way the effective reduction in the cross-section of the gas stream in a watertube boiler is attained only by placing the watertubes closer together, and not by reducing the number of tubes or baffling the boiler. So that to be effective a reduction in cross-section of the gas stream must always be accompanied by a reduction of "hydraulic mean depth," or the mean distance of the particles of gas from the dry surface. The last expression will perhaps appeal best to the reader, inasmuch as the reasoning back of it is a little plainer—the closer the gas particles are to the dry surface the more contacts they can make with it in a unit of time. The reasoning for a long gas path is that the longer the path the longer the time for the gas to pass over the heating plate and the more contacts the gas particles make with the dry surface.

At present there is no boiler designing based on the principles of heat transmission. The various important relations are merely guessed at, and the boiler builder sells his boilers with guaranteed efficiencies which he is never sure can be realized. As a result of this guesswork, one often comes across results of commercial tests that could not be duplicated and would not stand a close examination.

It may be objected that tubes of small diameter will become choked with soot and cinders. This objection was probably first made by the builder of the stationary firetube boiler; still the locomotive boiler builder in the attempt to increase the heating surface used tubes of half the diameter commonly found in stationary boilers; the proof that this reduction of tube diameter was "practical," and that there is no serious trouble from the choking of the small tubes is that thousands of locomotives are in use. Furthermore, the flues of well-kept boilers are cleanded in some plants every day, so that there is little chance for them to get choked.

What has been suggested for the firetube boiler can be applied equally well to watertube boilers. Here, too, the principles of heat transmission can be applied to increase the efficiency. To quicken the rate of heat flow from the gas to the dry surface bring the gas close to the metal by reducing the gas spaces between the tubes through the use of smaller tubes placed closer together; in other words, reduce the "hydraulic mean depth" of the gas passages. For the parallel-flow type of boiler the relation between the efficiency and the "hydraulic mean depth" is probably the same as for firetube boilers. An exact determination of this relation would certainly be of great value to the steam engineering industries. In the cross-flow types of boiler the relation would very likely be complicated by an extra factor, the eddying caused by the expansion and contraction of the gases.

In general, it can be said for all boilers that whatever increases the ratio of the length of the gas path to the "hydraulic mean depth" of the cross-section of the path, increases the efficiency of the boiler. This ratio can be increased either by increasing the length of the gas path or by reducing the "hydraulic mean depth."

The length of the gas path can be increased either by increasing the length of the boiler or by baffling in such a way that the gases will pass successively through different parts of the boiler; in other words, by putting parts of the heating surface in series with one another.

In the watertube type of boiler, the use of tubes of small diameter would tend to increase the work of cleaning the boiler internally. In plants having condensers this objection would not be serious, and in small plants without condensers the scale-forming ingredients could be chemically precipitated and removed from the water before feeding it into the boiler.

The application of some features of the laws of heat transmission, deduced from the experimental work of the technologic branch of the United States Geological Survey and the investigations of others, to steam boilers already installed is considered here. It is not practicable in the case of an existing plant to take advantage of all the improvements that the principles of heat transmission suggest. For example, it is unpractical to replace a small number of large flues in a multitubular boiler by a large number of small ones, or to exchange the large tubes of watertube boilers for a larger number of small tubes placed very close together; in other words, it is not feasible to increase the efficiency of such boilers as heat absorbers by decreasing the "hydraulic mean depth" of the gas passage. On the other hand, it is possible to increase the output of a boiler already installed, by pushing through it a larger quantity of gases; or, it is possible to increase its efficiency by inserting baffles in such a way as to put parts of the boiler's heating surface in series.

It is interesting to note that some of the points thus developed by this valuable series of experiments by the engineers of the Bureau of Mines were anticipated by the researches of the Swedish engineer, F. Almgren, many years ago. Quoting the investigations of Geoffroy, Almgren stated that the amount of steam produced by tubular heating surfaces depended upon the volume of heated gases passing through the tubes per hour. From experiments made upon a locomotive boiler, he deduced the advantages obtainable by increasing the velocity of the hot gases through the tubes, and showed the relations existing between the velocity and length of tubes for maximum efficiency.

Now that the subject has been given a critical discussion, in connection with additional experiments, it is probable that the whole subject of the design of tubular boilers, especially for locomotive and marine service, will be advanced by reason of the rational basis upon which the whole subject has been placed.

Cleaning Soot from Superheaters

Tests have demonstrated that 5 to 10 percent gain in fuel economy may be obtained through the regular blowing of soot from boiler tubes. Soot interposes additional resistance to the flow of heat, and its removal increases the coefficient of heat transmission and thus reduces the flue gas temperature.

If boiler surface is maintained free of soot and the superheater surface neglected there will be only a small excess temperature of waste gases, because the superheater surface is only a small percent of the total. But there is a decided loss in economy, because the superheater temperature will be very much less than that to be obtained with clean superheater tubes. It is quite possible for superheater tubes to be so covered with soot as to reduce the superheat temperature 50 degrees below normal, equivalent to 5 percent or more excess steam consumption.

Ordinarily boiler and superheater surface should be blown a number of times a day, and if this course is pursued the duration of blowing need be very short. The superheater blower is first operated, the soot being carried by the draft into the boiler setting, from which it flows to the up-take. Such parts of the soot as are redeposited in the boiler are then dislodged when the boiler is blown.

In order to insure regularity in the blowing of superheater and boiler surface, also in blowing off mud-drums, it is a good plan to rig up some simple automatic device, which will record the time at which soot blowers and mud-drum blow-offs are operated. This gives a check on the work of the firemen.

Boiler Manufacturers' Convention

The American Boiler Manufacturers Association will hold its twenty-fifth annual convention in Cleveland, Ohio, September 1 to 4, inclusive, with headquarters at the Hollonden Hotel. Matters of special interest to boiler and tank manufacturers and steel plate users will be discussed in consequence of the proposed adoption of standard uniform boiler specifications. The convention this year is also of special interest, as it marks the silver anniversary of the association. The local committee has provided an excellent programme of entertainment for the visiting ladies, and an excursion on the lake on September 3 for the members and guests. The convention will close with a banquet Thursday evening, September 4. All of the manufacturers and users of steel plate are invited to attend the convention, and as Cleveland is centrally located a large attendance is expected from both Canada and the United States.

Information Wanted

An inquiry from one of our subscribers asks for the design of a portable tool for cutting 3-inch and 3½-inch holes in 1-inch boiler steel, the tool to be so designed that it can be driven by a portable air motor. Our correspondent states that he wishes to install arch pipes in locomotive boilers with as little "stripping" as possible. Any information which our readers can send us for publication in the next issue pertaining to the installation of arch pipes and the design of a portable tool for cutting 3-inch holes in boiler plate will be highly appreciated by our correspondent.

John, Joints and Geometry

BY JAMES F. HOBART, M. E.

"Mr. Hobart, how do they figure the strength of riveted joints, anyway? And I would like to know, while you are about it, why they take the diameter of the shell instead of the circumference when figuring the bursting pressure of a boiler."

"So, John, you have come up against that stunt, have you? All right, then, we'll bring in a bit more geometry and thrash it out. Get your chalk, get onto that ½-inch sheet of boiler iron and draw a sketch like Fig. 1. Put in a lot of arrows, all pointing outward, to represent the steam pressure. This, if I get you right, is what you mean by the circumference pressure. Am I right?"

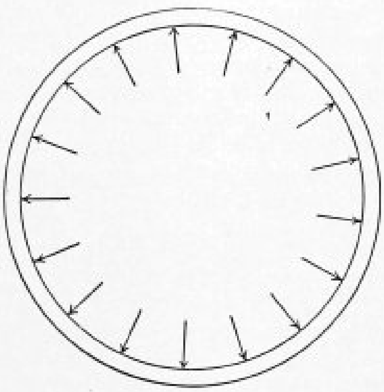


FIG. 1.—PRESSURE AGAINST CIRCUMFERENCE

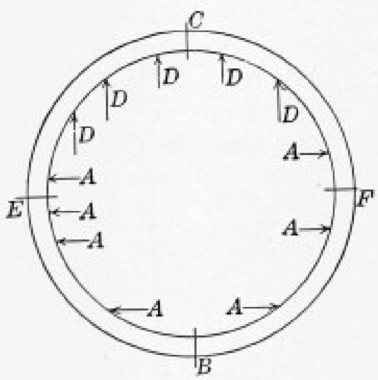


FIG. 2.—DIRECTION AND EFFECT OF PRESSURE

"Yes, that is what I mean. A boiler with 100 pounds steam pressure inside of it sure seems to be under strain in every direction. Now, if we take a 6-foot boiler it has about 237 inches of circumference and under 100 pounds per square inch there would be 23,700 pounds stress against every inch of shell length. Now, I don't see how they get ½-inch boiler plate to carry that amount."

"You're wrong. You're up against the wrong figure. I will tell you why they figure internal stress upon the diameter instead of around the circumference of a shell. Here's another sketch, Fig. 2, which shows the direction and effect of pressure. In this sketch we will consider that the boiler is to break in two along line *BC*. In fact, we will consider that the internal stress is great enough to rupture the boiler at *B*. In order to tear the plate at that point, the pressure must be all in the direction of *AA*. But the pressure is not all in that direction, as we have shown by Fig. 1. It is in every direction, but the stresses in the direction of *AA* tend to tear the plate at *BC*, while the stresses in direction of *DD* have a tendency to tear the shell plate at *EF*. It is that way all the way round. Each stress is seeking to tear the plate in a direction at right angles to its force; and if we could line up all the different stresses and make them go in one given direction, as in Fig. 3, then the rupture when it occurred would be along the vertical line."

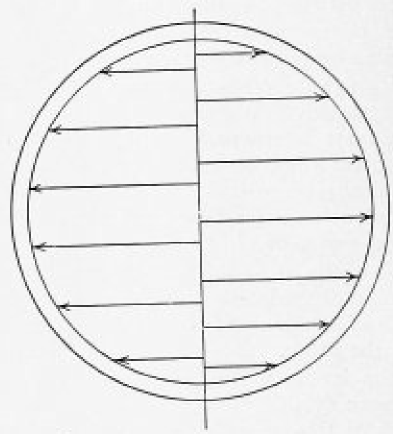


FIG. 3.—DIAMETRICAL PRESSURE ON SHELL

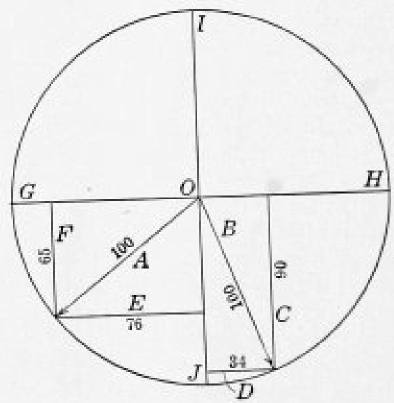


FIG. 4.—HOW THE STRESSES DIVIDE UP

"But, Mr. Hobart, they don't act in one direction, so how are you going to fix things so they will act in that way?"

"That is an easy matter, John. We just assume that they all act as shown by Fig. 3, and then go ahead and calculate the pressure due to the diameter of the boiler and the pressure from steam. The diameter is 72 inches, and under a stress of 100 pounds per square inch there would be 7,200 pounds pressure, tending to tear the boiler shell along the vertical line."

"But, Mr. Hobart, I don't get this thing right. How are you going to line up the direction of all the stresses as in Fig. 3 when they are really acting as shown by Fig. 1?"

"As they act in every direction there must be just as much stress on the vertical line in Fig. 3 as on any other part of the shell, isn't there?"

"Sure! I can see that."

"Well, then, we will just assume a diameter somewhere around the circumference, no matter where, and then we will assume that there actually is a set of pressure lines existing as shown by Fig. 3. We can turn the diameter line to the right or left and find another set of pressure lines. But as one set of pressure lines is exactly like all other sets, we will take the vertical line as shown by Fig. 3 and calculate the internal stress against the circumference of the shell."

"But, Mr. Hobart, all those stress lines bear clear against the shell, still some bear at a great angle. The little short fellows at the top and bottom bear almost in the direction of the shell plate. How are you going to find what real pressure is exerted against the shell by these lines?"

"That's easy, John. Fig. 4 shows you how the whole thing is done. We will take our vertical line and call it *IJ*; and to reduce a pressure in any direction to pressure against the shell square with *IJ*, we simply draw the line *A*, making its length equal to the pressure it represents. For instance, let 1 inch represent 100 pounds. Then line *A* will be just 1 inch long in order to show graphically the pressure of 100 pounds. Get that, John?"

"Yes, sir, that's dead easy. No trouble about that."

"All right. Now we will complete what the geometry sharps call a 'parallelogram of forces.' To do it we will just draw another vertical line *F* and another horizontal line *E* parallel to the diameter lines *IJ* and *GH*. Next, with a scale, we will measure the length of line *E* and find it to be about .76 inch. Line *E* then represents the actual force with which stress *A* acts against the circumference to tear the plate along the line *IJ*. In fact, 76 pounds is exerted to tear the plate at the point mentioned. But if we measure line *F* we find it to measure about .65 inch, and it therefore represents 65 pounds stress vertically to tear the shell along the line *GH*."

"Giminy crickets! That's a slick stunt. Can you mix up pounds and inches in that way?"

"Sure; it works right every time. If you hold a cold chisel on a certain angle and strike a blow of a certain number of pounds to drive the chisel in that angle, you can figure exactly the vertical and horizontal cutting power of the tool when driven at the angle mentioned.

"Now, to take the case of the little, short horizontal lines close to the circumference of the circle. One of them is shown at *D*, Fig. 4, and is shown very closely coinciding with the circumference. Line *B* represents the direction in which this force goes, and upon measuring we find its horizontal component, as the geometry sharps call it, indicates only 34 pounds, while the vertical stress is 90 pounds. In this case most of the force is exerted to tear the plate at *H* and 34 pounds of it get in its work at *J*. That's the way, John, in which the stresses divide up to rupture the plate along line *IJ*. But in actual practice we need take no account of this, but simply multiply the diameter by the pressure per inch, and we get the actual stress upon the metal at points in the circumference exactly opposite each other."

"I see what you mean, Mr. Hobart; but it sure is a bit hard to understand. Do you mean to say that out of all the 23,700 pounds pressure against the shell of the boiler that only 7,200 pounds per inch at length goes to tear the shell?"

"That's what; only 7,200 pounds to tear the shell at any opposite points in the circumference. All the rest of that 23,000 pounds is tending to rupture the shell at other points along the circumference."

"Gee! somehow or other that's hard to understand."

"Well, here's another way for you to look at it. Just look at Fig. 5. Here we have put a jackscrew inside the shell and have turned up the screw until it exerts just 100 pounds pressure in a vertical direction. Now if you put forty or fifty other jackscrews on different angles they will tend to rupture the shell in other directions than shown at *D* and *E*, won't they?"

"Sure! Jackscrew *A* tends to tear the shell at *D* and *E*, and to exert its greatest force there. But as you show by Fig. 4, this jackscrew would, if placed at some other angle, still have some effect upon line *DE*."

"Sure! but we don't have to take that into account. We simply say that there is 100 pounds pressure at *A* exerting itself in a vertical direction. Now, then, there is 100 pounds pressure upwards at *B* and 100 pounds vertically downward at *C*, isn't there?"

"Sure! I get that all right."

"Then how much pressure is that at *D* and *E* tending to tear the shell apart?"

"Why, it looks as though there should be 100 pounds at each

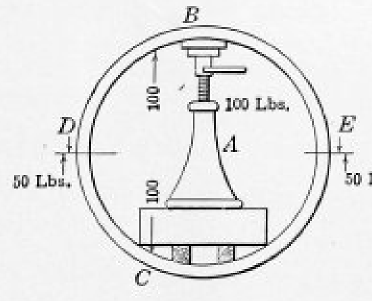


FIG. 5.—DISTRIBUTION OF BURSTING STRESS

place. The jackscrew bears up 100 pounds and down 100 pounds. That would make 200 pounds, and as each side has to carry half of it I should think there was 100 pounds pressure at *D* and 100 pounds at *E*."

"All right, John, but there is right where you fall down. Should the jackscrew exert just 100 pounds, then there is a stress at *D* and a similar stress at *E* of 50 each, and you can't get any more if you tried, at least without a bigger jackscrew or more pressure upon it."

"I believe I get that, Mr. Hobart, but it sure would bear a bit of study. Now, if I multiply the diameter of the boiler by the internal pressure per square inch, and divide it by twice the thickness of the shell, then I will get the actual pressure per square inch at *D* and *E*."

"Sure! that is what you will get, and if you want to find out the bursting pressure of this boiler, just multiply the tensile

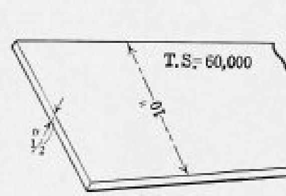


FIG. 6.—STRENGTH OF A SOLID SHEET

strength of the steel by its thickness, and you will have the bursting pressure which the shell will give way under at *D* or *E*. Now if you double this number of pounds ultimate or bursting strength and divide by the diameter of the shell, then you will have the bursting pressure of the boiler in pounds per square inch. This is the stress under which the boiler might hold or might let go. It is called the ultimate or bursting pressure. To make it safe you should divide by four or five, whichever factor of safety you prefer. This factor of safety goes to make up for poor workmanship, uncertainty of actual tensile strength or other incidental occurrences which might cause the boiler to be of less strength than we suppose it to be."

"Say, Mr. Hobart, how do they figure a boiler seam, anyway? Pete Manning told me the other day that the seam is always the weakest part of the boiler. Can you tell me how they figure that out?"

"Sure! If you cut a hole in a piece of boiler plate, that plate is not as strong as before it was punched, is it?"

"Sure not! There isn't as much of it."

"That's right. Now, if you punch out a row of large holes across the sheet and space the holes so that they will cut away just one-half the sheet, then the remainder of the sheet will represent the strength percentage of plate section. As we had a whole sheet and cut away one-half we have one-half remaining; therefore the shell's strength will be only 50 percent. Fig. 6 shows this matter to advantage. Here is a piece of boiler iron 10 inches wide and ½ inch thick. It is marked 'T. S. 60,000,' which means that its tensile strength is 60,000 pounds per square inch of section, or 600,000 pounds for a 10-inch strip 1 inch thick. As this strip is ½ inch thick its strength will be one-half as great, or 30,000 pounds per inch of width, and ten times 30,000 gives 300,000 pounds as the ultimate strength of this piece of plate."

"Then cutting rivet holes in a sheet is what weakens it, is it?"

"Sure!" Just look at Fig. 7. We will drill a hole, say *A*, and it weakens the plate by exactly the proportion of plate width removed by drilling the hole. For the same reason, if we drill two holes as at *B*, then the plate will only be one-half as strong as the uncut plate. If we drill three holes as shown at *C*, then the joint will only be one-third as strong as the uncut plate. Suppose, now, that we drill four holes in the plate as at *D*. The plate is now only one-fourth as strong as it was before the holes were drilled. While the above is not exactly correct, it will serve to illustrate the effect of drilling holes in boiler plate.

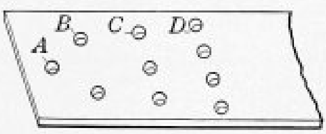


FIG. 7.—EFFECT OF HOLES ON PLATE SECTION AND STRENGTH

"Supposing, John, we have a piece of plate which has been put together with ¾-inch rivets. This means that the holes were drilled 13/16 inch in diameter, and, of course, the rivet being heated when driven was made to fill the rivet hole completely, and is therefore 13/16 inch in diameter instead of ¾ inch. The diameter of a 13/16-inch rivet, expressed decimally, is .8125. Supposing that the rivets were spaced 2⅝ inches, this equals 2.625, and subtracting .8125, the diameter of the rivet, we find we have 1.8125 inches of plate section remaining. As we originally had 2.625 inches and now have only 1.8125 inches, we will simply divide 1.8125 by 2.625 and obtain .69 as the result. This means that the piece of shell has lessened its strength by cutting the hole until it is only 69 percent of the strength of the uncut plate. Do you see how it is done, John?"

"Yes, I get you, Mr. Hobart."

"You just find out how much plate is cut away, subtracting the width of cut from the width of uncut plate and divide the remainder by width of the uncut plate. This gives the percentage of plate section. Is that right?"

"Sure, Mr. Hobart! that's O. K. I see now how they get the plate section, but the boss told me the other day that they had to calculate the rivet section. Now, how is that stunt done?"

"Yes, John, that's right. We have found the net plate section, and we can multiply that by 60,000 or 50,000, or whatever amount we are led to believe the plate is equal to carrying. You usually find the tensile strength stamped upon each plate, and you can look it up at your leisure."

"Say, Mr. Hobart, if we make the rivet holes cut out just half the width of the shell then we would have a seam of 50 percent efficiency, wouldn't we?"

"Probably not, John; the shell or plate section would be 50 percent, but we have not yet taken into account any of the rivets. A rivet usually doesn't show as much strength per square inch as the plates does. We have got to take the area of a rivet to find its shearing strength. Here we have 13/16-inch holes with rivets driven in snugly. This fraction equals .8125; but if we want to find the rivet section strength, we simply find the area of each rivet, multiply by the number of rivets and by the shearing strength of the iron or steel. This may be taken at about 35,000 pounds per square inch. Now, the area of a 13/16-inch rivet which equals .8125 is almost exactly .52 square inch. That is, each rivet has a little better than ½ square inch of section. If we multiply this by 35,000, the amount for which each rivet is good, we will have the shearing stress of the rivets, and if we compare the shearing stress of the rivets thus found with the tensile strength of the shell, then we can determine which is the stronger, the plate section or the rivet section; and in order to make the strongest possible joint these two should be equalized, either by changing the diameter of the rivets or their spacing."

"I guess, Mr. Hobart, I will have to chew over that a day or two. After I wear out a little chalk working the thing over,

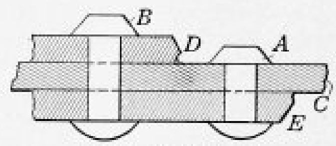


FIG. 8.—THE RIVETS

I think I will have it down pat. But tell me what they mean by rivets in single shear and in double shear. I heard the 'Old Man' talking about that, and I couldn't seem to make out just what he meant."

"Fig. 8 shows that matter quite plainly. Three pieces of boiler plate are shown at *C*, *D* and *E*. Rivet *B* passes through the three plates, and rivet *A* only passes through two plates. Now, were we to put the joint shown by Fig. 8 in a testing machine and try to pull it apart, then rivets like *B* would offer more resistance than rivets like *A*. As a reason for this we say that rivet *A* is in only single shear while rivet *B* is in double shear. At *A* we have only one plate, *E*, trying to tear itself free from *A*. At *B* we have a rivet trying to tear itself free from two thicknesses of plate. Therefore rivets like *B* are said to be in double shear, and show a great deal more strength than is possible for rivet *A* in single shear.

German Electric Riveting Machine

An electric riveting machine designed by the Leipziger Maschinenbau-Gesellshaft, Ltd., at Leipzig, Sellerhausen, Saxony, is provided with an electric motor of 3½ horsepower, and can close about 2,000 rivets 1 inch diameter in ten hours. A ¾-inch rivet requires a 2-horsepower motor under ordinary conditions.

The body of the machine and the lateral connecting rods are made of cast steel. The electro-motor is placed centrical on the machine, and actuates a mechanism of levers that moves the piston by means of a worm-wheel gearing with a cup-shaped die passing up and down.

The latter motion can be interrupted by means of a coupling, that will be engaged or disengaged. A friction coupling stops the machine if the maximum pressure for which the machine is designed should be exceeded.

It will be noted that the real work of riveting is performed not by the electro-motor above but by the aid of the energy of the fly-wheel, so that any damage of the motor is avoided. The motor is also provided with circuit breaker and fuses.

Furnace Efficiency*

The code of the American Society of Mechanical Engineers specifies the combined efficiency of a boiler and grate as being the ratio of the heat actually used in converting water into steam, to the total amount of the heat energy in a unit of dry coal, and, until recently, combined efficiency has been the basis for judging the performance of a boiler and furnace.

It is for the purpose of illustrating the insufficiency of that kind of an analysis that this paper has been written. Furthermore, it is desired to present a refinement of this method by which the efficiency of the elements themselves can be determined, and to discover and correct errors leading to low combined efficiency.

The development of the modern mechanical stoker has resulted in an improvement in steam generation, so that the process of burning coal is considered now the more delicate and important of the elements entering into the stoker-boiler the testing of the stoker-boiler unit without undue necessity for impractical refinement or the use of laboratory apparatus.

For a proper appreciation of the disposition of the heat contained in a pound of fuel, the only logical way to base this analysis is on the heat contained in the fuel as it is actually fired, rather than upon the basis of either dry coal or combustible, which, after all, are theoretical conditions and are never attained in actual practice. What the engineer wants to know is how the heat contained in the actual coal he is firing is disposed of, and as the moisture contained in the coal has an influence on the efficiency of the entire process, it must be taken into consideration in an accurate analysis.

In Fig. 2 is shown the effect of moisture in the coal as it affects the heat available for useful work. This is plotted on the following assumption: That the net coal in a pound

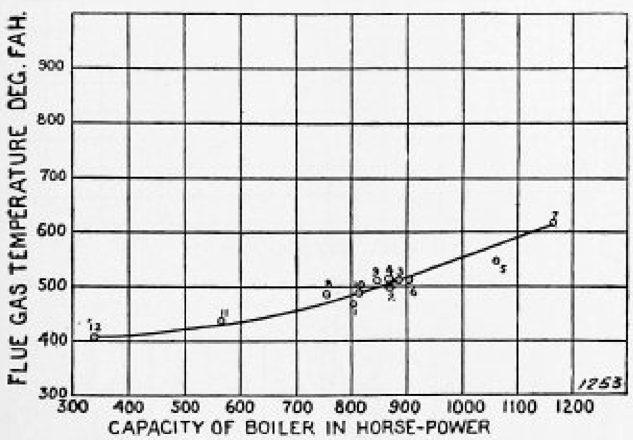


FIG. 1.—RELATION BETWEEN BOILER CAPACITY AND FLUE TEMPERATURE

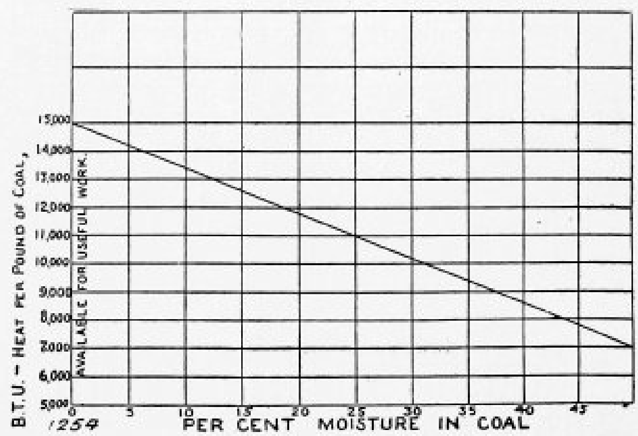


FIG. 2.—INFLUENCE OF MOISTURE IN COAL ON HEAT AVAILABLE FOR USEFUL WORK

unit. One of the sources of boiler losses is the heat loss due to the temperature of the gas above the temperature corresponding to the steam pressure. A study of Fig. 1 will show the rise in flue temperature corresponding to an increased boiler capacity. Inasmuch as the steam pressure was constant throughout these tests, the abscissæ may be taken as indicating the rate of combustion. If documentary evidence is required, this will show that the rise in flue temperature is not proportional to the rate of combustion or the developed capacity of the boiler. The significance of this is that the true boiler efficiency is not greatly affected by differences in the rate of heat absorption. Ability to absorb heat is the fact controlling boiler efficiency, while, as I will try to present later, furnace efficiency is affected by several considerations. I think there is no question but that the ability of a tube to transmit heat, when in a standard condition of cleanliness, is practically the same at all times under similar conditions.

A given weight of coal per square foot may be burned under widely varying furnace efficiencies, but the boiler efficiency that goes with it is not affected to a corresponding extent.

It is in the furnace that lie the greater possibilities of either high or low efficiency, and it becomes doubly important, therefore, that we develop a means whereby this part of the process may be segregated and analyzed.

It has been my object, of late, to develop these means or methods of analysis so that they can be practically applied to

of fuel (disregarding ash for the time being, or considering the ash percent constant) is the difference between the percentage of moisture and 100. For example, wet coal containing 20 percent of moisture would contain only 80 percent of combustible. In this way the diagram has been worked out within the range of ordinary moisture content.

In lignite coals we frequently encounter 35 percent moisture, which would mean 9,350 B. t. u., instead of 15,000 if the coal had not contained any moisture.

As a matter of interest Fig. 3 has been worked out, carrying it to the ultimate, wherein it is shown that if coal contained 93 percent of moisture it would take all of the remaining combustible to evaporate its moisture content. In other words, there would be no heat left for external work.

When other unavoidable losses are considered which are necessarily encountered in practice, this result is not so far from being a possibility. Add to the losses due to the moisture contained the unavoidable losses due to combustible in refuse, the losses due to excess air, the losses due to radiation and unaccounted for, and the other losses which may be charged against the particular method of operation in vogue, and a point will very soon be reached where a wet coal ceases to be of any value. We have found by experimentation that a moisture content of 25 percent is about the limit of practical usefulness with the ordinary form of furnace in commercial service.

Lignites carrying moisture in excess of this require a specially designed furnace, wherein the heat generated by the

* Abstract of a paper read by Joseph Harrington before the Western Society of Engineers.

combustion of the fixed carbon can be more efficiently brought into contact with the incoming fuel. Inasmuch as this is not a very practical possibility in the furnace, it brings up the question of pre-drying these fuels with the chimney gases, and the writer has in course of preparation a design suitable for this work.

The entire operation must be considered in a study of the efficiency problem, inasmuch as the heat taken from the waste gases for the drying of the fuel necessitates either an excessively high stack or some form of induced draft. In either event the coal must furnish the energy for its own preparation and drying, and the furnace efficiency in this case must be extended to include any such preparatory zone.

The design of the furnace to effect the necessary mixing varies widely with different fuels and drafts and rates of combustion, and in the absence of any means for determining this mathematically it appears to still remain largely a question of experience.

The product of incomplete combustion is CO, wherein only about one-third of the potential heat is developed. It is, therefore, obviously important that CO must not be present in appreciable amounts.

It has been stated that there are other hydrocarbon compounds which are present in flue gases, and which are carried away with the escaping gases whenever CO is present. These gases, not being of such a nature as to render it possible to

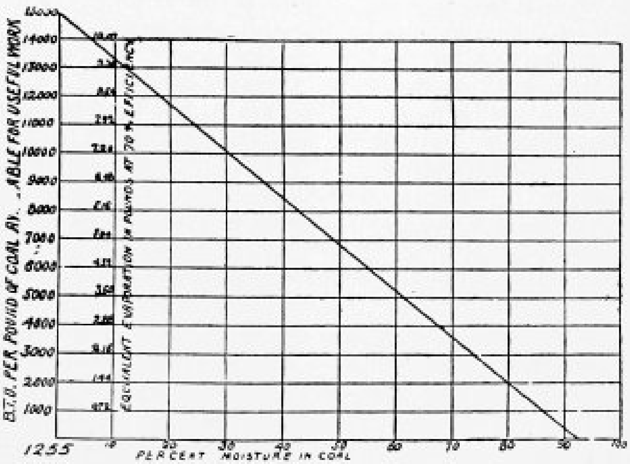


Fig. 3.—Influence of Moisture in Coal on Evaporative Power of the Fuel

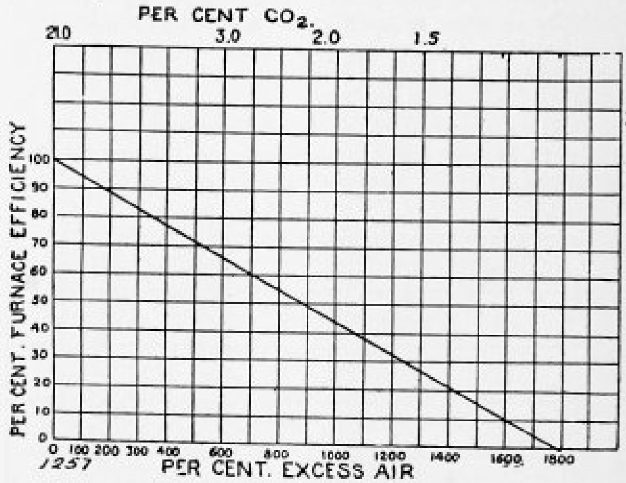


Fig. 5.—Relation Between Furnace Efficiency and Excess Air

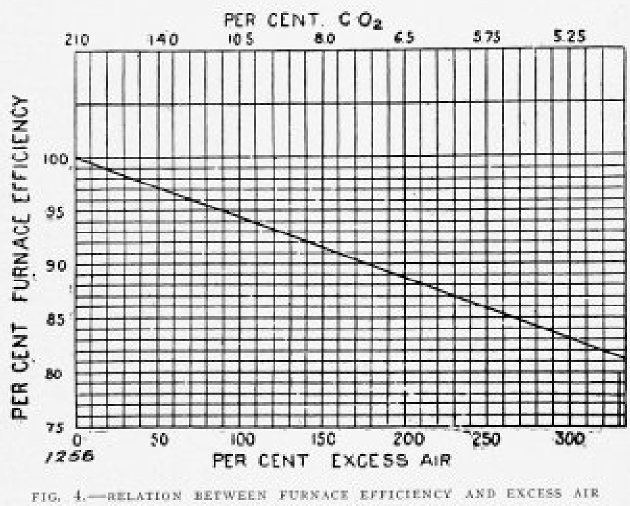


Fig. 4.—Relation Between Furnace Efficiency and Excess Air

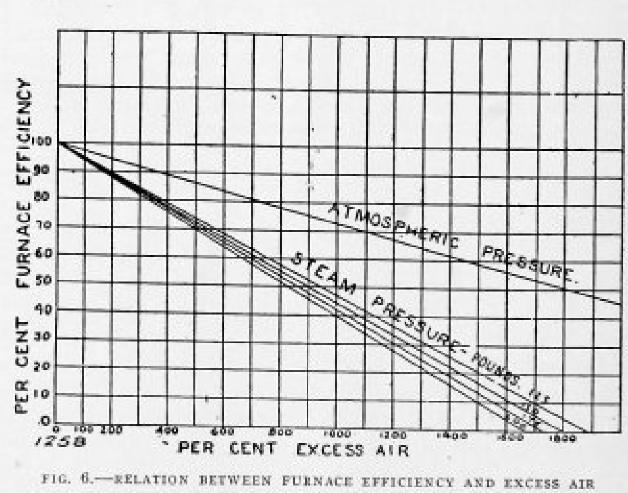


Fig. 6.—Relation Between Furnace Efficiency and Excess Air

In addition to the influence of moisture, furnace efficiency is affected by the amount of air used in burning the fuel. In Fig. 4 we note the effect on furnace efficiency of an excess of air. This curve has been carried to the ordinary extent of dilution and illustrates the result of a leaky fuel bed or porous setting. Fig. 5 has been carried out to the extreme merely as an interesting example, and from this curve it will be noted that if the furnace gases could be diluted to 1,800 percent in excess of theoretical requirements the efficiency would be zero. In other words, all the heat in the coal would be absorbed by the air without an appreciable rise in temperature.

In the curve, Fig. 6, is shown the effect of varying steam pressure on the relation between furnace efficiency and excess air. This is not materially important, but it is interesting to note that the lower the steam pressure the less is the detrimental effect of excess air.

detect them by the usual means, have added an element of uncertainty in the ultimate analysis of efficiency losses.

My experience in analyzing a large number of heat balances is that the presence of these intangible combustible compounds is quite apparent. A portion of the heat unaccounted for is undoubtedly due to this. It is doubly important, therefore, that CO in furnace gases should be held down to an absolute minimum. It is not always the case that heavy reduction in air excess must be secured before CO will appear. This is largely a question of the proper mixing in the furnace, which is dependent on the size and design of the combustion space. Both CO and excess air may be present at once, and the extent of this, as above stated, is purely a question of the capacity of the furnace to mix and retain the gases until the combustion is complete. It is, however, our experience that when CO appears it is time to stop the reduction of air supply, even though it is quite obvious that the mixing ability of the furnace is deficient. Fig. 7 illustrates the effect of CO on furnace efficiency.

Fig. 8 shows the theoretical efficiency of a furnace and boiler, by which is meant the combustion of a pound of coal minus only those losses which are absolutely necessary in the present state of the art. This is plotted on a capacity basis and gives us a standard at which we may aim in our attempts to improve the furnace efficiency under commercial conditions. It will be noted that the efficiency is absolutely independent of the rate of combustion, which is not only theoretically correct, but is a practical condition very greatly to be desired, as it opens up a vista of possible plant efficiencies that is startling in its magnitude.

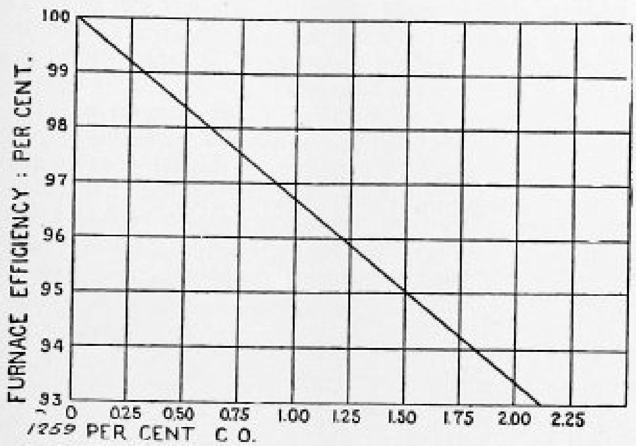


FIG. 7.—RELATION BETWEEN FURNACE EFFICIENCY AND LOSS OF CO

For comparative purposes Fig. 8 also shows another curve which illustrates the actual combined efficiencies that have been obtained with a choking chain-grate stoker under a fourteen high B. & W. boiler, using West Virginia coking coals of about 14,500 B. t. u. The same kind of curve, taken from Kent's "Steam Boiler Economy," page 223, curve f-25, is shown, and right here I desire to lay greatest stress on the significance of these curves from the standpoint of boiler room economy.

Outside of the question of a high versus a low efficiency, the matter of a horizontal efficiency is of greatest importance. There is no single question entering into the production of a satisfactory plant efficiency that is anything like the importance of a uniform efficiency curve. In practically all power plants the load is variable, and in the case of street railway and illuminating companies the load is extremely uneven, with sudden and high peaks, and in many cases unexpected peaks.

With the method in vogue which is most universally practiced the fluctuations are taken care of by putting boilers on or off the line, with intervals of banking periods between the peaks.

It is customary to carry a number of boilers in bank, warming them up in time to have them steaming by the time the load increases, and putting them on the line successively in sufficient numbers to provide the required steam.

The plant formed of individual units having a very peaked efficiency curve could only be operated at the rating corresponding to its maximum unit efficiency, or the efficiency of the entire plant would be reduced.

It was considered that the losses due to banking a boiler were not as great as those suffered from operating at a point considerably below rating, so that extremely variable loads necessitated a constant banking and breaking of banks throughout the day. There is no question that under certain circumstances this method is preferable, because of the heavy dip in the efficiency curve as it has heretofore been developed. The losses due to the banking period are invariably heavy, and there is no practical way of eliminating them. In the case of an illuminating company, where a sudden thunderstorm may double their load almost instantly, it is not practical to carry even banked fire, but spread fires must be maintained. This makes the losses even greater, and in a large plant the total of such losses reaches an immense sum.

The curves shown herewith, illustrating the practically horizontal efficiency with the chain grate, compelled a complete revamping of our ideas in regard to carrying of fluctuating loads.

With the tremendous advantage which this affords, the operating engineer, having a load represented by a certain number of boilers at, say, 300 horsepower, each minimum load

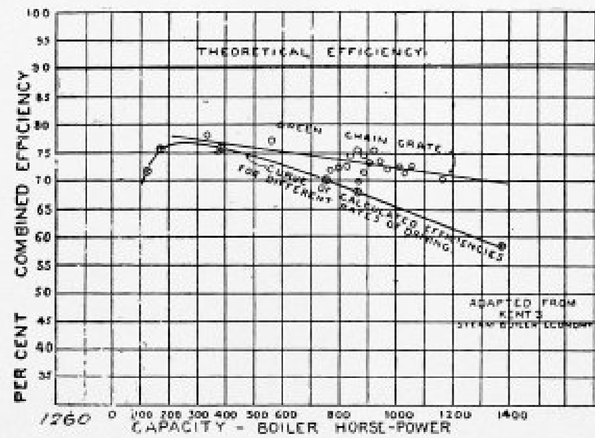


FIG. 8.—CURVES OF CALCULATED EFFICIENCY, FURNACE AND BOILER COMBINED

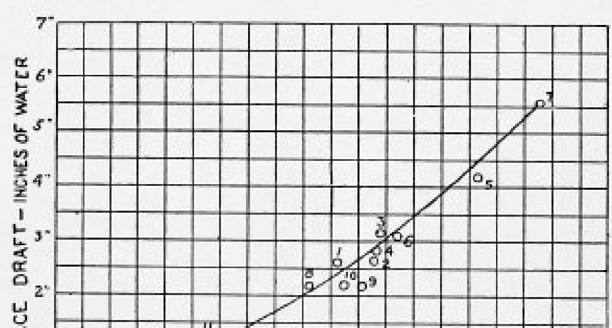


FIG. 9.—RELATION BETWEEN BOILER CAPACITY AND FURNACE DRAFT

during the early morning hours and an afternoon peak of 1,000 horsepower for the same number of boilers, can carry the load throughout the twenty-four hours with this number of boilers rated at 500 horsepower and equipped with stokers. Inasmuch as Fig. 9 shows the variation in the rate of steaming, it is only necessary to figure the draft required to develop 300 and 1,000 horsepower respectively and provide means for the ready development of this draft.

The 500 horsepower boiler, by checking the draft sufficiently, will thus deliver 300 horsepower or 1,000 horsepower at will, and the owner does not sacrifice anything in the way of efficiency in order to accomplish this variation. The problem of a large electric service company or manufacturing plant is but this problem magnified, with savings in coal in proportion to its size.

Tools for Boiler Makers and Their Uses—VII

BY W. D. FORBES

Horsepower required to compress 1 cubic foot of free air per minute to a given pressure with no cooling of the air during the compression; also the horsepower required, supposing the air to be maintained at constant temperature during the compression:

Gage Pressure	Air Not Cooled	Air Constant Temperature
100	.22183	.14578
90	.20896	.13954
80	.19521	.13251
70	.17989	.12606
60	.164	.11558
50	.14607	.10565
40	.12433	.093667
30	.10346	.079219
20	.076808	.061188
10	.044108	.036944
5	.024007	.020848

Horsepower required to deliver 1 cubic foot of air per minute at a given pressure with no cooling of the air during the compression; also the horsepower required, supposing the air to be maintained at constant temperature during the compression:

Gage Pressure	Air Not Cooled	Air Constant Temperature
100	1.7317	1.13801
90	1.4883	.99387
80	1.25779	.8538
70	1.03683	.72651
60	.83344	.58729
50	.64291	.465
40	.46271	.34859
30	.31456	.24086
20	.181279	.14441
10	.074106	.06069
5	.032172	.027938

In computing the above tables an allowance of 10 percent has been made for friction of the compressor.

In compressing and delivering air there is always a very large loss for the following reasons:

First, the loss of friction in the compressor, which is ordinarily 15 to 20 percent, and it cannot be made less than 10 percent.

Second, the losses caused by insufficient air supply; that is, not free enough air in-takes in valves, or large enough discharge valves, poor water jacketing, lack of proper lubrication, coupled with a poor selection of oil used.

Third, losses in piping, leaks and piping of insufficient size. The first cause of loss cannot be greatly reduced; and, as we have said, there must be a compression loss of at least 10 percent. All the causes of loss mentioned in the second heading can be brought to a minimum, and should be. The third named causes of loss are inexcusable; neglect will allow a leak to continue, and false economy will put in too small piping; but whether or not the piping is too small, a continued leak should mean the discharge of the man in charge.

Another cause of loss is that the in-take of air is not out in the open, but is taken from the boiler or engine room. It is clear that cool air is of value, as it helps to cool the cylinder and is more easily compressed. It is likely, also, to be freer from dirt. The losses from this cause are from 8 to 10 percent. As there is a gain of about 1 percent for every 5 degrees that the temperature of the air is lowered below that of the compressor room, it can be seen that a few dollars spent in leading the in-take pipe to where cool air can be had is a wise expenditure.

Wood or brick air inlet ducts are economical, these materials being non-conductors. It should be remembered that in piping air no very large sizes are used. To put in 3-inch pipe costs little, if any, more than to put up 2-inch pipe, so all that is saved by the use of small pipe is the difference in the first cost of the pipe, and the advantage of the larger size of pipe will very soon pay this difference.

It is asserted by manufacturers of air compressors that as the friction increases in piping, valves and engine, the pressure must increase to obtain economy, and that the pressure must not be allowed to drop below a certain amount. The following table gives the lowest pressures that can be used advantageously, or rather shows the advantage of higher pressures to overcome the effect of friction in piping:

Friction, pounds—	2.9	5.8	8.8	11.7	14.7	17.6	20.5	23.5	26.4	29.4
Pounds at compressor—	20.5	29.4	38.2	47.0	52.8	61.7	70.5	76.4	82.3	88.2
Efficiency—	70.9	64.5	60.6	57.9	55.7	54.0	52.5	51.3	50.2	49.2

The usual pressure at which air compressors are run is 100 pounds, but 80 pounds is sometimes used, and as high as 120 pounds is quite common. This gives a temperature of from 350 to 600 degrees.

Considerable trouble is encountered in air plants arising from the condensation of water in the pipe lines. To eliminate it the air should be cooled, but how best to do this depends on the conditions, or more properly the available cooling water. We know of one plant where the cooling coils were placed in the water of a river which runs past the shop. Another case was where the water was expensive, being taken from the city water supply, a water tower was erected, and the water after it had cooled the hot air ran to a reservoir, much like a hot well in a ship. The hot water was then fed to the boiler. This, of course, was economical. In another case the pipe line was fitted with several air tanks, and the air cooling in them precipitated the water, which was led to the boiler, proper means being provided to handle it. Bagging placed in the in-take pipes prevents grit working into the compressor, which prolongs its life.

To recapitulate: Give ample room for the incoming air, as well as ample room for the outgoing or compressed air. Have the in-take so placed as to get its air from as cool a place as possible, also as free from dust as is possible. Cool the air to extract the moisture and keep the piping tight.

The question as to how fast air can be compressed is open to discussion. It is believed, however, that 300 feet a minute is about the maximum advisable for continual work, yet this speed is considerably exceeded in some types of compressors. The speed is largely controlled by the area of the valves, but with the ordinary valve we cannot go beyond a certain point. The present style of valve is by no means perfect, and it is quite possible to design a valve for air compressors which will do far better than what we now have.

In the market to-day there are two styles of valves used in compressors, one called the automatic and the other the mechanically moved valve; the automatic valve is moved by the varying pressures on the top and bottom of the valve, while the mechanically moved valve is actuated by a positive movement, such as an eccentric. There are advocates of each style of valve, but, all things considered, the automatic valve is the most satisfactory. By its use there is very little friction. Such valves act just when they should, require no setting and there is nothing to oil. The fact that the automatic valve cannot be tampered with is a great advantage. They, of course, have to be ground and their stems do break, and when this takes place the inlet valves can cause considerable damage by falling into the cylinder.

On the other hand, the mechanically moved valve cannot do damage should it break. It has to be oiled, and if not properly set very severe strains will be thrown on the compressor. Their first cost is greater and their upkeep is greater, yet its advocates claim greater economy for it. The automatic valve is often placed in the cylinder head, and in so doing the least possible clearance is obtained. The disadvantage of this location is that if the valve stem breaks the head falls into the cylinder, and is trapped between the piston and the cylinder head, and is apt to break the latter. Also, the discharge pipe has to be made up in the head, and this joint has to be broken whenever the cylinder has to be inspected. When the valve is placed in the cylinder walls the clearance is greater, but it is more easily got at and it cannot fall into the cylinder.

Before describing the details of the commercial air compressors, we want to say a word about reheating compressed air. It has been found that a very great advantage is obtained if compressed air is heated just as it is to be used. It would not be practical to have a heater next to an air hand drill, but if air is used to run a motor reheating is possible. In an ordinary compressor the loss is about 70 percent, and with a very good compressor this loss may be but 60 percent; that is, without reheating. If now the air is raised, say, from 80 degrees to 300 degrees, the volume would be increased about 40 percent, and very little heat is required to effect this gain. It is, therefore, well to reheat the compressed air wherever possible. It is asserted that the gain by reheating can be as much as 20 percent above the power obtained by the compressor, and this with a fuel outlay so small as to be hardly noticeable.

Fig. 51 shows a new design of air compressor. The new feature is that the air inlet to the valves is through a tube made fast to the piston, and the inlet valves are rings fitted in the head of the piston itself. This design must give very large inlet areas, and the inlet valves can have a very small lift. The discharge valves are placed close to the cylinder bore and the cylinder is water jacketed, as are the heads. The compressor is belt driven.

The only advantage which this design seems to possess is that the inlet valves are very large, and this might be offset by the stuffing-box, which the inlet tube requires, and a certain loss of area on one side of the piston by the inlet tube.

Fig. 52 shows a compressor where the inlet and discharge valves are fitted to the walls of the cylinder. The inlet valves are on the lower side of the cylinder and the discharge valves on the upper. This is the usual design found in the boiler shops throughout the country.

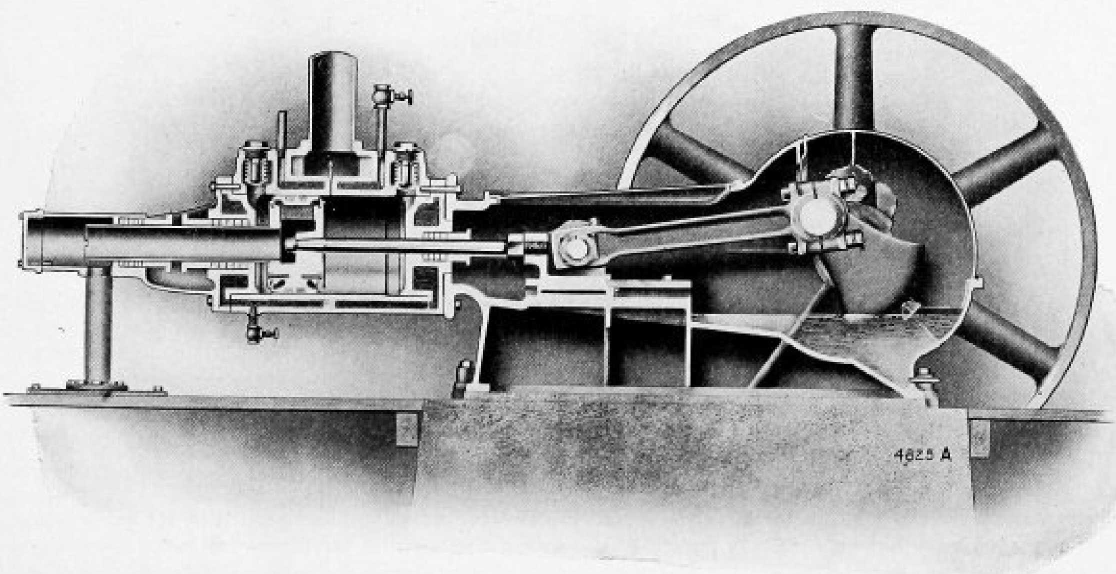


FIG. 51.—LONGITUDINAL SECTION OF STANDARD CLASS "NE-1" INGERSOLL-RAND COMPRESSOR, WITH "HURRICANE-INLET" AND "DIRECT-LIFT" DISCHARGE VALVE

Air or Pneumatic Tools

We have referred previously to tools which are actuated by air. We will now give a general description of such tools as are usually found in boiler works, or, perhaps we should say, should be universally found in boiler shops, as without them no boiler shop can hope to compete successfully against those who are well supplied with this very satisfactory type of tool.

First, we will refer to riveters. These may be placed in two classes, when we have to consider their actuating mechanism. One we may call the "valve class," and the other the "valveless class." Each has its advocates, and it is fair to say there seem to be no bad tools of either type in the market. There are, of course, preferences, and conditions may at times largely direct which type or class of tool should be used.

We show in Fig. 53 a sectional view of a valve class hammer or riveter. Here the moving parts are ready for the forward stroke, which, of course, is the one which does the work. Fig. 54 shows the moving parts in their position after the blow has been given and all is ready for the return movement of the piston. Live air enters through the passage *V*, Fig. 54, and through the smaller passage *M*, Fig. 53, to an annular space cut in the valve. Fig. 55 shows the valve on a larger scale than the sectional view. The valve is made of steel and hardened, great care being used in its production. This annular space presents two surfaces of equal area to the action of the live air; therefore the valve must be in balance, as the two pressures are just the same as are the areas, one to lift the valve and the other to depress it; but while the live air is entering through the port *M*, some of the live air from the passage *V* is finding its way down a slotted passage (not lettered) and through the small lassage *M'* into a circular space below the valve. From this space the air finds its way through the small hole *N* and through the somewhat larger hole *S*, Fig. 53, into the atmosphere.

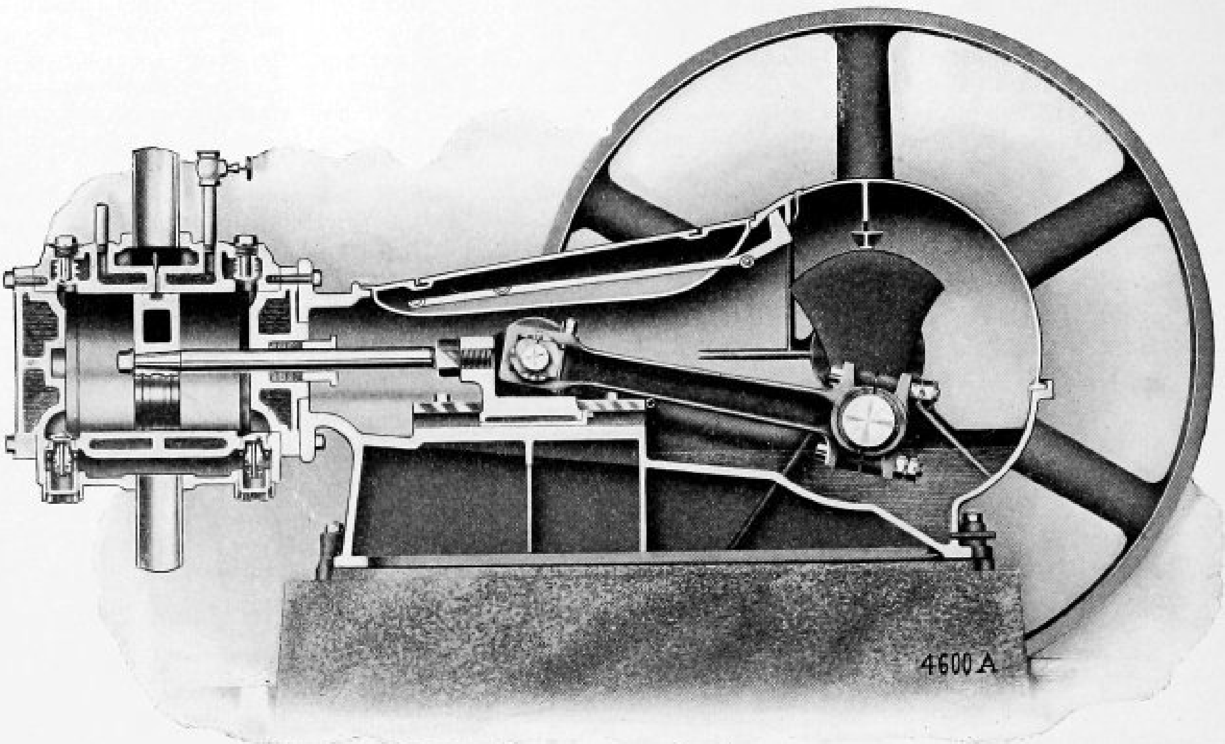


FIG. 52.—LONGITUDINAL SECTION OF STANDARD CLASS "NE-1" INGERSOLL-RAND COMPRESSOR, WITH "DIRECT-LIFT" INLET AND DISCHARGE VALVES STANDARD CONSTRUCTION

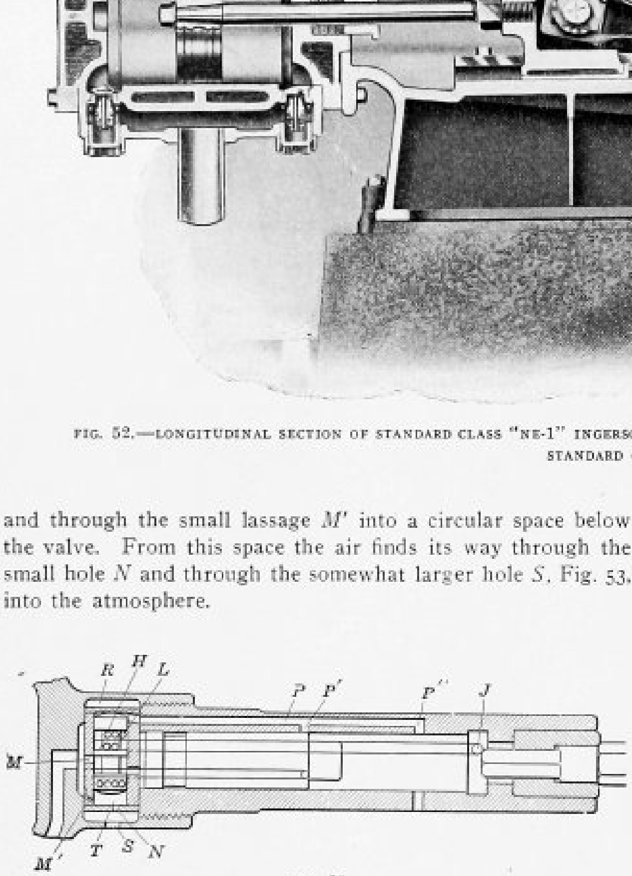


FIG. 53

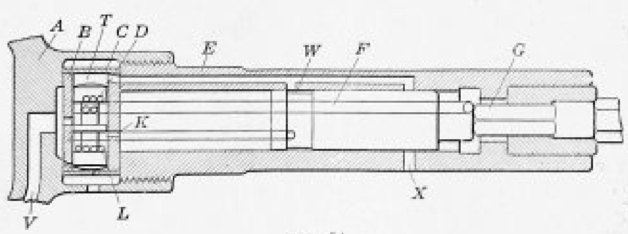


FIG. 54

It must be remembered that the valve is enclosed in a cage, and that the incoming air, finding its way as described, cannot pass around the valve cage, as the small vertical, unlettered passage shown to the left of the valve cage, Fig. 53, is quite narrow; and, further, it must also be remembered that the valve cage is so made that the exhaust passes out from the drilled holes, or passages *L* and *D*, Fig. 54, to the atmosphere.

Now, the leakage of the air through the passages *N* and *S* is faster than the entrance of the air through the small passage *M'*, therefore the valve is not in balance, but the under side of the annular central portion of the valve is acted upon with the pressure of the live air, as is the lower annular part of the valve; but as the pressure under the lower end of the valve is reduced by the leakage described, the valve must be held up against the top of the valve cage, as is shown in Fig. 53.

The live air passes around the reduced portion of the valve and through the passage *K*, Fig. 54, onto the head of the plunger or piston, and, of course, drives it forward. When the piston reaches the position shown in Fig. 54 the live air passes around the groove *W* through the port *P'* and the passage *P* to the top end of the valve, creating thereon a pressure which, of course, forces it down into the position shown in Fig. 54, as we have shown that the lower end of this valve is being acted upon by a less pressure than the air on the top, owing to the leakage which we have described.

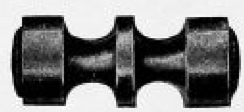


FIG. 55

It must be again noted that when the piston is in its forward position, as shown in Fig. 54, the port *X* is covered by the piston, as is also the port *P''*, shown in Fig. 53; therefore no air can escape through this hole or into this passage. A long drilled hole, shown in dotted lines in both figures, represents the exhaust air passage to the valve cage, and this passage leads to the front end of the piston and enters the cylinder through the hole *J*, Fig. 53. Through this passage and hole the exhaust air acts on the back end of the piston; and as there is no pressure on the forward end of the piston it is returned to its original position, as shown in Fig. 53, for another stroke. These strokes are very rapid, and, of course, their power will largely depend upon the pressure and length of stroke.

THE UNBALANCED AREA SYSTEM

When a valve is so made as to have different areas on which the incoming or live air acts, the same result is obtained as above described, only, of course, it will be seen that there is no leakage to make an unequal pressure; but this unequal pressure is obtained by making one end of the valve larger than the other.

The advocates of the straight valve, actuated by a reduced pressure in the valve chamber, claim that the same is very simple to manufacture and can be produced with great accuracy at very low cost, while the unbalanced valve makers point to the waste of air by the leakage system referred to.

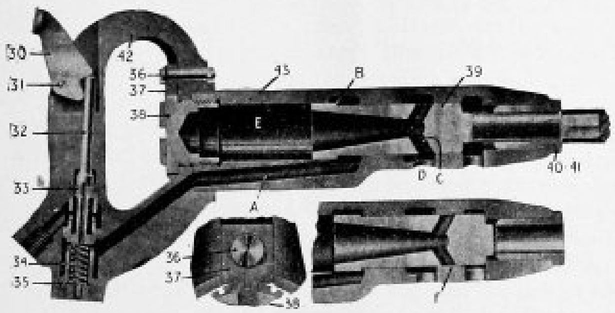


FIG. 56

THE NO-VALVE SYSTEM

When there is no valve used the piston in its movements is made to cover and uncover ports, and we describe the same by referring to Fig. 56. The piston here shown has two diameters. The cylinder, of course, is bored to correspond to these diameters. When the piston is at the bottom or end of its stroke, as shown, the air which has driven it forward is exhausted from the bore *E* through a tapered hole in the piston and the passages *C* and *D*. Live air from the passage *A* acts on the under side of the enlarged part of the piston at *B*, thus forcing the piston to the left until the port *C* in the piston registers with the air inlet on the passage *A*. The live air is therefore at once admitted to the top of the piston through the tapered hole in same, and the piston is driven again to the right; but it must be remembered that the pressure on the under side of the piston on the annular space marked *B* is constant, and the blow, therefore, has for its power the pressure of the air on a large area of the piston, less the pressure due to its effect on the annular surface *B*. It can certainly be justly claimed by those who employ this system that it is extremely simple.

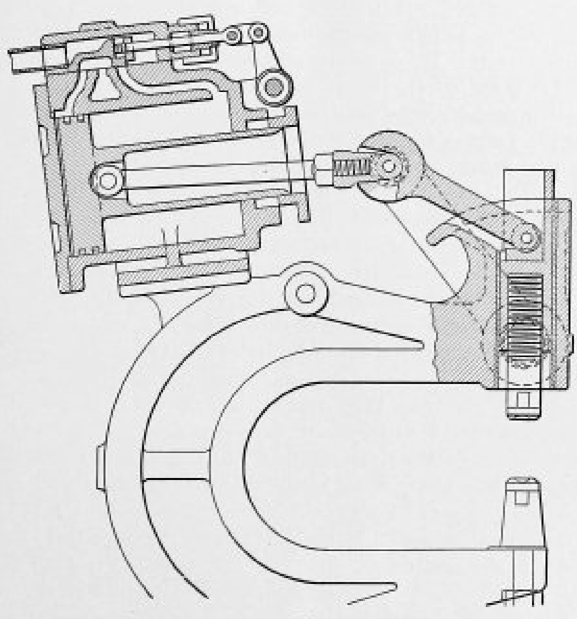
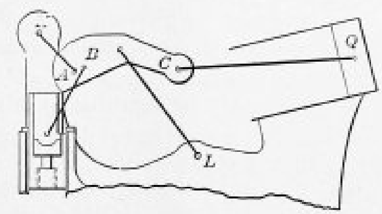
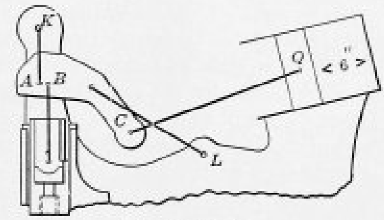


FIG. 57

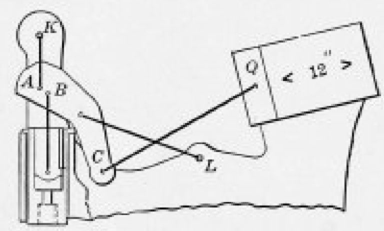
There are numerous modifications of both the types of the riveters and the hammers which we have described. There are long-stroke and short-stroke hammers in various modifications which are of value in certain cases, and the manufacturers of these tools are very glad at all times to put them in competition with each other, and it is really difficult in a short test to get any real idea of the superior values of a tool of this class.



Beginning of Stroke



One-Half Stroke



End of Stroke

FIG. 58

It must be remembered that the up-keep of any tool is a most important matter, and often tools of this class are reported as unsatisfactory when the trouble lies with the men who use them. Often they are left without being oiled, thrown into the dirt, or thrown off stagings, and treated in a way which really would seem to make it impossible that they could continue to operate after a very short time; but they do stand an enormous amount of hard abuse, which can, however, be stopped by the foreman.

OTHER FORMS OF AIR TOOLS

The use of compressed air is not limited to merely tools of this percussion type, but there are a number of rotary acting tools for drilling and countersinking, and in many cases the use of air instead of electricity is advantageous in boiler work. This is especially so when the work is to be done in a place that is confined and warm, as the exhaust air from the tool cools the atmosphere and furnishes pure air for the workmen. There are also riveters on the market which use air, steam or water for their motive power. We may call them hydraulic and fluid-driven. The hydraulic tool and the fluid-driven tool use an enormous power in a single effort to do the riveting, as against a multiplicity of blows, as in the tools we have just described. These latter may be said to be merely a reproduction of the effect of hand riveting, while the hydraulic or single-effort tool is quite the opposite.

Fig. 57 shows a cross section of one of the tools wherein a single effort is obtained for riveting by the use of either air or steam. The pressure on the piston carries it forward and the power is transmitted by a system of levers and links. It is generally conceded that in an ordinary hydraulic riveter much more power is required to drive a rivet than in the pneumatic system. To overcome this a compensating action has been invented which is known as the "Hanna motion."

Referring to Fig. 58 it will be seen that in this system the machine goes through its toggling action during approximately the first 6 inches of the piston stroke, and carries the die through practically 3½ inches of its travel. At this point the machine has reached its rated pressure, and the toggling action is then automatically changed to the lever action, which is maintained for the balance of the piston stroke, and for particularly the last half of die travel, thereby maintaining the rated tonnage throughout this distance. This comparatively uniform travel of the die under the rated tonnage for the last half of the piston stroke is sufficient, once the die screw is adjusted to the work, to take care of the ordinary variations encountered in the length of the rivet, thickness of the plate, size of hole, etc., without the necessity of readjusting the die screw.

In selecting tools it is wise to look into the market most thoroughly before making a selection; and above all, while we all know that money is a matter of great importance, a tool not just suited for your work which you buy because it is a little cheaper, is always an annoyance and rarely a money maker. Find out first in selecting tools what is best, and make your purchase not only for the moment but with an eye to the future.

In the purchase of second-hand tools there is at times an advantage, but such tools should be closely inspected before purchase; and it is advantageous to arrange, if possible, for a short trial with a tool to see that everything is all right.

THE NATIONAL TUBE COMPANY.—The National Tube Company, Pittsburg, Pa., announces their entry into the electric conduit field, commencing Aug. 1, 1913. Contracts have been made with the National Metal Folding Company and the Safety-Armorite Conduit Company, both of Pittsburg, to manufacture and sell this product for the National Tube Company as their agents under their various brands. The National Tube Company has also decided to sell this product on the "Pittsburg Basing Discount" plan in the same manner as all wrought pipe for other purposes has been sold for the past thirteen years.

BOILER INSPECTION IN NEW YORK.—A New York statute, which went into force May 15, 1913, provides for the inspection of all steam boilers in buildings and other places, carrying a steam pressure of 10 pounds or more to the square inch, except where a certificate is filed with the State Fire Marshal certifying that the boilers have been inspected by an insurance company and found to be in a safe condition. Insurance companies must report all boilers insured by them. Boilers on vessels, railroad locomotives or fire engines are excepted from the provisions of the statute.

Pressures in Hot Riveting

When the yoke type of riveter is employed to upset and head a hot rivet at a single squeeze the pressure exerted is accurately indicated by the springing apart of the jaws. This has been taken advantage of for measuring and recording the various pressures required for rivets of different sizes and at different temperatures, and is the subject of an interesting paper by E. D. Hays and W. L. Edwards in the March issue of the *Technic* of Rose Polytechnic Institute.

The deflections of the jaws of the riveting machine were magnified eight times by a pantagraph with a pencil tracing a record upon the drum of a steam engine indicator. The pantagraph was calibrated to determine the tensile displacement corresponding to a given force in the dies, and the result was plotted on cross-section paper, with the actual pressures as abscissæ and the tensile displacements as ordinates, the result being a line with a very slight upward curve.

A 26-inch portable bridge-riveting machine with toggle-driven dies was suspended, with the axis of the dies vertical and in such a position that the heads of the Rhiele testing machine were between the die holders and transmitted their stress to them through conical bearings calculated to insure alinement.

After calibration the riveting machine was removed from the testing machine and suspended in a similar position during the remainder of the experiment. Another series of tests was made to determine the difference between the actual and theoretical pressures at different points of the stroke, corresponding curves were plotted from the results, and an efficiency curve was laid out, showing that the efficiency increased throughout the plunger stroke until the last, when the theoretical pressure becomes infinite and the efficiency becomes zero. The maximum efficiency obtained was 62 percent, which it was thought may have been partly due to the newness of the machine.

The rivets were driven through several thicknesses of steel plates, clamped together and drilled 1/16 inch larger than the diameter of the cold rivet. They were heated in a portable forge with a hand blower to temperatures varying from 1,100 to 2,700 degrees F., as determined by a pyrometer embedded in the fire close to the rivet, the latter being kept there long enough to acquire the temperature of the fire. It was believed that the drop in temperature between the forge and the riveting machine did not exceed 200 degrees.

All of the rivets were of standard lengths, and had enough material to furnish a little excess steel in the head. The grips of the rivets varied from ⅝ to 1⅞ inches. The shortest one filled the holes completely, which was not the case with some of the longest ones. No loose rivets were found, and when some of the rivets were sawed through it was noticed that the very hot rivets had not filled the holes any better than some of the coldest ones. It was noted that the pressure did not increase in any large ratio as the plate thickness increased.

The lowest pressures, which caused many to completely fill the holes where the rivets gripped two plates whose combined thickness was about equal to the diameter of the rivets, were about as follows: For 1-inch rivets, 82,000 pounds; ⅞-inch rivets, 70,000 pounds; ¾-inch rivets, 60,000 pounds; ⅝-inch rivets, 35,000 pounds.

Of the fifty-three rivets driven, fourteen ⅝-inch rivets were driven at an average temperature of 1,914 degrees and an average pressure of 65,357 pounds, and in an average time of 11 seconds each. Seventeen ¾-inch rivets were driven at an average temperature of 1,935 degrees, 58,823 pounds pressure and 8 seconds time; fifteen ¾-inch rivets at 2,120 degrees temperature, 74,600 pounds pressure and 11.7 seconds time; three 1-inch rivets, 2,400 degrees temperature, 53,000 pounds pressure and 20 seconds time; four ⅝-inch rivets at an average pressure of 53,500 pounds.—*Compressed Air Magazine.*

A Large English Boiler Works

The engineering works of Ruston, Proctor & Company, Ltd., Lincoln, England, covering 52 acres and employing 5,200 men, is divided into three distinct branches, known as the iron works, the wood works and the boiler works. An interesting description of this large plant was published in a recent issue of *The Engineer* (London), from which we reproduce the following details and views of the boiler works:

The Boiler Works

The boiler works are, in the present form, the most recent of Messrs. Ruston, Proctor's three departments, having been erected in 1905 and enlarged in 1910. They are housed in an approximately rectanguarly shaped building measuring about 430 feet long by about 340 feet wide. Outside the western end of the building is the Midland Railway, and on the far side of this a large field has been acquired for the storage of boilers and for the future extension of the works. Over 400 boilers of various types are lying in this field ready for shipment.

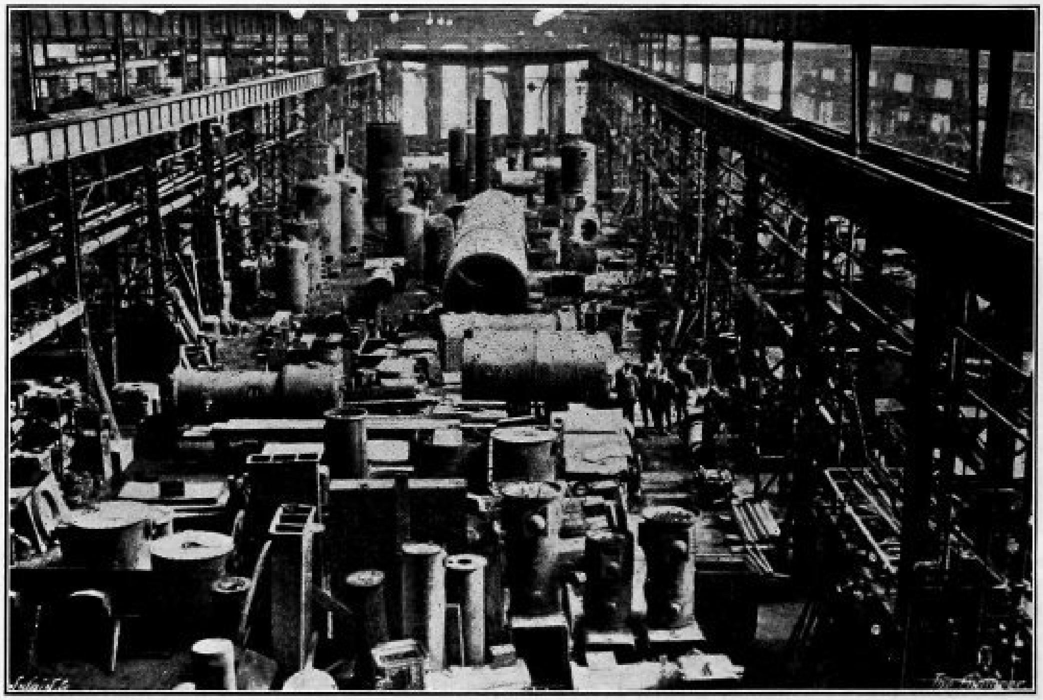


FIG. 1.—RIVETING BAY

The boiler works building is divided into six bays, each of which is served by two overhead electric traveling cranes. Slow combustion stoves are employed for heating the building, the size of which is, we were informed, too great to permit of its being heated efficiently by steam pipes.

In No. 1 bay, the most southerly, the erection of steam navvies and gas producers is carried out. Hydraulic pressing, flanging and welding machinery is accommodated in the second bay, and in the third bay plating and marking off and drilling operations are conducted. The assembling of boilers is begun in the fourth bay. Here also heavy machine riveting is to be found in progress. The fifth bay is devoted to hand riveting and calking work, and in the sixth the production of smokeboxes and ashpans is effected. A section of this last bay is also given over to the testing of boilers under hydraulic and steam pressure.

In passing through these shops several interesting tools and methods of working are to be seen. The employment of the oxy-acetylene blow-pipe for cutting out irregular shapes should be noticed. Oxy-acetylene welding is also employed, but only in connection with such jobs as ashpans and similar non-pressure work.

Among the more interesting tools is the Longworth pneumatic flue welding hammer shown in Fig. 4. The flue is heated in a special gas-fired hearth, and is slipped over a mandrel projecting between the hammer legs. The valve controlling the admission of air to the hammer cylinder is so arranged that the speed and weight of the blow are automatically controlled.

A Hanson patented circular flanging machine, made by Wm. Muir & Company, of Manchester, is shown in Fig. 7. The flue section or other job to be flanged is chucked on an inclined face plate driven by bevel gearing and belt from an electric motor. Two guide pulleys, adjustable on a cross-slide to accommodate different diameters, support the flue. These guide pulleys are mounted on a carriage adjustable on an inclined headstock, so as to suit different lengths of jobs. Between the two guide pulleys a coned former pulley projects from the carriage on a horizontal axis, and immediately above this a roller is arranged at the end of a lever journaled on the carriage. Pressure is applied to this roller by means of a sector, worm and hand wheel. The manner in which the flanging is carried out will be obvious from the engraving. The work, of course, is done hot.

An interesting milling machine, of German design, is illustrated in Fig. 8. As will be gathered, this machine is employed for milling the edges of firebox back plates. The usual method of effecting this operation is to plane each edge separately, thereby involving three settings of the job, and to chip the corners. With the machine illustrated the three sides and

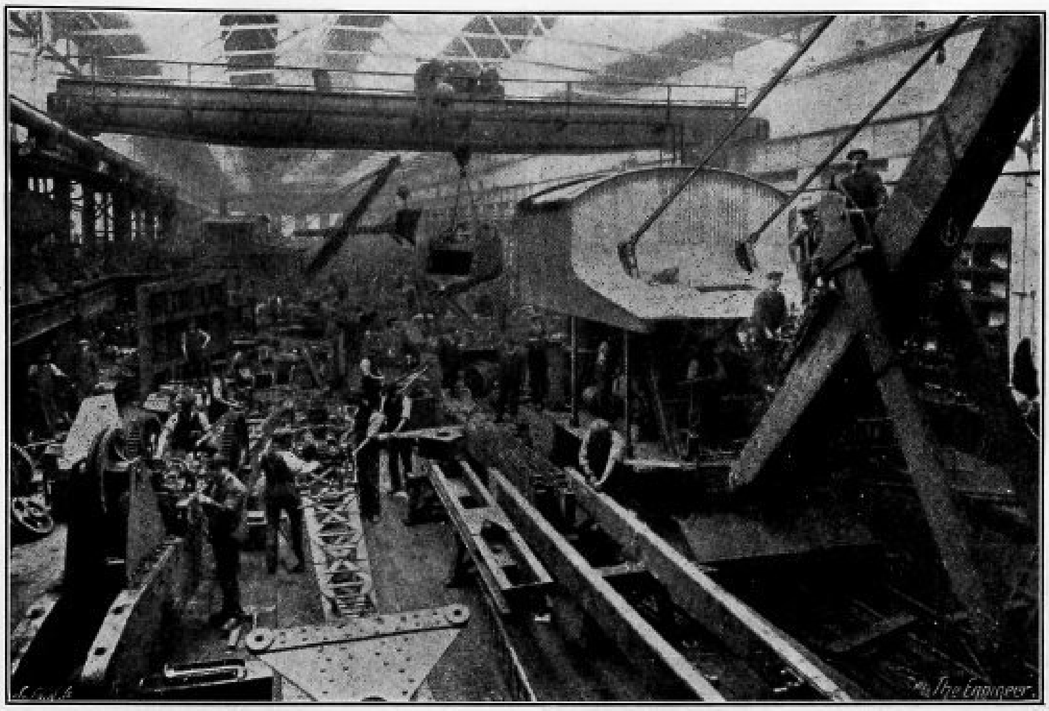


FIG. 2.—STEAM NAVVY ERECTING BAY

two corners are finished completely at one setting. The details of the machine will be gathered from the engraving. We need only say that the plate is held on a trolley, and that power feed is given to the job by means of a wire rope and drum.

A four-head, eight-spindle firebox drilling machine is shown in Fig. 5. Two men look after this machine, each taking charge of two heads. Two holes can be drilled simultaneously on each of the four sides of the firebox.

Of the six flanging presses in use the largest is shown in Fig. 3. This machine is one of Henry Berry & Company's

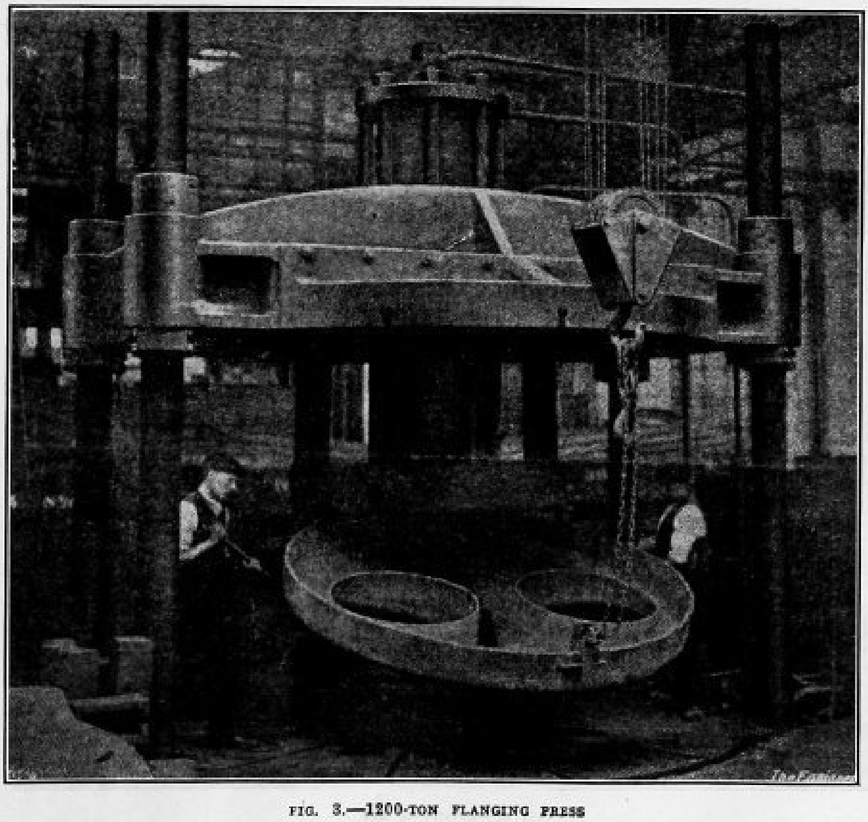


FIG. 3.—1200-TON FLANGING PRESS

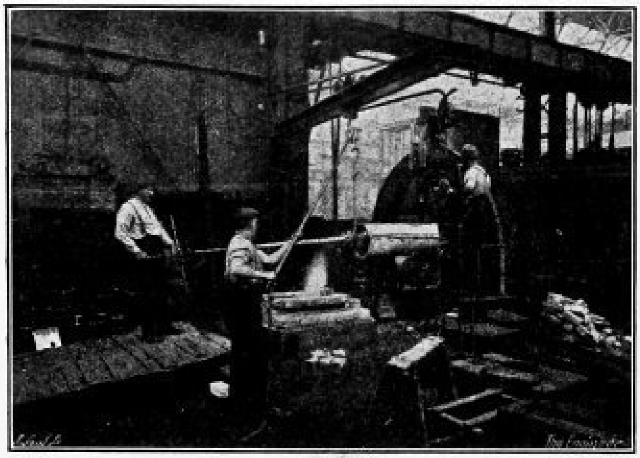


Fig. 4.—Pneumatic Flue Welding Hammer

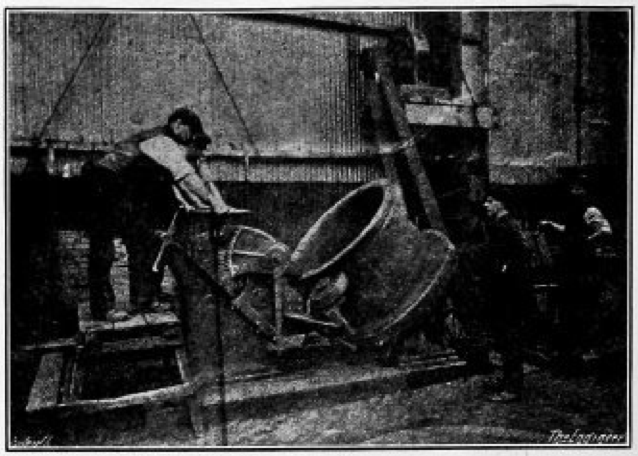


Fig. 7.—Circular Flanging Machine

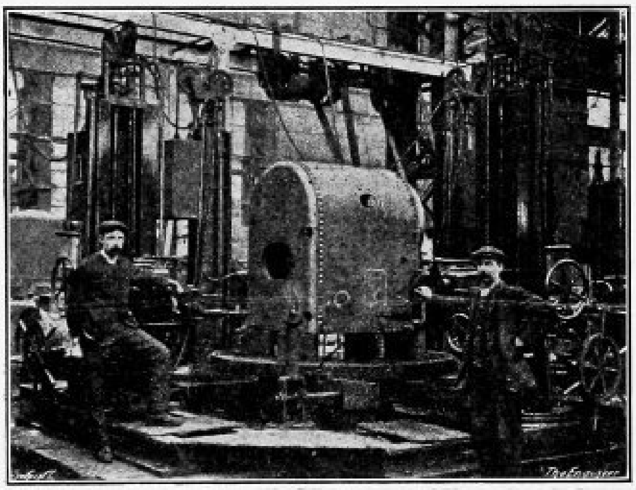


Fig. 5.—Eight-Spindle Firebox Drilling Machine

make, and can exert a total pressure of 1,200 tons. The rams and table provide four separate movements, and are specially arranged for such work as the dished ends of large boilers, where the dishing, flanging and finishing of the flue holes are carried out in one heat.

The Power House

The main power plant consists of three tandem compound drop valve steam engines of Messrs. Ruston's own design and manufacture, driving three direct-current Siemens' generators. The total output on normal load from these generators is 900 kilowatts, the voltage in use being 230. Two small stand-by high-speed sets of 150-kilowatt output are also installed to supplement the main engines at times of heavy lighting loads. At one end of the power house—the far end—the floor is stepped down 6 feet for the full width of the building. In the pit thus formed the surface condensing plant is accommodated. Beneath the main floor of the power house and running lengthwise close to each wall is a tunnel. In one of these

Fig. 6.—Erecting Bay

tunnels the main steam and exhaust pipes of the engines are situated, and in the other are the main cables from the generators. This arrangement greatly facilitates inspection and repair work.

The boiler house adjoins the engine room, and contains four Ruston Lancashire boilers fitted with superheaters, Bennis stokers and Green economizers. One of these boilers is arranged for sawdust and wood chip firing. Steam at 160 pounds pressure and superheated to 450 degrees F. is used. The average feed temperature is 250 degrees F.

Opening out of the main engine room is a compressor house, supplying compressed air and hydraulic power to the boiler works. The hydraulic pressure employed is 2,000 pounds per square inch, and the compressed air pressure 100-120 pounds. The hydraulic machinery comprises several main and stand-by pumping sets and an accumulator loaded with 180 tons. The air compressors are three in number. Two are driven by a Ruston tandem compound drop valve steam engine. The third is an Ingersoll-Rand compressor.

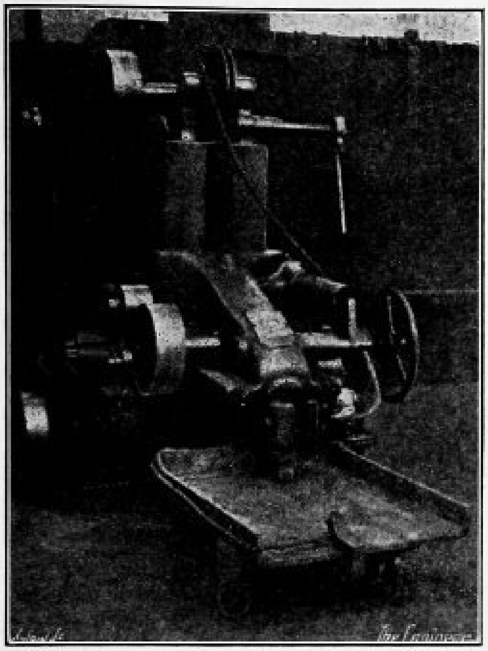


FIG. 8.—MILLING FIREBOX PLATE

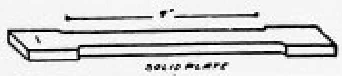
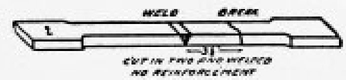
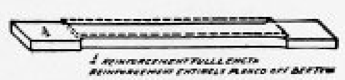
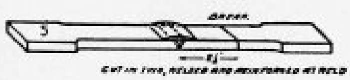
For Trade Press Efficiency.—President H. M. Swetland, of the Federation of Trade Press Associations in the United States, announces that the programme has been completed for the eighth annual convention at the Hotel Astor, New York, Sept. 18 to 20. Acceptances are in hand from over sixty speakers of national reputation in the manufacturing, selling, advertising and publishing fields. There will be fifty 10-minute addresses at the Editorial, Circulation, Advertising and Publishing Symposiums on vital questions affecting all those who have dealings with the business press of America. Other features of the convention will be an exhibit of successful class, technical and trade journal advertising campaigns; a big business meeting, at which will be told the inside stories of the big trade paper publishing successes, and an inspirational mass-meeting, with addresses by representative business and professional men on subjects of live interest to editors, publishers and advertisers. All the regular sessions of the convention will be open, but tickets must be secured for the inspirational mass-meeting. These may be obtained from any member of the Federation, or from W. H. Ukers, chairman of the committee on arrangements, 79 Wall street, New York.

The Repair and Manufacture of Steam Boilers by Autogenous Welding

BY HENRY CAVE*

One of the most obvious uses for autogenous welding by means of the oxy-acetylene process is the repair of steam boilers. Cracks can be welded up, patches welded in, corroded plates can be built up to their original section or made thicker if desired. Cracks from rivet holes and between rivet holes can be welded up. Landing edges reduced by repeated calking can be built up as desired. Cracked door frames can be replaced by plate construction. Broken mud-rings can be welded up. Cracked tube plate bridges can be made solid again and numerous other defects corrected with the least possible delay and expense. The process compares very favorably in both directions with boiler shop methods of repairing, and the results are infinitely superior.

U. S. Government Tests of Boiler Plate Welds.
Welds made by Davis-Bournonville Co., New York.

Description	Breaking load lbs. per sq. in.	Remarks
	57,484	Original plate not welded,—for comparison.
	58,333	No reinforcement, broke 3½" from weld. Shows weld stronger than original metal.
	55,275	Shows metal added was practically equal in strength to solid plate.
	53,134	Shows metal in plate not materially injured by the heat of welding.
	57,713	Reinforcements of any amount can be built on.

All samples broke in solid plate. Welds not injured.
Welds stronger than original metal.

On account of the vital nature of a large proportion of these repairs, it is necessary that a considerable proportion of the original strength should be obtained and also that the welds should have considerable ductility. This has resulted in various authorities imposing certain restrictions as to what work should be carried out by welding, and in this way minimizing the value of the process for the boiler repairs to a considerable extent, and particularly so in the relation of the process to boiler manufacture. These precautions are wise when considering the present state of the welding industry, and the comparatively small amount of reliable information on the subject possessed by those making the restrictions.

Those of us who have thoroughly considered the matter, and have at heart the best interest of the future development of the process of autogenous welding as applied to the repair and manufacture of boilers, are in the peculiar position of desiring increased restrictions in the use of the process for this purpose, as we realize that at the present time in the large majority of cases anyone who can obtain the use of a welding equipment can carry out work on steam boilers even though they may not have, previous to that time, carried out any welding nor may they have any knowledge of the considera-

* President, Autogenous Welding Equipment Company, Springfield, Mass.

tions of the design of steam boilers or the structure and heat treatment of metals. The equipments they are using may not be capable of making a satisfactory weld, and the attempt to repair even a small defect may result in the boiler being seriously damaged, or at any rate provide an element of danger which may result in a disaster of such moment as to cause further restrictions being imposed on the use of the process for boiler work as will largely restrict the development in this direction, and be a hardship on those who carry out a successful repair and upon those who require to have such a repair carried out.

Our desire is to see restrictions imposed on this use of the process by, preferably, a national body. But if this cannot be done the State authorities and the insurance companies could impose such restrictions themselves, these restrictions to require three certificates before work can be carried out on boilers.

First, a certificate should be required that the equipment is capable of carrying out a satisfactory weld. In this matter the torch will be the chief consideration. It is a fallacy to suppose that when the oxy-acetylene flame is adjusted by the eye to the clear outline of the inner cone, which is popularly supposed to indicate a neutral flame, that this indicates the gases are being brought together in the right proportions for complete combustion. That this is not so can readily be proven by those who investigate the matter.

The consumption of oxygen may be twice as much as it ought to be, even with the clear outline of the flame, because the two gases can only unite in certain proportions, leaving any surplus oxygen free to pass through the flame and mingle with the molten metal, thus producing a brittle oxydized material more or less defective as to strength and ductility.

In addition to the torch the question of the source of the gases should be considered, as certain impurities in the oxygen may produce weak welds, and there can also be variations in the acetylene which will produce similar results, depending upon the source of supply. For instance, if an automobile lighting tank was used to supply acetylene to a large flame, the absorbent liquid would be drawn from the tank and will mix with the molten metal, causing a weak weld, and, unfortunately, these weak welds cannot be distinguished except by the most experienced eye.

Certificates could be issued to the makers of the equipments in the same manner as the laboratory engineers of the National Board of Fire Underwriters issue their certificates. The makers would gladly pay for the expense of the investigation.

A second certificate should be issued to the welder showing that with a certified equipment he is capable of making a weld of sufficient strength and ductility under all the varied conditions which come up in boiler work, such as overhead welding, as to be satisfactory for all requirements.

Most people would think that with a certified welder and a certified welding equipment it would be then possible to go ahead and obtain satisfactory results in every case, but this is not so, as can be realized by a little consideration.

In a general way the skilled welder is developed from a handy man, and even though he be developed from a first-class mechanic this does not insure his having the necessary knowledge of the structure and treatment of metal and of the design of steam boilers to be able to judge where and under what conditions welding should be carried out. It is therefore necessary for the firm using the licensed equipment and the licensed operator to be investigated as to their general technical knowledge, their knowledge of boiler construction and of metals, and if satisfactory they should be licensed to carry out boiler work with a licensed equipment and a licensed operator. With these three licenses all other restrictions could be removed, as none of those interested would risk their licenses by doing anything that would be liable to cause trouble.

It has been repeatedly shown that welds under the proper conditions can be carried out so that the weld is as strong as the rest of the material, and will have a satisfactory elongation under test, and if this could be depended upon, as it assuredly could under the above conditions, there would be no reason why rivets should not be practically eliminated in the construction of steam boilers, all the seams being welded. That this would be a great advance over existing conditions can be understood when it is realized that at least 75 percent of the troubles to which steam boilers are heir are due to the riveted seams.

The lap joint destroys the true circle and produces irregular strain. The butt strap eliminates flexure and produces cracks. The double thickness of metal interferes with the conductivity of the heat and produces trouble with the seams. The nature of the seam causes cracks from the rivet holes or between them. The boiler is only held tight by a thin film produced by calking, any distortion will cause this to be disturbed and produce a leak, and the leak frequently produces corrosion.

The strength of a riveted seam under the best conditions is less than that of the original plate, and as the attached report of the Department of Commerce and Labor on oxy-acetylene welds shows that welds can be made so that when the piece is pulled it will break right away from the weld. This would indicate that when the weld is carried out in the proper manner the strength would be considerably superior to that of a riveted joint, thus producing a superior structure. By the three-certificate system the scope of repair work would be considerably broadened with advantage to all concerned, and the elimination of rivets would only be dependent upon the development of the skilled welder.

Record for Driving Rivets Made with Vanadium Steel Rivet Set

According to the *Panama Morning Journal*, a West Indian workman who was on the gang riveting the spillway gates at Miraflores on the Panama Canal, drove 1,237 rivets during eight hours of work. Out of all these rivets only 167 were ordered by the inspectors to be cut out and redriven, so the actual record stands as 1,070 rivets properly driven in eight hours' working time.

The man who made this record, Mr. Gerald Goodrich, while one of the best men in the gang, made no special preparations for this high record beyond selecting a Vanadium steel rivet set so that he would lose no time with changes. Comparative service records of Vanadium and carbon tool steel rivet sets show that the former last from three to nine times as long as the latter on the same class of work, so undoubtedly the selection of a durable tool had something to do with the record-breaking as well as the recognized skill of the workman.

As the hours passed and it was seen that a new canal record was being established, the inspectors watched the work critically, and during the day ordered 167 of the rivets cut out so that new ones could be properly driven. Mr. Goodrich received hearty congratulations, and had the satisfaction of knowing that his name went to Colonels Goethals and Hodges for making the riveting record.

Address Wanted

Will Mr. Frank C. Dickman, or any friend who knows him, send his address at once to Harry D. Vought, Secretary of the Master Boiler Makers' Association, 95 Liberty street, New York City. *FDLF*

The Boiler Maker

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GEORGE SLATE, Vice-President
E. L. SUMNER, Secretary
H. H. BROWN, Editor

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

NOTICE TO ADVERTISERS.

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

Two subjects of the utmost importance for the successful performance of a steam boiler are discussed in this issue. They are Heat Transmission and Furnace Efficiency, two factors which combined determine the success or failure of any steam boiler. Both should be carefully studied, but of the two, furnace efficiency is more likely to be misinterpreted; for losses in furnace efficiency may be due to several causes, each of which is difficult to measure or distinguish apart from the others without the aid of an intelligent analysis of boiler tests based on accurate and comprehensive data. Whenever losses occur, however, there is always a remedy or at least a partial remedy available, provided the cause for the loss is correctly determined. Cases are not infrequent where inefficiency in the furnace is laid to the boiler and vice versa the furnace may be giving very efficient results while the final performance of the boiler plant is not giving satisfaction at all, although the installation of retarders in the boiler tubes to control the flow of gases through the boiler, or a change in the steam and water connections to improve the circulation of the water in the boiler, would bring the final results up to the expected efficiency at once. The ability of the boiler to absorb the heat generated by the furnace is something quite apart from the ability of the furnace to develop all of the heat energy stored in the fuel fed into the furnace, and these two factors should be thoroughly understood by the boiler maker before he can expect to design and build the most efficient type of boiler.

For the thirty years since the Boiler Explosions Act of 1882 went into effect in England, the average number of persons killed each year in that country from boiler explosions was only 26.3, and for the three years ending June 30, 1909, 1910 and 1911 the average was only 13. During the year ended June 30, 1912, however, 30 persons were killed and 75 were injured. The total number of explosions was 106 and of these 16 resulted in loss of life or personal injury. The 30 deaths were caused by 14 explosions, of which 9 occurred on land and 5 on ships. In 20 out of the 27 explosions which occurred on ships no person was injured, while in the remaining 7 explosions 13 persons were killed and 4 injured. The fact that so many more persons were killed during the year ending June 30, 1912, was due to two disastrous explosions, one of a cast-iron steam pipe, and the other of a cast-iron main boiler stop valve chest. In each of these explosions 6 persons were killed. There were 10 explosions from heating apparatus early in 1912, and all were due to the freezing of pipes, connected with steam apparatus. In 4 out of the 6 cases in which formal investigations were held, the courts found that persons who had been connected with the boilers were to blame for the explosions. The most common cause of explosion was deterioration or corrosion, which accounted for 29 cases. Twenty-four cases were due to ignorance or neglect on the part of the attendants; 17 explosions were caused by defective design or excess pressure; and 16 by defective workmanship, material or construction. Water hammer was responsible for 8 explosions and 12 were attributed to miscellaneous causes. The parts of a boiler installation which failed most frequently by explosion were found to be steam pipes, stop valve chests and the like, which might be classed as boiler accessories, and during the year from which the foregoing statistics are taken, 24 out of the 106 explosions were caused by failure of such parts. No figures are given showing the number and horsepower of boilers in service each year, although it is apparent that both have steadily increased in recent years, but the comparative freedom from disastrous explosions in England speaks well for the excellence of construction and operation of steam boilers as well as for the efficiency of the Boiler Explosions Act, which is responsible for the thoroughness with which each explosion is investigated, so that future accidents from the same cause may be prevented. In America, where disastrous boiler explosions are much more frequent, a similar law would certainly not be out of place.

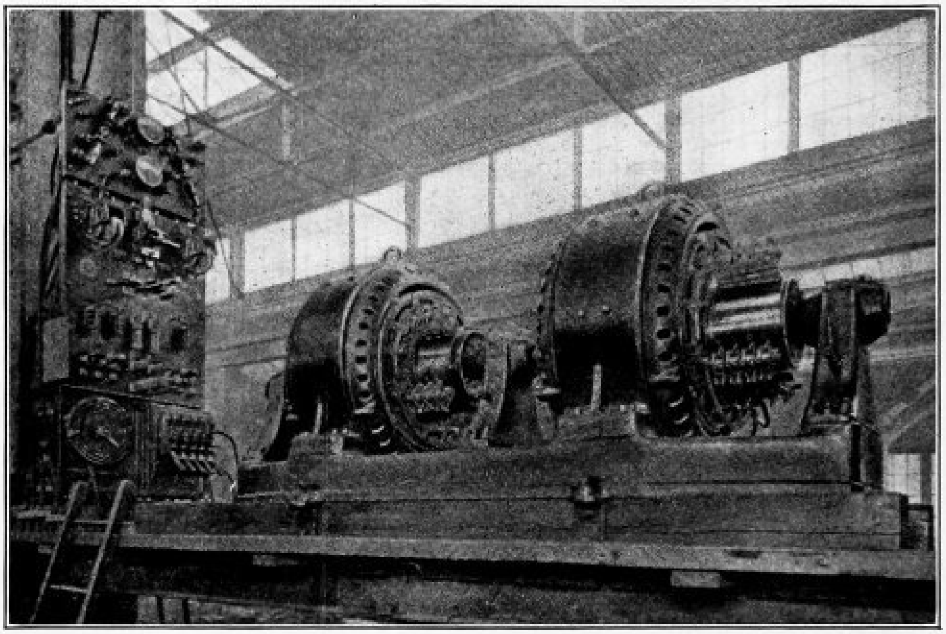
Engineering Specialties for Boiler Making

The C and C Electric Welding Apparatus

Briefly stated, electric welding consists of connecting the work to be repaired with one wire from an electric current and attaching the other wire to an electrode handled by the operator. The electrode is first brought into contact with the work, establishing the circuit, then drawn away from the work, forming an arc, the heat from which melts the metal with which it comes in contact. The operator can then move his electrode about over the work and the arc will follow, thus enabling him to concentrate the heat on one spot or spread it over a wide area. Theoretically, any source of direct current is suitable for this kind of heating, but when it is considered that a potential of only 10 to 60 volts is necessary at the arc, it is evident that if this voltage is secured by introducing resistance in series with existing shop circuits, the method would be very wasteful, and only a small fraction of the current drawn from the line will actually be used in maintaining the arc, the rest being dissipated in heating up the resistance. Furthermore, unless means are provided for maintaining the proper potential and for protecting the line against short circuits which necessarily occur every time contact is made before the arc is drawn, it would be impractical to do electric welding from the regular shop circuit. In order to overcome these difficulties the C & C Electric & Manufacturing Company, Garwood, N. J. have placed on the market an electric welding outfit, consisting of a motor generator set, together with an automatic controlling apparatus which provides a ready means of efficiently changing the shop circuit, whether alternating or direct current and of any voltage, to the proper voltage required for welding, and at the same time providing against short circuiting of the machine.

The apparatus consists of a driving motor, which can be applied for alternating or direct currents of any voltage or number of cycles and phases, direct connected to a welding generator which is of a specially wound variable voltage type, together with a switchboard on which are mounted the necessary automatic-controlling devices for handling and safeguarding the apparatus.

The electric welding is done in two ways: either with a graphite electrode or with a metallic electrode. The graphite electrode method requires a potential of 50 to 60 volts at the arc and a current of 300 amperes or more, and can be used for all kinds of welding, filling in, building up, cutting, etc. In this case the filling in or welding metal is supplied from an outside source, such as scrap metal or a rod of soft iron.



COMPLETE DOUBLE ARC C & C ELECTRIC WELDING OUTFIT AS INSTALLED IN A RAILROAD SHOP

When the metallic electrode is used, however, the potential at the arc is usually lower, according to the nature of the weld. In this process the metallic electrode is consumed, and is used in general for welding purposes, care being taken to maintain a uniform potential while welding. The graphite electrode, on the other hand, is used for general cutting purposes, such as cutting out portions of cavities or forming V grooves preparatory to welding with the metallic electrode.

The C & C electric welding set is so designed that it can be used interchangeably for either metallic or graphite welding, or double arc sets are supplied in which different operators can work with carbon and metallic electrodes at the same time.

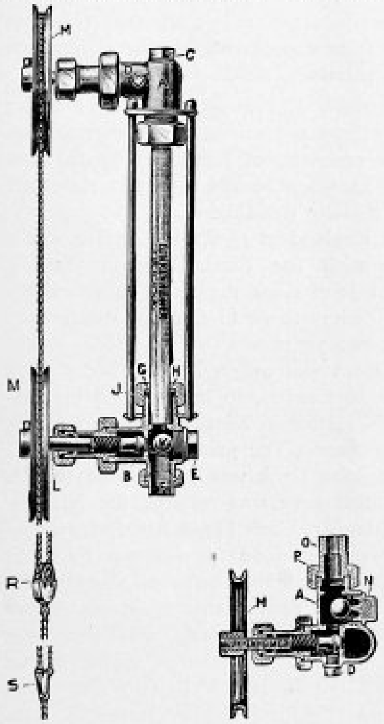
Improved Automatic Water Gage

The improved automatic water gage herewith illustrated, designed and patented by the Lunkenheimer Company, of Cincinnati, Ohio, is made in two patterns, termed "medium" and "extra heavy," intended for 200 and 300 pounds working pressures, respectively. They are made either right or left-hand, as desired, to facilitate the operation of the gage.

Should the gage glass break, the ball check valves *K* will, it is claimed, automatically seat themselves, owing to the rush of steam and water on one side thereof and the lack of pressure on the other. This automatic closing feature is a valuable one, as it prevents the escape of steam and water, and permits the safe closing of the hand-operated valves for the purpose of renewing the glass.

To renew the glass it is only necessary to loosen the stuffing-boxes *G*, take off the cap *C*, remove the broken glass and substitute a new one, after which the stuffing-boxes are tightened and the cap *C* replaced. The change can be performed with perfect safety, for, owing to the quick-closing valves, which should be closed upon the discovery of the broken glass, there is no danger to be anticipated from escaping steam and water.

Particular care has been exercised in the design of the gage to facilitate cleaning, and access can be readily had to any part. The plugs *C, D, E* and *N* are provided for this purpose. By removing the plugs *D* and opening the regrinding valves to their greatest extent, a rod can be inserted entirely through the body and tail pieces, and any sediment that might have collected in or around the entrance of the tail pieces can thereby be easily removed. By unscrewing plugs *E* and *N* the



check balls will of their own accord fall from the body, as they rest on inclined surfaces.

It has been the practice heretofore to attach both pulleys together by means of a chain or cord, which was pinned to the pulleys, so that the proper closing of one depended entirely on the other. While in some cases this method was satisfactory, it has been found that unless great care was exercised in pinning the chain to the pulleys, or after the valves had been reground several times, one of the valves would not seat properly. To overcome this difficulty the arrangement illustrated herewith was designed, by which it will be readily seen that both valves can be made to positively seat independently of each other. This arrangement consists of a block pulley operating over a chain, which is pinned to both the upper and lower pulleys, this method being employed for closing the valves. Should one of the valves become closed before the other a continued pull on the block chain will close the other. To the left of the pulleys the chain is merely attached to a triangular plate, as the opening of the valves need not be regulated to as fine a degree as the closing of them.

The valves are constructed on the same principle as the Lunkenheimer well-known regrinding valves, therefore they can easily be reground when worn. The valve seat opening is very large, and consequently a free and unobstructed passage for the water and steam is insured. It is claimed that the gage cannot show a false level, as the ball checks are so constructed that unless the glass breaks they will, owing to their weight and position, fall away from their seats.

Automatic Regulation of Superheat

The temperature to which steam will be raised in a superheater depends upon the design of the superheater, the amount of tube surface, the number of passes which the steam makes through the surface, the weight of steam passing through the superheater, the volume of hot gases passing over the superheater tubes and the temperature of these gases. Among the possible methods of controlling superheat temperature are, first, to regulate the volume of steam passing through the superheater tubes so that after it has been mixed with saturated steam from the boiler the mixture will have the desired superheat, and, secondly, to regulate the amount of hot gases passing over the superheater tubes, so that the desired steam temperature is obtained for any weight of steam passing through the superheater tubes.

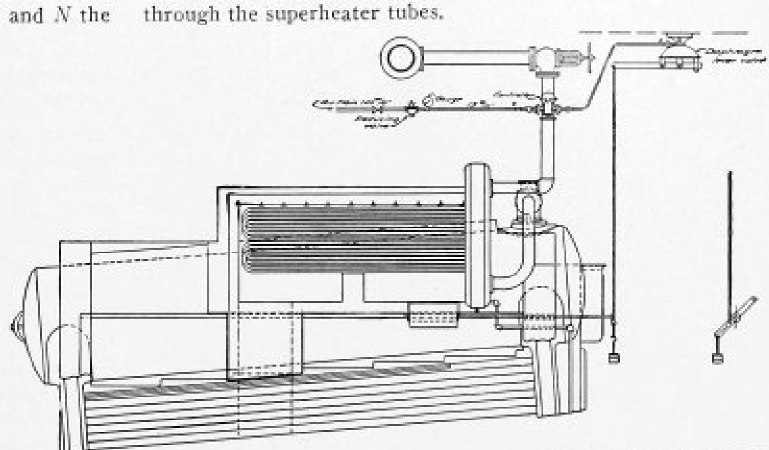


FIG. 1.—ARRANGEMENT OF AUTOMATIC TEMPERATURE REGULATOR WITH HEINE SUPERHEATER

The first method is open to the objection that hot gases are always flowing over the tubes, and therefore if no steam, or only a small quantity of steam, is passing through the tubes, they are liable to overheating.

Fig. 1 illustrates the arrangement of Heine superheaters to obtain temperature regulation by the control of flow of hot gases. This figure also shows the automatic control apparatus. The superheater is located in a firebrick superheater chamber, forming part of the boiler setting, at the side of the boiler drum. The rear of this superheater chamber communicates with the furnace by a flue, through which a small percentage of the furnace gases rise, making two passes over the superheater tubes, and then flowing out to the front at the bottom of the superheater chamber, where a damper is located.

An automatic temperature regulator controls the damper opening, so as to give constant superheat. This automatic regulator comprises two principal parts, a diaphragm lever, actuated by compressed air, and a thermostat controller which regulates the admission of compressed air to the diaphragm lever, in accordance with the temperature of the steam.

The diaphragm lever in this drawing is suspended from a convenient beam; the outer end of the lever is in line with the damper rod, a link connecting the two. Air enters the top of the diaphragm chamber, which is a convex casting with a rubber diaphragm across the bottom. Springs hold a "saucer" against the diaphragm, the saucer itself being recessed to hold a link connecting with the lever. When there is no air pressure within the diaphragm chamber, the springs press the saucer against the diaphragm and hold it against the inside face of the diaphragm chamber. When air pressure is admitted, it overcomes the resistance of the springs, and causes the saucer to move downward with corresponding movement of the lever and damper.

The controller for regulating the supply of compressed air to the diaphragm lever is installed in the outlet line of the superheater with a thermostat protruding into a suitable fitting. The thermostat consists of two tubes, one of a metal that changes considerably in length with temperature, so that changes in superheat cause changes in relative length of the two tubes. This motion causes changes in the opening of a small ball valve which controls the supply of compressed air to the diaphragm lever.

The chart of Fig. 2 tells the whole history of the performance of an automatic superheater regulator of this type. In this plant the load comes on at 7 o'clock in the morning, and as the engines and compressors are started steam is drawn from the superheater, and the superheat temperature comes up to 460, the setting of the regulator. From then on till noon the superheat remains absolutely constant. From 12 to 12:30 the engines are shut down, and no steam is drawn from the superheater, which is acting simply as additional steam reservoir space. The automatic temperature regulator closes the

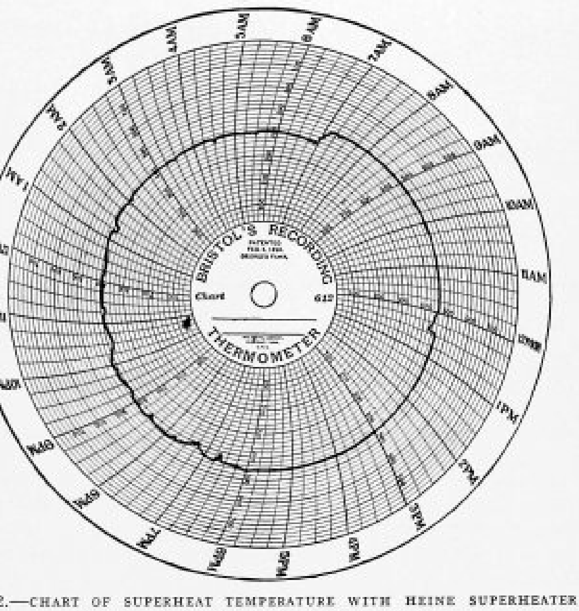


FIG. 2.—CHART OF SUPERHEAT TEMPERATURE WITH HEINE SUPERHEATER AND AUTOMATIC TEMPERATURE REGULATOR

superheat damper, but the temperature of the steam does not immediately fall to boiler temperature, because of the heat stored in the metal of the superheater and the setting. When the load starts up at 12:30, the temperature immediately rises to the normal of 460 degrees, and continues until the end of the working day, 6 P. M. During the night the boiler is idle, and no steam is drawn through the superheater. The temperature approaches that of the steam in the boiler, and the superheater damper is tied shut to positively shut off all gases. During the noon hour and at night the superheater is not flooded.

An advantage of control apparatus with superheaters is that the temperature may be changed as desired after the plant is installed. The thermostat controller has a small dial and adjusting screw, whereby the mean temperature maintained may be raised or lowered as desired. Thus a plant may be operated for a week or a month at 50 degrees superheat, then 75 degrees, 100 degrees, etc., operating records being kept at the same time of the load and coal consumed. From this a determination may be made of the most economical working conditions.

LOCOMOTIVE WITH WATERTUBE BOILER.—A locomotive with watertube boiler and corrugated firebox or furnace flue of the marine type has been tried experimentally on the Prussian State Railways. The furnace is about 42 inches in diameter and 10 feet long, with grate 8 feet long. Beyond the bridge wall it opens into the bottom of the boiler barrel, which is filled with water tubes running from a header at the smokebox end and into the water chamber which surrounds the firebox (the end of which is closed by the tube plate). Horizontal baffles cause the products of combustion to pass first upward, then back toward the tube plate, and finally forward to a passage over the top of the header into the smokebox. The tubes are about 12 feet long. Air passes through the ashpan and up into the rear end of the firebox. The engine is of the 0:8:0 class. It was built at the Orenstein & Koppel works, at Drewitz, and the boiler is known as the Strooman type—*Engineering News.*

Personal

J. A. HOLDER, foreman boiler maker of the Seaboard Air Line Railroad, Atlanta, Ga., has been appointed general boiler inspector for the same company, with headquarters in Portsmouth, Va.

MR. CHRISMAN, formerly associated with the Hastings Foundry & Iron Works, is now operating a general machine and boiler repair shop in Hastings, Neb.

JOHN COOK, of Springfield, Ill., a veteran in the boiler making industry and a frequent and valued contributor to THE BOILER MAKER, was the recipient of hearty congratuations from his friends on July 13, when he and his wife celebrated the fiftieth anniversary of their wedding.

Mr. Cook was born in England in 1838. His father was a British soldier, serving with the First Dragoon Guards. Shortly after the birth of John Cook the troop to which his father belonged received orders to go to Canada, where they were quartered for about two years.

In 1840, when the regiment was ordered home, Mr. Cook's father decided to remain in Canada, so he obtained his discharge from the army and settled in Niagara, Ontario, which at that time was a busy place. The principal industry was shipbuilding, and in 1852 John Cook was apprenticed to Mr. Andrew Herron, who at that time was running the Niagara Dock. A few months after Mr. Cook began his duties as an apprentice construction was begun on the steamer *Peerless,* which was the second iron steamboat built in Canada, the first being the *Magnet.* The *Peerless* was fitted up on the Clyde, knocked down and shipped to Canada, where she was put together at Niagara. The foreman boiler maker at the Niagara Dock at that time was the late Mr. James Currie, of Toronto, whose motto was "Willful Waste Makes Woeful Want," a motto that, apparently, was thoroughly inculcated in the men under him.

After Mr. Cook had served about three years at the Niagara Dock the plant was closed for a time, and he moved to St. Catharine, where he worked for about a year as a blacksmith's helper. The dock then opened again, and they built two large wooden boats, the *Canada* and *America,* for the Great Western Railroad. There were three boilers in each boat, and it took nearly a year before the vessels were completed.

Mr. Cook's first employment as a foreman boiler maker came about soon after the boilers were finished for the Great Western steamers. He entered a boiler shop at a small place called Simcoe as a riveter, and after he had been there about a month the boss quit and Mr. Cook was called upon to fill his place. It was not what would be called much of a job at the present day, but like all young men he was greatly encouraged at the advancement. The work in hand at the shop, however, was soon finished, and he was obliged to leave.

He then went to Dundas, and worked there for about a year and a half, riveting, chipping and calking; from there he went to Buffalo, N. Y., and spent about four years in various shops. During that time Mr. Cook became skillful in riveting, chipping, calking, flange turning and laying out boiler work, and ever since he has been adding new methods and ideas. He has been foreman boiler maker in several shops, but the greater part of his life in late years has been spent in Springfield, Ill., where he is at present engaged in his trade.

Letters from Practical Boiler Makers

Rolling a Cone

In the June issue of THE BOILER MAKER I have spoken about a third method of rolling a cone. This may be a thing of the past to some of the more experienced boiler makers, but I have not seen any of the old-time men use it as yet, so I do not know whether it has been tried or not. I tried it about four years ago in rolling a petticoat pipe of light stock, and was very successful in the experiment.

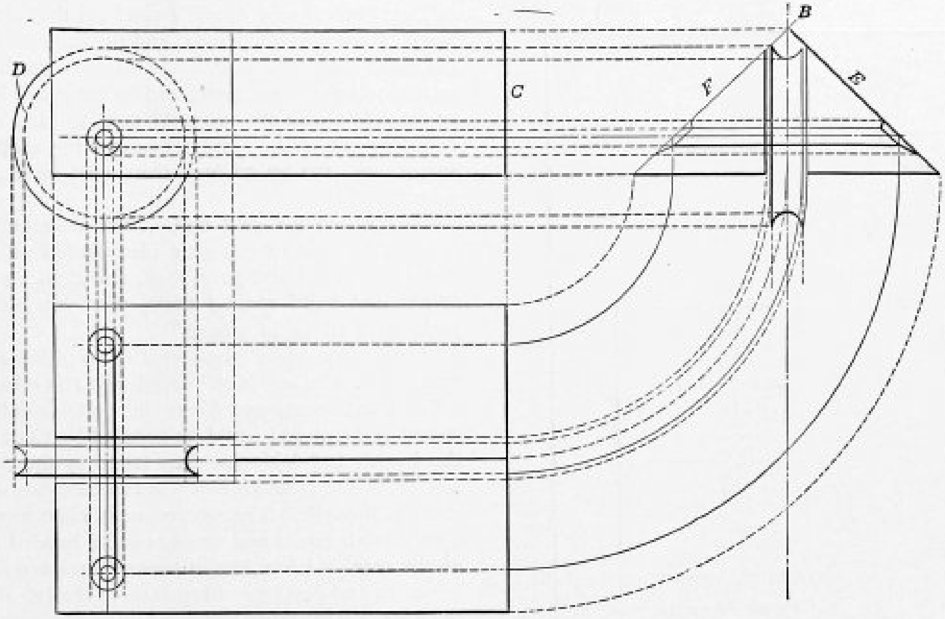


FIG. 1.—GUIDE BLOCK

Before I begin to explain this method, I wish to say a word of caution: With heavy material it is possible that it might cause the roller bearing casting to give away under the strain of guiding the cone in the rolls. A guiding block should be made with a wheel attached, as shown by the sketch (Fig. 1),

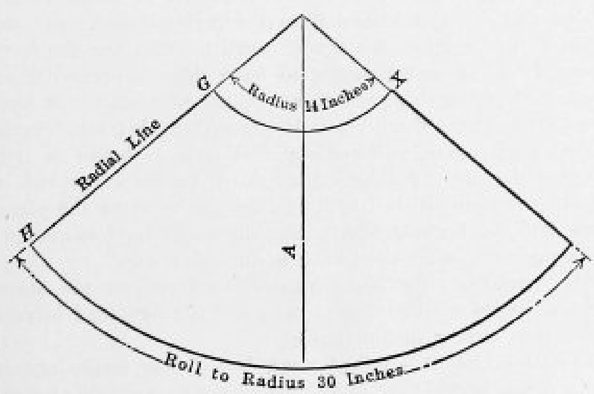


FIG. 2

and fastened by a rivet driven in a countersink to act as an axle.

Now take the guide block and place it against the rolls so that *C* rests against the roller casting and sides *E* and *F* form points of tangents to the bending rolls and the distance of radial line *G* to *H* (Fig. 2) on the rolls. Where the distances *G* and *H* are indicated on the rolls set to roll a narrow strip of stock the same thickness as that for the cone, and at *G* on the rolls set it to bend the strip to a radius of 14 inches, likewise at mark *H* on the rolls set to roll the strip to a radius of 30 inches. Now having set the rollers to conform to the required radii to form the cone we will proceed to roll the cone.

Place the piece to be rolled against the guide block at *D*, and in such a position that radial line *H G* will be parallel to the rollers. The plate will follow its path on the wheel of the guide along the line of the cone piece, *G X*, therefore forming an approximately uniform cone.

EMIL EATON.

Talks to Young Boiler Makers

As the next Saturday a "rush" repair job came in, Carl and Alex could not meet their friend, who was a Mr. Walter, so they agreed to do some "church work" Sunday, and were very well satisfied with the lot Mr. Walter had picked out.

It was about 4 acres, with the railroad running along one end of it, with a very nice brook, which never ran dry, they were told, as a second boundary.

It could be bought for about $1,500, and three dwelling houses were not far from the road leading down to Milltown, which could be rented for the men. The soil was gravel and the land lay level. Mr. Walter said the railroad would run a spur onto the property without charge, if they were given the right to unload freight there if they wanted to.

One thing that pleased the boys greatly was Mr. Walter's statement that he knew two new boilers were wanted for one of the mills not far from town, and he could get all particulars so that a bid could be made. It would be a pretty good starter for them, as, of course, a stack and up-take would be required and some new tank work also.

When Carl and Alex got together in Alex's room Monday evening they had a drawing board, a T-square and a couple of triangles, and a nice piece of white paper stretched and pinned on the board, so that with Carl's box of drawing instruments they were ready to lay out their shop.

They settled on a scale of a quarter of an inch to the foot, and decided that a building 60 by 100 feet would be quite large enough, as they had made up their minds that repair work only would mean "a feast or a famine," and as they were afraid of too much famine, they determined to build so as to take in the new boiler proposition.

They had got the lines down when Ben turned up; they were glad to see him and began explaining the building. The rolls would take 5½ by 12 feet, and they had laid them in not far from the main door, which was at the north end of the building, or the railroad end.

Ben looked at the plan, shook his head, and said: "Yes, I know that's the way they all start a shop, but it ain't the right way."

"Why?" asked Carl, "how are you going to begin if that ain't the right way?"

"You start wrong in laying down your lines for the building," was the answer. "Now what you want to do is to take some cards; cut them to your scale just the size of the machines you are to put up; write the names of the tools on them,

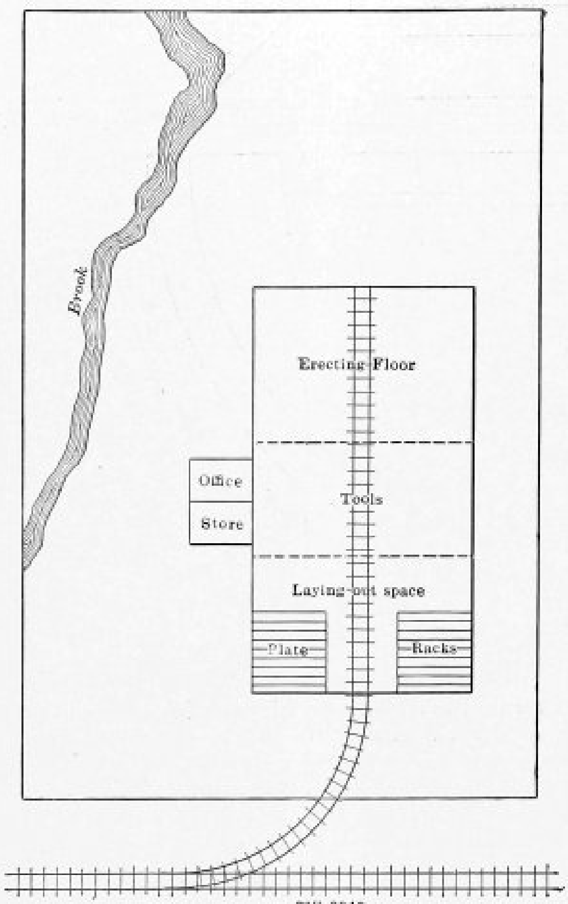


FIG. 1.—ALEX'S SKETCH OF THE SHOP

then you can lay them down anywhere and see how they work out, and shift them to suit as you go along. See?"

The boys saw all right, and Alex finding a box in his closet started on the job of cutting out the machines.

"Now," said Ben, "why do you put your rolls up by the door?"

"Well, mainly because they were in that position in the old shop."

"How do you build a boiler, anyway?" asked Ben. "You first have to make your drawing and figure out your material. Then when you get started you don't want your material all over the floor. You will have to keep some stock, of course, and when you start on the actual work you will first have to take your drawings and lay out the work. Well, your laying-out space should be close to your plate racks, so when you start your plate it will keep on going and not be coming back and running over all the shop."

"Sure thing!" said Carl. "Now we will put the laying-out space over in the corner in the side bay, so that it will not interfere with the main bay space. How's that, Alex?"

"Well, if we do that we will have to have another crane, as the middle crane won't reach under the sides; and even if we do have another crane we would have a lot of extra handling in shifting. I guess we had better think about putting the laying-out space about the middle, close to the north door; but, gee! it's going to make a mighty big *span* for the crane and that runs into money. I don't know about this bay or lean-to idea we have. It seems to me, now we get into it, that it would be better to have, first, a big, square shed and no side bays, then our crane can reach any point. Let's talk that over a while."

"Now, here," said Alex, "I can't get that old shop out of my head. I know it is unhandy, and the lean-tos were put on after the main shop was built, and I have heard the Boss often say he had to have more room, and he could not lengthen the shop as he didn't own the property next to him, so they were the only way out of it. Here, let's make the shop longer and narrower, say 150 by 50 feet, then we'll have all the room we want."

"That's just it," said Ben. "But never mind the size, the way to do it is to get your idea settled as to what general shape you will build your shop, and then lay down your machines and build around them, then you won't be crowding your tools all up in a heap."

"I get your idea," answered Alex. "Here, I will make a rough sketch of my idea." And Fig. 1 is what he drew.

"You see," continued Alex, "the plates would come in and be stored in front and could be handled by the crane, brought to the horses and laid out, then taken to the punch and shears and on to the rolls, so down to the back end of the shop, just straight through. The storeroom is right next the office, and all material, rivets and so on, can be handed out and checked up for sure. I know lots of times things are taken by the boys for work and don't get charged up to the job at all, so the costs are all out. What do you think of that layout, fellers?"

Both men studied the sketch for a time, then Ben said:

"If you could take the finished boiler out of the back end of the shop that place would be all right, except the storeroom should be on the other side of the office, as you don't need the fittings, or even the rivets, until the plates have been machined, so it would be better to put the office and storerooms so as to save steps. I figure it this way: put the plate racks at the back of the shop, as when a car comes in it can be unloaded and the plates started to the layout space, onto the machines and erecting floor, and, when finished, out the front door. It won't cost anything to have the car backed down to the end of the shop, and it will cost something if you have to take the plates there yourself—everything helps in saving money. Of course, you can say that it is as broad as it is long, as the car could be backed down to the lower end of the shop for the finished boiler as well as to carry the plates there first, but I would rather have the boiler start at one end and go out the other than have it the other way."

Alex could not see any advantage one way or the other, and Carl could not see why plates could not be stored in yard racks, thus saving in building cost.

This last idea was talked over, but it was finally agreed that a trestle would have to be built over the plate racks for the crane, and it was a hard job to make any arrangement in the end of a shop which would allow the crane to run out and in and yet keep the weather out. Both young men knew what it meant to brush the snow off your job at 7 A. M. or work in the wet, and neither wanted more of it.

Ben pulled out his watch and said, "Come on, fellers, it's quitting time." W. D. FORBES.

New York.

(To be continued.)

Steam Pipe Troubles

The material chosen for most steam pipes is still in many cases copper, although much has been written about the danger connected with the application of copper steam pipes with brazed flanges, and although many accidents show the necessity of departing somewhat from the common practice in this respect. No doubt copper was originally selected for steam pipes on account of its non-liability to corrosion and on account of its great ductility. It is often assumed that in bending pipes the axis of the saddle of the pipe does not lengthen, and that the material at the throat of the pipe becomes compressed to an amount about equal to the expansion on the back of the bend. This is not the case. As a matter of fact, the compression of the material is not very great, and the pipe expands by bending not only at the back of the bend but also on the sides, and, if it is remembered that the thinning of the metal must be proportional to the extension, it will be found that a pipe which has to be bent should be at least one gage thicker than required for the allowable pressure, and in many cases this is scarcely sufficient. Often the larger steam pipes are bound around with wire, while some firms put iron bands around the pipes every few inches. Such practices show that many engineers look upon copper with a certain amount of distrust.

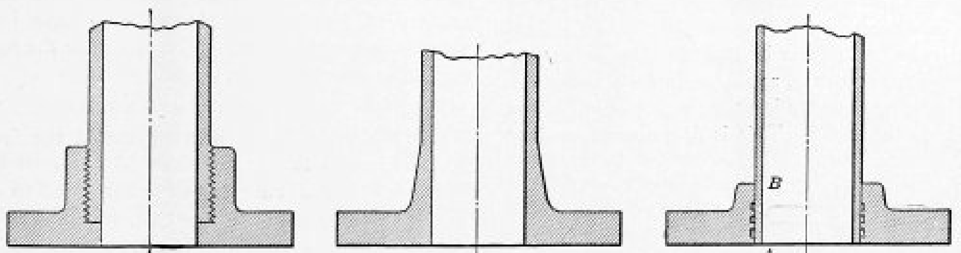


FIG. 1 FIG. 2 FIG. 3

FLANGES FOR STEAM PIPES

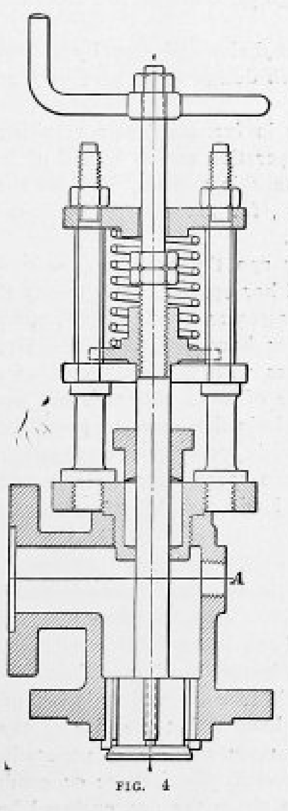


FIG. 4

When main steam pipes have to be made of copper, they should always be fitted with an automatic stop valve on the boiler, which will shut off the flow of steam to the engines if the pipe bursts. There are many such stop valves which are not entirely trustworthy, but some good ones are obtainable. A boiler explosion will always be realized as a serious matter; and therefore the dimensions of the safety valve are controlled by law. But why does not the law also require the application of automatic stop valves when copper steam pipes are applied? No doubt more men are killed by the bursting of copper pipes than by actual boiler explosions.

Brazed flanges are seldom trustworthy, the working of the pipes causes the spelter to become brittle, so that they will crack in the flange. For larger steam pipes the flanges are riveted to the pipes, which is a good practice, but the joint should be diagonal and not chain riveted, as with the latter method too much material in the pipe is drilled away and the strength of the pipe is too much diminished. In fact, this has frequently been the cause of fractured pipes.

Steel is often used for steam pipes, and in such cases the flanges are threaded on the pipes, as shown in Fig. 1, or the whole pipe is made from the solid shaft, as shown in Fig. 2.

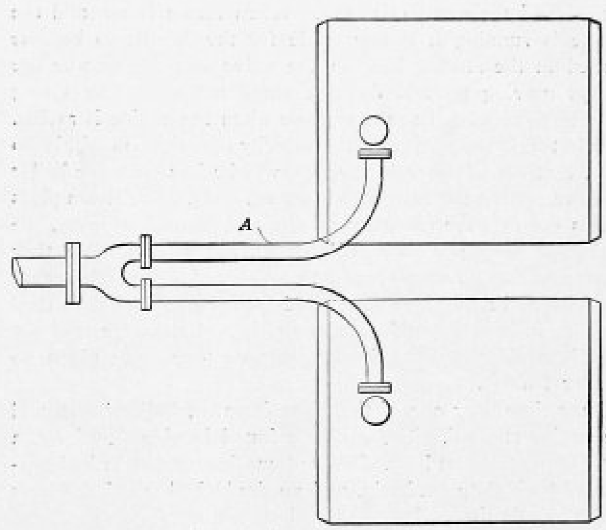


FIG. 5

In the latter case the hole is often bored eccentrically to provide for the bends. Steel is much stronger than copper for withstanding the pressure. Its thickness is more equal than that of cold-drawn copper pipes. Its strength is not diminished by the steam pressure, and its coefficient of expansion is less, but this latter property does not allow smaller bends, as the steel is much stiffer than copper, so that the flanges of the valves must be very strong, and especially well ribbed to the body and fastened with strong bolts. For long pipes the application of stuffing-boxes for expansion is necessary, but this is also the case with copper steam pipes. Steel pipes are often expanded in the steel flanges in the same manner as boiler tubes are expanded in the tube plates. Grooves are turned in the flange, as indicated in Fig. 3, and the hole at *A* is bored about 3/32 inch wider than at *B*. This manner of flange attachment is very efficient.

Copper pipes are also expanded in the steel flanges, and for circulating, waste and other water services cast iron flanges are used.

In one case on board a steamship the main steam pipes had to be made of copper, as no other material was allowed. As the engine builders had had several accidents with copper pipes they considered it necessary to place on each of the two boilers an automatic stop valve, as shown in Fig. 4. The valve was especially constructed for this case, as shown in the illustration. At *A* a small pipe 1 inch diameter is connected, leading steam from a small valve on the boiler. This is first opened, and by

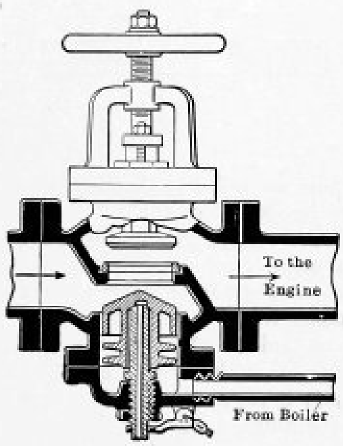


FIG. 6

this means the engine is warmed up. When the pressure in the pipe is the same as that in the boiler the main valve is opened and the small one shut. When steam is on and the engine is running it is impossible for the spindle to become burned in the stuffing-box, as the valve and the spindle are always moving up and down a small amount. The spring must be so regulated as not to close when the engine is racing. Should the steam pipe burst the velocity of the steam will be so great that the pressure in the pipe will be less than the boiler pressure, so that the valve closes immediately. The steam pipes of this engine were expanded in the steel flanges, which at the beginning were perfectly steam-tight, but after a time they became so leaky that they had to be altered. The pipes were taken off and steel rings hammered into the pipe. These steel rings were then expanded in the pipe and the pipe was put back into place again. Since that time they have given no further trouble.

Some time later one of the pipes from the boiler burst, and the engine stopped. The engineer found in pipe *A*, Fig. 5, a burst seam 4 inches long. The automatic stop valves had performed their duty perfectly, and no doubt had saved the lives of the men in the engine room and stokehold. From this time on the engineers and firemen who had at first considered the valves as superfluous and troublesome were very anxious, and took special care to keep them in good order. They were not very good automatic stop valves, but better ones are on the market, as, for instance, the one shown in Fig. 6. In this valve the steam flows in the direction of the arrow. When a steam pipe bursts the piece, *A*, will rise, forced up by the great velocity of the steam, and the pressure will be less on top of this piece than on the under side. The hole in the piece *A*, which leads to the atmosphere, allows the piece to be held down. The piece *A* may be put in place again by means of a lever and hand-wheel on the outside.

In any case, where copper steam pipes are used, an automatic stop valve is necessary, and it is unwise to do without them. It makes little difference what material is used for the steam pipe, an automatic stop valve is not out of place, and frequently where least expected it will save both lives and property. D. K.

Modern Boiler Plant Equipment

Sometime ago the writer visited twenty-five of the largest power plants in the East. It may be of interest to many readers of THE BOILER MAKER, who have not had such an opportunity, to learn through this article the tendency of present boiler plant practice.

BOILERS AND STOKERS

The watertube boiler has supplanted the firetube type and the stoker has taken the place of the husky Irish fireman. There are only a few types of boilers used to any extent, and these are of the inclined tube type, such as Babcock & Wilcox, Heine, etc., or of the Sterling type with slightly bent tubes more nearly vertical. The average steam pressure is 175 pounds per square inch and the superheat of the steam is rarely more than 125 degrees F.

The past ten years have not brought about any very important or far-reaching changes in the design of the steam boiler itself, though many improvements have been made, all of which contribute toward the production of steam at a much lower cost than would have been possible a few years ago with the present high price of fuel, the more important changes being:

1. Increase in rated size and capacity of boilers.
2. Stokers of such design as to give very great increase in capacity.
3. Improvements in furnace design resulting from a closer study of furnace operation mainly by aid of flue gas analysis.
4. Better workmanship and material for the production of fittings, valves, etc., for use under high steam pressure and superheated steam.

About ten years ago the average power plant boiler was less than 500 rated horsepower, while to-day there are boilers of nearly 2,500-horsepower rated capacity, which on peak loads develop 5,000 boiler horsepower. These large boilers have low radiation losses with minimum cost of repairs and attendance. The use of large boilers is not general, but there is no doubt that within five years they will be very common. The boilers installed in most of the large power plants recently built range from 600 horsepower to 1,200 horsepower, which develop on peak loads 200 to 300 percent of their rated capacities.

FURNACES AND SETTINGS

A mechanical engineer of much prominence has said that the capacity of any boiler depends more upon the size of combustion chamber built in connection with it than upon the number of square feet of heating surface. To just what extent or limit this is true the writer is not prepared to state, though it is well known that the size of the furnace has a tremendous effect upon the steam generating capacity and efficiency of any boiler. By furnace or combustion chamber is meant the space above the fire, enclosed by the setting, in which the gases from the fuel can burn before coming in contact with and being chilled below the ignition temperature by the comparatively cool boiler heating surfaces.

The value of a large combustion chamber has been known for years, but, like many other new and good ideas, it has been slow of general adoption. Much impetus has been given to considerations of furnace design by the rigid smoke laws of many cities. High volatile bituminous coal requires for smokeless combustion, in addition to sufficient air supply, a thorough mixture of the gases and air, and a considerable flame travel without chilling. These conditions are fulfilled by a sufficient size combustion chamber and without the aid of any patented article, steam jets or other devices. Several underfed type of stokers which advertisements claim as "smokless" are not so unless installed within a furnace suited to the quality of coal burned.

The average size of combustion chamber, figured from several plants smokelessly burning high volatile coal (30 percent to 35 percent), is about 2.5 cubic feet per 10 square feet heating surface or per rated boiler horsepower. All of these plants are located in large cities and meet the requirements of the city "smoke ordinance." With an allowance of 2 to 3 cubic feet of furnace space per rated horsepower it is possible to secure 12 percent to 15 percent CO_2 in the flue gas with almost any boiler capacity up to 300 percent of rating. Of course, the capacity of the boiler depends upon the ability of the stoker to burn the coal, or, as we might say, volatilize the fuel, after which the duty of the furnace is to secure the highest percentage of CO_2 with the slightest trace of CO. Too much stress cannot be placed upon the value of a large and suitable furnace.

Boiler makers and engineers should specify that their boilers be "set" well up above the grates. The slight extra cost of setting will soon be repaid to the owner by increase in boiler efficieny, and the maker of the boiler or the engineer will enjoy a good reputation. A good boiler can be made very inefficient by a poor setting, the function of which is to confine the gases around the boiler heating surface, prevent loss of heat by radiation and a decrease in temperature of the gases by air leaking into the furnace through the walls.

Boiler settings are made of 18-inch to 27-inch brick walls, the inner part of the wall being lined with 4½-inch to 9-inch firebrick well bonded to the common red brick. To guard against air leakage and further reduce radiation losses, the setting is often encased in sheet iron with a layer of 2 inches to 3 inches magnesia between the brick and the casing. In many of the latest boiler installations the top of the settings above the steam drums is finished off flat either by brick paving or steel plates. This method of construction makes it more convenient for men to work at the safety valves, stop valves, etc., than is permitted by the old method in which the top of the boiler conforms to the shape of the steam drums.

Valves and Fittings

Superheaters are now almost universally installed with every boiler, even in small plants. From costly experience it has been found that cast iron fittings, valve bodies, etc., are not durable and reliable for use with superheated steam at temperatures over 400 degrees F. Under the temperature stresses producted in a superheated steam line the cast iron elongates, warps and eventually cracks. Not only do the fittings become a source of danger to life but it is impossible to keep the valves tight. Steel castings have been very successfully used and should always be installed in superheated steam lines. Open hearth steel is claimed to be superior to either semi-steel or Bessemer steel.

For the mountings of valves, valve seats, valve stems, etc., the best material is nickel or Monel metal, which contains a very large percentage of this element.

Threaded pipes and screw flanges are seldom used in high-pressure steam lines. The thread is bound to leak sooner or later, and the pipe is weakened by removing the metal in cutting the thread. The Van Stone joint, made by flanging the end of the pipe, is now very widely used in connection with rolled steel flanges. Some engineers prefer to have the pipe rolled or expanded into slightly groved flanges. This latter joint is satisfactory, but is far from being as popular as the Van Stone. Corrugated steel gaskets made from No. 20 sheet steel are extensively used for high pressures and high superheat. At high temperatures copper gaskets often waste away. Those made from steel do not have this fault, are cheaper and can be used indefinitely. Steam mains are seldom larger than 18-inch pipe. The thickness of the metal in the pipe is ⅜ inch for pressures up to 180 pounds and ½ inch (extra heavy pipe) thick for higher pressures.

Boiler feed mains conveying water from surface condensers are very often made of extra heavy cast iron flanged pipe, because the water from the condenser pits steel pipe. In other plants, standards or extra heavy steel pipe, with Van Stone flanges, are used. The feed lines from the mains to the individual boilers or to the economizers are either of steel or extra heavy brass.

Boiler Feed Pumps

Anyone at all familiar with power plant practice knows that the steam turbine has taken the place of the reciprocating engine, and the up-to-date engineer well knows that the turbine boiler feed pump has come to stay. It is surprising to learn of the number of plants which have installed the centrifugal type of boiler feed pump and hold as "spares" the old-style plunger type. Centrifugal pumps occupy much less floor space than any other type. They have no valves, springs, and much less packing to cause trouble. A still greater advantage is the continuous flow of water without any pulsation, the absence of which greatly reduces the strain on valves, piping and gaskets. "Engineer."

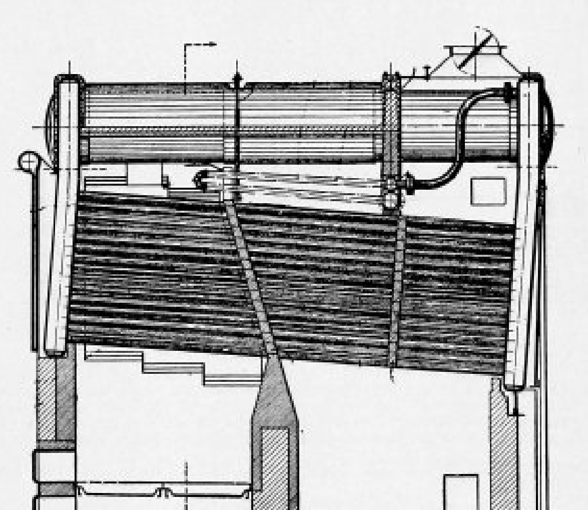
Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
Loan and Trust Building,
Washington, D. C.

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

1,060,334. APPARATUS FOR SUPERHEATING STEAM. ERNEST H. FOSTER, OF NEW YORK, N. Y.

Claim 2.—The combination of a boiler setting and furnace, a drum supported in said setting, a superheater located below said drum, a baffle



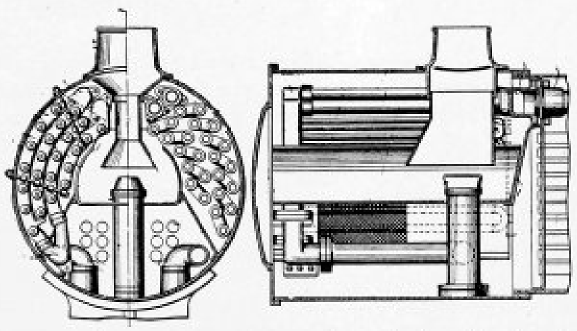
located below said superheater, by-passes for hot furnaces in the sides of the boiler setting, and extensions or deflectors on said baffle to disseminate the hot gases flowing through the by-passes throughout the superheater elements. Four claims.

1,059,153. FURNACE. JOHN HARRIGAN, OF NEW YORK, N. Y.

Claim 2.—A furnace having an exit flue, two compartments in direct communication with each other through an inter-communicating passage way, and with said exit flue for the passage of products of combustion from one chamber through the other to the exit flue, grates movable in said compartments to cause the products of combustion from the fire bed of one compartment to pass through the fire bed of the second compartment, extensions on the grates extending exteriorly of the furnace, such furnace being provided with openings for the passage of such extensions, a block-like member capable of engagement with the extensions of the grates to hold such grates against movement and means for alternating the flow of such products of combustion through said compartments. Ten claims.

1,060,359. STEAM-SUPERHEATING APPARATUS FOR LOCOMOTIVE BOILERS. JOHN PRIMROSE, OF DANSVILLE, NEW YORK.

Claim 2.—In a steam superheating apparatus for boilers of the locomotive type, the combination of a smoke box, receiving furnace gases at the rear, of walls within said smoke box forming a chamber with the walls of the said box in the lower portion thereof, said walls also form-



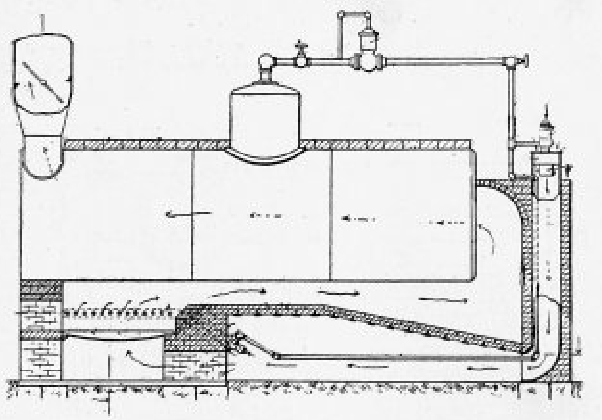
ing an upwardly open rearwardly closed trough shaped chamber in the upper portion of said smoke box and substantially concentric chambers at the sides thereof, said concentric chambers being open at the bottom and closed in the rear, superheating elements, comprising tubes located within said chambers, and means at the rear of said smoke box to cause the hot gases to flow through said chambers. Seven claims.

1,060,800. BLOWER FOR BOILERS. THOMAS S. WALLER, OF DETROIT, MICH., ASSIGNOR TO DIAMOND POWER SPECIALTY COMPANY, OF DETROIT, MICH., A CORPORATION OF MICHIGAN.

Claim 4.—In combination with a boiler setttng having two openings in the wall thereof, of a supply pipe, a tube section pivotally attached to said pipe midway between said openings to swing from one opening to the other, and a second tube section pivotally attached to the end of the first section to project into said openings. Nine claims.

1,061,379. BOILER FURNACE. JOHANNES CHRISTOPHER HEINRICH, OF MILWAUKEE, WIS., ASSIGNOR TO HEINRICH MANUFACTURING COMPANY.

Claim 1.—In a steam boiler furnace the combination with the combustion chamber, ash pit, grate and bridge wall, of an air heating chamber located behind the bridge wall and below the combustion chamber and communicating with the ash pit through an opening in the bridge



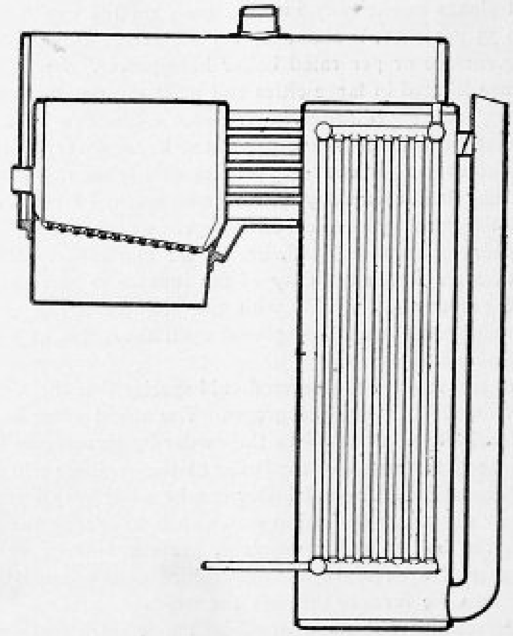
wall, a flue leading downwardly in the furnace wall into said heating chamber and having an air intake opening at its upper end, a blower in said flue having a steam supply connection and an air inlet, a twyper pipe in the furnace wall leading from said heating chamber and having an outlet directed into and across the space above the grate, and an auxiliary blower connected with said twyer pipe. Four claims.

1,061,502. SMOKE CONSUMER. CHARLES A. RUSH, OF LA GRANGE, ILLINOIS.

Claim 1.—In combination a furnace comprising a preliminary combustion chamber and a secondary combustion chamber, water heating coils situated within said secondary combustion chamber, said preliminary combustion chamber having its top, side and rear walls converging to a centrally disposed outlet, an annular opening surrounding said outlet, said outlet discharging through said opening into said secondary combustion chamber, said outlet being funnel shaped, an air heating chamber directly and completely incasing said outlet, and air inlet into said air heating chamber, a spiral rib connecting the walls of said outlet and said air heating chamber whereby air is fed with the whirling motion directly to the gases of combustion as they issue from said outlet through said opening. Two claims.

1,061,444. BOILER AND ECONOMIZER. PETER WILLIAM BRITTS, OF ARLETA, OREGON.

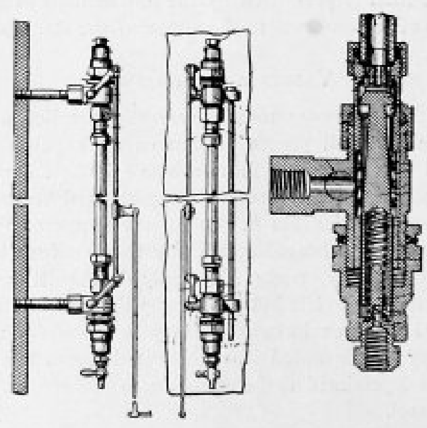
Claim 1.—A boiler and economizer, comprising a fire box including grate bars, a horizontally extending smoke chamber, a boiler, a feed water heater in the smoke chamber having its upper end disposed above the plane of the grate bars and below the plane of the boiler crown



sheet, a horiontal smoke stack adjacent said smoke chamber, a connection between said smoke chamber and said smoke stack below the lower end of said feed water heater, a by-pass leading from said smoke chamber to said smoke stack adjacent the upper end of said feed water heater, means for controlling passage through the said by-pass, a feed water pipe communicating with the lowest point of the feed water heater, and a pipe connecting the top of said feed water heater to the said boiler. Two claims.

1,061,832. SAFETY-VALVE FOR WATER GAGES. JOHN GEISINGER, OF NEWPORT NEWS, VIRGINIA.

Claim 2.—In combination separated valve casings, sleeves slidably mounted in said casings, means for holding the sleeves in adjusted position with the casings, a glass arranged between said sleeves, valves oper-



ating within the casings and held in position by the said glass, springs for holding the valves against the glass, means for adjusting the tension of the springs independently of the adjustment of the sleeves, and a petcock carried by the spring adjusting means and communicating with one of the casings. Two claims.

1,061,573. APPARATUS FOR REGENERATING STEAM. RICHARD H. STEVENS, OF MUNHALL, PENNSYLVANIA.

Claim 1.—A steam regenerator comprising a vessel to contain a heat storing fluid having a fluid overflow outlet and having a partition separating the vessel into steam-receiving and steam-regenerating chambers, said partition having openings connecting the chambers below the level of the overflow outlet, a steam inlet opening into the receiving chamber, a steam outlet opening out of the regenerating chamber, depending partitions within the chambers terminating above the overflow outlet and forming separate compartments within the chambers, a passage directly connecting the chambers, and a trough in one compartment of the regenerating chamber having a perforated bottom, said trough being positioned above the level of the overflow outlet to receive fluid discharged from said passags and spray the outgoing steam therewith. Six claims.

THE BOILER MAKER

SEPTEMBER, 1913

Boiler Inspection*

BY GARLAND P. ROBINSON†

About one hundred years ago boilers were worked at pressures not usually exceeding 5 pounds per square inch. The workmanship and design were crude; the material unsuitable and little thought had been given to the strains to which the boilers were subjected when at work. It was found necessary to raise these low pressures and explosions occurred. We find that a disastrous explosion occurred in London in the year 1815. This explosion and others were subsequently made the subject of an inquiry by a Parliamentary committee in 1817, which recommended "That boilers should be made of wrought iron instead of cast iron or copper, which had been the materials mainly used previously; that they be inspected and tested, and that there should be two safety valves, each loaded to one-third of the test pressure, under penalties for any excess."

Although the necessity for Government supervision of boilers was pointed out in 1817, locomotive boilers were not made the subject of Government regulations in this country until about 1870, when a locomotive boiler inspection law was passed by the New York State Legislature. This law was afterwards repealed and another law was passed in 1905. A similar law was passed by the State of Ohio in 1910. and other States were at this time preparing to pass inspection laws. The State of Pennsylvania requires the inspection of boilers, but there was no specific law passed. The Dominion of Canada and the States of Indiana and New Jersey also re-

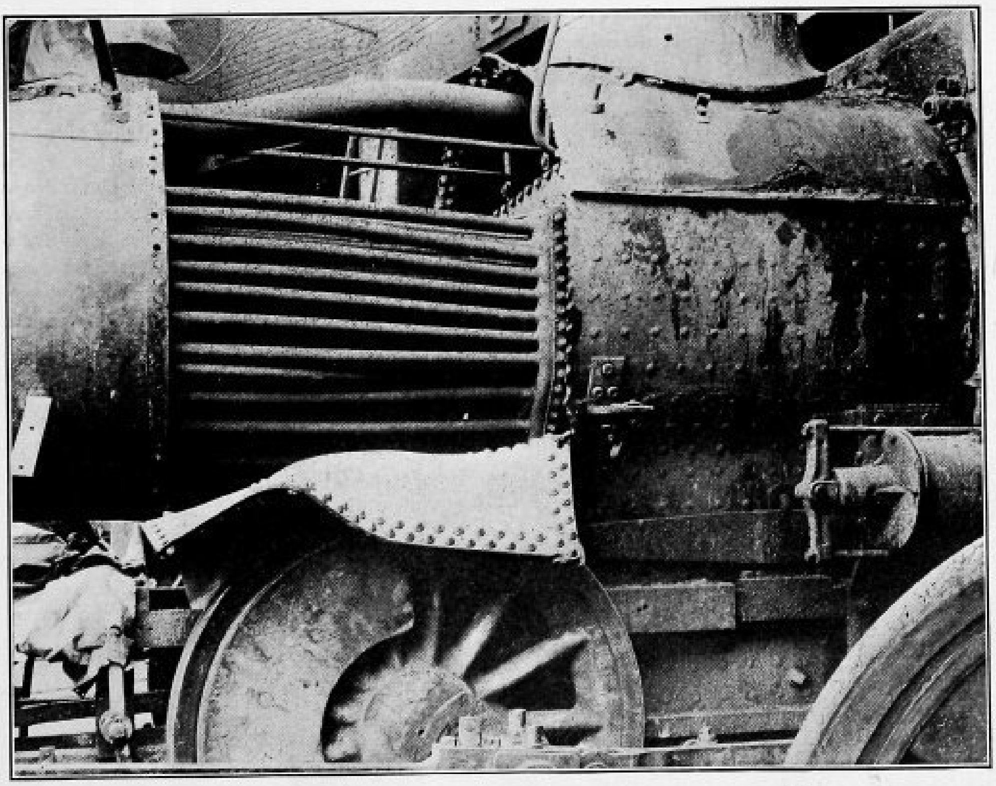


FIG. 1.—BOILER PLATE APPARENTLY CRYSTALLIZED. FACTOR OF SAFETY ONLY 3.44

* From an address delivered before the Richmond Railway Club, Richmond, Va., March, 1913.

† Assistant chief inspector, Division of Locomotive Boiler Inspection, Inter-State Commerce Commission.

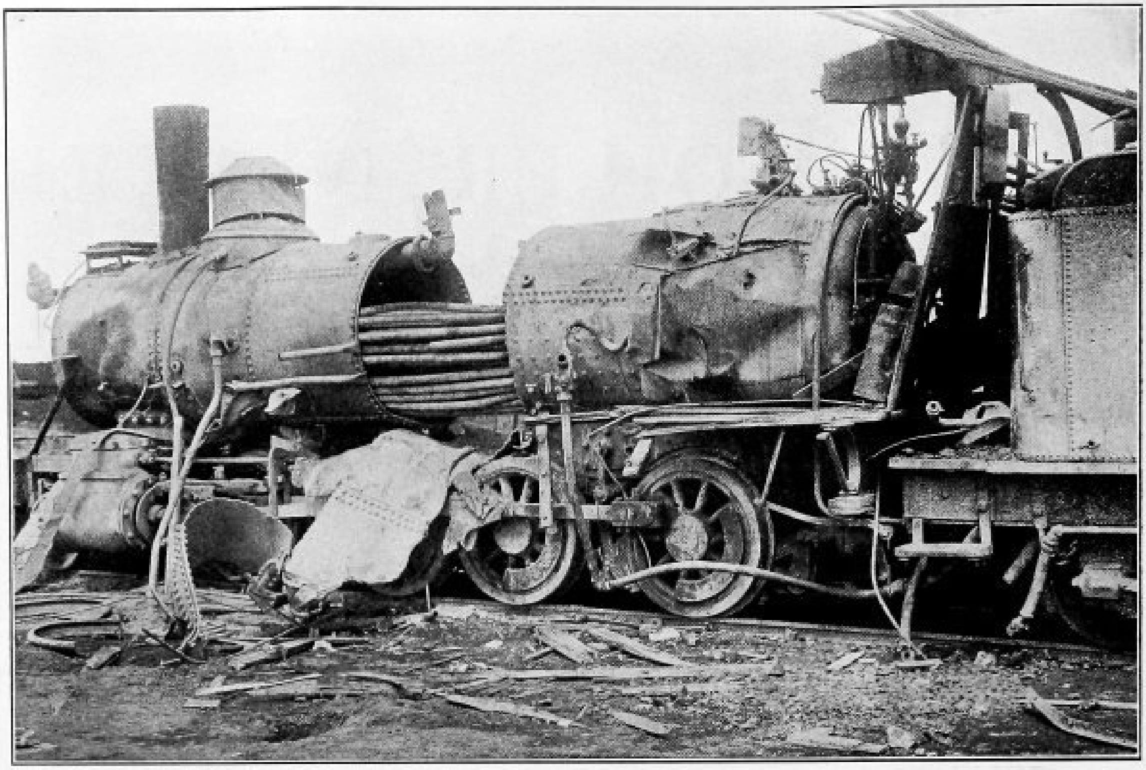


FIG 2.—EXPLOSION CAUSED BY CRACK IN DOME CAP

quire the inspection of locomotive boilers, and their regulations are almost exactly the same as those used by the Federal Government. The Federal inspection law was passed February 17, 1911, and went into effect July 1 of that year. This law, as most of you must know, provides for a chief inspector, two assistant chief inspectors and fifty district inspectors. It also provides for regulations governing the inspection and repairing of locomotive boilers and penalties for the operation of unsafe boilers. The regulations provide for the removal of flues every three years and a thorough internal inspection; the removal of all lagging every five years and a thorough external inspection. Once a year the boiler must be given a hydrostatic test 25 percent above the working pressure. Every eighteen months special examination must be made of flexible staybolts; all rigid staybolts must be tested, boiler washed, gage cocks and water-glass cocks cleaned once a month. The steam gage must be tested, safety valves set every three months. At first there was some diversity of opinion among railroad officials as to what inspection was required, but we find that most officials have familiarized themselves with the regulations and little trouble is experienced at the present time.

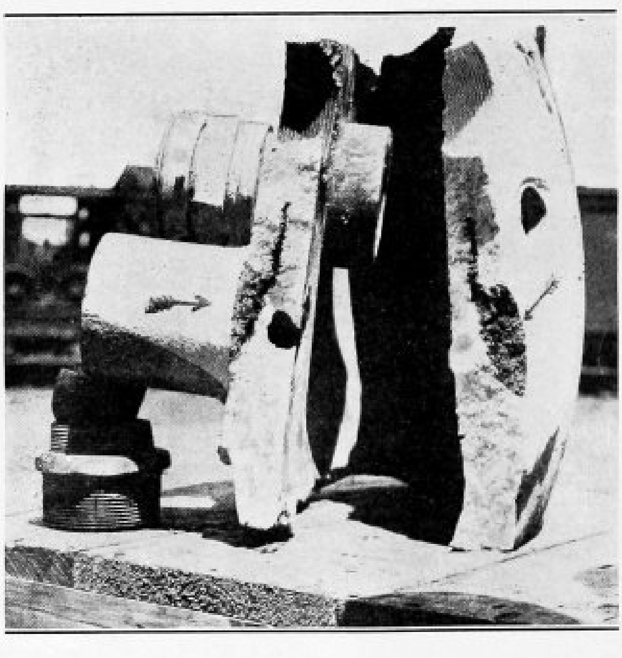


FIG. 3.—DOME CAP

Our inspectors have endeavored to visit all inspection points and explain in detail the manner in which inspections should be made and how reports should be rendered. It should be remembered, however, that district inspectors make no rulings or interpretations. All rulings and interpretations are sent out over the signature of the chief inspector. While a great deal of time was spent during the first year in familiarizing the railroad inspectors with our rules, we found time to inspect 74,234 locomotive boilers. It was necessary to order out of service for proper repairs 3,377 locomotives. We also found 48,768 locomotives defective. You will note that only a small proportion of the defective boilers were removed from service. Locomotives are removed from service for dangerous defects or for violations of the inspection regulations. All defects are reported in order to determine the general condition of the power and to ascertain whether the company is inspecting and repairing their locomotives properly; also to give the proper railroad officials an opportunity to correct minor troubles which in time might cause a serious accident. Tabulations of the results of our inspections are sent to the officials of each company. At first this caused some resentment on the part of a few mechanical officers. They feared that the operating officials would not be able to analyze the statements, and would think that every defect reported was of such a dangerous nature that the locomotives could not be operated. We were not sure that the various companies appreciated our sending monthly statements, giving in detail the results of the inspections, so we discontinued the monthly and substituted

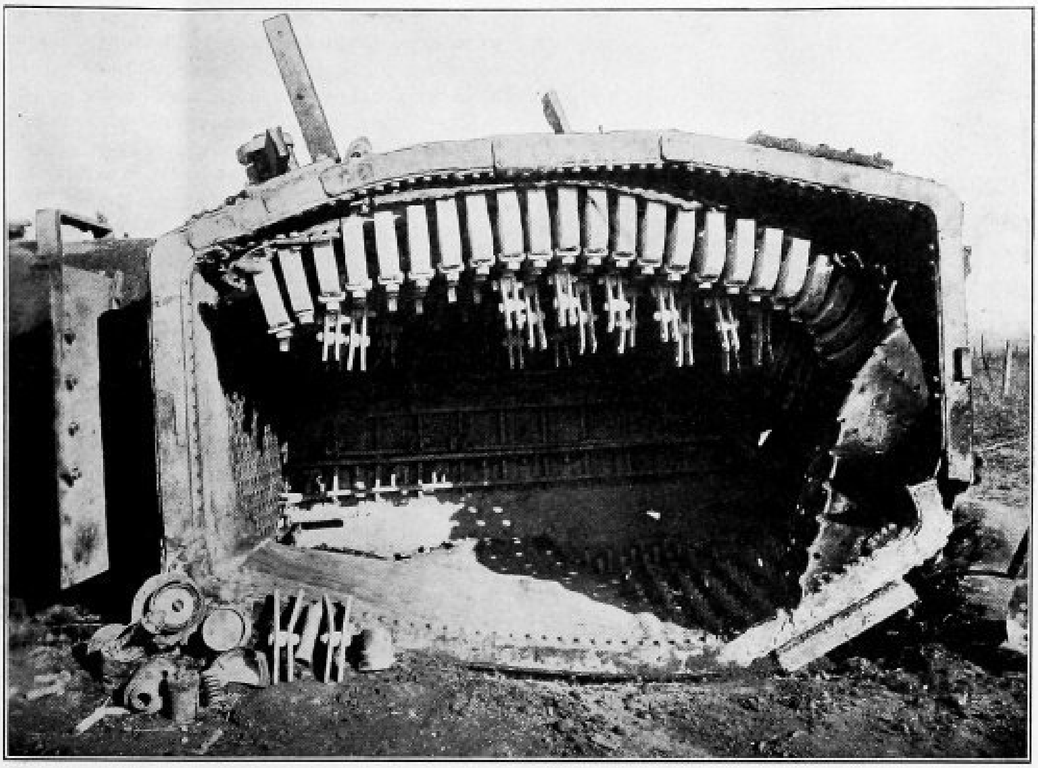


FIG. 4.—EXPLOSION CAUSED BY DEFECTIVE BRACING OF CROWN SHEET

a quarterly summary. We at once began receiving requests for information regarding the defects, and decided that it was necessary to send out the monthly statements giving full details of what our inspectors found in the field. We believe that most railroads are finding these monthly statements helpful in checking their own inspectors and supervisors. We hope all officials will read these statements carefully. Our inspectors are inclined to be lenient and will often report various parts as defective rather than remove a locomotive from service, hoping the company will remedy the condition and thus avoid harsher measures. When water-glass shields, lubricator shields, squirt hose and various other parts are re-

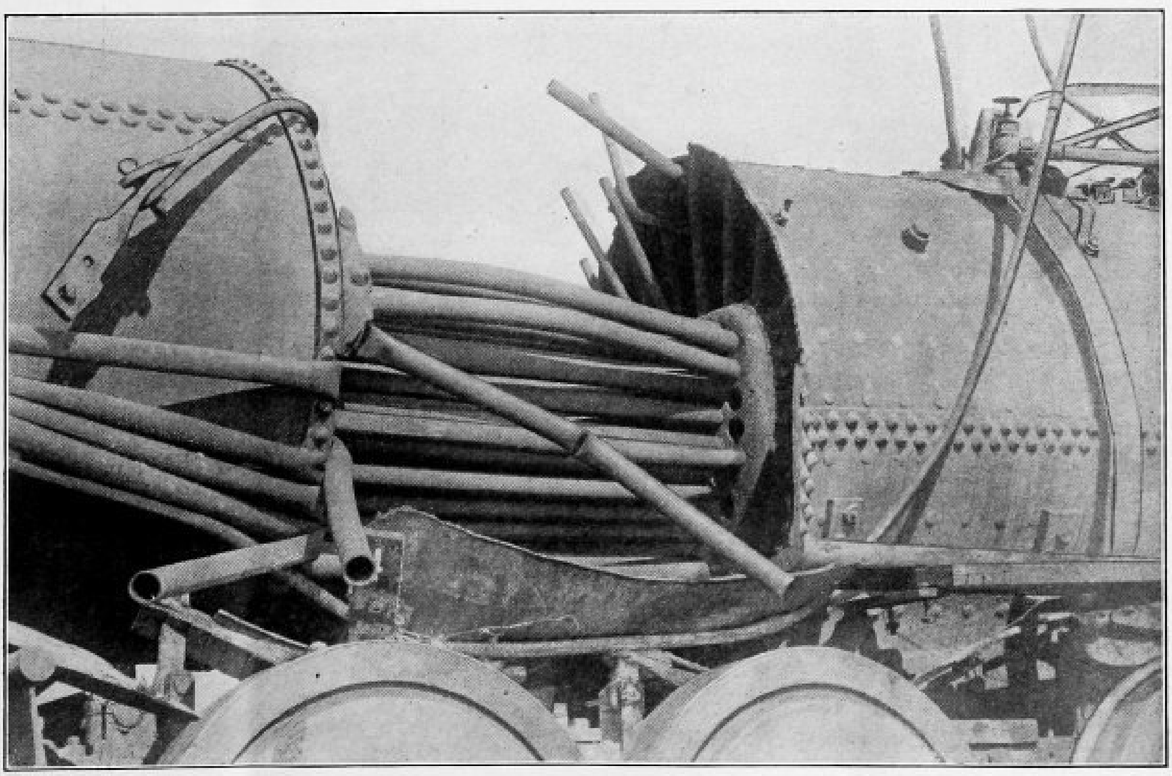


FIG. 5.—BOILER SHELL BADLY PITTED AND CRACKED

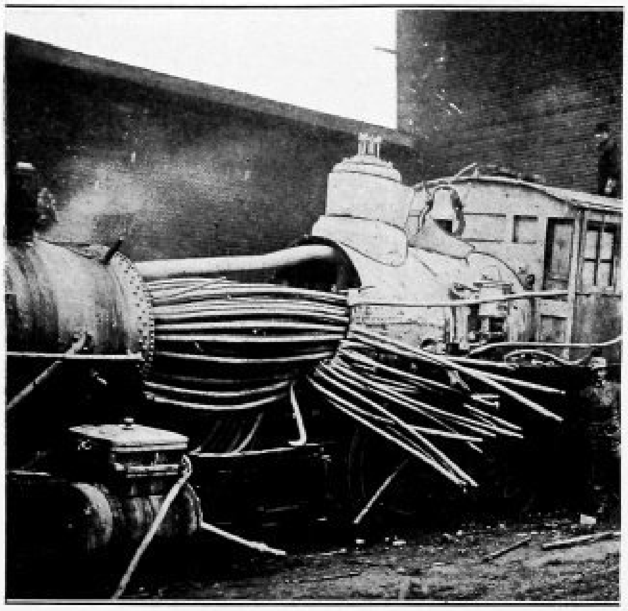


FIG. 6.—EXPLOSION CAUSED BY EXCESSIVE PRESSURE ON DEFECTIVE SHELL

ported defective, the official should at once correct the trouble if he wishes to avoid our inspector removing the locomotive from service on his next visit.

The purpose of any inspection law is to prevent accidents. During the year ending June 30, 1912, there were 856 accidents, resulting in the death of 91 and seriously injuring 1,005 people. We are striving to reduce these accidents, and with the co-operation of the railroads the accidents can be reduced materially at once.

There were 243 accidents due to defective squirt or sprinkler hose during the last fiscal year. Squirt hose accidents are absolutely preventable. The squirt hose can be removed from the locomotive, but we do not recommend this. We do recommend that better hose be used; that the company furnish the hose instead of the engineer being required to furnish same as on one large railroad. We believe that the end of the iron pipe leading to the hose can be turned downward toward the rail so as to avoid the possibllity of an accident should the hose blow off. The hose connection can be made outside of windshield, so that accidents may be avoided even though the hose bursts or is blown off the nipple. An arrangement can be made whereby cold water can be used by

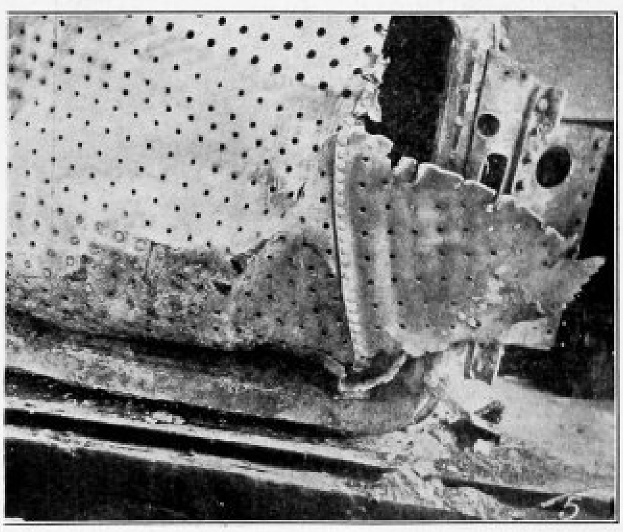


FIG. 7

taking it from a small compartment in the tender tank. I understand that three or more companies are working on designs for air operated squirt hose and several locomotives have been equipped already. Despite the fact that this matter has been taken up with the various companies repeatedly we find that for the quarter ending Sept. 30, 1912, there were 182 accidents due to squirt hose, out of a total of 350 accidents from all causes. In other words, during July, August and September, 1912, 51 percent of all accidents were caused by defective squirt hose. These accidents were caused in forty cases by burst hose and in 127 cases by hose blowing off. The remaining cases were caused by defective valves, broken nipples, etc., and just one accident was caused by the carelessness of the crew opening the injector with squirt hose valve open.

One hundred and sixty-five (165) water-glass accidents, resulting in the death of one and the serious injury of 168 persons, occurred during the last fiscal year. During the first quarter of the present fiscal year 48 water-glass accidents oc-

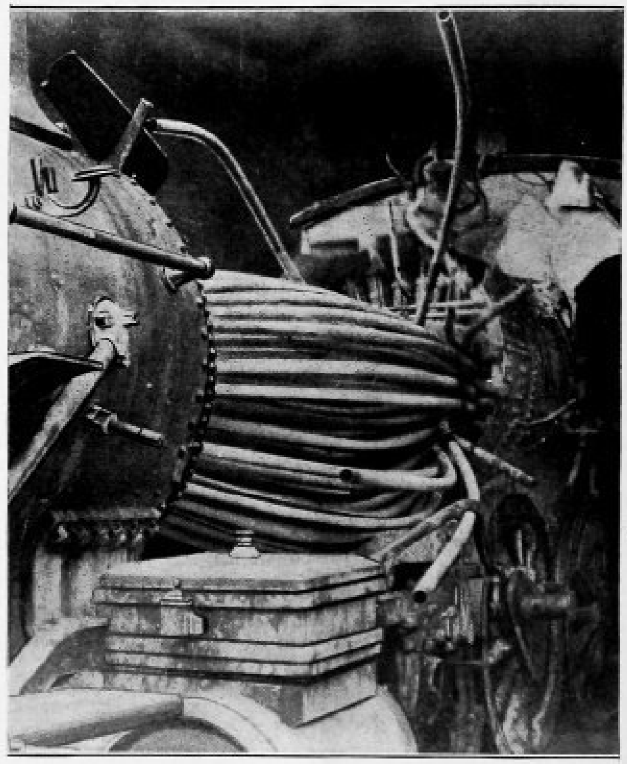


FIG. 8.—EXPLOSION CAUSED BY DEFECTIVE BARREL

curred. Of these 48 accidents 31 were caused by unsuitable shields which allowed glass to fly and seriously injure the crew. Fourteen (14) of the accidents were due to scalding when the men were trying to shut off the cocks after the tubular glass had burst. We believe that practically all the water-glass accidents can be eliminated by the use of the Klinger type glass or a suitable shield for the tubular water-glasses. Several roads have developed shields consisting of heavy metal frames and thick glass panels which appear to be satisfactory. When such shields are used care must be taken to see that there is an opening at the back or bottom of shield to relieve the pressure after the tubular glass breaks. We have found that shields made of slotted pipe, even when used in connection with netting, are unsafe and unsuitable, and will not prevent the glass from flying in case of breakage. We have also found that spiral coils of wire are unsafe shields for water glasses. We have allowed the use of wire netting for water glass shields when the holes in the netting are not larger than one-eighth of an inch, but do not recommend them for the following reasons: If fine mesh netting is used in an effort to prevent glass from flying, the crew will find it difficult to see the water through the netting. The netting becomes clogged with grease and lint and has to be removed frequently. When the crew find that they cannot see through the netting clearly, the shield is removed and often destroyed. If large mesh netting is used it will not prevent glass from flying. If netting of any mesh is used there will always be the danger of scalding when the glass breaks. During the last fiscal year there were 94 accidents due to low water, resulting in the death of 54 and the serious injury to 168 persons. For the quarter ending Sept. 30, 1912, there were 18 low-water accidents, resulting in the death of 10 and the serious injury of 32 persons. Many people believe that all accidents are due to low water. Last year 27 people were killed and 41 persons seriously injured in explosions due to excessive pressure. accident showed that the water-glass, injector and other parts were defective.

In an endeavor to prevent defective locomotives from being dispatched, we have asked the companies to have the enginemen sign reports showing that they have examined the water-glass, gage cocks, injectors and firebox crown sheet just before leaving on a trip. This arrangement is now in effect on several large roads and we believe will accomplish some good.

Two serious explosions last year were caused by carelessness in setting safety valves. These explosions resulted in the death of 27 and the serious injury of 41 persons. We believe the setting of safety valves and testing of steam gages should be done only by experienced workmen, who thoroughly understand the construction, operation and repairing of these appurtenances. We frequently find safety valves which open

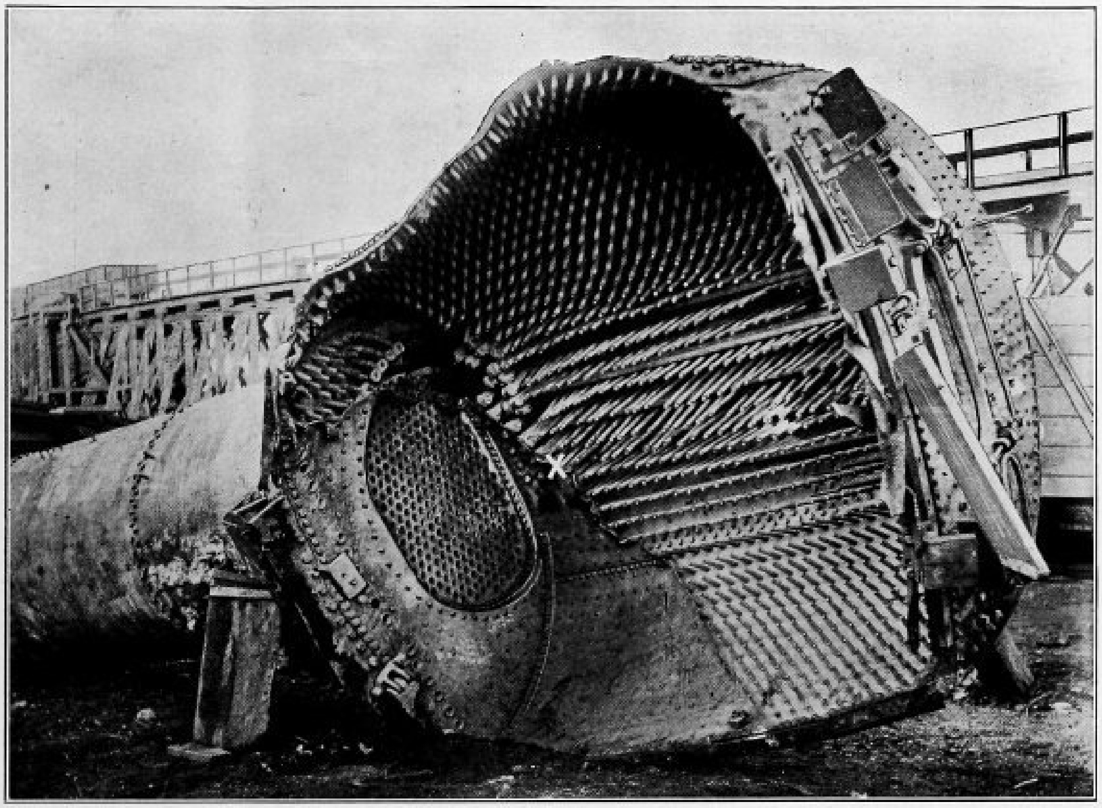


FIG. 9.—LOW WATER EXPLOSION

There were 10 killed and 796 persons injured from appurtenances, flues, etc. Therefore, 40.8 percent of the deaths and 83.3 percent of the injuries were due to defective boilers and appurtenances; 59.2 percent of the deaths and 16.7 percent of the injuries were due to low water. We firmly believe that low-water accidents can be greatly reduced by careful inspection and careful repairs. If locomotives are operated with defective injectors, defective boiler checks, defective hose, defective water glass and gage cocks, the probobility is that the engineer will in many cases be fooled as to the amount of water in the boiler or he will lose the water attempting to adjust some of the defective parts. A case is on record where a machinist closed the water-glass cocks to remove the water-glass tube and forgot to open the upper cock after the repairs were completed. The engineer was evidently fooled by the false water level caused by the upper cock being closed and the boiler exploded a short distance from the shop. In a great many cases examination of the boiler after a low-water

at pressures 10 to 30 pounds above the working pressure. In one case the valves failed to open at 135 pounds above the working pressure. We also frequently find steam gages with the dial hand bent. This is an improper way to repair a steam gage, and indicates to us that the company is not employing competent men for this important work. We have had several boilers explode on account of cracks in the barrels. These boilers had lap joint seams. We believe that boilers should not be built with lap joint seams. To prevent such explosions lap seam boilers should receive a very careful inspection whenever a sufficient number of flues are removed. We frequently find that flues are removed but boilers are not properly scaled. Unless the scale is removed and the interior of the boiler inspected by an experienced man there will be a possibility of sending a cracked, pitted or grooved boiler into service. Many believe that scaling a boiler means simply shoveling out the scale which has piled in the belly or has fallen down when the flues were pulled out. The entire interior should be hammered with suitable tools and a close search made for defects. Our inspectors have found serious pitting recently after the boiler was inspected by company inspectors and flues were being replaced. In such cases our inspectors require the removal of all the flues even though the flues have just been replaced, if it can be shown that the scaling was not properly done. We believe that this is necessary in order to bring the matter before the proper officials. There have been no explosions recently which were caused by broken staybolts or crown stays, although several boilers have in the past exploded from this cause. Many inspectors believe that crown stays need not be tested by hammer test. These stays should be tested for two reasons: First, the inspector must swear to the condition of the crown stays when he swears to the Federal reports; second, because crown stays frequently break, although not as frequently as the short stays. I recently investigated an explosion and found that there were forty-four broken crown stays in the boiler, although the boiler was inspected about one month prior to the accident. In another case 108 crown stays were found broken in one boiler. You readily appreciate that such cases represent dangerous conditions. Some time ago I investigated an accident which was caused by nineteen crown stays being broken. Several companies are drilling tell-tale holes in crown stays, which we believe is good practice.

Your attention is called particularly to the patching of boilers. Locomotives are carefully designed and usually the boiler has a factor of safety of four and a half to five. After a locomotive has been in service a few years the barrel is frequently pitted and cracks often develop. The boiler maker then puts on patches or half courses. He is usually an experienced workman, but may not be able to calculate the strength of the boiler after it has been patched; therefore, he is not in a position to lay out the patch. Before barrels are patched the mechanical engineer should advise the boiler maker what kind of a patch should be applied. We are finding numerous cases of well-designed boilers weakened by putting single-riveted patches on boilers with triple-riveted butt seams. Sometimes the patches are of thinner material than the barrel sheets. Once in a while we find a crack in the barrel which has been repaired by putting in plugs in the manner that small cracks in the firebox are closed up. This is a practice that cannot be too seriously condemned.

Another practice which we believe should be condemned is where the bottom half of two or more courses of a boiler is removed and one long plate used for the entire lower part of the barrel. This is a very bad practice and has caused serious accidents. A boiler accident recently investigated showed that a patch had been applied covering the lower portion of three courses of the barrel. The metal grooved, as was to be expected, and the boiler finally exploded.

We believe that a number of accidents can be avoided if spanner nuts on main steam valves and injectors were done away with. Frequently main steam valves are placed so near the cab roof that a spanner wrench cannot be used; also many times engine houses do not have proper wrenches and a cold chisel is used. This is a vicious practice and has caused serious accidents. Joints in copper pipes can be held by bolts, as has been demonstrated by one or more manufacturers of injectors. Great care should be used in brazing the pipe. The manufacturers should be required to furnish brazing nipples of a proper composition, if cracked nipples and serious accidents are to be avoided.

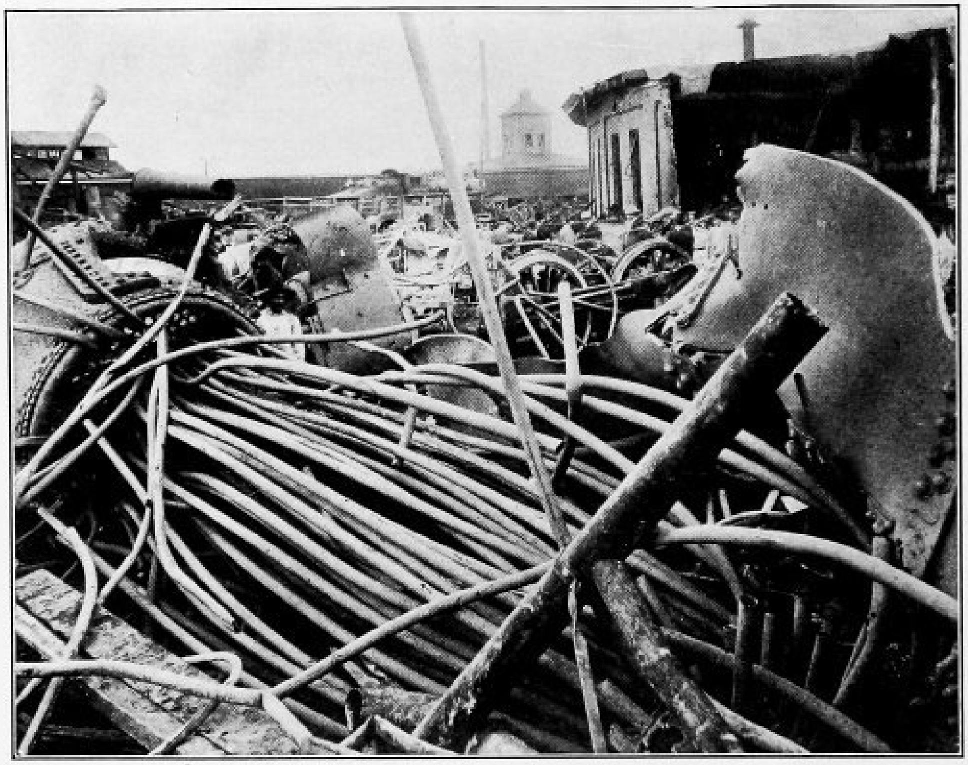


FIG. 10.—HAVOC CAUSED BY TAMPERING WITH SAFETY VALVES

Fig. 1 shows an explosion which occurred in New England. The sheet was torn through the rivet holes of the longitudinal seams on both the right side and left side. Examination showed that there were no cracks or flaws in the sheet but the sheet appeared to be crystallized. Locomotive was sixteen years old and the steam pressure 150 pounds.

The safety valves were blowing at time of accident. The locomotive was hauling a train at a speed of about 15 miles per hour, and the factor of safety was calculated to be 3.44. This explosion illustrates the need for a large factor of safety.

Fig. 2 shows an explosion caused by a crack in the dome cap. It was a radial stay bolier, with a working steam pressure of 145 pounds per square inch. The third course of the barrel, on which was located the dome, ruptured and was blown entirely away from the boiler. An examination, after the accident occurred, showed that a crack had opened at the base of the whistle boss on the cast iron dome cap, and this crack had extended into a flaw in the interior of the castings, thus weakening the cap to such an extent that failure took place, resulting in the rupture of the third course of the barrel. Fig. 3 shows the dome cap of locomotive. The extent of the old cracks can be plainly seen.

The explosion shown in Fig. 4 occurred in Indiana, and was caused by defective bracing of the crown sheet in a crown bar boiler. The working pressure was 160 pounds per square inch. Twelve crown bar braces were defective on account of seven pins missing, four pins broken and one brace broken. Scale was found in the crow-foot holes, where pins should have been, showing that the pins had been out for some time. The boiler was blown 222 feet by the explosion.

In Fig. 5 are shown the results of an explosion which occurred in Southern Alabama. A narrow firebox, radial stay boiler, 52 inches diameter, with a working steam pressure of 120 pounds per square inch, was equipped with two 2½-inch old-style Richardson open-spring safety valves. An interior inspection had not been made for seven years. The second course of the barrel was ruptured. The upper half of the sheet with the dome was blown 1,000 feet from the point of the explosion. This sheet was seven-sixteenth inch thick and was badly pitted. The longitudinal seams on either side were double riveted lap joints. This sheet was cracked at the edge of the longitudinal seams on both right and left side, almost through the sheet. The depth of crack varied from one-fourth to three-eighths inch deep. The sheet was also badly cracked at circumferential seam between the first and second courses.

The explosion shown in Fig. 6 was caused by excessive pressure and a defective barrel on a radial stay boiler, designed for a working steam pressure of 165 pounds per square inch. The boiler was built in 1887. The plate which failed was applied in 1905, and was three-eighths inch thick. Circumferential seams were single riveted lap joints. Longitudinal seams were double riveted lap joints. The locomotive was equipped with two old-style Richardson open spring safety valves. One day prior to explosion the steam gage syphon pipe was reported leaking and the safety valves blowing at a pressure exceeding the working pressure. At the time of the accident an employee was engaged in setting the safety valves. After the accident occurred the safety valves were tested up to 300 pounds pressure per square inch, but the valves failed to open. The first and second courses of the barrel were ruptured and blown away. An examination of the longitudinal seams of the first course showed that there was an old crack 40 inches long at the edge of seam. The crack was five-sixteenth inch deep for 8 inches and from one-eighth to three-sixteenths inch deep for 32 inches. The explosion was so violent that the front axle of the locomotive was broken. All boilers in this class were condemned.

The explosion shown in Fig. 7 occurred recently in the Northwest, and was caused by the water being driven away from the sheets, due to the character of water used and forced oil fire. Practically all of the firebox above the brick work, with the exception of the front part of crown sheet, was overheated. Two fusible plugs located in highest part of crown sheet did not fuse. These plugs were afterwards removed and were found to be in good condition, fusing at or about the proper temperature.

Fig. 8 shows an explosion caused by a defective barrel. It was a crown bar boiler, built in 1887, with a working steam pressure of 165 pounds per square inch. In May, 1905, a patch, three-eighths inch thick, 48 inches wide and 118 inches long, was applied to the belly of the boiler. Practically the entire barrel was torn from the boiler. The explosion was so violent that a driving-wheel axle was broken, and a barrel sheet, about 12 by 14 feet, weighing approximately 2,600 pounds, was blown about 1,200 feet from the scene of the explosion. An examination of the large patch indicated that the sheet ruptured along the seam on the right side of boiler and also through the line of rivet holes in front flue sheet. The large patch was found to be pitted in a large number of places and grooved along edge of longitudinal seam. The plate was also found to be very brittle.

An explosion caused by low water in a Wooten boiler is shown in Fig. 9. The working pressure was 180 pounds per square inch. At the time of explosion the level of the water was 3½ inches below the highest part of the crown sheet. About ten months prior to this accident the crown sheet had been overheated on account of low water and the boiler was repaired by renewing a number of radial stays.

Excessive steam pressure was responsible for the damage shown in Fig. 10. The boiler was allowed a working steam pressure of 200 pounds per square inch. The crown sheet was supported by T-bars and oil was used for fuel. The locomotive had just received heavy repairs and steam pressure was being raised preparatory to putting locomotive into service. An employee of the railroad company was engaged in setting the safety valves at the time of the explosion. An examination of the safety valve indicated that the adjusting screws had been screwed down more than five-eighths of an inch, which allowed a steam pressure to accumulate. It is probable that the steam gage did not indicate the correct pressure. The explosion completely destroyed the locomotive and badly damaged the surrounding buildings. One part of the boiler, weighing about 16,000 pounds, was blown a distance of about 1,200 feet. Another part, weighing about 900 pounds, was blown a distance of about 2,250 feet. Tests made of various parts of the boiler indicated that the steam pressure at the time of explosion must have been greatly in excess of the working pressure.

A New Use for the Oxy-acetylene Torch.—Cleaning boilers of scale by means of an oxy-acetylene flame does not at first thought seem to be within the range of possibilities, but Mr. Adolph Schror, of London, England, has demonstrated it is not only practical but more economical and efficient than the older methods. The heat of the torch is applied directly to the scale, which, due either to expansion within itself or expansion of air or moisture between it and the plate, becomes detached. To demonstrate that the heat of the flame does not injure the metal under the scale, a piece of the scale about ⅜ inch thick and 6 inches square was held on the operator's hand, and after a full minute's application of the flame to the scale, the temperature on the under side was not uncomfortable. This practical demonstration of the insulating property of scale emphasizes the necessity for its frequent removal if economical operation of the boilers is desired. Tests have proven that there is a loss in heat transmission of 10 or 12 percent for each ⅛ inch of scale thickness.—*Ryerson's Monthly Journal.*

Meeting of Executive Board of Master Boiler Makers' Association.—A meeting of the executive board of the Master Boiler Makers' Association will be held at the Hotel Sherman, Chicago, Ill., Sept. 27, at 9:30 A. M., for the purpose of selecting the time and place for the annual convention of the association in 1914.

John and the Geometrical Cones

BY JAMES F. HOBART, M. E.

"John, what on earth are you trying to do with that 8-foot extension on the long tram?"

"I'm trying to lay out a big cone, Mr. Hobart, and the blamed thing don't seem to come right worth a cent."

"Let's see what you are after, John? Oh! that's it, eh? Fig. 1 shows it, you say? Sort of roof-cone and sleeve business, isn't it? Well, that's all regular and in the day's work. What is the matter? Why don't you lay out that cone and develop the surface, then mark it out on stock and have it sheared out? No. 14 gage, is it? Well, just develop it right on that big sheet over there and see what it looks like."

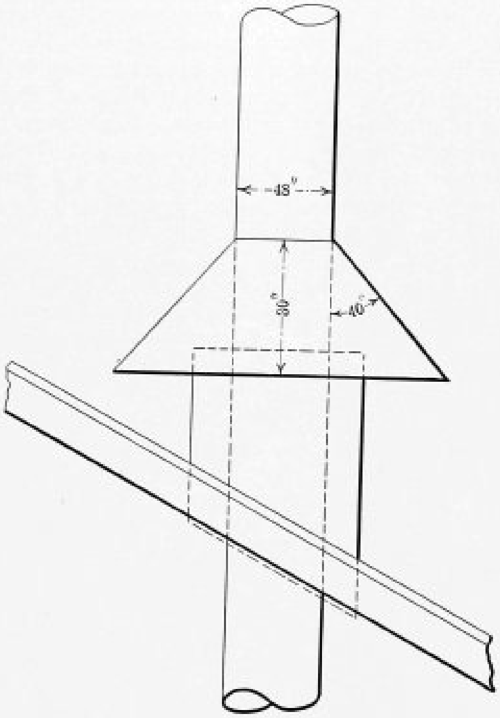


FIG. 1.—STACK HOOD

"But that's just the trouble, Mr. Hobart. The blamed thing don't seem to develop worth a cent."

"Go to it, John. You're rattled a bit, that's all. Just draw the diagram shown by Fig. 2, and set to work to determine the dimensions *A*, *B* and *C*. When those are found you will be ready to lay out the cone, and I'll show you a couple of ways for doing that work."

"Yes, Mr. Hobart, but that's just what bothers me. The hood is 30 inches high and 24 inches across the top, but what it measures on the slant is another matter, and I don't see any way of calculating that length *A* or distances *B* and *C*. How can it be done?"

"Here is one of the places, John, when a bit of geometry is worth its weight in gold a dozen times over. With geometry the solution of this problem is dead easy. Without geometry it will sure make you go some to figure out the matter. Now throw away one-half of the cone and lay down what you have of the other half, as in Fig. 3. Sketch in the dotted lines, making them at an angle of 40 degrees by means of a protractor or table of sines, as directed in a previous talk. Measure the lines until you find a point where they are exactly 24 inches apart, then draw in the line to represent the top of the cone or hood. Draw another line parallel with and 30 inches below to represent the bottom of the cone when standing on the floor. We want the distances *A*, *B* and *C*, and we have only the width of the top, 24 inches, and the height 30 inches."

"Say, Mr. Hobart. I can measure these lengths now and scale them pretty close. Won't that answer as well as calculating?"

"Yes, measurements are all right provided the drawing is made carefully and on a pretty large scale, but what would you do if you trusted to measurements and then a job came along which must be figured exactly? Isn't it better for us to figure this job in order to find out just how such a problem is solved? Then we can check the work by measurements, and work to the latter figures if we want to do so."

"I guess that's right. If I know how to figure such an example, also how to do it by measurements, then I sure won't fall down on any job the old man may poke at me. Just 'show me,' Mr. Hobart, and I'll be right along from Missouri in a hurry."

"Then the next thing to do, John, is to get rid of one-half the problem shown by Fig. 2. We need only solve one-half

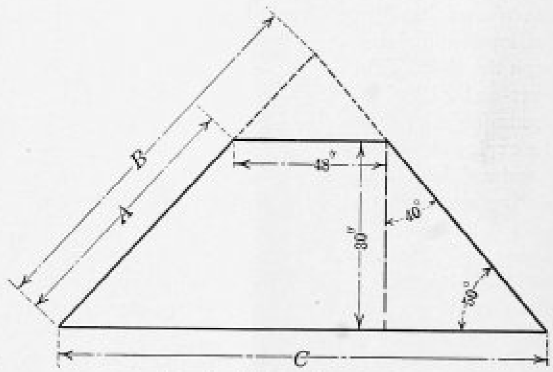


FIG. 2.—DIAGRAM OF HOOD

of the triangle, the other half will take care of itself, and we have then the old reliable right angle triangle to work with in place of the double-barreled figure shown by Fig. 2. In Fig. 3 we cut the width—48 inches—in two, and have to do with a plain right angle triangle, the base being 24 inches, the height unknown, but having an angle of 40 degrees at the top and 50 degrees at the bottom. Now, hark back to the talk we had about sines and cosines some time ago, and see what would happen if we called the half-width, 24 inches, the sine of the 40-degree angle. In that case wouldn't the sloping side—the hypotheneuse—be the radius?"

"I believe it would, Mr. Hobart. If we just turn the picture down on what is now the vertical side, then the 24-inch side will lie just as the sine does in the sketches we had of that."

"Right you are! Now, look in your book of sines and take out the sine and cosine of a 40-degree angle—.64279 and .76604, are they not? Then if the sine of an angle with a radius of 1 is .64279, will not the radius be as many as .64279 is contained in 24, which is 37.3? Therefore the slant height of the little dotted triangle in Fig. 3 is 37.3 inches long; and if the radius of this cone angle is 37.3 then the vertical height of the little dotted triangle must be $37.3 \times .76604$; therefore the height of the dotted triangle is 28.55 (slide rule calculations), making the total height of cone and triangle 58.55 inches."

"Say, Mr. Hobart, it beats all how you can make geometry work out problems when you are broke to it. Gee! I wonder if geometry is what makes the world go 'round?"

"Hardly, John, but geometry is what made it possible for men to find out all about just how and when the world and thousands of other planets do go 'round. Geometry is just a sort of a tool. It will help you do work easy which is hard by other methods, and the better you understand geometry the easier and better you can do a whole lot of work you would otherwise be 'stuck on.'"

"Say! How are we going to get the length of the sloping side and the distance across the bottom of the triangle? These are the measurements we want, but I don't see them coming our way yet."

"They'll come in right good time. Now take a look at that dimension, 58.55. Now isn't that quantity—58.55—really the cosine of the length of the whole sloping side of the triangle? And if so, how are we going to find the length of it?"

"Say, I just believe that's what. The distance 58.55 is the cosine of a radius having an angle of 40 degrees; now, if we just divide .76604, the cosine of radius *L*, into 58.55, we obtain 76.4, which is the length of slant side of the triangle shown by Fig. 3; and, Mr. Hobart, if we multiply 76.4 by the sine of 40 degrees = .64279, won't we get 49.2, the length of the bottom of the triangle and half the bottom width of the cone, won't that bring it right?"

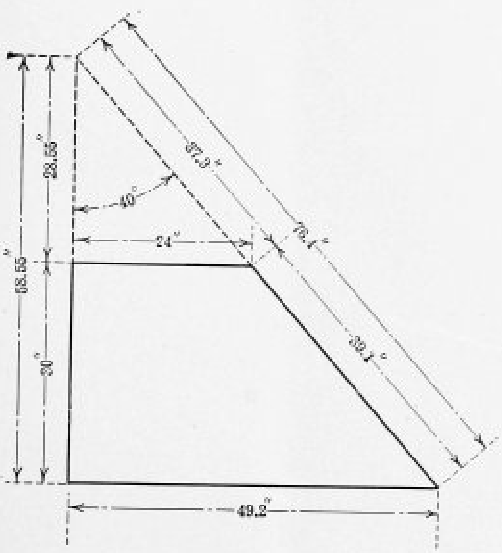


FIG. 3.—GETTING CONE DIMENSIONS

"Right you are, John, and I sure am glad you catch on so quickly. Just keep it up. Practice and think a whole lot, and geometry will be yours to do anything with it that you wish to accomplish. Now, let's see you get busy and work out the cuts for that cone sheet. Don't you think you can do it all by your lonesome with the start you have got?"

"I'll make a stab at it. I believe the dimension 76.4 is what we have been working for, isn't it?"

"Yes; both 76.4 and 39.1, which is the length on the slant of the cone sheet. And, John, just tell me how we got the length of the cone sheet 39.1?"

"Huh! That's dead easy. Just subtract 37.3 from 76.4, and there you are! Is that right?"

"That's O. K. Now, what are you going to do next?"

"I believe that 76.4 is the radius of the circle to which the cone sheet is cut, is it not? And don't I draw a part of a circle as in Fig. 4 and lay off a part of it for the cone sheet, and let the rest of it go into waste?"

"Correct, John."

"And then I'll strike another circle just 39.1 inches inside the first or outer circle, and the smaller circle is the top line of the cone, while the larger circle is the bottom?"

"O. K. again, John; but now let's see you get the length of the sheet so the cone will be just 98.4 inches in diameter and 30 inches high when it is rolled up and riveted together."

"Say, Mr. Hobart, that's a cat of another color entirely, and I will have to study it a bit before I find a way to lay off the right length. But say, what difference does it make, anyway, whether or not the cone is exactly so many inches across the bottom or just so high within a fraction of an inch?"

"Probably it won't make the least difference in the world, John, to the cone, but it will make a heap of difference with you. If you are able to lay out that cone so it comes exactly to the right diameter, height and angle, then you have learned how to do such work, and can undertake any similar piece of work with confidence, so that it will come out as close as is necessary; but if you slouch along and have to cut and try to get an approximate fit, then the old man will be onto you mighty quick when it comes to giving you a job in which exact results must be obtained. Therefore, go through this time by the exact route, and next time, and in practice, where it will do no harm, then you can use the 'approximate route' and save many an hour thereby. But be sure of the know-how of exactness before you try any short-cuts."

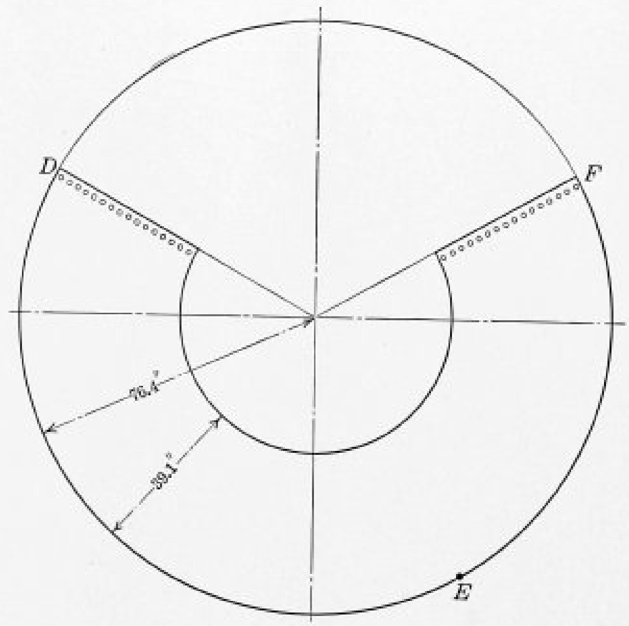


FIG. 4.—LAYING OUT THE CONE

"All right, Mr. Hobart. Now I've got a measuring wheel here which is just 24 inches in circumference. How will it do to figure the circumference of the bottom of the cone, then run around on the line *D E*, Fig. 4, until just the right distance has been laid off? Won't that do the trick?"

"That is one way by means of which you can get there, but it isn't a scientific way at all. In fact, it is only a little better than lapping the cone sheet and cutting it off when the taper looks about right. The proper way is to find the circumference of the bottom of the cone, which is 98.4 inches in diameter. The circumference of such a circle would be about 309.13 inches. Adding 2 inches for lap would make 311⅛ inches, nearly.

"But the circumference of the cone sheet circle, 152.8 inches in diameter, is about 475 inches, and to find the number of degrees to set off for the cone sheet just make a fraction of the two numbers above obtained, and multiply by that fraction

360, the number of degrees in a circle, thus: $\frac{311.13}{475} \times 360 =$ 235 (by slide rule calculation), and $360 - 235 = 125$; that is the number of degrees to cut off and reject from the circle *D E*, Fig. 4. In fact, the cone takes mighty close to two-thirds of the circle, and from *D* around *E* to *F*, where the sheet may be cut off, but should be left a trifle long at the inner circle, to make the lap the same there as at the larger diameter, where it is 2 inches."

"Oh, I see! If we cut right on a radius line the lap would be too little at the top of the cone. Say, Mr. Hobart, why not mark the plate or sheet to 309.13 inches, the exact length required for the cone proper, then allow 2 inches all along the lap edge?"

"That's a good way to do it, John, and one which is used a good deal. But there is danger of forgetting to allow for lap after the sheet once gets away from the layer-out, therefore the marking had better be done, once for all, when the radius lines are laid out—then there can be no mistake or omission."

"Say, is the cone properly laid out as shown by the heavy lines in Fig. 4? And will it come to the proper height and top diameter when rolled up?"

"Yes, if you have made no mistake in the figures the cone will come all right, and it will make a good job, too, if you can bend it without marking the sides with a lot of straight lines."

"Say, that's no joke, either, but Bill Smith showed me how to roll up a cone by setting the rolls further apart at one end than at the other, and I guess I can do that stunt all right. But that radius is so big that it is hard work to get it on a sheet, and we will have to use two sheets at least to make the cone from. Is there any way by means of which I can lay out a big circle without the tram, or without the use of ordinates as described a month or two ago?"

"Yes, John, there are several ways, and I'll show you one right here and now. It is a bit of work, though, and it will pay to use it only in case of very large work, when there is something in the way so you can't get a string or a straight-edge to the center?"

"How would you do it with a sheet like that shown in Fig. 5?"

"Just draw the lines *I J* and *L K* through three points in the circle, preferably not more than a semi-circle. At *G H M* a segment is shown of less than a semi-circle, but at *I J K* a full semi-circle is shown. Draw the lines *I J* and *L K* parallel, and through the three points of the circle given; then draw light lines *L K* and *K I*, and divide these lines into any number of equal parts. Draw the line *I L* from center *K*, and also draw a similar line from *J*, and divide this line and line *I L* into as many equal spaces as were put into *I K* and *K L*. Draw lines from points in line *I L* to point *K*, and where these lines intersect corresponding numbered lines drawn from *I K* will be points in circle circumference *I K J*, and these points are to be connected for the desired circumference."

"Phew, Mr. Hobart! That's some geometry for 98 degrees in the shade, and I move that we adjourn to the ball game. I want to chew over that geometry cone and circumference business a bit, but I believe I see how it works and I'm just going to salt it down with a whole lot of other geometry stuff in the back of my head where I can get it in a hurry when needed, but where old 'forgetit' never can get hold of the dope. So long, Mr. Hobart, much obliged."

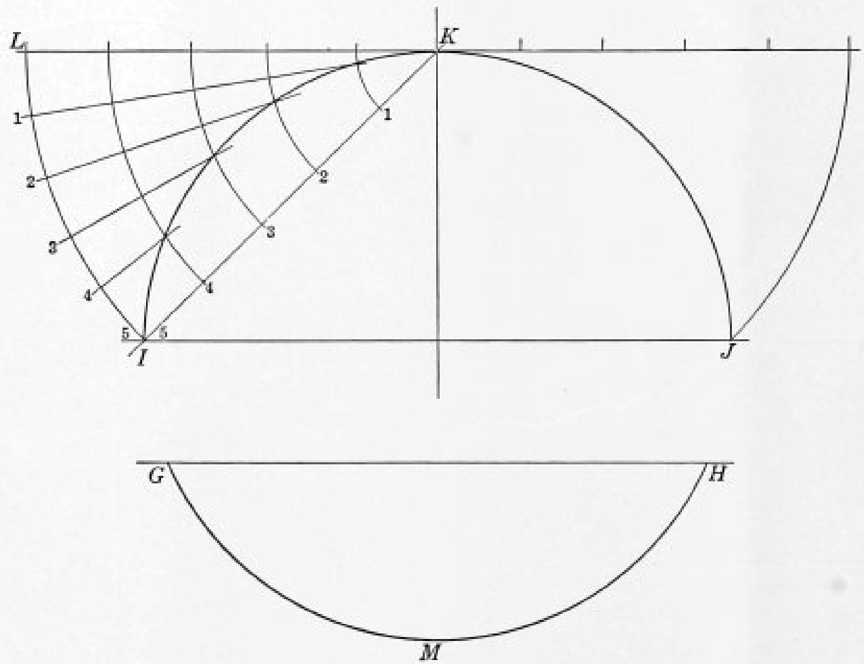


FIG. 5.—DRAWING A CIRCLE WITH UNKNOWN CENTER

Personal

HENRY L. WRATTEN, superintendent of S. Freeman & Sons, Racine, Wis., resigned Aug. 1 to take a well-earned rest. Mr. Wratten has been associated with the firm for over twenty-five years, and for the last seven years has been superintendent of the large boiler works.

M. L. LAUERMAN, formerly superintendent of Willis & Sons Company, has opened a sheet metal shop in Galesburg, Ill., under the name of the Galesburg Sheet Metal Works, for general metal work.

HENRY GOODAPPLE, of Cedar Rapids, Ia., well known among the boiler makers of his State, died suddenly of heart failure July 20 at the age of 72.

Boiler Manufacturers' Annual Convention

The twenty-fifth annual convention, or silver anniversary, of the American Boiler Manufacturers' Association was opened at the Hollenden Hotel, Cleveland, Ohio, Monday afternoon, Sept. 1, with the president, Col. E. D. Meier, in the chair. Hon. Newton D. Baker, Mayor of Cleveland, warmly welcomed the members and guests of the association to the convention city.

After Col. Meier's response to the address of welcome, Mr. A. V. Cannon, a member of the committee on Uniform Boiler Specifications of the National Conference on Uniform State Laws, addressed the convention,* giving a résumé of the various boiler laws which have so far been enacted in the several States of the United States, and referring to the difficult nature of any effort to harmonize them. The speaker said that this would be done only with the assistance of experts

COLONEL E. D. MEIER, PRESIDENT

thoroughly familiar with the construction and operation of boilers, and some thorough agreement would have to be arrived at before the Conference on Uniform State Laws, which is composed of commissioners appointed by the Governors of the various States serving without pay, and many of them paying their own expenses, could take the matter up and support the movement for uniform laws.

Col. Meier, in response, thanked Mr. Cannon for his careful elaboration of the matter, and agreed with him in the general statement that the principles of construction must be laid down by boiler experts. In many directions this had already been accomplished; the fundamental principles of safe boiler construction being now pretty universally acknowledged, and capable of being drafted into simple and brief legal form for uniform adoption by the various States. Variations in minor details will always, of course, be necessary and can with safety be left to local boards which would no doubt in time be appointed by the States, all of them.

* This address will be printed in the October number.

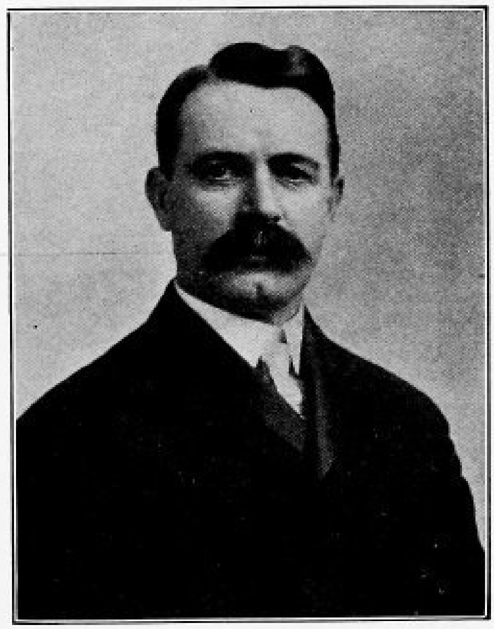
Mr. George A. Luck, chairman of the Board of Boiler Rules of the State of Massachusetts, and also chief deputy of the Boiler Inspection Department of that State, was then introduced, and made a short address, which was listened to with attention. He gave the following interesting data as compiled from the records of the board, viz.:

Number of boilers constructed to Massachusetts Standard from May 1, 1908, to August 27, 1913, 9,377; Nov. 1, 1911, to Oct. 31, 1912, 2,002; Nov. 1, 1912, to Aug. 27, 1913, 2,245.

Number of reports of boiler inspections received from nine insurance companies authorized to inspect and insure steam boilers in Massachusetts from Nov. 1, 1912, to Aug. 27, 1913, 13,455.

Number of insurance inspectors holding certificates of competency, 106.

Number of manufacturers authorized to construct Massachusetts Standard boilers throughout United States, 104.



J. D. FARASEY, SECRETARY

Mr. Luck read for the information of the convention the recently enacted statute relating to the construction and inspection of tanks for the storage of compressed air for the use of pneumatic machinery which went into effect on the 8th of this month, ninety days after its passage. This law refers only to compressed air used for pneumatic machinery, and has no reference to compressed air tanks for hydraulic machinery, regulations concerning which have not yet been formulated. Mr. Luck further stated that the recommendations contained in the back of the Book of Boiler Rules of the Commonwealth of Massachusetts have been stricken out by vote of the board recently, and the next issue of the rules will not contain these recommendations. One of said recommendations that has been thus eliminated was that no externally-fired boiler shall be made greater than 84 inches in diameter. Mr. Luck stated that the maximum thickness of material in the shell of said boilers would hereafter govern the diameter and also the pressure, instead of a specific limit stated.

This closed the proceedings of the afternoon, an adjournment being taken until 9:00 o'clock Tuesday morning.

TUESDAY MORNING SESSION

The following convention committees were appointed by President Meier:

Auditing—J. Don Smith, George N. Riley.

Time and Place of Next Meeting—H. J. Hartley, T. M. Rees, J. Don Smith.

Nominations—A. J. Schaaf, W. J. Kehoe, B. Scannell.

In response to an invitation the members of the National Tubular Boiler Manufacturers' Association, who were holding sessions of their own in the same hotel simultaneously with the A. B. M. A. convention, came into the room to listen to the report of the committee on uniform specifications.

Report of Committee on Uniform Boiler Specifications

Our report of March 14, 1912, was printed and sent to all members of the association on May 25 of that year, with a circular by the secretary asking for criticism and suggestions. To this circular only seventeen members replied, and as they all approved of the report as a whole the presumption is that those who did not reply are satisfied with the report and found no reason for further discussion or criticism.

The suggestions of those who did reply have been carefully considered by the committee and are given due weight in the amendments and additions below.

For the benefit of those who have not followed our work and discussions since 1897, we here repeat the short historical review contained in our report of 1912:

This movement was inaugurated in 1889 at the first convention of this association, held in Pittsburg, Pa. The first practical action taken was to formulate certain specifications in regard to materials. At that time the general trend toward the substitution of steel for iron in boiler construction was in its beginning. After the first committee on specifications had formulated rules for steel a demand was made and a motion passed instructing the committee to report also specifications for iron. This was accordingly done, but there is no record of these specifications for iron ever having come into practical use.

The specifications for steel were formulated after hearings given by the committee to engineers and metallurgists representing the steel manufacturers; and the first report was discussed in every detail on the floor of the convention to which the representatives of the steel interests contributed, having been accorded the privilege of the floor for that purpose. The consequence was a fair compromise on mooted questions which gave satisfaction to both our membership and the steel makers.

In subsequent years a number of committees on uniform boiler laws were appointed, and all of them did yeoman's service in the various States in which boiler laws were proposed. Not a single one was successful, for after the most strenuous efforts, with able arguments in which members of various societies of practical engineers co-operated, the measures were in each case defeated by adverse interests, mainly those dominated by manufacturers engaged in the mass production of small boilers for agricultural and oil boring industries.

In the meantime, during eight following conventions, topical discussions on methods of manufacture were held in which the leading practical boiler manufacturers of the country took part.

In 1896 the two committees on materials and on uniform boiler laws were merged into the committee on uniform American boiler specifications. After a preliminary report in 1897 to the ninth annual convention, this committee was instructed to prepare a complete set of boiler specifications based on the results of the experience embodied in the topical discussions referred to.

In the summer of 1898 the committee met at Atlantic City, and elaborated a set of rules covering in a practical and general manner all the important details of materials and workmanship.

These were reported to the tenth annual convention at St. Louis in October, 1898, and after a discussion occupying three full days, in which every article was carefully discussed and many modifications adopted, the convention on Oct. 6, 1898, unanimously adopted the specifications thus amended. They will be found in full with the discussions preceding their adoption in the Proceedings of 1898. The chairman was then instructed to edit all this material with a view of cutting out any superfluous matter and arguments and stating the conclusions in short and mandatory sentences. This was done in thirty-one short paragraphs divided into five sections, viz.:

(1) Materials.
(2) Workmanship and Dimensions.
(3) Factor of Safety.
(4) Hydrostatic Pressure.
(5) Hanging or Supporting the Boiler.

In this form these uniform American boiler specifications were widely distributed in the United States as well as in foreign countries, and in consequence they were frequently embodied in specifications from engineers asking for bids on work. In the conventions of 1905, 1909 and 1910 they were further discussed and modified, such changes as were found necessary being in every case adopted by unanimous vote.

The attempt to have these specifications adopted into the laws of various States was formally abandoned by a general agreement among those most active in the work that an educational campaign would have a wider and more permanent effect, and that a general acquiescence of parties interested, either as producers or consumers, must precede all legislation.

Our association can justly claim that its work on these lines had a determining influence in the movement toward State and municipal laws which has been in progress during the last ten years; in fact, many of the practical conclusions of our work have been embodied in the boiler inspection law of the State of Massachusetts. This was conceded in the discussions at the Detroit convention in 1909, in which a general endorsement of the Massachusetts Boiler Rules was unanimously adopted.

This endorsement has been misunderstood and misrepresented as pledging the American Boiler Manufacturers' Association to every detail of these rules, whereas the truth is that this association always has and always will maintain its right and duty to work for further improvement and amendment in every case where the practical working of any law or rules indicates the necessity therefor.

At the Boston convention in 1911, the request was made to our members in Massachusetts to formulate from their experience suggestions for such modifications. Your chairman further invited all members of the committee to a careful study of these rules, to which several members have responded. These various reports were laid before your committee here on the 12th of March, 1912, and fully discussed on that and the following day, and a unanimous agreement reached on the points in question. While your committee reasserts its full concurrence in the Uniform American Boiler Specifications, as issued by our association, and will continue to hold them as the foundation for its further work, it seems most convenient at this time to carefully consider modifications and improvements suggested by the experience of our membership, in the existing boiler rules, as being those which have longest stood the test of practical use.

We recommend the acceptance of this 1912 report, with the following amendments and additions, viz.:

We recommend that the amendment to Paragraph 23, Part 3, Section 4, be withdrawn.

We also recommend that in Part 3, Section 3, to Paragraphs 6 and 8, respectively, there be added the words: "When exposed to direct action of the fire."

We further recommend that all plates be stamped to the nearest 100 pounds of what the test piece actually pulls.

As the other points that were raised by the writers of the seventeen letters referred to above were thoroughly discussed at a hearing of this committee on the 1st inst., and it was found that many of them had been already fully discussed and settled by the committee of 1912 in New Orleans, there did not seem to your committee sufficient ground to alter the decisions then reached.

All who have worked on this problem of uniformity, and all who have carefully followed these labors, must agree that local conditions are so different in the vast territory to be covered that State boards must necessarily be created to modify existing rules and make new ones to meet the just demands of our industries. The short small-tube boiler of New England would be as much out of place on a Mississippi River steamboat as the long four-flued boiler of that craft would be on an ocean liner.

When, therefore, the Massachusetts or Ohio rules have been improved and simplified to meet all just criticisms, they will still be far from suiting the necessities of Illinois, Iowa, Colorado or California. Even in New England some provisions necessary in sections having limewater seem unnecessary and arbitrary to those in the granite territory. Your committee has, therefore, become convinced of and earnestly recommends to you the necessity of dividing the subject into two parts, each of which demands your attention and energy, but in a different manner:

First. To formulate and press for adoption in all the States a simple, short law embodying the general provisions for honest and safe construction, inspection and care of boilers and all other vessels subject to internal pressure.

Second. To recommend to all builders and users of boilers, and especially also to any boards of inspectors in the United States, in individual States, territories and municipalities, the adoption of fair, clear rules modeled after the Massachusetts and Ohio rules and the regulations of the Steamboat Inspection Service.

The boiler law should not go into details, but concern itself with well-established principles only, and provide for the appointment and discipline of a board of inspectors intrusted with the duty and power to establish and modify rules and regulations covering all details.

The enactments of this board to be subject to debate and criticism at public hearings at fixed dates each year, sixty days' notice of any proposed change having been previously given, and the final action to be subject to the approval of an executive officer, named in the law, to give them legal effect.

Such a uniform boiler law could well be evolved from the excellent boiler laws of Massachusetts and Ohio, simplifying as much as possible, and leaving the name and manner of appointment of the board of rules to local preference.

There exists now an association for unifying the laws of the different States, called the Conference of Commissioners on Uniform State Laws. One of our members, Mr. L. E. Connelly, has attended one of their meetings as our delegate, and found them willing to take this subject up actively as soon as we give them a definite statement of our requirements.

The rules, as established in Massachusetts and Ohio, are finding general approval and are made part of specifications in many contracts outside of these States. Engineers and manufacturers are studying them with a view to further improvement and simplification. A very thorough study of them has been under way for the last two years by a committee of experts of the American Society of Mechanical Engineers, of which Mr. Stevens, until recently the mechanical engineer of the Massachusetts Board, is chairman, and two members of which belong to the A. B. M. A. It is therefore certain that these rules will be much improved during the next few years.

This part of the work should be continued by this committee in co-operation with other bodies having similar purpose.

The committee should be instructed to communicate to the Boards of Boiler Rules of Massachusetts and Ohio, and to other kindred bodies, the modifications recommended in this report and in that of March 14, 1912.

The matter of the uniform boiler law would be placed in the care of a special committee of five members, instructed to formulate such a law as outlined above in collaboration and agreement with the "Commission on Uniform Laws" above referred to.

In this work we need the assistance—in fact, the collaboration—of men versed in the law and devoted to uniformity, to dress our conclusions in proper legal phraseology.

E. D. MEIER, Chairman.
T. M. REES.
BARTHOLOMEW SCANNELL.
HENRY J. HARTLEY.
A. J. SCHAAF.
L. E. CONNELLY.
Committee.

DISCUSSION

Mr. C. V. Kellogg, President, National Tubular Boiler Manufacturers' Association, Chicago, Ill.: While I am interested as a manufacturer of boilers, I am not a practical boiler man. We formed an association of manufacturers who were interested more particularly in the commercial line of tubular boilers. We found on investigation that there was a growing agitation on the part of legislatures and city councils to pass laws or ordinances in reference to the construction of tubular goods and also in reference to their inspection; and while we cover apparently the territory of the Central West, yet we do cover, so far as the product goes, the United States and Canada. We found that if the laws which were introduced in the Legislature this year were enacted it would be impossible for a manufacturer of goods to manufacture in advance, it would be impossible for him to purchase his material in advance unless he were obliged to carry nearly every conceivable line that was made; and the gentlemen who are members of our association felt that it was necessary to formulate something that was applicable to the practical commercialism of the goods, although not pertaining so much to the technical part of the manufacture. We found also that in figuring on a bid or a specification that there were being written so many specifications by people perhaps who were not enough familiar with the technical knowledge or the commercialism of a boiler that it was impossible for two or three or four people to figure according to the specifications as given to them and deliver a perfect article. We also found that the manufacturers who were figuring would come back with specifications of their own make, and the result was that there was so much variance in reference to trade conditions that it was impossible for the manufacturers not to be misled by the buyers, so that from a practical standpoint it was necessary for the manufacturers who were operating in that line to get together more closely and to have a common basis for their policy and methods of business; that is, so far as the commercial or practical specifications were required.

We met and we have worked upon the problem for nearly a year; and after very careful consideration thirty-four companies have made up what they call standard specifications for simply horizontal return tubular boilers, and have adopted the same. The object of such adoption was to endeavor as far as possible to obtain, you might say, the silent consent on the part of the architect or engineer who is specifying, especially in the small country places or towns where they make up specifications where they are perhaps but slightly familiar with technical details. These specifications are being distributed among the architects and engineers with the hope that they will adopt them and use the same so far as practicable in the ordinary line of business.

We found another thing, that in several States, such as Indiana, Montana, Michigan, California, Illinois and Missouri, legislation was pending requiring the inspection of tubular goods. The intent of some of the legislation, it seemed, was to place too large powers in the hands of boards who might thereafter make laws and rules unto themselves as to what would be required of the manufacturers; and it was our judgment that if that condition continued without some action on the part of the manufacturers who were vitally interested, it would be absolutely impossible for any manufacturer to carry on his business and know what he was doing or what he intended to do in any given locality; in other words, he would have to consult a dictionary and carry it around with him in his pocket in order to determine what line of goods he might manufacture. So we have started in to take up with the different bodies who were endeavoring to pass these laws the questions involved; and we have succeeded in having a law passed in the State of Indiana which was on the line of the specifications which we have adopted. And in several of the other States we succeeded in having bills that were introduced defeated. In others they were held over until the next legislature for further consideration.

We also found this difficulty somewhat in the cities. We do not object to a fair law so long as we are informed what it is, but if every State and every city passes a law unto itself, and they are all different, how are we going to purchase the materials? How are we going to carry on a manufacturing business? We would be subjected to an increased expense either in carrying charges or otherwise which would have to be borne by the user in the end.

Hence, gentlemen, it was and is the object of the association of which I have the pleasure of being the president to try as far as possible to bring uniformity in the practical commercial side of this line of business.

I will say, further, without desiring to take up your time, that we went further. Do not, gentlemen, be led into the misunderstanding that we are a price body, for we are not; but we adopt a uniform price list, not so much for the benefit of the manufacturer himself as for the benefit of the numerous distributors that we have throughout the country in handling this line of goods, and because of the errors which they made in not being able to properly figure their own costs when they were buying the goods and placing an order or a contract. Hence we have worked out a uniform basis or policy or a price list as a foundation or a starting point for the manufacturers themselves or their numerous distributors. And we have adopted that. That does not mean that we have adopted a uniform price, because the discounts may vary as much as you please, the nets may be one thing or another; but it was simply to correct the numerous errors which were creeping into the business by reason of the multiutdinous number of distributors or people who are to-day trying to handle the business, such as the jobber or agent. That was the purpose which we have accomplished within the year.

Mr. J. H. Optenberg, Sheboygan, Wis.: Now, the matter under discussion is uniform boiler specifications throughout the United States and Canada. It appears to me that in order to be successful in carrying that into effect we must not forget that we cannot dictate to our legislatures, they must be shown. Having been somewhat of a politician I know what the inconsistencies of politics are. Unless you gentlemen will interest yourselves in politics you will never succeed in getting proper legislation either in your State legislatures or city councils. We must first of all co-operate. It is for the purpose of co-operating with you that I have joined your organization. I do not see why we cannot get a Federal law just the same as the marine boiler manufacturers have. Let us be active and push things from a practical standpoint. Let us all take hold and not compel a few men to do all the work and bear all the burdens. Let us see that these specifications are adopted throughout the United States and Canada.

President Meier: In regard to the matter of a national law, we have investigated into the possibility of that, and found that it is not practicable to obtain it. We have had the opinion of the best lawyers; we have taken it up with the people in Washington, and learned that it was incompatible with the Constitution of the United States, because it involves the question of States' rights.

Mr. Taylor: I want to say that in the preparation of specifications for horizontal tubular boilers we took into consideration the former work done by your committee on uniform specifications, and we want to acknowledge our indebtedness to that committee. Our organization felt that if something could be prepared and placed in the hands of the boards established in various States a great deal would have been accomplished in the direction of a uniform law. We have no particular dislike or serious objection to the Massachusetts law or the Ohio law, or various other laws that might be mentioned; but there are political reasons why none of those laws could become universal throughout this country. Inspections will be made by insurance companies who insure boilers, and they must be taken into consideration in the framing of any law; they must be considered. Then you run across peculiar local political situations in some States which must be taken into account, and there may be certain matters in a proposed general law which would be distasteful to certain interests who may be authority and who will wipe all of that out of the law. That is one reason why I say that the Massachusetts Rules cannot become general in this country. Another reason is the matter of expense.

Mr. Optenberg: The important thing is not so much the securing of the law being placed upon the statute books as the enforcement of the law thereafter. And it is our customers who are benefited and who should see to the enactment as well as the enforcement of these laws.

Mr. H. D. MacKinnon, Bay City, Mich.: As a member of the A.B. M. A., I want to say that, for one, I am delighted that these gentlemen from the National Association of Tubular Boiler Manufacturers have seen fit to meet us in a joint session, this new association that has been formed within the past year. I must confess that in my judgment we in a way have lost sight of a very important question, that of the commercial side of the boiler manufacturing business. We have talked "quality" for many years, which, of course, is profitable; but I am really delighted to see the sales end of the business being so vigorously taken up. Good construction is all right, but the commercial aspect of the business must not be neglected. I believe that the joint efforts of our two associations cannot help but strengthen the A. B. M. A., and the boiler business in general. I do hope that we will affiliate more closely, and that a broadening of the scope of our work to a greater extent than in the past will be brought about by this joint session.

Mr. C. H. Wirmel, Chief Inspector, Board of Boiler Rules of Ohio, Columbus, Ohio: We have here in Ohio, as they have in Massachusetts, a Board of Boiler Rules, that is composed of the different interests that are vitally concerned in the construction, inspection and operation of steam boilers, and also their ownership. As our law requires, we get together occasionally and we hold our quarterly meetings, and occasionally special meetings, for the purpose of carrying on the work of our department. We have only been in existence for a period of about eighteen months, but we hope in time to be equal, if possible, to our great Massachusetts leaders.

The Boiler Inspection Department of our State was taken over by the Industrial Commission on the first of this month. Under the broad scope of the law which governs this new commission, and under which the boiler inspection department will operate in the future, we are given sufficient authority to co-operate with other States along lines of a kindred nature, and also to attend gatherings of this kind, associations of a technical nature which have for their object the advancement of the science of steam engineering and the science of boiler construction, inspection and management.

Capt. T. M. Rees, of Pittsburg, Pa., related some interesting experiences which he had had in regard to the Board of Supervising Inspectors concerning laws governing marine boilers. He pointed out that it took some twelve years before this association could get in touch with that board and know what was coming up in the marine law or what they would take up, but through organized effort different relations have been established, so that the laws can be modified to suit the needs of good construction.

Capt. Rees gave a good idea of what this organization has accomplished for the boiler manufacturers of the United States which individually the members could not have brought about. The A. B. M. A. has brought about a great change in the relations with the Government at Washington, and there is now no trouble in getting a hearing regarding important matters.

Mr. H. A. Baumhart,* Cleveland, Ohio: We are indebted in a measure to the Massachusetts Board for the rules that we go by, although we have altered them some. Since the rules have been in operation we have not received very many complaints, which is evidence that the rules are apparently satisfactory. I wish to discuss one subject that was mentioned by some one who objected to the thickness of material. I have been inspecting steam boilers for twenty-three years in the States of Pennsylvania, Ohio, West Virginia and Kentucky. I believe that those four States contain every kind of water that is ever used in a boiler that you can find anywhere in the United States. I have examined boilers as heavy as 4/5 inch in thickness; I have examined boilers that had almost every conceivable defect, but I do not recall a case now where any of those defects arose from the thickness of the material. If a plate is overheated it is due to some deposit on the internal surface. Oil is one of the most dangerous substances that can be deposited on the inside of a boiler, especially if you are firing a boiler heavily, as it becomes very hot and the oil keeps the water away from the shell, and you will have a bulge or a leaky seam. Leaks are due more to defective workmanship than to any other cause, in my judgment. If the shell plate is not properly fitted you will have trouble with a curved seam just the same with thin as with heavy material. Of course, I have seen shell plates in use in this State as thick as 1½ inches, but they were not subjected to very high temperature. It has been my experience that if a boiler is kept clean the thickness of the material will have no injurious effect on the safety of the boiler.

The discussion was closed, and the report of the committee on uniform boiler specifications adopted unanimously.

TUESDAY AFTERNOON SESSION

Factory Efficiency†

Mr. Yeomans: I am not advocating any new system of scientific management. I do not believe that the management of years gone by was unscientific by any means; I simply say that the extension of the detail to every branch of your business that you have already perfected in some one particular of it is what scientific management means.

* Member Board of Boiler Rules of Ohio and manager Hartford Steam Boiler Inspection Insurance Company.

† This paper is printed on page 295.

Uniform Boiler Specifications*

Mr. Durban: We have shown by innumerable reports from the mills that have come to us that there is absolutely no difference between flange and firebox steel except the stamp. We would also recommend that the number of places of putting the stamp ought to be eliminated, and instead of the brand the mill test number be put on. We have a system in our factory so that every plate we put in every boiler can be traced back for fifteen years, and ascertain the mill test, and from the record of the mill test we can tell exactly what is in that plate. Now instead of having the stamp in five places on the plate, let it be in three places diagonally across, and always placed where it can be examined by the inspector. I feel that where they specify firebox in regulations of certain States and cities, they are taxing us people 2 percent on the plate without an adequate return; and I sincerely believe that if this organization, or combination of organizations, can resist that law, that any of us could place a boiler in Massachusetts, in Ohio, in Detroit, or any place else, regardless of the brand of the steel, provided that the physical qualities were in the steel. I do not believe that the mere giving to the material a certain name amounts to anything, provided that the essential qualities are in the material.

President Meier: I have listened to this paper of Mr. Durban's with a great deal of satisfaction, because Mr. Durban has, after a long study of the subject and in ways entirely his own, without being influenced by what we have done in our association, come to the same conclusion that we have. That, of course, strengthens our position. Now the very first committee on materials of this association, in October, 1889, eliminated the brands. We had nothing to do with the brand. Our whole contention was that the brand is misleading. One man brands his "Parke Bros., Black Diamond Firebox," another man uses another brand. We do not care for that, we simply want to know what we are buying; we simply say that we will have a certain specified T. S., ductility and chemical requirements, especially with regard to sulphur and phosphorus. We had it without any trouble until 1897, or even longer; then the steel men got in their fine work and returned to the brands, of which you have the result to-day. I am very glad to find that Mr. Durban's experience corroborates my own. I had occasion less than a year ago, when we had two boilers, to build Massachusetts Standard, and I had some material which was stamped flange steel, but in the chemical requirements and physical test it was entirely in consonance with the requirements for firebox steel in Massachusetts. I gave them the facts. I knew that they could not do otherwise, but I wanted to have this corroboration. I wrote to the Board of Boiler Rules and asked them whether I might use that without branding it "firebox," after showing by the mill test that everything was as specified. They wrote back saying, that if I had it stamped "firebox" they would accept it. I communicated with the mill, and they stated that they would stamp it "firebox" without any trouble—for two dollars a ton; nothing could be plainer than that. Mr. Durban tells me, and also Mr. Rees, that they have letters in their possession which can be used, showing that the steel mills know all this. All we have to do is to stand pat and stand together, and say that we do not know what firebox brand is; but we do know what ductility is, and we do know what T. S. is; we do know when we get the sulphur and phosphorus right; that we stand by our specifications, and we will not go by their brands alone, and I think that the various Boards of Boiler Rules and Inspectors

* This paper is printed on page 300.

in the several States will stay with us. What we want is quality; we do not want simply a name.

Shop Costs*

Mr. J. R. Ashley, Muskegon, Mich.: I would like to ask Mr. Connelly if it is his opinion that the entire drafting room expense should always be charged to expense?

Mr. W. C. Connelly: No, not if you have a job that you are figuring on. I figure that the hours spent in the drafting room after a job is procured should be charged to that particular job, but that all the other time that is expended in the drafting room and on drawings that you do not keep should be charged into your general expense.

Mr. J. R. Ashley: I might say that that is the method that we follow. We have an account—"Standard Drawings"—which Mr. Connelly perhaps would take exception to. If we have some particular job requiring the turning out of particular plans which can be used in the future over and over again, we charge that up to "Standard Drawings," and not to that particular job. All of the labor in the drafting room that goes onto drawings which are charged against a particular job goes onto our producer pay-roll. I find that that is a point on which a great many manufacturers disagree, but I think it is just as right to call the draftsman a producer as the laboring man, as long as his work enters into the expense of turning out that particular job.

Mr. W. C. Connelly: I think that is very true; but I think we ought to be very conservative in the matter of the cost of our drawings and our patterns. We personally have expended over $20,000 in drawings that we do not carry one dollar of on our books. I do not think that drawings, patterns or dies are any more an asset than good will, except while your plant is operated. If your plant is not operating, they are not. I think we fool ourselves if we try to show a profit on our books from money expended on drawings, patterns and dies.

Mr. Lucian I. Yeomans: May I ask Mr. Connelly what his experience has been as to average overhead expense? You say credit to direct labor rather than to sales. What has been your personal average; what does it run? You mentioned one hundred dollars a year. I would say that was rather low. I would think it would run one hundred and fifty dollars.

Mr. W. C. Connelly: I think one hundred and twenty-five dollars would be a very fair basis as an average. In using that average I neglected to state that I do not believe we should take the average overhead for 1913 as our basis for 1914, but that we should take at least an average for the three or five years preceding, because we have certain business depressions all the while, and if we used our 1907 average, or 1908 or 1909, we would have an average that would be entirely too high. If you take an average of the five years preceding I think that would establish a very fair charge on overhead expense.

Mr. Lucian I. Yeomans: I have had quite a little experience with the printing and paper box-making trades. The printing trades and the paper-box manufacturers have had perhaps as big a war internally as any manufacturing lines in the country, and they never did get to a satisfactory basis until they did just what the previous speaker suggested—adopted a uniform cost system for all of their plants. I believe that the Cleveland company handles that also, a system which was developed and was followed out largely on the lines described here; but I might say that their cost congress holds two conventions a year, and it is working out very nicely; they take care of the costs on the same basis, whether referring to the man well equipped to handle a job or the man who must let it entirely alone and allow it to go to some competitor who is better equipped to take that particular job.

* This paper is printed on page 298.

It was voted that the chair appoint a committee on uniform cost systems.

After discussing the possibility of amalgamation with the National Association of Tubular Boiler Manufacturers, the convention was adjourned to meet at 9 o'clock Thursday morning, Sept. 4, as Wednesday had been set aside for an all-day excursion on the Lake.

THURSDAY MORNING SESSION

The report of the auditing committee, stating that the books and accounts of the secretary and treasurer were correct in every respect, was received and accepted.

The report of the committee on time and place giving the consensus of opinion in favor of New York City as being the most desirable place to hold the next convention, during September, 1914, was unanimously adopted.

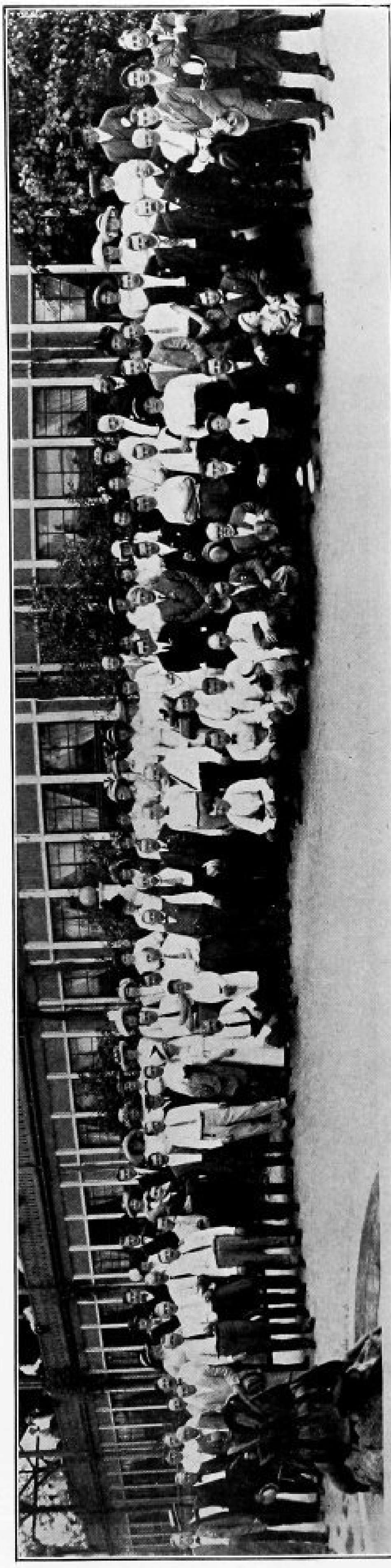
The committee on nominations submitted the following nominations for officers for the ensuing year:

President—E. D. Meier, New York, N. Y.
Secretary—J. D. Farasey, Cleveland, Ohio.
Treasurer—Joseph F. Wangler, St. Louis, Mo.
First Vice-President—T. M. Rees, Pittsburg, Pa.
Second Vice-President—J. Don Smith, Charleston, S. C.
Third Vice-President—H. D. MacKinnon, Bay City, Mich.
Fourth Vice-President—L. E. Connelly, Cleveland, Ohio.
Fifth Vice-President—R. Joy, Oswego, N. Y.

The several nominees were unanimously elected to serve for the ensuing year, and the various officers-elect responded with brief addresses accepting the responsibilities placed upon them and pledging their unqualified support to the work of the association.

President Meier: Pursuant to your vote yesterday in adopting the report of the committee on uniform specifications, the chair is authorized to appoint two committees, one of which will deal strictly with the matter of uniform specifications, and will take up all minor details which enter into boiler rules; the other committee will deal with uniform boiler laws. That committee will co-operate as far as it can with the National Association of Tubular Boiler Manufacturers, who were here in joint session with us yesterday. Now I think that Mr. Connelly will find some way to bring the matter of uniform State laws before the Conference of Commissioners on Uniform State Laws, through Mr. Cannon, in such a manner that Mr. Cannon will find that the objections which he raised to their conference will be removed. Mr. Connelly's committee will not only be authorized to co-operate with the National Tubular Boiler Manufacturers' Association but with every body of men that is interested in the subject, and even with firms or individuals that have anything to do with this matter. We want to push this forward. There never was a time so opportune as now to secure uniform boiler laws.

The chair is also authorized to appoint a committee on uniform system of keeping costs. This is a very important matter, and the chair is not prepared to name the committee at this time, but it will be announced in due course. As you saw from Mr. Will Connelly's paper yesterday, many people cheat themselves through not knowing how to keep a proper account of their costs. This is very natural, because a great many of the boiler manufacturers originally started with small shops and were not themselves accountants, so that their ideas of what was necessary in the way of bookkeeping were not very comprehensive; whereas, nowadays, in all manufacturing establishments there should be a definite system of keeping account of costs. This has been brought to a high state of efficiency by the railroad men. You will find that the railroads all keep their accounts in a uniform manner so that comparisons can be made one with the other. That is the



GROUP OF BOILER MANUFACTURERS, SUPPLY MEN AND GUESTS ATTENDING THE TWENTY-FIFTH ANNUAL CONVENTION OF THE AMERICAN BOILER MANUFACTURERS' ASSOCIATION AT CLEVELAND, OHIO

result that we want to secure, but in arriving at it nobody need give away any secrets. The committee will simply endeavor to ascertain what are the items which should enter into cost and which should be made uniform, and which can be easily made so through co-operation. This will be an entirely new departure, and is a sufficient answer to the criticism made that we have been only considering technical matters here in our meetings and have neglected shop costs. Our costs are very important items in fixing selling prices, and oftentimes a man who is underbidding you in doing it is losing money, and he would not lose money in that way if he knew just exactly what his costs were. If there was a more complete understanding of this subject it would result in a much more healthy competition than we have now. We all know that the worst competitors we have are those who cheat themselves.

After brief discussion on various matters the convention went into executive session, at the conclusion of which, upon rising from executive session, the convention adjourned to hold the twenty-sixth annual meeting in New York City in September, 1914.

Annual Banquet

The twenty-fifth annual banquet of the Boiler Manufacturers' Association and associate members was held at the Hollenden Hotel on Thursday evening, Sept. 4. As on the occasion of the last banquet, the company were seated at small tables, an arrangement which proved enjoyable and conducive to social converse. The attractive decorations of the banquet hall and the tables, and the charming array of ladies present, all contributed to the pleasure of the evening.

The list of speakers included Hon. M. P. Mooney, of Cleveland, whose subject was "Standardization"; Capt. M. B. Nelson, Supervising Inspector, Ninth District, Cleveland, who spoke on the "Co-operation Between the Boiler Manufacturer and Inspector," and Mr. D. J. Champion, of the Champion Rivet Company, Cleveland, who immediately riveted the attention of his audience on the "Friendly Relations Between Boiler Manufacturers and Supply Men."

On behalf of the Supply Men's Association of the A. B. M. A., Mr. W. O. Duntley presented to Mr. Thomas Aldcorn, of New York, a beautiful solid silver pitcher as a token of their esteem.

Following the presentation and acceptance of this gift, brief remarks were made by Mr. W. C. Connelly, Mr. W. H. S. Bateman and Secretary Farasey, who, according to custom, read the resolutions of thanks adopted by the association.

Officers of Associate Members of A. B. M. A. Elected Sept. 4, 1913

President—J. T. Corbett, J. T. Ryerson & Son, Chicago, Ill.

Vice-President—Thomas Aldcorn, Chicago Pneumatic Tool Company, New York, N. Y.

Treasurer—D. J. Champion, Champion Rivet Company, Cleveland, Ohio.

Secretary—F. B. Slocum, The Continental Iron Works, Brooklyn, N. Y.

EXECUTIVE COMMITTEE

W. O. Duntley, chairman, president Chicago Pneumatic Tool Company, Chicago, Ill.

W. H. S. Bateman, sales agent, The Champion Rivet Company, Philadelphia, Pa.; The Parkesburg Iron Company; The Chicago Pneumatic Tool Company.

D. J. Champion, vice-president and general manager, The Champion Rivet Company, Cleveland, Ohio.

George W. Denyven, Arthur C. Harvey & Company, Boston, Mass.

Geo. H. Partridge, *The Engineering Catalogue,* New York.

A. M. Mueller, Jos. T. Ryerson & Son, Chicago, Ill.

Factory Efficiency*

BY LUCIAN I. YEOMANS †

The Century Dictionary defines "efficiency" as "The quality or power of producing desired or intended effects." I have quoted this definition, as I intend to consider "Factory Efficiency" in this discussion as the production of desired or intended effects in a factory.

A considerable army of self-styled "Efficiency Engineers" has sprung into existence in the last few years, and the results of their work are, on the whole, good. It is unfortunate that the entire movement has been surrounded with any mystery, and that so much of theory and untried method has been allowed to creep into a practice that should be essentially sane and sensible, and, above all else, most simple.

In all the development of so-called "scientific management" I have been unable to find one single new element of efficiency. Not one single thing has come to my attention in this connection that precedent may not be found for in the practice of former years. Many of our foremost writers on the subject have based their investigations on some little trick of time-saving performance that was new to them, and for that reason they assumed it was new to all. I wish to join myself to that conservative element who are becoming more prominent as time passes, and who, like Mr. Hartness, can define scientific management—if that name is to be used at all—as "the best use of the present means."

Manufacturing policies, the steady flow of production, sales methods, cost records, the selection of employees, details of finance, patent protection, and many other considerations enter into the efficiency of any business, but they will not be otherwise commented on in this paper, as they are rather outside the subject of factory efficiency proper.

I should list the essential elements of factory efficiency proper, from the inception of manufacturing down to date, as follows:

I. Labor-saving equipment of all sorts, and all mechanical means for the reduction of human labor in any given process.

II. The division of labor in such ways as to further reduce time required for a given output, and also permit the employment of brains or brawn in just the required porportion at consequent reduced average costs.

III. A carefully predetermined performance which will leave nothing to the imagination—nothing to recollection.

IV. An adequate supervision, which supplements the last-named element and is to it what the executive is to the legislative power in a government.

V. The best arrangement of factory layout for the particular process, and such provision for material handling and storage as may best serve the purpose.

VI. Readily accessible means and materials of production that will in the last possible degree promote economy in the labor of every unit in the entire organization.

VII. Such methods of wage payment and reward for efficiency in the individual as will best stimulate acceptable performance.

VIII. The betterment of working conditions and surroundings and all means that tend to re-establish a community of interest between employer and employee.

LABOR-SAVING EQUIPMENT

Probably the development of labor-saving devices in the days before manufacturing commenced was always due to that natural aversion for work that is a trait common to us all. All efforts tending to eliminate labor of the individual were the result of ordinary laziness and a desire to escape from, or lessen, necessary effort. A study of very old labor-saving devices shows us plainly that their invention was largely confined to those processes that were disagreeable and without accompaniment of any pleasure or amusement when more crudely performed.

The elimination of labor in the playing of musical instruments seems to have been less studied and delayed longer than any other process—probably because the performer derived pleasure from the process, and, in consequence, objected less to the labor. On the contrary, devices for lessening labor in pumping water, and other tasks of the individual that were not agreeable, were of early development. As time passed it occurred to the individual that in really pleasurable pursuits, such as hunting and war, vastly greater results could be accomplished with the same available labor by improving the equipment. More men could be killed with less effort with a bow and arrow than with a club. Game could be trapped in greater quantity than could be secured by running it down. In the first steps disagreeable labor was lessened, and later steps increased production.

Through ages of this progressive training the individual arrived at the age of manufacturing with an instinctive idea that production could be increased and labor lessened through the development of equipment. It is not strange, then, that for many years in our age the study and improvement of the means of production held the place of first importance in the minds of manufacturers. This was as it should be, since the refinement of process by invention of equipment was the greatest opportunity of all in factory efficiency.

DIVISION OF LABOR

Manufacturing soon grew to a position of such importance in the affairs of civilized nations that the attention and thought of great statesmen and political economists were drawn to it, and something less than two hundred years ago there entered another element into factory efficiency, in the principle of division of labor. Analysis of costs and production showed a distinct lack of economy in the fact that a skilled worker was invariably assigned to work, any small part of which required skill, and if, perchance, the work also required strength, the worker selected must also possess that. Such a procedure limited the selection of available workers, and it was further observed that a worker would seldom live long enough to become proficient at all branches of any intricate process, and, granting that he would, even then years of his life had been wasted in acquiring the necessary degree of skill and knowledge. The item of cost reduction also entered into this and the use of all grades of available labor. And so the principle of division of labor was accepted as a new factor in factory efficiency, and is one that it is well worth while to watch closely and extend as far as possible to-day.

Where a gunmaker used to completely manufacture a weapon, and as a result of his lack of extreme proficiency and speed gained by frequent repetition made the labor cost extremely high, to-day we see low-priced, ignorant laborers, possessed of strength, operating machines on thousands of duplicate parts; deft fingered, skillful girls performing delicate assembly operations, and a few high-priced intelligent men of skill supervising the work of automatic machines and making the accurate tools that render possible a transference of skill from them to the untrained laborer.

* A paper read before the American Boiler Manufacturers' Association, Cleveland, September, 1913.

† Industrial engineer, Chicago, Ill.

The cost is reduced, the output increased, and a labor market provided that is most elastic and that provides opportunity for the entire community.

Predetermined Performance

Our first manufacturers were almost invariably inventors, and as such they promptly realized the necessity for predetermination of design and proportions, and the fatal results if the workers were permitted to assume anything in connection with these details of manufacturing. More for this than any other reason they took great pains to see that designs and all details were reduced to a matter of record, from which performance could be duplicated, and to insure that no worker would depart from the proportions decided on by them. The consequence was that the third element in factory efficiency was only partially developed. Beautiful and most complete drawings of the product that contained all the information relative to material, sizes, workmanship, etc., were produced and then turned over to the worker. From the conception of the invention to the worker the record was perfect. From that time on there was no record, and to the completion of the product everything was left to recollection, imagination, questionable judgment of too frequently unintelligent men. There has been much improvement in the last few years along these lines, and there exists great opportunity for more of it. Many manufacturers have realized that the necessary information and record have been but partially collected and perfected when the drawings are furnished to the shops. Many are still trying to decide how far to go. Others are still asleep.

Perhaps the most familiar example of time-wasting lack of information is found in the still common foundry foreman's method of issuing work to a molder by chalking the number of castings wanted on the pattern and handing it out. All the equipment of flasks, and gaggers, and boards, and nails, and cores is left to the recollection and imagination of the molder to measure up, decide and select.

Adequate Supervision

Careful planning, labor-saving machinery and wisely selected employees alone cannot accomplish the results desired. Competent direction of every activity is imperative. I have frequently talked with manufacturers who boasted of their low overhead expense, and who seemed to think the fact that expense due to supervision and clerical labor was unusually low, must result of a necessity in a minimum cost of the product. This is much on the order of reasoning an ostrich must follow when he buries his head in the sand and thinks he is entirely hidden.

I have no hesitation in saying there are more manufacturing costs higher than necessary because the overhead expense is too low than because it is too high. Very often an increase in overhead expense through an increase in supervision and clerical labor shows an immediate and effective reduction in manufacturing cost.

It is perfectly obvious that, if to a gang of twenty men and a foreman a production clerk be added and the result is that the same production is then secured with seventeen men instead of twenty, a saving of about 10 percent in the total cost has been effected, although the overhead expense has been almost doubled.

Such a condition, or one even more marked, may often be created by intelligent study of a shop. The aimless efforts that we frequently see made along these lines are to be deplored, and increased provision for supervision and clerical work that is not intelligently made is often useless, if not positively detrimental.

Perhaps the thing that is most often done wrong in this way is the provision of assistants. A certain department becomes too large for one man to handle easily, and he is provided with an assistant. The result is that although the work is easier for both it is not nearly so well performed, and the really responsible man of the department gradually draws out of the active detail. I have seen many an excellent department head ruined by giving him an assistant, and, as in everything else, close study of the conditions and personality of the man should be made before deciding whether to leave the department as it is and use an assistant, or divide the department into two and use no assistants.

Every one here can think of some shop that is handicapped by this unreasonable procedure—shops in which a condition has gradually developed that seems to permit every one from the president down to have an assistant, and in which the extra overhead expense has not been offset by equal or greater saving in costs.

I believe in plenty of supervision but as little divided authority as is possible.

Factory Layout

A great many factories are so arranged that it is impossible to route work through them in an ideal manner, and this is sometimes due to ignorance of the requirements but more often because the business developed a little at a time and inconvenient additions were necessary. I have in mind two recently-built factories—one for sewing machines and one for automobiles—in which the construction was good but the design ridiculous for the purposes intended. Both these factories are under a heavy daily expense that is constantly increasing, simply because the factory layout was not proper for their particular manufacture.

Every time I pass a new factory that is surrounded by sheds and additions, I always think that place would be a promising one to establish a connection with, because the outside indicates such a lack of careful preparation and forethought that it is certain to be mismanaged otherwise. Frequently the proper routing of material in process justifies the actual removal of some such afterthoughts and a radical rearrangement of the premises.

Another frequently observed point of weakness is the absence of suitable provision for stores and material in process. Many a plant has been entirely completed with no plans made for stores other than the vague idea that they can be put almost anywhere.

A few years ago I overhauled a large factory that was quite new and employed 350 men in the manufacture of gas engines. The factory proper was an excellent building, half of which was foundry and half machine shop. No provision was made for stores of any kind, nor had it been assumed that anything beyond those two departments were necessary. The consequence was that they had built on six additions to provide space for cleaning room, casting storage, blacksmith shop, pattern shop, testing room and paint shop. The lack of forethought so indicated had been in evidence everywhere, and was the sole reason why a nice business had been a failure in the hands that started it and had been lost to others.

Any man can better the performance in his own shop by giving a certain amount of his time to a careful study of the means for handling material in process and the manner in which it is done, but it is usually hard to confine his attention to one thing at a time, and for that reason outside talent has always been more successful in this way than those connected permanently with a business.

Bringing Information, Tools and Fixtures to the Workman

Quite as important as the proper movement of material are the means provided for bringing to all productive labor the information, tools and fixtures required for the work, and the elimination of any excuse for leaving their places.

Some causes for such wasted time have been eliminated in some shops, but I have never yet known of ideal conditions realized in that way. In some places when work is issued all the necessary tools and drawings are sent out with it. In others the management has been satisfied with having these collected in one accessible place and letting the workmen get them. In still others it has been deemed sufficient to keep them scattered under the care of some one man, or group of men, and let the workman call for what he needs.

In only one place—an office, not a factory—have I seen everything provided for the worker. A large institution in Chicago employs about 500 girls as order writers. Their desks are arranged in rows facing the front of the room. A division manager and two assistants manage the room, and over each of the rows of desks is a supervisor in direct charge. Each girl has a colored signal disk on her desk, and each color signifies something different. The supervisors do the walking and the operators remain seated. There is no confusion in the place, and the turning up of a signal immediately sends to the girl assistance, more work, stationery, or permission to leave the room, as the case may be. Economy of time and space has been alike studied in that place, and the waste baskets at the desks have even been removed and replaced by steel spindles for waste paper on the desks, in order to give a clear aisle space and save room.

Consider this example and imagine how much improvement could be made in some manufacturing departments if the men always stayed at their places and the foreman did all the walking. How much better it would be to eliminate the confusion often found at a foreman's desk when half a dozen men all seek information or advice at once. How much better to have the foreman at the worker's location, where he could actually see the work. Perhaps such a plan would call for less easy chairs and enclosed department offices. Ideal conditions would obtain when a workman never had to leave his place to secure anything, and when all material, tools and information were automatically produced in anticipation of his wants.

Reward for Increased Efficiency of the Individual

Whatever is done in the way of betterment along any of the lines already discussed may do much good, but sight must never be lost of the fact that increased efficiency of the individual through rational stimulation of his effort is of vastly greater importance than any other single element in factory efficiency.

Efficiency of the organization as a whole usually follows attempts to better individual performance. Because this is so there have been many attempts made to devise some satisfactory system of payment that will compensate the individual in proportion to his performance, and all efforts to accomplish that result have bettered matters to some extent.

I would not say that any one scheme is better than another as a general proposition. I used to think a certain plan was better than others in all cases, but have changed my opinions to the end that I believe now there is a proper place for day work, a place for piece work, conditions where the premium plan is better, others where the bonus system will give good results, and really a place for all, and sometimes for several in one shop.

Practically the only plan I can find no justification for is any scheme of so-called profit sharing. Under profit-sharing methods the reward is too remote to be effective, the workmen are frequently rewarded for success in which they had no part, all share alike in the benefits, and the impression the men get is rather that their employer has a guilty conscience, and is dividing up the spoils, than that it is due compensation.

The results of a proper application of suitable methods of reward are readily noted and justify the necessary refinement in preparation. Adequate methods of detail cost accounting are the first step, and this should be followed by an entire analysis of the work before any selection of payment scheme is made.

Too much caution in this cannot be exercised, since it is very poor practice to change in so important a matter.

Betterment of Surroundings and Relations Between Employer and Employee

Although the matter of reward for individual efficiency is so important, it alone is not enough to establish the proper relation between employer and employee.

In the last few years we have all seen and approved the progress made in attempting to make the surroundings of the men better. Our newer shops are laid out with the idea quite prominently in mind that our men spend about half their lives in the shop—more, in fact, than they do in their homes—and that it is a paying proposition to make the place as desirable a day-time home as may be.

Everything for comfort and convenience is profitable; fair treatment and cheerful surroundings are alike necessary, and anything that may tend to develop a community of interest and responsibility between the employer and his men, and so approximate the old friendly relations when the boss worked with the men and knew each one by name, is to be carefully studied and undertaken.

Summed up in a few words, factory efficiency results from applied knowledge carefully checked by common sense.

The Passing of Riveting

Flame welding is slowly coming into use in our shops, though not in a way to attract special attention as a shop process with great possibilities. But the visitor to some German machine shops begins to be impressed with the idea that riveting and soldering as means of fastening together two pieces of metal are fast passing away.

Not only is flame welding used for the operations with which we are familiar, but for others. Aluminum tanks, pipes, etc., for brewers' and chemical manufacturers' use are flame welded. Nickel is successfully handled under the torch. Cutting tools are being made from low-carbon steel by changing the structure in the oxyacetylene flame. Bases for oil engines, automobile engine cylinders, boiler tubes, pipe, ornamental iron work, are either in the commercial stage of manufacture by flame welding, or are well through the successful experimental stage. The application seems to be as wide as the necessity of joining together or severing two pieces of metal.

In construction work flame welding is being used by plumbers and pipe fitters who are putting in entire piping installations without threaded joints. An instance of this is the five English miles of piping in the Palace of Justice in Cöln, put in in 1910. This is iron pipe put together with oxyacetylene-flame welded joints. Not a single screwed joint was used.

In general, flame welding is stated to cost but 40 to 50 percent of riveting on the same piece. The shop consuming the greatest amount of gas per day for such welding is a government shop in St. Petersburg, working on army and navy equipment.

The interest in the process is further shown by the facts that for six years a journal has been published in Germany exclusively devoted to autogenous welding, an 800-page handbook has sold to some 5,000 copies, and a textbook for industrial schools is just entering its second edition.—*American Machinist.*

Shop Costs*

BY W. C. CONNELLY†

I have been requested by the committee in charge of this convention to read before you a paper upon the subject of "shop costs," and before going further I wish to state that in my opinion there are many others here present who are more competent to prepare this paper, but who for various reasons would not do so. I am very anxious to see the men in this industry receive suitable returns upon their investments and labors, and believing that one of the greatest weaknesses in our industry is lack of proper costs, I have consented to prepare this article, and trust you will accept same as simply the opinion of a layman. I have also narrowed up the title to "costs" only as applying to the manufacture of boilers and kindred work.

We have in the manufacture of boiler shop products three principal articles that enter into the cost, the same being material, labor and overhead expense. It is a very easy and simple matter to obtain the exact cost of the material entering into any job. In obtaining our labor cost there are various methods, some of which are good and others, in my opinion, of not much value; but as I hope that not later than our next convention some one will go into this subject in detail, we will assume for the present that all boiler manufacturers have a good method of arriving at their labor cost.

The third item of cost in a job is, as stated above, known in a general way as "overhead expense," and it seems to me that boiler manufacturers in general have not placed enough importance upon this subject, learned enough about it, or determined what relation it bears to our business in general; that is, its relation to our shop pay-roll, and also to materials purchased. No doubt one might go to an extreme in this matter of "costs," but I have no fear of any boiler manufacturer doing so. On the other hand, I feel that a large proportion do not go into this subject far enough, and for this reason sell their product at little or no profit, and do great injury to themselves and the others engaged in the same line of industry.

I would suggest that the following items of expense be carried under separate accounts by all boiler manufacturers, in order to properly determine their overhead expense:

General expense.
Legal expense.
Advertising expense.
Traveling expense.
Drafting room expense.
Taxes.
Fire insurance.
Liability insurance.
Heat, light and power.
Interest.
Discount.
Water rents.
Cartages.
Stable account (if you own your teaming outfit).
Machinery repairs.
Building repairs.
Tool steel account.
Salaries of officers.
Salaries of office force.
Non-productive labor account.

No doubt all of the above titles denote exactly what items ought to be charged under same, with possibly the exception of the last one. Under the title of non-productive labor should be charged the salaries of superintendent and foreman, also wages of the engineer, fireman, night watchman, teamsters, traveling crane operators and the general repair man, as no plant is without at least one such man.

The twenty items enumerated above are by many considered as their total overhead expense, but my opinion is that they are not correct. To the total of the above items should be added an amount equal to 6 percent on the actual capital invested (not the authorized capital stock, as same may be more or less than the investment). This amount should be added, for the reason that one would have to guarantee a net 6 percent to the owners of the plant if the company operating in same was not the owner. We should then add for depreciation on buildings and equipment. For depreciation on buildings I would suggest that twenty-five years be estimated as the life of buildings, which would mean a 4 percent depreciation on the first cost of buildings. I would also assume that the life of machinery and equipment be estimated at not more than fifteen years, and this would mean about 7 percent depreciation on the first cost of these items. These items, added to the total of the twenty titles given above, would then represent the total overhead.

Perhaps some of you have noticed that I have not included the item of freight and commission. I do not feel that they ought to be included, because, as a rule, all plates, tubes, etc., are purchased f. o. b. our track, and the freight on same is added to the mill invoice, so that this takes care of all "inbound freight." It is a very simple matter to add to the estimate sheet the amount of freight from our plant to destination, so that this covers all "outbound freight." In the same way the commission should be added, if there is to be any.

After finding out what our total overhead expense is the next step is to know what relation it bears to our business in percentage, so as to arrive at a factor for estimating on work. The question is, whether this factor ought to be determined by comparison with total sales or by comparison with total payroll of shop force.

A journal that comes frequently to all boiler manufacturers recently had an article on this subject, and stated that this factor should be gotten by comparison with total sales, and to this I would take exception in so far as boiler manufacturing goes, as I believe the proper method is to make comparison of overhead with shop pay-roll. No doubt a great many boiler manufacturers are using the former method and are continually cheating themselves, and I shall try to illustrate.

Most all boiler manufacturers build a general line of boilers and other steel plate work. Now, then, take as an example the estimate for a small firebox boiler, made in accordance with the United States marine laws, for a small craft like a river tug. I have taken off the cost record of such a boiler, and find the actual cost of material approximately $500, while the actual cost of labor was approximately $600, thus getting a total of $1,100 for these two items. If one should add to this total an amount equal to that determined by figuring overhead against sales, we will assume that he arrived at 25 percent as his factor, and in this case it would be equal to $275, so that the total cost would then be $1,375; and assuming that he adds 20 percent (which would only net about 16 percent on the sale) he would then have $1,650 for a selling price.

Now, by using the other method of getting an overhead factor, he will find that his overhead total is at least equal

* A paper read before the American Boiler Manufacturers' Association, Cleveland, Ohio, September, 1913.
† President, D. Connelly Boiler Company, Cleveland, Ohio.

to his shop pay-roll, or 100 percent. To the $1,100 for material and labor he will add $600, or the amount equal to his actual pay-roll on this boiler, and then gets a cost of $1,700, and to this adds the same 20 percent, getting $2,040 for a selling price.

You will see that by the first method he has sold the boiler at $50 less than the actual cost, although his record makes him believe that he has had a profit of $275. Furthermore, you will note that it took $600 to produce a sale of $2,000, and the same amount of labor applied to simpler work would have produced, roughly, $5,000 in sales, and as the margin is figured on the cost, the profit made on the tug boiler is only about one-third of what it would have been on the other class of work. It must therefore appear that a larger margin of profit should be had from the difficult jobs. However, I feel that a net 16 percent, as given above, is small enough on even the simplest work, for the reason that after considering the amount of capital invested, the small volume of business a boiler shop can do as compared with the total investment, the years of experience and knowledge necessary to successfully operate a plant of this kind, it is to-day the most underpaid industry connected with the iron and steel business.

In some of our boiler manufacturing establishments, where the ownership rests wholly with one or two men, there still remains an old custom of granting to the owner or partners a nominal drawing account, so that when the books are closed at the end of their fiscal year they show a good profit. This, in my opinion, is wrong, as these men, who give their entire time to the business, ought to charge against the business salaries commensurate with their services, or what they would work at for some one else. Unless they do this they are fooling themselves in regard to the actual returns from their investment.

It takes as much study and labor to be a successful boiler manufacturer as it does to be a good lawyer or a good doctor, and lawyers and doctors to-day refuse to sell their services for less than from $50 per day upwards; and why should the men in this industry, who have equal ability in their line, sell their brains and time for little or nothing? I would here state that I am strongly in favor of economical management, but would also give to those who carry great responsibility a fair remuneration for their services.

The great trouble is, in my opinion, that we do not charge enough into our overhead to cover same. Some leave off the interest on their investment, others charge drawings up as an asset instead of expense; others charge patterns and dies into assets at full cost price, others will trade off old tools, as, for instance, an air hammer or drill, and charge to their assets the amount paid in trade. This is all wrong, in my opinion.

I take it for granted that we are all in business to make money, and we must therefore co-operate to our mutual benefit, and if we will carefully look into our costs and then try and get a fair margin for what we do, we will help to get the boiler business back where it belongs, as I feel that it has never recovered from the business depression of 1907 and 1908. The cost of plates, tubes, labor, etc., has been going higher steadily, and the cost of boilers has advanced slightly, if at all.

We represent an honest industry that takes capital and brains to operate, and we should stand together for everything that will be of mutual benefit. Practically every article we consume, such as boiler plates, tubes, rivets, corrugated furnaces, etc., have fixed prices, yet the price of boilers will vary from 5 to 25 percent in the same city. I feel safe in stating that there is not a boiler manufacturer present who feels he has equitable returns on his labors during the past few years.

I would also suggest that there should be a normal rate attached for the use of such tools as hydraulic riveters, hydraulic flanging machines and presses, large bending rolls, etc. To-day in Cleveland it costs 90 cents per hour for plumbers on repair work, 85 cents per hour for high-grade carpenters on repairs, and 60 cents per hour for a machinist in any auto repair shop in this city, and they have no power to furnish, and only such tools as can be carried in a satchel, and yet there are very few, if any, of us that can say we average 60 cents per hour for all our help.

A Job on the Magnolia

BY JAMES ROSSAN

Upon her arrival in port the *Magnolia* had sent in a call for boiler makers, and Cassidy was the man selected to take charge of the job.

As it was early in the morning he arose from his bed, invigorated himself with a cold bath, attired himself in clean linen and a natty suit of clothes, donned his shiny derby and spotless gloves and proceeded to the shop.

Through a wireless call system his assistants and helpers had been summoned and were here awaiting his arrival.

Promptly Cassidy went to a number of lockers conspicuously marked for various repair tools. Opening a door he brought forth a small truck plainly marked "material and tools for repairing a reinforcing ring."

"God bliss 'im for that," said Cassidy. "Shure Oi remimber the toime whin we used to have to hunt the owld shop over to find sledges, driftpins and other contraptions that we need. And just think, here we are, me hearties, ready to start in two minnits."

By the aid of skids the truck was easily backed aboard the low automobile, and they were off at a 10-mile clip, while Cassidy held discourse on the days when they used to bump over the cobblestones in an old express wagon, or, more often, walk through dangerous railway yards with a heavy pack on their backs at the risk of their lives.

Arrived at the steamer they were met by a pleasant engineer; complimented for their promptness in responding to his summons and then taken to the job, where the reinforcing around a manhole had split.

"Here you are, Mr. Cassidy," said the engineer. "You will observe that we have cleared all piping and other obstructions away. We have not only blowed down the central boiler, where the job is, but also the two others for fear the heat would be oppressive. As I feared some bad air still remained I have installed a dozen portable electric fans to give a good circulation and supply a cold draft. To eliminate dirt or any possibility of you soiling your clothing we have scrubbed the boiler tops and adjacent work with the sandblast, which renders it chemically clean. You will also note that we have placed a number of comfortable chairs near your work. Please make yourselves comfortable, do not hurry, you will find it a pleasant place to work."

"Now, that's what Oi'd call a gintleman," said Cassidy. "Shure Oi moind the day, more's the pity, whin we used to crawl to our work through soot and grime, and in a heat that'd boil the kidneys out of ye."

Presently, after a smoke and a pleasant chat, they started the job. A machine worked by a compressed air tank no larger than a water pail was used to shear off the rivet heads. This was a combination machine and was also used to punch out the rivets and to ream and fair the holes for the new ring, and finally it served both to hold on and drive the new rivets. There was practically nothing for the men to do but to sit in their comfortable chairs and watch their respective gages for the pressure applied. Even the smoke and gas from the usual forge was eliminated, as the rivets were heated in an electrical furnace.

"Oh, the heartache of it all!" said Cassidy, as he neatly adjusted the pressure to a pound while setting up a hot rivet. "It makes me blood boil whin Oi think of how we used to flog and slug on 'em only to find that they were ayther not up at all, at all, or ilse up so tight that they'd burst whin cool. And here Oi am putting 'em up so neat with the pressure of me thumb that Oi havin't missed one in a year."

They took their time, adjusted their machine with precision, and were careful not to soil their clothing. At meal time they were taken to the dining room and served with good, substantial food, and hot coffee and sandwiches were served between.

But all things have an end, especially good things. The job was finished, the brightly polished tools wiped clean and placed in their respective places on the truck. Leisurely they donned their clean collars and neatly brushed hats and coats, and jumped aboard the auto for a pleasant jaunt back to the shop in time for an early quitting hour.

"Good bye, gentlemen, and a pleasant evening to you," said the engineer.

"Thank you, sir," Cassidy answered, "and many happy returns o' the day." Then as he took the steering wheel and threw in the clutch, he added: "Shure, a boiler maker's job's the nifty job to-day."

Perhaps the auto struck something, there was a fearful jolt as Cassidy was yanked from his bed out on the floor.

"I've been trying to wake you for fifteen minutes," said the watchman from the shop. "Hurry now, man, there's a split manhole ring on the *Magnolia,* and ye're the man to go and do the job."

Cassidy rubbed his eyes, dropped back in bed and muttered: "Ye can go to blazes! Oi've done work enough on that owld hooker to know her. She's hot enough to fry the liver out o' ye up there, we have to lie in the soot and swing a sledge in a place where it would bother a rattlesnake to get through. There's a nigger driver of an engineer who expects ye to do two days' work in one. No, sir, none o' that fer me!"

"The boss said if ye didn't get down there as quick as ye know how ye can be looking for yer time in the morning," the watchman continued.

Slowly, sleepily, disgruntled Cassidy donned his soot begrimed overalls. As he wended his way to the shop, facing the wind and sleet, curses deep and sonorous rang out on the frosty air of the night.—*The Marine Review.*

Uniform Boiler Specifications*

BY THOMAS E. DURBAN †

It is safe to assume that no one subject has consumed so much of the time and thought of the majority of manufacturers of boilers as has the subject of uniform specifications. The possibility of uniform specifications is beset with many difficulties; but I feel that the chief difficulty has been overcome, and that a uniform action among boiler makers will bring about the much desired uniform specifications. I think that we all have been responsible to a degree for not having a uniform specification owing to the fact that we have been consumed with petty jealousies, each of the other, and our endeavor to get slight advantages by making changes in specifications in order to get business has retarded the progress of a uniform specification. While we would all unite in a general way in singing the praises of the uniform specification, we did not exercise any degree of sincerity in our attempt to get to the bottom of the proposition.

About ten years ago the company that I represent addressed a letter to all boiler makers in the United States trying to get some concerted action. The replies that were received were most agreeable, but the action was not there. We took the matter up with our Congressmen and Senators, and finally with the President of the United States; and pointed out to him the necessities of a standard specification from the public's viewpoint; citing to him that the United States exercised jurisdiction over boilers on navigable waters in order that they might protect, as far as possible, the lives and property of people who used these waters as a means of transportation, and citing to him that life was not less dear to the man who lived on land, and pursued his occupation on the land, than the man who traveled on the water and pursued his occupation on the water.

However, we ran across that insurmountable barrier of States' rights when we urged the necessity of a common law governing the building of boilers. In spite of any argument that we could bring about we landed always in the same place: Our Congressman would have been glad to have introduced a national law, but after consultation with the President decided with the President that it was absolutely useless.

Now fortunately, due to various causes, it has become manifest that boilers must be built better and nearer to a common standard than ever before in this country. The large number of laws has made it almost imperative that a man who is engaged in the manufacture of boilers for distribution throughout the United States should throw his whole energy into having the law so constructed that he does not have to carry a stock of material and stock of boilers on hand to meet the requirements of the various laws in the various States and cities. These laws, varying as they do, one from the other, make a needless waste, which comes from the fact that a manufacturer is now almost compelled to build each boiler to meet the requirements of each law. This necessitates slow progress through the shop, an enormous investment in material, and, due to the fact that different manufacturers put different interpretations on the laws, it brings about a great conflict in the price of boilers.

With a uniform law and the co-operation of all manufacturers these differences would be largely overcome, so that the boiler would reach the consumer not only a better boiler but for less money, and not only would the manufacturer be able to produce the goods and sell them for less money, and be more certain of his profit, and he would eliminate the probability of a large loss in case his foreman or designing engineer should get confused in the various laws.

I think there is no concern that has manufactured boilers that has not suffered from the lack of uniformity in State or city laws, and of a concern that is engaged in making various types of boilers for distribution throughout the entire country and in Canada, I venture the assertion that there is no one concern but what has met with a very considerable loss.

All this can be eliminated; the public can be protected, both as to its life and its investment; the manufacturer can make more money on less investment if we can succeed in getting concurrent legislation or approximately concurrent legislation in various States.

It seems to me that beyond doubt a concurrent effort among the manufacturers of boilers and mechanical engineers and users of boilers cannot help but bring approximately concurrent legislation. As it is now the laws are confusing in the extreme, and it requires the undivided attention of a

* A paper read before the American Boiler Manufacturers' Association, Cleveland, Ohio, September, 1913.

† General Manager, Erie City Iron Works, Erie, Pa.

bright mind to so issue the orders to the shop that the boilers will come through without trouble. The boiler laws are coming out from the East, West, North and South—in every direction. Not only are the laws themselves different, but different interpretation has been put upon the same law by different inspectors and different builders. I presume without exaggeration that there are at least one hundred laws and changes to laws in the United States alone governing the manufacture of our product, and this can be multiplied by a thousand times as many inspectors as there are laws.

For instance: We have asked a decision of one point—the butt-strapping of drums. It is our interpretation of the law as it is written in several of the States that it is necessary to make all butt-strapped seams to a minimum length of 12 feet. We have been informed by some inspectors that this does not apply to watertube boilers, and by other inspectors that it applies to all boilers. We conformed our specifications to meet the letter of the law—that is, to have no butt-strapped seams over 12 feet long; whereas we have found out since we put this order into effect in our works that many boilers or drums of boilers are being made and passed with butt-strapped seams as long as 20 feet.

In spite of all this we are thoroughly impressed that the boiler inspection laws have been and will be beneficial to us all—all the boiler manufacturers and all the users—and that out of it all will come the ideal boiler in both design, workmanship and material, and this is a consummation to be desired; so that when we come to figure on a job we will be all put on the same basis, and it will be necessary for us all to furnish a boiler that in the estimation of all the law-makers will produce the best boiler made.

The present laws as enacted have been of great benefit, as they have reduced what was formerly opinion and frequently guesswork to something definite and right. It is the opinion of the writer, which he believes is concurred in by the majority of people engaged in the business, that nothing could be more advantageous to the manufacturer than to have all these questions settled and settled right.

The laws as we now have them have been classified by our engineers into three groups:

First group, comprising Massachusetts, Ohio, Detroit, Manila, Chicago and Indiana. Detroit, Ohio and Manila are practically identical. Massachusetts law differs somewhat, and the Chicago and Indiana laws are modifications.

The second group comprises all British specification in which we are interested—British Columbia, Alberta, Saskatchewan and Ontario, which are all copies or modifications of the British Columbian law.

The third group, comprising inspection laws of States and cities—Philadelphia, Seattle, St. Louis, Los Angeles, Montana, New York and others. They differ from each other, but in a general way are less complicated than the other groups.

All the laws in the United States unite on a factor of safety of five. The Canadian laws require a factor of safety of five and a half to six and a half, and it is optional with the inspector just what factor of safety he will accept, depending upon his opinion of the good workmanship that is done and upon just how the boiler happens to strike his fancy.

The material for Massachusetts, Ohio, Detroit and Manila is special, both as to the chemical and physical properties. A certified mill test is required for all plate material, and the plates must be stamped in five different places. Other inspections require only a mill test, and are not so particular about the chemical analysis of the material.

We at one time had a boiler refused in Massachusetts because the chemical analysis of sulphur was off one one-thousandth of one percent. We have now coming through our shops, as we presume most of you have, boilers that come under almost all these laws, and the resulting confusion may be something stupendous, and must be taken care of in the price we make to the consumer on the boilers.

We have established now, through the effort of the steel manufacturers, a standard specification on steel, and by common consent we have established the efficiency of certain seams and also a certain strength that can be allowed per inch of area on braces and staybolts, so that it does not seem a far cry to get a definite specification on a boiler itself.

One problem that will confront us will be the variation in tensile strength which is standard with mills; a variation of from 56,000 to 62,000 in tensile strength would make a considerable difference in the thickness of a boiler. If one of us should figure on 56,000 tensile strength and another on 62,000, necessarily one would be figuring on a thicker or thinner plate than the other.

In a common specification it would be necessary to specify the material in the braces and the working stress in pounds. Now, it varies from 6,000 to 8,000. Unquestionably all holes should be drilled from the solid, or punched ¼ inch small and reamed to size; that is, there should be at least a full ¼ inch of reaming.

In Ohio, Detroit and Manila there is a uniformity in the number of braces above the tubes; there are no particular specifications as to tubes or the material in the tubes, but in almost all the specifications the tube holes must be either cut from the solid or punched ½ inch small and reamed to size.

The butt-strapped seam is now demanded on all boilers, due to the fact that it has been proven to the satisfaction of many people that lap seams are a menace to the life of the boiler, and many boiler explosions have by experts been attributed to lap seams in the longitudinal section.

Some laws limit the thickness of plate to ½ inch, and therefore limit the pressure on horizontal tubular boilers. We should strive in our uniform specification for a standard specification on material, so as to remove the necessity of carrying two grades of material; the carrying material in stock of two different physical and chemical qualities.

I feel thoroughly convinced that it will not be a difficult proposition to get concurrent legislation in the various States so closely to conform to one another that the boiler itself can be used in any of our various States, provided the present laws are used as a basis, and provided this organization and all organizations and firms and individuals who are interested in the sale of boilers or in the use of boilers will make a united and intelligent effort in such States as have not yet passed boiler laws that we can gain our point, and in doing so we can safely feel that we are guided not entirely by the selfish motive which usually prompts a manufacturer's effort, but by the general good for the public, in procuring for them a better, safer boiler at a less price, and get quicker shipments than would be possible under laws that have not emanated from a common source, and have not had in view the production of the best article for the least money.

It seems to me that there is no subject along any mechanical lines so important to us, and to the public in general, as a uniform boiler specification, both as to material, design and workmanship. If this organization, through its various connections, can establish in each legislative assembly the necessity of uniform treatment of this subject, so that when laws of this kind are coming up they can bring the influence of all interested people, as they easily can, by keeping in touch with the situation of the laws to be enacted, we can accomplish our purpose in the end.

Of course it will be attended with much hard work and honest effort, but now that we have at last reached an agreement that a standard specification is necessary, the greatest obstacle that has prevented us from having it heretofore has been removed.

A uniform steel specification seems to be very easily accomplished. By comparison with three mills we find that there seems to be absolutely no necessity for special requirements such as Massachusetts and Ohio. We find in the law requiring special steel that there is practically no difference between firebox and flange steel on these special requirements, except as to the matter of the brand. Eighty-five percent of flange steel coming from one mill has all the qualifications and could be stamped as firebox, and in another mill 93 percent of all flange steel could be stamped firebox.

That is, both steels have the same chemical and physical qualities, and they are changed from flange to firebox, or from firebox to flange, by a stamp which is put on, the only difference being that the mills charge $2 a ton extra for using a stamp marked "Firebox," as against a stamp that would brand it as "Flange Steel."

As a matter of fact, we would suggest that what is really required is more stamps on the plate showing mill test, and less stamps showing the brand. If the mill test stamps are put on so that they can be observed by the inspector, he can get then the full record of the plate from this heat and mill test stamp. He can then tell what the tensile strength is and not assume it.

As a matter of fact, all inspectors and all State laws will assume the minimum tensile strength the law permits, unless they have access to the physical test as made by the mill. There ought to be uniformity regarding this point.

In these specifications, particularly Massachusetts and Ohio, firebox steel is specified in the shell and flange steel in the heads. This, in our estimation, is an error. If there is a difference in the steel, and if the firebox steel is supposed to be of a better quality than is attributable to it, it is increased ductility, which would make it a better steel for flanging; therefore, the law is exactly contrary to the best practice in steel. The best steel should be used for flanging, therefore the specifications and the law should read—according to our ideas—flange steel in the shell and firebox steel in the heads. But, as before stated, as a matter of fact there is no difference in the quality of the steel. We therefore feel that the Massachusetts and Ohio and Detroit inspection laws calling for firebox steel in the shells is clearly in error, and it militates against people who buy boilers under this law.

We doubt very much whether any State law would hold good, if it were tested, that specified a certain brand on the plate. We believe that any court would decide that if the plate came up to the physical and chemical test required by the law, it would make no difference what the plate was branded, and it might not be a bad idea for this organization to designate some manufacturer to ship a boiler into a State and have it branded "Flange Steel" and make a test case; of course, with the hypothesis that the flange steel passed the physical and chemical tests to entitle it to a brand of "Firebox."

The boilers that the concern that I represent manufactures, and whose specifications have been submitted, would pass any of the American laws except such laws as call for firebox steel. To a concern who is building an occasional boiler, and does not have to carry material and finished boilers in stock, the difference in price of $2 a ton would not be material, but to a concern that carries a large amount of stock, and a large amount of finished boilers, and uses from 10,000 to 12,000 tons of steel a year, it is readily appreciated it would cost from $20,000 to $24,000 a year to use flange and firebox steel, and it would necessitate him carrying in stock, in order to supply his trade promptly, double the amount of stock, both in the flange plate and in the finished boiler, all of which would have to be made up to him in the price charged to the consumer for the boiler.

Along the line of conservation and economy, if we are right in the data which we have—and we know we are right—would it not be wise to adopt flange steel for boilers throughout? For, as illustrated before in this paper, there is no difference between flange and firebox steel from the majority of mills except the stamp, and it is a direct descrimination against purchasers in various States where they have the law of firebox steel, and causes them to pay more money for their boilers; and as the only difference in the steel consists in a brand that is stencilled on it, it certainly has a very strong resemblance to what is commonly known as "graft."

In other words, is it not a fact that the people who reside in States that have not yet passed these laws will get a better boiler, or as good a boiler at least, for the same money as a resident of a State who buys under the law providing for special steel? The man in the adjoining State would get steel of the same physical requirements and the same chemical analysis, and he would get it for less money.

Again, some States require brackets on the boiler, and some States require the boiler being suspended from a gallows frame. Will a gallows frame support a boiler any better in Indiana than it would in Massachusetts, or will a boiler with brackets on, stand any better in Massachusetts than it will stand in Indiana? All these things cause extra expense to the manufacturer, which makes an extra price to the consumer, for which he gets no adequate return.

In conclusion we would recommend that boilers be built on a factor of safety of five; of uniform steel, and that this specification cover flange steel; that the steel be marked with the heat number instead of the brand, and that it be made minimum tensile strength of 60,000 pounds, and be subject to the bending and quenching test, and that it have phosphorus not to exceed .03, sulphur not to exceed .04 and manganese .50.

That weldless crowfoot type braces be used, the same quality of steel as the plate, and they be figured on a basis of 7,500 pounds per square inch of section in the brace, and that on this basis no brace be used containing more than 1.28 inches area of section.

That through braces, either above or below the tubes, be weldless, and be figured on 7,500 pounds per square inch of area; that all seams be butt-strapped with inside and outside covering strips.

That all manholes be 11 inches by 15 inches.

That no plates be used in a tubular boiler thicker than 5/8 inch.

That all holes for rivets be punched 1/4 inch small and reamed to size:

That all flue holes be punched 1/4 inch small and reamed to size.

That no cast iron be used in connection with the boiler, either for reinforcement or any other purpose.

That all plates be beveled on a planer instead of sheared on a bevel shear.*

That water column connections all be 1 1/4 inches.

We would recommend, also, that a committee be appointed with power to act to bring together a committee of boiler makers, steel manufacturers, State and city officials—whether they be inspectors or chairmen of the boards—also one from the American Society of Mechanical Engineers, and a representative from the leading boiler insurance inspection companies; and that the meeting of this committee so appointed shall be open to the general public, and that this be done within the next sixty days, in order that rules and regulations may be adopted that can be made uniform for the construction of tubular boilers.

I would recommend that the utmost publicity be given to the effort of manufacturers to procure a standard specification in all the trade and mechanical papers.

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*A demonstration on a 9/16-inch plate shows that it is impossible to do a good job on a splitting shear, and that the same objection that exists to a punched hole holds good in the use of a splitting shear on thick plates. That is, that the metal is distorted by use of a splitting shear.

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

The subject accorded first place in the discussion at the annual convention of the American Boiler Manufacturers' Association, held this month in Cleveland, was "Uniform Boiler Specifications." Those who are familiar with the records of this association can readily appreciate the interest shown in the matter, because work in this direction was begun by the association as long ago as 1889, when at its very first convention specifications were formulated for boiler steel. In subsequent years a number of committees on uniform boiler laws were appointed, which became actively engaged in an attempt to secure legislation covering the construction and inspection of steam boilers in various States. Although these attempts were unsuccessful at the time, the project has never been wholly abandoned and the subject has been brought before the association in one form or another at nearly all of its regular meetings. An important step was taken in 1896, when the association's committees on boiler materials and boiler laws were merged into a single committee on uniform boiler specifications whose recommendations, covering in a practical manner all of the important details of materials and workmanship, were unanimously adopted by the association in 1898. These specifications were widely circulated and, together with the modifications and amendments afterwards introduced to meet the requirements of progress in boiler making, have proved useful as a basis for some of the boiler laws recently enacted. Attempts to have such specifications adopted without modification in various States were abandoned, however, when it was realized that local conditi ns differ so greatly in different parts of the country that boiler construction must be made to conform with these conditions. This idea was borne out by the recommendations of the committee which were unanimously adopted this year, in which it was suggested that the subject be divided into two parts: First, to formulate and press for adoption in all States a simple short law embodying the general provisions for honest and safe construction, inspection and care of boilers; and, second, to recommend the adoption wherever possible of fair, clear, rules modeled after the Massachusetts, Ohio and Steamboat Inspection rules.

It is very evident that general boiler laws cannot be too specific on account of the diverse conditions that must be met in various localities, but there seems to be no reason why uniform laws should not prevail throughout the country covering the basic, well established principles of boiler construction and boiler materials, once the advantages and benefits of such uniformity are recognized by boiler makers and steam users alike.

The papers on "Factory Efficiency" and "Shop Costs," presented at the Boiler Manufacturers' Convention this year, were a welcome addition to a programme that has usually been devoted entirely to the technical side of boiler construction. These subjects were so well received that a committee was appointed to ascertain which items should enter into shop costs and which should become uniform. By thus establishing a uniform system of figuring shop cost it is expected that some of the evils of unfair competition will be eradicated from the boiler making industry, as much of this unfairness is apparently due to ignorance on the part of the manufacturers themselves regarding the true relation which shop costs bear to the selling price, so that in underbidding their competitors they are cheating themselves to the advantage of no one except the buyer, and that only temporarily. The matter of shop costs can certainly be placed on a sound basis in the average boiler shop just as easily as is done in any other manufacturing establishment, and the report of this committee will be awaited with interest.

The question of factory efficiency, however, is open to more debate, as it is a many-sided question and involves so many factors depending upon local conditions that a number of applications of the underlying principles of efficiency can usually be made to almost any case with a varying degree of success. In studying this question, however, practical experience is a most valuable guide, and a close study of current practice will help greatly in increasing factory efficiency.

Engineering Specialties for Boiler Making

Electric Riveting

Riveting with an electric current by heating and heading rivets in place seems a new art to the trade, but it has been in operation successfully, it is claimed, in a number of private factories for several years, and electric riveting machines are now offered to the trade by the Eveland Engineering & Manufacturing Company, Philadelphia, Pa. A cold rivet of any shape or size is placed in position in the article to be riveted, and by pressing a foot or hand lever, according to the requirements of the work, the rivet is heated to any degree desired, and by suitable arrangement of levers pressure is exerted, either by power or by hand, and the head formed, both the heating and heading being done in one operation.

FIG. 1.—UNIVERSAL ELECTRIC RIVETER

The Eveland electric riveter is made in various shapes, types and sizes, consisting of large and small bench and portable machines, as well as power-driven machines, capable of heating and heading rivets from 1/16 inch to 2 inches in diameter. While the work is done by an electric current, the machines being capable of developing a degree of heat exceeding 2,000 degrees F., they are claimed to be absolutely safe to use, as there is no possibility for an electric arc to form, nor any danger of an electric shock.

One source of economy with the electric riveter is the fact that no air compressor or other apparatus is necessary, and one man and a helper can carry out the entire operation, or even one man alone, if the work is done on bench machines. Thus, compared with the ordinary method of riveting by forge heating, when one man, one helper and a rivet heater are required, besides an air compressor and the necessary power for operating the apparatus, it is evident that the electric riveter will result in substantial savings, especially as skilled labor is not required to operate the machine.

Same marked advantages are also obtained in the nature of

FIG. 2.—ELECTRIC RIVETER IN OPERATION

the work done by the electric riveters. For instance, it is claimed that the rivets can be made to fill the holes more uniformly than by any other method, since owing to the method of heating the rivet while in place the hole can be made

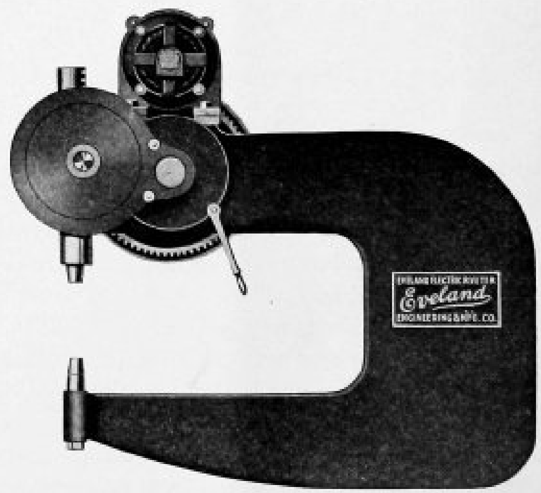


FIG. 3.—PORTABLE RIVETER

only very slightly larger than the rivet, and a small part of the metal surrounding the rivet is slightly heated, so that the rivet can become practically welded fast to the plates, filling the hole completely. Furthermore, the rivets do not become chilled by being brought into contact with the cold iron plates in which they are placed.

When plates are riveted by hammering there is a creeping effect, so that at some point in the seam the holes in the upper or lower plates do not match but overlap. This, it is claimed, cannot take place in the electric riveting machines, nor is there any danger of overheating or underheating the rivet with consequent brittleness caused by hammering the metal at a blue heat.

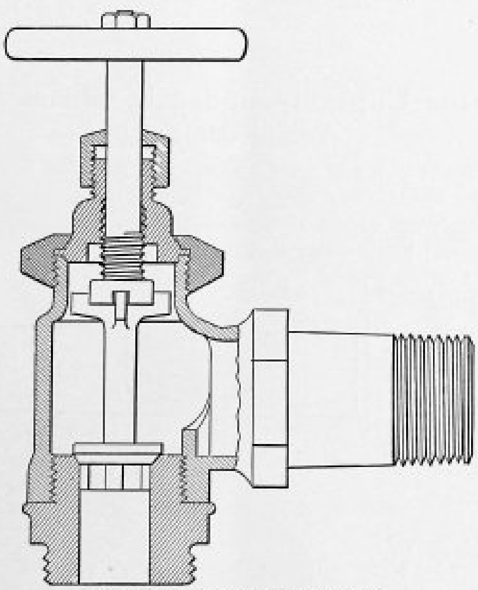
The cost of operation, basing the cost of electric current on 10 cents per kilowatt-hour, is found to average 8 to 10 cents per 1,000 rivets for 5/16-inch rivets, 12 to 14 cents per 1,000 for ⅜-inch rivets, 20 to 25 cents per 1,000 for ½-inch and ⅝-inch rivets, and the larger sizes in proportion.

The small bench machine will rivet any piece within the range of length and depth and for rivets up to ¼ inch diameter, while the base machine will take larger and heavier work and rivet up to ½-inch diameter rivets. The universal machines will take up to the same sizes, but will rivet at an angle, and will cover a large range of sizes and shapes at any angle, including medium-size boiler tanks, etc.

The power-driven riveters are automatic in operation, being made with a motor-driven special variable speed attachment, by means of which the operator may regulate the pressure as well as the speed of operation, rapidity of heating, etc. It may be added also that the Eveland electric riveters will meet every tempering or hardening purpose in classes of crucible, manganese or alloy steels, and they also may be used for heating steel for bending or shaping articles.

Osman Boiler Check Valve

The Osman regrinding and pressure equalizing boiler check valve illustrated is constructed with a loosely-operating divided clutch connecting the valve spindle with the main spindle, so that by screwing in the stem the clutch, dropping automatically over the valve, serves to release the valve in case it should be stuck in the valve chamber by sediment or



SECTION OF OSMAN CHECK VALVE

other foreign matter, a condition which is the cause of most boiler check difficulties. The clutch also serves for regrinding the valve seat, all of which can be done without dismantling the valve in any way. As can be seen from the illustration, a combination nipple and seat is screwed into the check body, which enables the seat to be removed for repair or examination without removing the body of the valve from the boiler. At the entrance of the stem to the valve chamber, a bridge is provided which, it is claimed, equalizes the distribution of steam pressure under the disk, thus preventing oscillation of the disk and excessive, one-side wearing. Another feature is found in the application of a Union nut to the bonnet end, a ball joint being provided, the action of which, it is claimed, will keep the Union nut and thread clean and free from sediment or accumulations of foreign matter under all conditions. This valve is the invention of Mr. G. H. Osman, Decorah, Ia., and the patents are owned by Mr. Osman and Robert M. Law, of Decorah, Ia.

Technical Publications

Laying Out for Boiler Makers and Sheet Metal Workers. Second Edition. Size, 10 by 13 inches. Pages, 305. Illustrations, over 600. New York, 1913: Aldrich Publishing Company. Price, $5.

One of the most important operations in a boiler shop is the laying out of the various parts of boilers, stacks, tanks and other sheet metal work. This work requires considerable technical knowledge involving a thorough understanding of the elementary principles of geometry, mechanics and elementary mathematics, although a complete mastery of such subjects is not essential. The most common layouts require the development of cylindrical, conical and other curved surfaces, as well as the determination of the intersection of these surfaces when the article to be manufactured is in the shape of an elbow or irregular transition piece. In this book the practical application of the principles involved in the laying out of such work is explained by numerous examples, including an explanation of the various calculations which are necessary to determine the proper size of the different parts of the boilers, tanks, etc.

Most of the material in the book is reprinted from *The Boiler Maker,* and the first edition, which contained eight chapters covering the subject of laying out, triangulation, how to lay out a tubular boiler, how to lay out a locomotive boiler, how to lay out a Scotch boiler, repairing locomotive and other types of boilers, the lay out and construction of steel stacks and miscellaneous problems, has been amplified in the second edition by the addition of 113 new pages fully illustrated, a large part of which, including forty-four new laying out problems, is a continuation of the last chapter in the first edition on Miscellaneous Problems. There are also two additional chapters, one on miscellaneous calculations showing how to figure the strength and efficiency of riveted joints, the area of circular segments and the cost of boiler construction, and a chapter on Tools for Boiler Makers and Their Uses, in which can be found many practical hints as to the proper way to use the ordinary tools and to operate the more complicated machine tools.

This book is recommended as a valuable aid to anyone engaged in the layout and construction of boiler and heavy sheet-metal work, and especially to those who are seeking advancement in the boiler-making trade, as promotion to the position of layerout is one of the most important steps in the boiler maker's climb to the top of his profession.

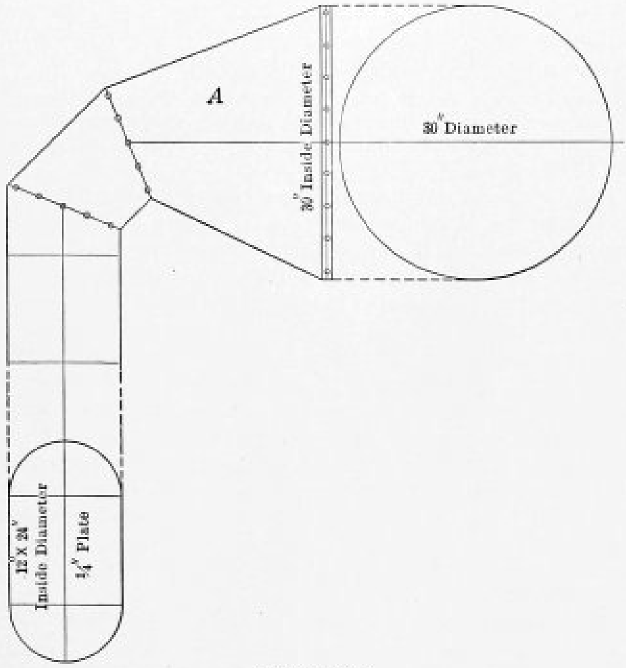
Official Proceedings of the Seventh Annual Convention of the Master Boiler Makers' Association. Size, 5⅞ by 8¾ inches. Pages, 174. Six illustrations. New York, 1913: Harry D. Vought, 95 Liberty Street. Price, $1.00.

In this volume are given the complete proceedings of the seventh annual convention of the Master Boiler Makers' Association, held at the Hotel Sherman, Chicago, May 26-29, 1913. Some of the principal subjects discussed are: The limit of length for a boiler tube; methods of welding superheater tubes; effect of superheaters on the life of fireboxes and flues; autogenous welding; methods for applying and taking care of flues, etc.

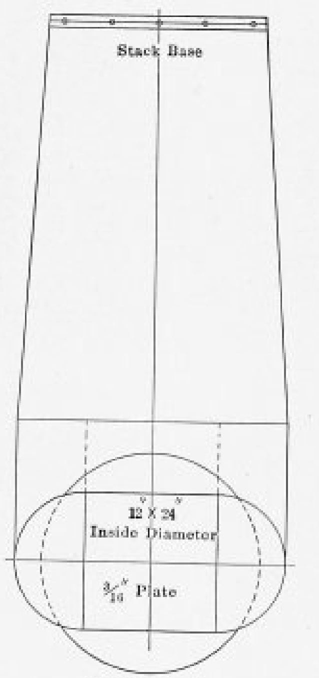
Letters from Practical Boiler Makers

Explanation of Layout Wanted

The writer would like to have some of the readers of THE BOILER MAKER explain how to lay out the problems shown in sketches 1 and 2. What I want to know is how to allow for the different thicknesses of iron so that there will be a large



SKETCH NO. 1



SKETCH NO. 2

and small end, so that I can use one pattern to mark off both end pieces of a regular 90-degree oblong elbow. Also, I would like to know if there is a way to connect the sheet marked *A* in sketch 1, so that I can mark off and punch the holes before rolling the sheet.

In sketch 2 I would like to know how to mark the holes in the stack base; that is, when the holes for the stack and base are marked off the same template. Y. W.

Portable Tool for Cutting Arch Pipe Holes

In answer to the inquiry on page 249 of the August issue from a subscriber to THE BOILER MAKER, asking for a description of a portable tool for cutting 3-inch and 3½-inch arch pipe holes, I submit the sketch of a tool shown in Fig. 1, which, after numerous experiences with other styles of cutters, has been found to answer the purpose admirably. This tool can be made in the rough by a blacksmith and machined to

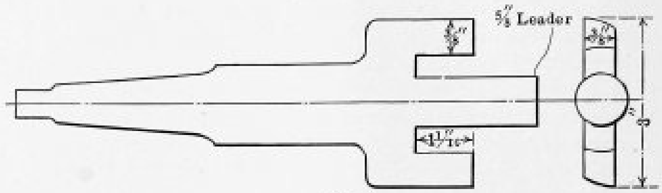


FIG. 1

size at a small outlay. With reasonable care in the feeding of the motor the tool will prove its usefulness. "Suds" should be used for a lubricant.

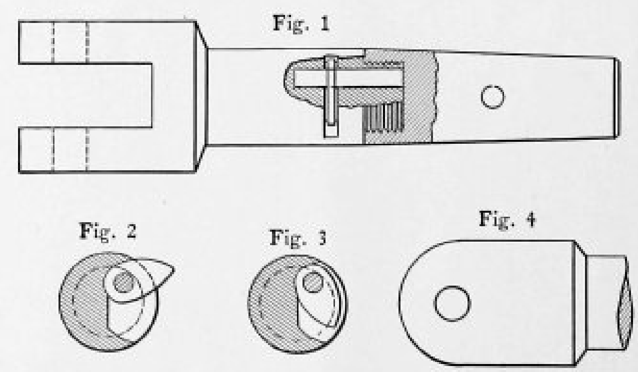
I would suggest to your correspondent that a hole 1/32 inch larger than the arch pipe should be drilled, as where the arch pipe is bent to a radius with a short bend at the front end of the pipe it will be found difficult to enter the pipe if the hole is drilled to the exact diameter of the pipe.

If the holes are drilled inside of the firebox first, the outside holes can be drilled in the same manner if the shank of the drill is made long enough to extend through the water space, thus eliminating the stripping of the back head of the boiler.

Lorain, Ohio. J. SMITH.

Flue Cutter Designed by Practical Boiler Maker

Within the past ten years a number of patented flue cutters have been put on the market, some of which are very good and some very poor. Most of them entail a great amount of cumbersome and unnecessary machinery.



FLUE CUTTER

The cutting of the flues in the front ends is accompanied by an endless amount of dirt and soot and accumulation of scale caused by water and steam leaks, and a machine for this work must be built to withstand these conditions. After a number of years' trying experiences under such conditions with the various cutters on the market, the writer determined to make a machine that would overcome some of these conditions, and one that would also be durable enough to stand up under heavy work. The illustrations show the outcome of these efforts.

The flue cutter is made from a solid piece of steel with only one moving part. The cutter, which is the only breakable piece about the tool, is made of carbon steel, and can be made for 5 cents. Two or three sets of flues have been cut off with one knife or cutter of this type.

The operation of the machine is very simple, as it is accomplished by means of a flexible shaft and gearing. On being turned to the right, the weight of the cutter forces it out and it punches through the flue; then one revolution of the tool completes the cut. As can be seen from the illustrations, when working the cutter rests in a groove of the same radius as the knife, insuring ample strength. When the cutter is at the top the cutter drops into its recess by the force of its own weight, or if using a reversing motor the reversal will permit the withdrawal of the tool.

The flues can be cut as fast as the tool can be handled from flue to flue. The higher the speed the better for the tool. The time required for cutting a set of flues, of course, depends entirely upon the operator. B. C. KING,

Foreman Boiler Maker, Northern Pacific Railway.

Helena, Mont.

Leak Caused by Careless Boiler Maker

A bad case of pitting was found on board a steamship at the front end of the bottom of all three main boilers just above the knee plate, as shown on the sketch. A good layer of cement had been put on the inside, which lasted well until the ship came into port for repairs.

The boiler makers fitted a bent patch 5/8 inch thick over the end, as shown in the sketch, fitting bolts in places where the riveter couldn't swing his hammer. They had to cut the knee plate away to allow for the patch to fit in, which they jointed with some patent cement that proved useless after a while.

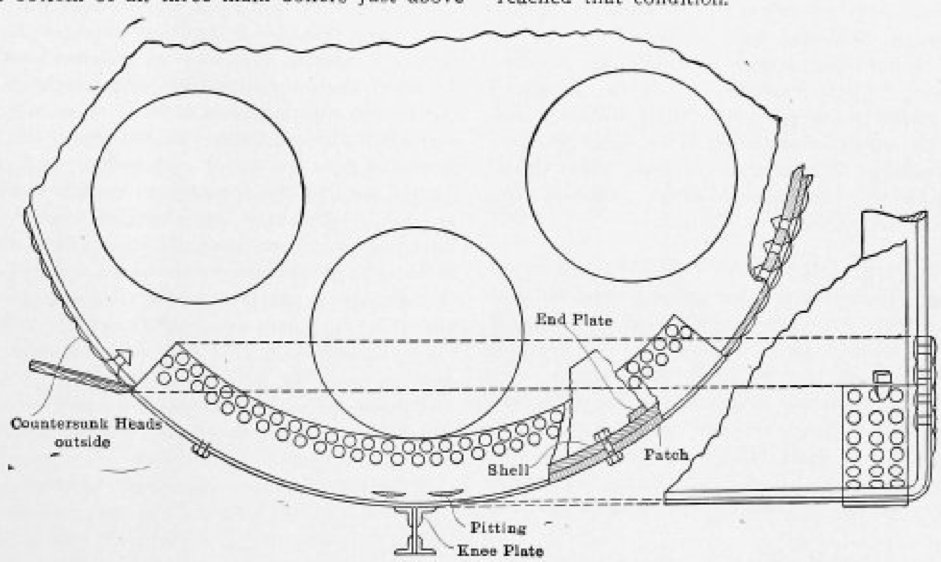
After the repairs had been made, and the vessel had been under steam three days, I had just gone down on watch one night, when one of the flat-faced Chinese firemen ran into the engine room, shouting, "Misses! Misses! too much puff! Plenty too much puff! Come! Look! See!" Well, I went to look, "see see," as he called it, and found a great opening in one of the calked joints of a patch, as shown in the sketch. After calling the chief to see it, he went up to report to the captain, saying he would let the boiler down.

I went in the engine room to oil around, attend to matters, etc., and after a few minutes the same Oriental came in and said, "Misses, puff finish! You look, see! Yes, allight." When I got in the stokehold, I found they had sharpened the end of a piece of wood they had found about 5 feet long by 3 inches by 2½ inches, and hammered the wedge end in the blow hole, completely stopping all steam. They tried to look pleased at what they had done on their own initiative, but their faces wouldn't allow for the expression. The chief couldn't believe it would last without giving out, but it did for seven weeks. It did seem funny to us, under steam, with a great wooden chock rammed in one of our boilers.

However, when we did let the boiler down we found the end of a boiler maker's calking tool had been carelessly jammed between the patch and boiler plate and broken off, the man leaving it in without saying anything on the matter, and, of course, this piece of calking tool had blown out, causing "too much puff," as the fireman called it.

We hammered the patch up close, filled the joint with putty and recalked it.

I may say that when they had tested the boiler bottoms before fitting the patches, they found the plates pitted all in the one place, in the shape of a hollow the size of a man's hand. In some cases the plate was worn down to about one-eighth inch thick, yet 160 pounds pressure had been on the boilers the day before. To my mind, it is a good thing no heavy vibration of the furnace flues had taken place while under steam, or there might have been a serious accident. Needless to say, the boilers must have been a pretty old job to have reached that condition. R. STEIN.



SKETCH OF FRONT OF BOILER, SHOWING POSITION OF PATCH

Modern Boiler Plant Equipment*

ECONOMIZERS

Perhaps there is no other piece of machinery or apparatus in a power plant about which there is such a diversity of opinion among engineers as there is in regard to the real gain in dollars and cents resulting from the use of an economizer. For the benefit of those who do not know it might be well to say that an economizer consists of a series of vertical cast iron pipes placed in the path of the warm flue gases on their way from the boiler to the smokestack. The purpose of the economizer is to heat the feed water before it enters the boiler. The temperature of the gases leaving the boiler is in the neighborhood of 500 to 600 degrees F., which is more than 300

* Continued from page 274, August issue.

degrees higher than the usual feed water temperature. There is a gain of 1 percent in the efficiency of steam generation for every 11 degrees that the feed water is heated by means of heat that would otherwise be wasted, hence it is readily seen that the economizer can effect a large saving by taking heat from the flue gas and imparting it to the feed water. In practice, however, there seems to be a considerable expense in caring for, repairing and cleaning the economizer, which in addition to interest and depreciation charges on their high first cost of installation so greatly reduce the theoretical saving as to make it questionable whether or not economizers are a profitable investment in many installations.

Economizers are more frequently installed in electric railway plants than in lighting or power plants. This is because of the benefit to be derived on peak loads, due to the storage of heat in the water. For this reason economizers are often used, especially with hand-fired grates and fluctuating loads, even when there is scarcely any financial gain. In the majority of the latest and largest plants no economizers have been installed. This fact is largely due to the installation of such furnaces and stokers as are capable of increasing the boiler capacity 100 percent or 200 percent above the normal rating, in order to take care of any sudden demand for power. Further, there is usually sufficient steam from the auxiliaries to heat the feed water to a temperature of 210 degrees F. With this temperature of feed water entering the economizer, and the small amount of flue gas per pound of coal with 12 to 14 percent CO_2, there is not much saving to be made by use of an economizer.

Economizers are usually cleaned by scrapers which continually pass over the tubes. This is a very neat way, theoretically, to clean them, but in practice it is sometimes found that the scrapers do not cut clean and pack a layer of soot on the tubes, which is very hard and acts as an insulating medium, reducing the efficiency of heat transmission. In two instances the writer knows where the scrapers have been discarded and the tubes cleaned by means of an air jet in the same manner, as is commonly employed to blow the soot from boiler tubes. The economizer tubes are clean and in better condition than when the scrapers were used.

Coal and Ash-Handling Systems

In all large power plants, and in some smaller ones, the coal and ash-handling systems are very elaborate and are designed to convey the coal from boat or railroad car to the coal bunkers at a very low labor cost per ton. There are in use a great many different systems and an infinite variety of conditions under which the handling has to be done. Many plants are located on the banks of navigable streams so that the coal may be transported by boat. There is a saving in freight charges of about 5 cents per ton when coal can be shipped by water.

A very common and efficient method of conveying coal from boat to bunker is by use of hoisting towers and self-filling buckets of the clam-shell type. The operator and hoisting machinery are located at the top of the tower, which in some instances is more than 150 feet above the water level. The bucket of coal is hoisted from the boat to the top of the tower, where it is dumped into a hopper which delivers the coal to a crusher. The coal is broken up so that the largest pieces will pass through a 1½-inch square hole. When the coal has been crushed it is automatically weighed and placed in cable cars holding about 2 tons or on belt conveyors, which transport the coal to the bunkers above the boilers or to the coal storage yard. There are many systems of this type which are handling 200 tons of coal per hour from boat to bunker, requiring the services of only four men.

Where the coal is delivered by rail there is a greater variety of machinery in use. In some installations the coal is dropped through the car hoppers to a railroad track hopper, which discharges into a crusher, from whence it is passed to a coal-weighing hopper scales, emptying into the buckets of an endless elevator passing over the coal bunkers. Sometimes an automatic skip hoist is used to lift the coal from bottom of track hopper to an elevation suitable for discharging onto a 24 to 30-inch rubber belt, which conveys the coal to the coal bunkers. Some coal-handling systems employ a screw conveyor to move the coal to the required location, and others a scraper conveyor. This latter consists of a series of movable flights placed in a trough in such a manner as to drag the coal to suitably located openings in the trough, through which the coal falls to the bunkers.

The belt conveyor and cable car systems are the most efficient, and perhaps more widely used, than any other system, especially for distributing coal over the bunkers. Either system is often used in connection with the hoisting tower or the bucket elevator. The screw conveyor and the scraper conveyor require more power to operate, and have higher repair charges for the same work than either a belt conveyor or a bucket elevator. For this reason they are used only in small coal-handling systems. The capacity of the coal conveying systems in some power plants ranges from 200 to 300 tons per hour, and the cost of handling the coal varies from 2 to 4 cents per ton. In smaller plants, using 50 tons of coal per day, the cost varies from 4 to 6 cents. Manufacturers of conveying machinery claim that it is a good paying investment to install a simple coal conveying system where more than one carload of coal is to be handled each week.

Methods for disposing of ashes are usually very much simpler than those required for coal. Large ash hoppers are built directly under the furnace, and sometimes they are large enough to hold the ashes accumulated for 24 hours, so that the hopper need be cleaned but once per 24 hours. The ash hopper is usually built of steel and lined with common brick. In some cases the lining has been made of concrete, and in others the entire hopper is built of reinforced concrete. A sprinkling pipe of ample size, not less than 1¼ inches, should be placed near the top of each hopper, and valve conveniently located, so that the fireman can quench the ashes and clinker as soon as they have been dumped from the grate. Perhaps the cheapest, and no doubt the most widely used, system of ash removal from the hoppers is by the use of ash cars hauled by storage battery or trolley electric locomotive. The cars are hauled to the dump and contents easily removed. If the ashes are to be taken away by railroad or by boat, as is usually the case in cities, the cars dump their load into a hopper which can discharge either into a skip hoist or a bucket elevator. The ashes are then elevated to a storage bin from which they can be chuted into car or boat.

Some boiler houses are so arranged that one bucket conveyor can be used for taking the coal from railroad track hopper to coal bunker and also for conveying the ashes from the ash hoppers to the storage bin. This makes a very simple layout, but in the case of a long boiler house requires considerable power and a somewhat high cost for repairs, which is greatly augmented by the corroding effect of the warm, wet ashes. Pneumatic and hydraulic ash-handling systems are occasionally used in small plants, but neither of them have been developed sufficiently to warrant their installation in a large plant.

Recording Meters, Gages, Etc.

Most engineers in charge of up-to-date power plants are well aware of the importance of keeping a daily record of the performance of the various machines and conditions affecting their efficient operation. For by a close study of such records the highest efficiency in steam plant operation can be attained. The manufacturers of instruments and gages have not been slow to recognize this fact, and to-day the engineer can readily purchase, at a price well within the reach of every power plant owner, a complete set of recording gages which will enable him to operate the plant on a strictly scientific basis and have for future reference a written record.

Among the more important recording meters and recording gages to be found in the up-to-date plant are

Flue gas analysers.
Pyrometers.
Draft and pressure gages.
Steam flow meters.
Hot water meters.
Coal scales.
Watt meters.

The CO_2 recorders, for analyzing flue gas, give a record of the percent of CO_2 in the gas. Sometimes a recorder is installed for each boiler, and in other installations the apparatus is so connected to the battery of boilers as to be able to analyze the gases from any single boiler or the mixture of gases coming from the entire battery. When arranged to give a chart for each boiler it is an easy matter to detect lack of attention on the part of the fireman regarding the condition of the fire. A good CO_2 recorder used in connection with a recording pyrometer is a great help to the fireman and a paying investment for the plant owner. By their use the condition of the fire and the boiler heating surface is known. If the CO_2 is low, too much air is passing through the fire and the temperature of the escaping gas will be lower than usual. If with the average percent of CO_2 the temperature of the flue gas is higher than usual, it is safe to assume that the tubes are covered with soot or with scale, and proper steps can be taken to clean the boiler before the loss runs to any large amount.

The use of a steam flow meter on each boiler insures the maximum output of the entire boiler plant. It shows just what each boiler is doing at every instant, and if for any reason a boiler is not working up to the capacity of the other the fact is detected instantly. If the meter is of the recording type a permanent record is had of the boiler output for any period of time, and the manager knows just what the different firemen have made their boilers do.

Engineers and inventors have spent much time and money on the perfection of hot water meters. There has been little change in the meter itself; most of the improvements have been in the recording apparatus. The Venturi tube and the V-notch are used for measuring hot water with better success than any other type. The Venturi meter tube and recording apparatus are used very extensively on boiler feed mains under pressure. On account of the cost of the recording apparatus, about $460, it is not used permanently on individual boilers. The meter tube itself is very cheap, and sometimes a tube is installed in the feed line to each boiler, so that one recording apparatus may be used temporarily on each boiler. The V-notch meter is used in connection with feed-water heaters of the open type. They are accurate and give entire satisfaction when used under suitable conditions. They cannot be used to measure water under pressure, and for this reason the Venturi meter tube is more convenient. Sometimes there is trouble with the Venturi tube, due to formation of scale in the throat, and with very hard water this type of meter is not satisfactory.

Some plants are equipped with recording coal scales, so that the amount of coal burned under each boiler may be readily ascertained. This refinement in boiler house practice is not common, but a great many plants weigh the total coal put in the bunkers each day, and as a check the coal bunkers are surveyed each week and the coal contained therein is computed.

In electric generating plants the useful work done is readily recorded by the watt meter, and the coal consumption per kilowatt hour readily computed. If for any reason the consumption increases, the various recording gages and instruments usually enable the operator to locate the cause and immediate steps can be taken to remedy the trouble. It is well to remember that a very elaborate system of gages, recording instruments, etc., are of no value to the owner of the plant, unless the operating engineer keeps systematic records and studies them closely with a view to improving the over-all efficiency of the plant.

DRAFT SYSTEMS

The intensity of the draft required for the efficient combustion of any fuel is the pressure needed to cause sufficient air to flow through the fuel bed. This depends upon the character of the coal, the thickness of the fuel bed and style of stoker. Such stokers as the Roney and the Murphy are adapted to either natural or induced draft, because the fuel bed is thin, while underfed stokers with a much heavier fuel bed require forced draft. The induced draft system has been used to a large extent in connection with economizer installations, but at present seems to be losing popularity. Where neither economizers nor underfed stokers are used the high stack with natural draft is employed. There are about as many large plants using natural draft as there are those equipped with forced draft installations. The combustion of fuel by forced draft is very easily controlled, automatically by varying the speed of the fan engine to suit the demand for steam. With a forced draft system the pressure of the gases within the boiler setting can be maintained at atmospheric pressure, which prevents loss in efficiency due to air leaking through the setting walls.

Fans for mechanical draft are more usually direct connected to motor or steam turbines, though in many of the older plants a reciprocating engine is used. The steam turbine has the advantage of being able to economically use high-pressure superheated steam and cost less for repairs than a reciprocating engine. The exhaust steam from the turbine is usually used for heating the feed water, which fact, in addition to the freedom of the turbine from any electrical break-down about the plant, makes the turbine installation more desirable than a motor. Also the speed of the turbine is easily regulated automatically to suit the demands upon the fan to meet a sudden fluctuation in the load.

ENGINES AND STEAM TURBINES—PRIME MOVERS

So far very little has been said in regard to the engines and turbines required to furnish the power, because boiler makers are more interested in the boiler house equipment than in the power plant itself. In the generation of electricity the steam turbine is almost universally used, while for driving shafting and other power purposes the Corliss engine still "makes good." The steam turbine, which is not more than a dozen years old commercially, has grown very rapidly in size and perfection. The development in design has been in the direction of increase in capacity and decrease in weight, space occupied and steam consumption per kilowatt capacity. There are two general types, the vertical and the horizontal, and either is now built in units of any size up to 25,000 kilowatts. The turbines are always run condensing, with 28 or 29 inches vacuum, under which conditions the steam consumption is about 18 pounds per kilowatt-hour.

COST FOR GENERATING ELECTRICAL CURRENT

The cost of current varies with the cost of coal, efficiency of the machinery employed, and many other items. With coal at $3 per ton and a good power plant equipment it is possible to produce current for less than .4 cent per kilowatt-hour. The total cost is made up about as follows:

Cost of coal at 70 percent of .4 = .28 cent.

Cost of labor for operation at 20 percent of 0.4 = .08 cent.

Cost of incidentals, repairs and interest charges at 10 percent of 0.4 = .04 cent.

Total cost, .4 cent per kilowatt-hour. ENGINEER.

Care of Flues at Terminals

The care of locomotive tubes has always been a source of trouble to those who have charge at terminal points. A good deal of the trouble starts right at the ash pit, for the hostler, not always the brightest of men, gets the blower going full blast (and with a dirty fire and other troubles incidental to cleaning grates) for a considerable time, and finally when the job is completed, flues that were perfectly dry coming over the road are found to be leaking and have to be treated. In this treatment the man in charge shows his good or bad judgment, for this position calls for a man of large experience in handling flues, and he should be an expert flue setter himself, so that his knowledge of what various flues can stand will enable him to instruct those under him how they should do the work to get the best results.

To illustrate what I mean I will tell of a little experience of mine. A large manufacturing company in the Middle West ordered a locomotive, which was delivered in due time and accepted by the manufacturing company's master mechanic, but in a very short time they began to have trouble with leaking flues, so, not having a boiler maker at the plant, they instructed a *machinist* in the use of the flue expander, and left him to his job, which the man faithfully completed in ten hours. So thoroughly had he done his work that they were compelled to send for a boiler maker to find out what was wrong with the flues, as they would not hold. When he examined them he found that they were all out of shape. The machinist had see-sawed his rolls, not knowing any better. There was quite a lot of correspondence between the builders and the manufacturing company, their master mechanic making all kinds of claims as to the cause of the trouble. At this point the writer was sent to the scene of trouble to investigate. It appears that they were using lake water, which, if used direct, was of a good quality, but having no storage tank they pumped the water out of a cistern which received the water after it had passed over the neck of the rolls in the mills. This water, well mixed with steel scales and grease from the rolls, was what they fed the locomotive with, and then they wondered why their flues leaked; this coupled with the fact that the master mechanic had gained his experience of flues by putting them in thrashing machine boilers. Here was a case of the wrong man in the wrong place.

Another case of very recent date, and with locomotives of the most modern type, was the practice of beading a leaky flue regardless of the condition of the flue, whether it stood in need of it or not. Now there is only one thing that results from this practice and it happens in a very short time. It is that the beads drop off and the flue is all in; therefore, I think that there should be some system used with regard to the indiscriminate use of this tool.

There is no doubt that a light beading is beneficial, say once in three to five months, according to the condition and the water used and a proper record kept of each beading, which would enable the man in charge to see at a glance when the flues were beaded or reset. I think all resetting should be done with a sectional expander; in fact, I am of the opinion that all hot work should be done with such a tool. Whether you roll or bead your flues first is a matter that boiler makers differ over; but always bead first, for should you by any chance not hold the tool at the proper angle you will bring the flue away from the sheet instead of setting it against it. By rolling last you are sure that the flue is in proper contact with the sheet.

Another evil from frequent beading, and the greatest of them, is that it shortens the life of the flue by the loss of the bead, which gives rise to another pernicious habit, that of ferruling the flues after the bead is gone (this practice is as bad as that of drilling a hole in the end of a staybolt and inserting a copper plug to form another head), there is nothing in it but trouble and more trouble. When the beads get bad cut the flues out and keep your boiler in good shape, and above all *safe* for *men* to work around.

When compelled to remove flues for any cause, remove the diaphragm and netting so that the operation can be done in reasonable comfort and dispatch, for it is a mistake to think that you are saving time by having your men crawl under the damper and around the steam pipes and expect him to give you the engine in a hurry. *It can't be done.* Remember the time you did this work yourself. Insist on giving your men room enough to use their tools to the best advantage. If you have good experienced men to do your work, there is very little danger that they will make any mistake in the proper use of tools, but they will perform the various operations with great care, for many of these men pride themselves on their reputation for good work. With such men it will be an easy matter to keep down your flue troubles. FLEX IBLE.

Pittsburg, Pa.

Coal and Fuel Saving

The cost of coal consumed in producing steam power constitutes a large item in the daily expenses of manufacturers, and anything that will lessen this item of expenditure is worthy of the careful consideration of all users of steam power.

The heat-producing elements of coal are carbon and hydrogen, and the principal product of its perfect combustion is carbonic acid gas, which is formed by the chemical union of two equivalents of oxygen with one of carbon. But carbonic acid gas has a strong affinity for carbon, and when rising up into the furnace through the ignited coal will take up another equivalent of carbon therefrom, thus changing the carbonic acid gas into carbonic acid, thus absorbing heat from the carbonic acid gas, and this carbonic oxide appears in the furnace as a luminous flame, and if permitted to pass under the boiler and to the tubes in that form results in great loss.

The problem to be solved is to again convert this carbonic oxide into carbonic acid gas by the process of combustion and thus secure for use under the boiler the heat evolved by such conversion. This can only be accomplished by thoroughly mingling with the carbonic oxide an equal volume of oxygen at a temperature high enough to secure ignition, and to secure such a volume of oxygen five volumes of atmospheric air are required. It should therefore be the object of the engineer to prevent the formation of carbonic oxide in the furnace, for if it is once formed there is no way of utilizing it except by introducing a sufficient quantity of air into the combustion chamber to convert it into carbonic acid.

There are some very efficient patented methods for accomplishing the combustion of carbonic oxide, but where these are not used effort should be made to prevent its formation. This can be best accomplished by keeping the bed of coal upon the grate very thin and by frequent firing, taking particular care that the fresh coal be spread evenly over the whole surface of the fire, and, as nearly as possible, but one layer of fresh coal. The consumption of fuel in a marine boiler is nearly proportioned to the diameter of the furnace, the following agreeing with ordinary practice: Diameter of one furnace or width of grates in feet multiplied by the number of furnaces gives the amount of tons consumed in twenty-four hours approximately. CHAS. MILLS.

Albany, N. Y.

FILLING HOLES IN CASTINGS.—Defects in castings may be filled with a paste made of 2 pounds of iron borings, 1¼ pounds of dextrine and ¾ pound of litharge, the whole mixture being colored with lampblack to the desired shade. The iron borings should be sifted. After the parts are thoroughly mixed, add enough water to make a paste. This is applied to the defects and blow-holes with a putty knife. When the paste has dried thoroughly it can be machined just as the metal.—*Railway and Locomotive Engineering.*

Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

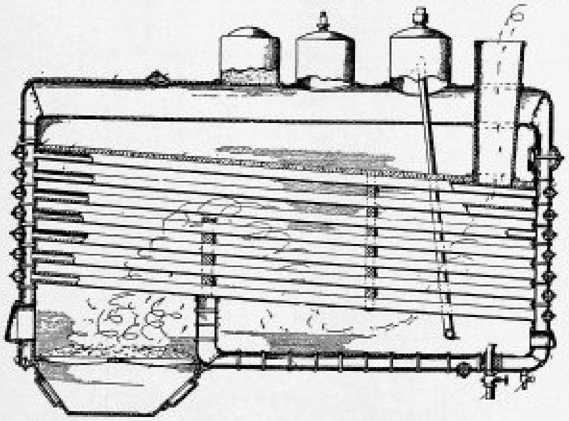
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,061,312. STEAM BOILER. EGBERT R. MORRISON, OF SHARON, PA.

Claim 1.—A tubular boiler having five rows of tubes, located beside each other, the tubes of the two outer rows being located with alternate wide anl narrow spaces between the tubes of each of said rows, the wide spaces in each of said rows being opposite the narrow spaces in the other. Six claims.

1,062,451. STEAM BOILER. JOSEPH OMER GAGNE, OF SHERBROOKE, QUEBEC, CANADA.

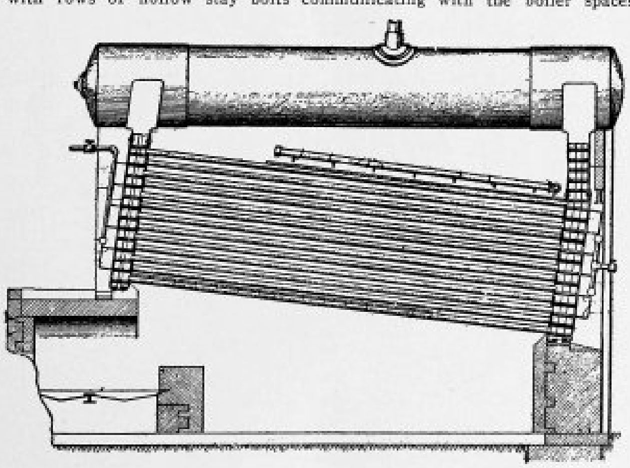
Claim.—A steam boiler comprising inner and outer shells each consisting of a top, ends, sides and bottom spaced apart throughout their extent to define an intervening water space, the bottoms of the shells terminating short of the front ends thereof and being upturned to form a water leg in direct communication with the water space, grate bars



supported by and extending between said water leg and the front end of the inner shell, a bridge wall supported by and rising from the water leg, water tubes extending between the ends of the inner shell, some of the tubes passing through the bridge wall, a refractory partition between said bridge wall and the rear ends of the shells, a refractory roof between the ends of the shells above the tubes, and a stack rising from said roof adjacent the rear end thereof and extending through and beyond the shells. One claim.

1,062,941. BOILER TUBE CLEANER. FRANCIS P. WILSON, OF CHICAGO, ILL.

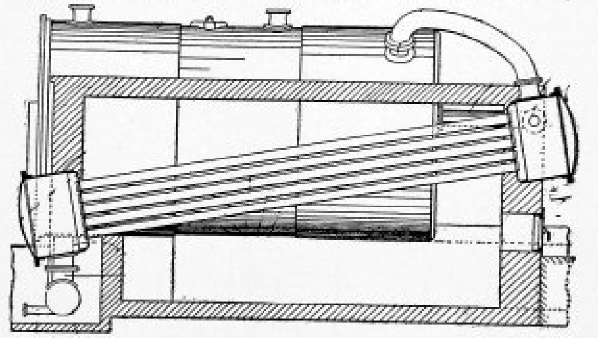
Claim 1.—In a device of the character described, the combination of a water tube boiler having opposite double wall headers each provided with rows of hollow stay bolts communicating with the boiler spaces



between the water tubes of the boiler, and a manifold associated with each said header, each manifold comprising a pipe connected to a source of fluid under pressure and a series of nozzle tubes extending from said pipe and disposed in rows for permanent arrangement in alternate rows of hollow staybolts at the respective end of the boiler, the rows of nozzle tubes at one end entering said boiler spaces left vacant by the alternate rows of nozzle tubes at the other end, whereby simultaneous operation of all said rows of nozzle tubes, so staggeringly arranged, results in the formation of whirls within said spaces. Two claims.

1,063,032. STEAM BOILER. THOMAS HUDSON, OF AIRDRIE, SCOTLAND.

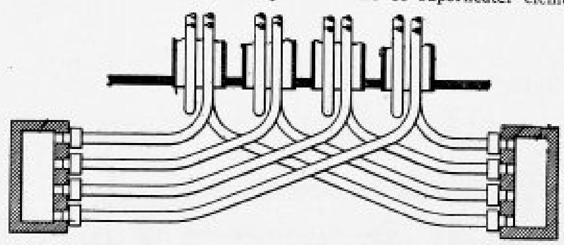
Claim 3.—In steam boilers, the combination with the usual cylindrical boiler, of two sets of inclined water tubes arranged in the usual side flues, circular headers on the front and rear ends of such sets of tubes, a horizontal mud drum located beneath the front of the boiler, ver-



tical pipes between the front headers and the mud drum with the boiler, a pipe connecting the rear headers, a pipe connecting the last mentioned pipe with the water space in the boiler, and a pair of steam pipes connecting the rear headers with the steam space in the boiler near the rear end thereof. Three claims.

1,063,394. SMOKE-TUBE SUPERHEATER. WILHELM SCHMIDT AND PETER THOMSEN, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNORS TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT, M.B.H., OF CASSEL, GERMANY.

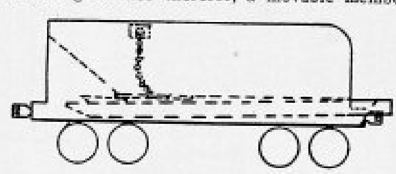
Claim 1.—A smoke tube superheater comprising, in combination, a boiler provided with parallel rows of smoke tubes, steam collectors on opposite sides of said tubes, and parallel rows of superheater elements



in some of said smoke tubes all the wet steam ends of each row of said elements being bent to one of said collectors and all the superheated steam ends being bent to the other of said collectors, the openings of said wet steam ends and of said superheated ends lying respectively each in a single row. Five claims.

1,063,420. STOKER MECHANISM. DAVID F. CRAWFORD, OF PITTSBURGH, PENNSYLVANIA.

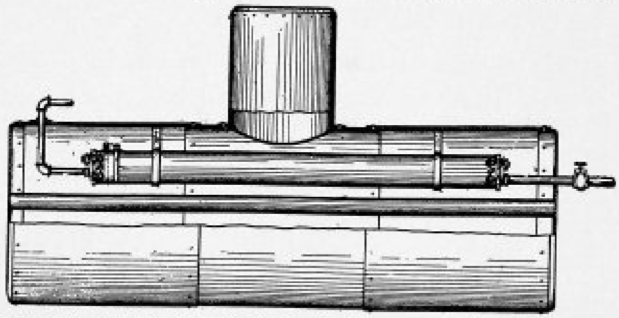
Claim 1.—In apparatus, the combination of a hopper or containing receptacle, a discharge orifice therefor, a movable member for control-



ling the discharge of the coal from the hopper through the discharge orifice, and an agitator located above said orifice, one end of which is secured to the movable member and the other end supported in the hopper against movement of translation. Five claims.

1,064,195. FEED-WATER PURIFIER. CHARLES H. CORT, OF SAN FRANCISCO, CALIFORNIA.

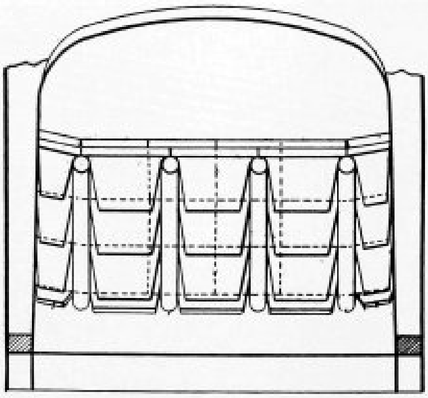
Claim.—In a feed water purifier for boilers, an elongated feed-water vessel located in the upper portion of the boiler, a steam tube open at



both ends extending longitudinally in the upper portion of the vessel and through both its ends, a feed-water pipe entering one end of said vessel, extending longitudinally in its lower portion, and opening at a point adjacent to its other end, and outlet pipes leading upwardly through the top of said vessel near its first-named end. One claim.

1,063,575. REFRACTORY BRICK ARCH FOR LOCOMOTIVE-BOILER FURNACES. CHARLES BREARLEY MOORE, OF EVANSTON, ILLINOIS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO AMERICAN ARCH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

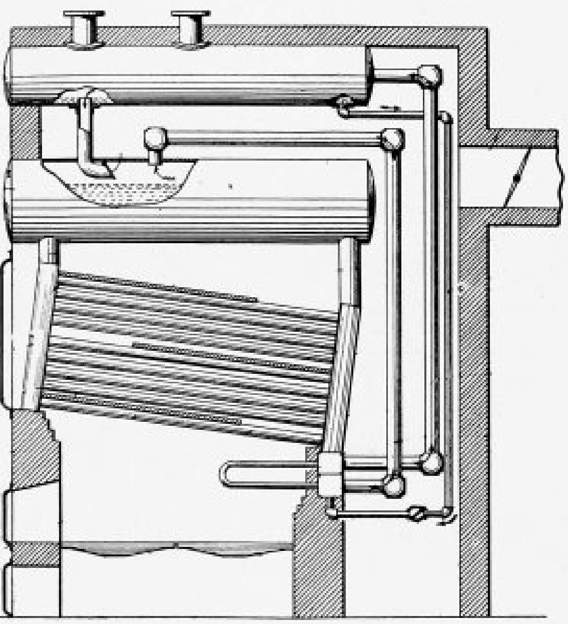
Claim 1.—A locomotive boiler firebox having a plurality of arch tubes, in combination with a refractory arch body resting on said tubes, said body comprising spans which extend between and rest on said tubes, said spans being disposed in spaced-apart rows, and panel or cover



bricks which rest on said spans space the same apart and close the spaces between the rows thereof, and said spans being provided with a plurality of transverse depending portions opening from the tubes. Fourteen claims.

1,063,585. STEAM-SUPERHEATER. JOHN C. PARKER, OF PHILADELPHIA, PENNSYLVANIA.

Claim 1.—In a superheater, the combination of a furnace and a generator having a steam collecting chamber, with a set of superheater tubes exposed to the direct action of the furnace fire, a conduit for



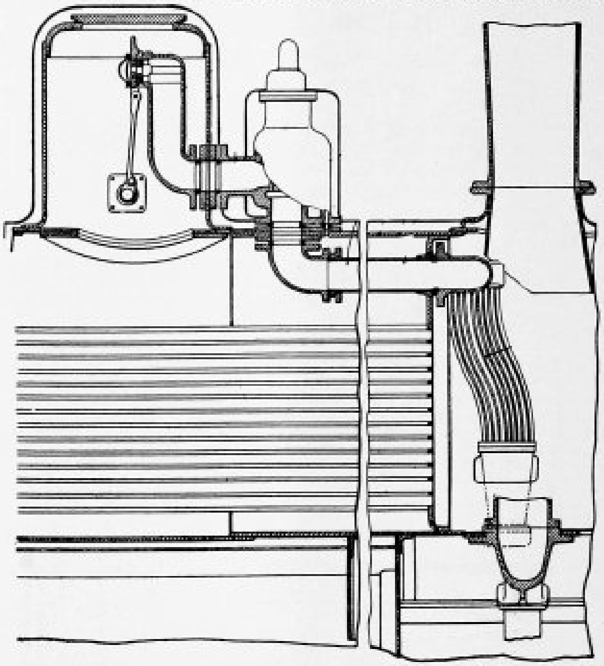
carrying steam from said collecting chamber to said superheater tubes, a reservoir, a conduit for carrying steam from said superheater tubes to said reservoir, and a conduit for carrying water from said reservoir to said superheater tubes. Six claims.

1,062,473. SMOKE CONSUMER. WILLIAM KELLY, OF MEMPHIS, TENN.

Claim 1.—In a smoke consumer for furnaces, the combination with a furnace having a fuel feed door, of a manifold provided with air inlets and discharge nozzles, the latter communicating with the firebox of the furnace, a steam feed pipe arranged within the manifold and having jet nozzles communicating with said discharge nozzles, a steam supply pipe connected with the feed pipe and having a controlling valve therein, a branch pipe leading from said supply pipe at a point between said manifold and valve, a diaphragm casing connected with the branch pipe, a diaphragm arranged therein and provided with an outwardly projecting stem, a pivotally mounted weighted lever supported by said stem, a regulator in the branch pipe for controlling the feed of steam to the diaphragm casing, a controlling valve in said branch pipe between the regulator and supply pipe, a relief pipe communicating with the branch pipe between the diaphragm casing and regulator and provided with a controllng valve, connection between the furnace fuel door and the lever and valves whereby when the door is opened the valves in the supply and relief pipes will be respectively opened and closed, and means operated by the lever through the action of the diaphragm for closing the valve in the steam supply pipe and opening the valve in the relief pipe. Three claims.

1,063,953. PROCESS AND CONTRIVANCE FOR SUPERHEATING STEAM TAKEN FROM A GENERATOR. CHARLES CAILLE, OF LEPERREUX, FRANCE.

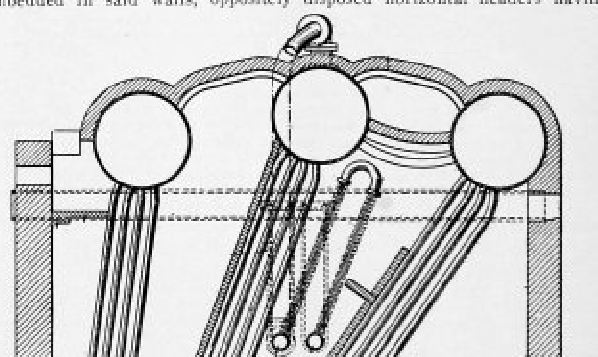
Claim 1.—In combination, a boiler, a collector, and an expansion chamber adapted to receive steam from the boiler and communicating



with said collector, whereby said collector will receive the expanded steam, said collector being exposed to the steam from the boiler. Three claims.

1,064,309. STEAM-SUPERHEATER. ERNEST H. FOSTER, OF NEW YORK, N. Y.

Claim 1.—The combination with a water tube boiler of the vertical type, and the boiler setting including vertical walls, of metallic hangers embedded in said walls, oppositely disposed horizontal headers having



end portions entering said walls and hung in said hangers, and vertically extending U-shaped superheater tubes connected to the respective headers and extending upwardly therefrom. Three claims.

1,064,174. STEAM-BOILER. MINOTT W. SEWALL, OF ROSELLE, NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim 1.—In a steam generating plant comprising a series of superposed boilers each provided with steam and water drums, a weir inside of the steam drum of the upper boiler, having a free opening to the outlet connection, the said weir placed at the required water level. Two claims.

THE BOILER MAKER

OCTOBER, 1913

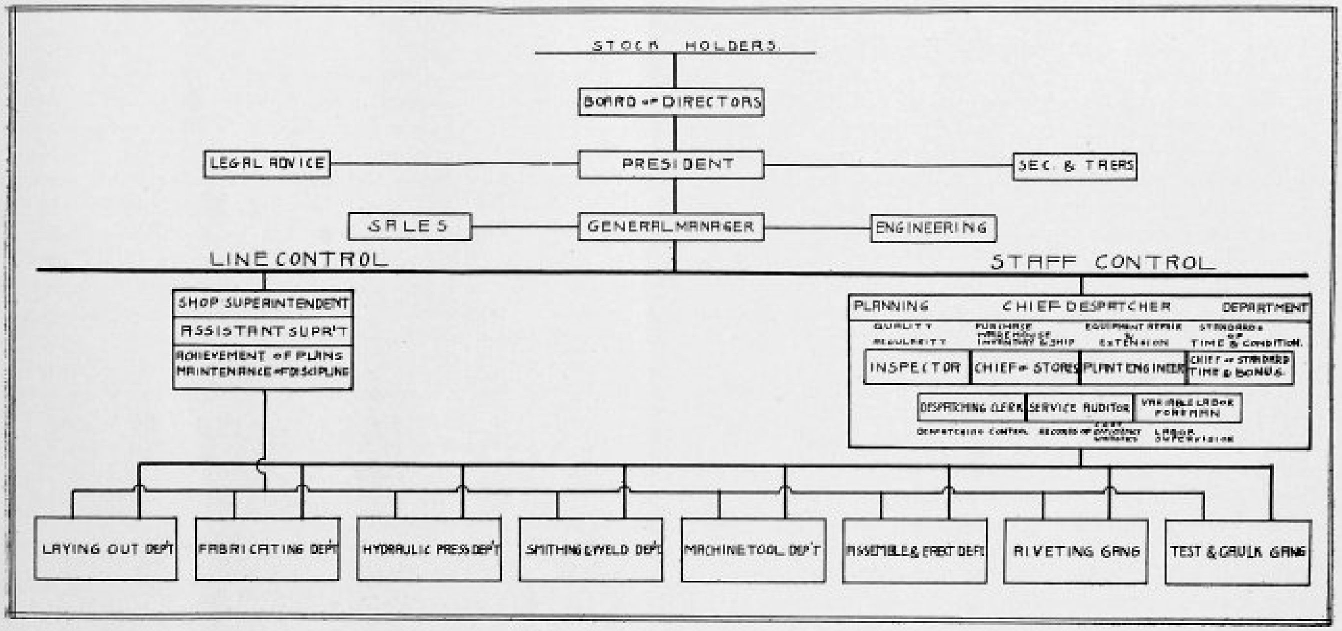
Securing Efficient Results in the Manufacture of Boilers

BY DELBERT E. MERRIFIELD*

Not many years ago the unloading of a cargo of iron ore from a vessel sailing the Great Lakes required 100 men working for several days, and at a cost that averaged 18 cents per ton of ore unloaded. Since the introduction of modern ore-handling machinery a vessel is now unloaded in a few hours, and the cost has been reduced to 3 cents per ton. The direct saving in labor totals up to a large amount when all the vessels that compose the ore-carrying fleet of these lakes are taken into consideration, but one of the most important gains came about in the increased operating efficiency of the vessels and the docking facilities due to the saving of time. Instead of a vessel which represented an investment of several hundred thousand dollars being tied up for unloading for several days, each vessel practically gained four to six days on a trip from what it had formerly taken. To those engaged in handling ore, either as carriers or furnishing docking facilities, this reduction in time added something to the earning power of the capital invested, and more especially as this business has only a comparatively short season in which to operate before the harbors are frozen over.

Increases of earning power on the capital invested in a business are desired in all branches of industry. There exist many business analogies to the carrying of ore, in which the capital investment is high and the earning power much lower than it was reasonable to assume it should be when the business was originally started. Investigation into the affairs of several lines of business has shown in many instances that there was a lack, primarily, of applying definite methods by which all the resources of the business could be utilized, consequently there exist many latent possibilities, which, if efficiently used, would aid materially in placing the business in a desirable position as far as earnings are concerned. Increased earning power secured in this manner is of more direct value to a business than that brought about through a policy aiming at expansion of sales with which to overcome the handicap of unrecognized inefficiency. Dollars saved in this manner are dollars earned which have few strings attached to them.

Factories devoted to the manufacture of boilers, tanks, stacks, etc., are not without this prevailing fault to a large degree, and this is due largely to the following reasons; First, the product is unstandard in shape, size and specification re-



ORGANIZATION CHART SHOWING CENTRALIZED CONTROL OVER PLANT ACTIVITIES

* Efficiency engineer, New York.

quirements in detail; second, the business has settled down to a routine of manufacture in which little recent progress has been brought about in the machinery used in the general operations of manufacture; third, factories have often been located to serve a restricted community which has given little occasion to note competition; fourth, rigid specifications pertaining to pressure boilers have reduced to a marked degree certain competition that might have prevailed through new designs.

The ordinary management reflected from the average boiler shop has paid too much attention to holding direct wages to a constant average rate per hour, or it has lavishly surrounded itself with equipment from which the earnings have been allowed to fall away. To secure higher efficiency, therefore, the president, manager or other executive must analyze his plant in the closest detail, and determine from this whether there exist undeveloped possibilities which if properly brought into use would quite automatically decrease the labor applied to operations or bring about substantial increases of output, with the attending reduction of indirect expenses.

Evils of Over-Equipment and Haphazard Planning

Boiler shops in general can be greatly aided by the adoption of the basic efficiency methods. The effort displayed in increasing the efficiency of boiler shops has either run to over-equipping the plant or to the application of haphazard systems, neither of which has been guided with any definite plan in view, so that the final results have not been successful. In the instance of over-equipment the capital charges have far exceeded the gain in output; in the latter instance the usual display of system has not furnished the proper records by which the business could be managed in a more effective manner. The various recognized principles of efficiency are of small help unless they are properly understood and applied through established methods; they must be constantly upheld by the entire organization having these affairs in charge.

A business to be efficiently operated should not alone be provided with adequate equipment and sufficient capital, but it should also be provided with a properly arranged organization which has definite purposes and established methods at its command. That the real significance of this is not generally realized is evidenced from the many crude attempts which the average industrial plant has made in an effort to gain a control over certain activities. Due to this practically all effort expended toward increasing efficiency by ordinary management fails, and these factories continue to operate at 70 percent, 60 percent and even 50 percent efficient. Generally these inefficient conditions become more unwieldy as the details of the business become more engrossing and as the nature of the business leads to a variety of unstandardized products. This condition is characterized in boiler making, for of the great amount of business that goes through the shops only a small percentage is of the same design or make in large quantities. It is then of considerable importance to have methods available through which a strong centralized control over all factory activities can be had. Boilers are made in a vast range of sizes and shapes, out of a still greater range of material specifications, and it is therefore of the utmost importance to have a method by which a close regulation of the movement of one piece or 1,000 pieces can be directed through the shops to the final destination and in proper relation to the time when the piece is most needed.

The manufacturer then who desires to increase the output of his plant without endangering his business by over-equipment, or who wishes to reduce costs without incurring false economies, should realize that there exist definite avenues for the realization of these results through the use of certain principles of management. To obtain lasting results he must direct his attention from new equipment and plant appliances to methods that will bring about maximum efficiency of equipment already available; from labor and wages to the efficiency of labor and labor's reward; from unstandardized conditions of shop routine to prearranged plans of operation, and from intangible results to predetermined standards of achievement. In general, the executive will find, if he is guided by competent advice during the transitory period, that there are many avenues to be opened from which substantial benefits can be secured. The benefits, he will learn, are tangible and wholly apart from mere comparisons of conditions that may prevail in his plant as against some other plant.

Many concerns in all branches of industry are to-day confronted with the problem of reducing costs in order that they can meet legitimate competition. With others the problem is that of increasing production in order that they can get the highest returns from the capital invested. The accomplishment of either one of these aims, without working a permanent injury to the business, is a difficult task, but to those who have seen these same results brought about for themselves the experience is both pleasing and gratifying.

Experience with Moderate-Sized, Well-Equipped Boiler Shop

It has been the writer's experience to have been associated with one boiler-making concern and to have supervised the work necessary to the bringing about of highly efficient conditions and placing the entire shop on an efficient basis of operation. The results obtained were very satisfactory, because a desirable reduction of direct labor cost was realized, the labor engaged was better paid, and the indirect costs were reduced, due to a substantial gain in output.

The factory in which the work was carried out was a moderate-sized plant. The buildings were substantially built and laid out in a manner that was entirely satisfactory to the shop operations. The plant was located in a large manufacturing center, which was especially convenient for the securing of the material needed in the building of boilers; this same location, however, was not a favorable labor market. Although there was plenty of labor for rough work available there were often times when it was difficult to secure men skilled in boiler making, with the result that much work had to be done by foreigners, which called for the usual amount of close direction and supervision.

The product of the plant consisted, primarily, of horizontal shell boilers, boiler connections, special tanks and smoke-stacks. In the main all activities of the plant could be classified as fabricating, machining and erecting. All castings required by the various orders were secured from an outside foundry, and the machining operations on these were completed in the boiler shop.

In point of equipment and machine layout the plant was well equipped and the arrangement of the machines on the floor was satisfactory. Within the main building, where practically all of the operations were carried out, the various punches, shears, laying-out benches, etc., were arranged parallel with the outside walls; thus ample space was provided in a central gallery for the piling of material in process and for finished material. The machines were grouped to form sub-departments, covering the work as it progressed until the finished material found its way to the erecting shop.

The handling of the material was done by an overhead crane for general shop use. At the machines, where possible, swinging electric hoists were provided. Later, after the work had progressed to some extent, it was found that much lost time resulted in waiting for the overhead crane. To eliminate this evil a system of small industrial tracks was laid, upon which small cars ran. This arrangement aided materially in the more rapid movement of material among machines, and permitted the crane to give more time in the erecting shop, where it was needed most on long-time lifts. It might also be stated here that aside from the addition of the industrial tracks and the addition of one special punch and shear, there were no other machines added, and the increases of output were obtained with this small outlay and the increase of efficiency throughout the plant.

Gross Earnings Increased 29 Percent, Costs Reduced 14 Percent

When the plant was working under normal conditions 150 men were employed. Due to the product varying in size and shapes a comparison of the amount of labor expended per unit of product was not possible, but after figures had been compiled for the year the plant had operated on an efficient basis (the year also includes the beginning of the work), and these were compared with the average of two previous years, it was found that the company had increased its gross earnings by 29 percent, and that the shops had been able to make this possible by giving early shipments in a manner that was free from objectionable workmanship and delays in shipping. Many instances where direct reduction in cost had occurred were noted by comparing the cost of a given order with a similar order that had been completed before the efficiency work had begun. These comparisons showed that very desirable results were being realized. A comparison of twelve of these orders revealed that an average reduction of 14 percent in cost had been effected.

To show these satisfactory savings by which the employer benefited without showing how the employee fared during this period the comparison would be incomplete; but since the methods used kept a current record of the efficiency of each man on the basis of his actual efficiency, this information is fortunately available. The average increase of earnings for the last six months after the schedules had been in effect were as follows:

	Percent
Those engaged in laying-out and fabricating....	14.0
" " machine shop	12.5
" " assembling	18.3
" " reaming and countersinking..	15.0
" " riveting and calking.........	10.8
" " rough labor activities........	8.1
" " as gang foremen............	14.6
Superintendent and others in special class......	14.2

The total bonus distributed in addition to wages for six months was $5,080.

With these statements in mind the balance of this article will deal with the details which governed the bringing about of the foregoing results.

The one thing that stood primarily in favor of the ultimate success of the undertaking was that the organization of this company realized that assistance from an outside source was essential to having the work begun properly, and in this respect too much stress cannot be laid on having the work begin with the assistance of constructive advice. The concern that is about to begin this new order of events should fully realize all that the work entails, and it should carefully guard against the forming of early opinions or false impressions in the mind of any member of the organization, as it is from these premature conclusions that complications develop which often place the final success of the work in jeopardy.

Preliminary Investigation by Efficiency Engineer

The work began under the direct supervision of the writer, who acted as an efficiency engineer in a staff capacity in conjunction with the general manager. In this manner close touch was secured with the entire working arrangements and conditions of the plant. The first few days were spent in closely investigating the detailed manner and method then being employed. During this investigation the real problems of the plant were being determined. This information is only secured after close association to the plant and all of the activities. In many instances short-time study observations were run for the purpose of gaining a temporary idea of the real conditions that underlie apparent loss of production from the men or machines; other investigations extended over the movement of material from yard to machines and subsequent handling; investigation of the manner in which the work was being routed and despatched into execution, and also investigation into the wage and incentive plan if there is one partially in effect (which is more often the case) to determine what results are being realized from it. This information, classified, gives the engineer the first real data upon which to formulate definite plans with which to attack the problem.

These data may be more completely summarized as follows:

1. Do all members of the organization understand the purpose of the new undertaking and know how they will be affected by it eventually?

2. What recognized intentions does the company hold out to its customers that the employees could lend their support to if these were known to them?

3. What policies regulate the business in both selling and manufacturing?

4. Has the organization been clearly defined by the establishment of functional limitations, or does it exist as an undefined growth?

5. To what extent do the selling and manufacturing divisions of the business interlock for the benefit of both?

6. To what extent is co-operation encouraged among the departments, and with what result?

7. In what manner and through what methods are the activities of the business (selling included) controlled?

8. What statistical data are available that are of constructive value?

9. What is the efficiency of labor, machines and equipment?

10. To what extent has sandardization of procedure, operations and conditions been carried?

11. In what manner and through what methods are costs of production obtained?

12. What incentives are held out to obtain efficient effort from all employees? What is the result secured?

13. What members now on the organization are desirable to use in a staff capacity under a rearrangement of functions?

14. What undesirable arrangement of machines exists that causes loss of time?

With these data well at hand the engineer will have a very good insight of the conditions which he must face. Among these conditions it is generally found that there are many operations on which time studies must be made to determine the correct time they should be done in, and to analyze closely the operation to find out what standard conditions shall in the future surround the operations. As this work will require the constant attention of one man during the entire service an assistant is detailed to secure this information. An experienced man, however, is necessary for this task, as the accuracy with which this information is secured is of great importance in the final development of standard time schedules.

From the preliminary investigation it was seen that the method of placing the orders in the shop, together with the subsequent control exercised over them, leads to considerable confusion throughout the shop. On account of this very strenuous times occurred in the shop and office. This trouble was particularly in evidence when orders had been placed in the shop which required specified times of delivery or on certain rush orders. Special attention directed along this condition revealed that in order to make the shipments in accordance with the promises, nearly all members of the organization took a hand in trying to push matters along, and in a few early instances the salesmen who were directly interested in a certain order would show up at the factory to render such pressure as they were able to exert. These strenuous times were generally productive in getting the shipments out, but this was only a temporary letting up on the strain that every one was laboring under, because in the rush to attend to the needs of the single order, other orders were held up or overlooked until another customer began to chafe at the delay he was experiencing.

Establishment of a Planning Department

Viewing this situation as one not directly concerned in all this rush and hurry it became readily apparent that some method must early be evolved that would reduce at least to a minimum this waste of effort and strain. To overcome this condition of affairs it was decided that the organization must undergo a rearrangement that would bring about a strong centralized control over all shop activities. Accordingly, to bring this about, the first step was to establish a planning department which would serve as a clearing house for all regulating information, and also to co-ordinate the efforts of all members composing the manufacturing division so that each member of the defined organization would be working along common lines of purpose.

To aid in defining the functions of the new organization in a manner that could be understood by all, a chart of the proposed new arrangement was made. (See Organization Chart, page 313.) On this chart all functions were shown with reference to the interlocking connection that existed with all other functions, together with the authority that was placed within the function. This organization differed from the previously existing organization, inasmuch as it aimed above all else to use certain established methods throughout the entire plant in common, to avoid delegating responsibility from one to another, and to definitely repose responsibility with those having recognized authority. In the rearrangement of the organization all members were transposed from an old function to the new as nearly the same as possible. Each member was selected in accordance with his previous experience and capabilities to discharge the duties incumbent of the new function. In addition, each member was well informed as to how success in his function would be rewarded. The entire reorganization took place quietly, and soon each member found himself well established in his new duties and gradually working into a groove of enthusiasm.

The rearrangement was carried out with the recognized intention of developing a line and staff type of organization. In the line and staff type of organization we have but one common unit as a whole, but this is readily separated into two divisions when certain duties are to be performed. The function of the staff in the closely defined sense is to plan the work in advance of the line, the function of the line is to execute the work in accordance with the plans developed by the staff. We thus know the staff as the division of the organization that is always working in advance of the line, in which all possible contingencies are being anticipated and provision is made to surmount the conditions when the time comes to complete the work. The staff also secures the proper information that should be had on a given order, purchases the material, sees that it is properly inventoried, and in general provides the best way and means for the line to follow. The staff was closely in touch with the entire affairs of the business, as to current business policy, selling conditions and all factory affairs. With this information available the staff formulated operating plans and schedules covering all orders entering the shops and further exercised a control over the despatching of these orders into execution. The line was developed for the purpose of carrying to a definite completeness the plans as furnished by the staff; in this respect the line did not differ greatly from the previous arrangement

Line and Staff Control

Referring to the organization chart (page 313) it will be seen that the operating division as it leaves the general manager flows into a heavy line, which is divided as to line control and staff control. The responsibility of each includes the functions which are graphically shown, but more complete information is necessary to clearly outline the full purpose of this arrangement. Since too much consideration cannot be given to the problem of developing a satisfactory organization, the one important instrument with which a concern is to be propelled, it is well that full understanding is had of it. We look to the stockholders, board of directors and the president, together with their immediate advisors, to furnish the operating division with administrative guidance, and as such these functions will be excluded from further discussion. The general manager then becomes the dividing function between administration and operating. If he is capably assisted by a selling staff, engineering staff and an operating staff there should be no occasion to displace this assistance by arbitrarily delegating responsibility where authority is not predetermined. When an order has been received from the selling staff, and its specification requirements have been interpreted into drawings and material lists by the engineering staff, the division of staff control quite automatically comes, ready to prepare the way through the shop for the work.

Composing the division of staff control are the following officers:

1. Chief Despatcher.
2. Inspector.
3. Chief of Stores.
4. Plant Engineer.
5. Chief of Standard Times and Bonus.
6. Despatching Clerk.
7. Service Auditor.
8. Variable Labor Foreman.

Composing the division of line control were the following officers:

1. General Shop Superintendent.
2. Assistant Superintendent.
3. Foreman of Laying-Out Department.
4. " Fabricating Department.
5. " Hydraulic Pressing Department.
6. " Smithing and Welding Department.
7. " Machine Shop.
8. " Assembling and Erecting Shop.
9. " Riveting Gangs.
10. " Test and Calking Gangs.

In the new shop organization the line division was not changed from what it had been before, excepting the removal of many of the duties pertaining to clerical work into the staff division.

The chief despatcher is in direct charge of all work centering among the various functions in the planning department, as the staff division will be known hereafter, the chief despatcher bears the same relation to the balance of the organization as the shop superintendent, sales manager or the designing engineer does. In this respect, early upon the receipt of new contracts, the chief despatcher is advised in a general way, so that he is fully acquainted as to what work he must make provision for. And even before the order is secured it is often necessary to make quotations in order to secure the work. In these instances the chief despatcher and the designing engineer together rapidly go over the specifications, and from the standards of time compiled in schedule books the work is estimated from a source that leaves very little room for errors to creep in due to estimating the order in bulk, based upon some job that had been done before under conditions that had been forgotten. The chief despatcher is to be actively engaged in closely supervising the work done by each member of the staff.

The inspector becomes a staff member because he is there for the purpose of upholding quality and passing on the regularity with which the workmanship is executed. His decisions are of importance to the engineering department and also to the planning department, as any changes that are to be effected in the work due to his decisions influence the manner in which the work is to be planned for successive days, and also is an important factor in the payment of incentives.

The chief of stores attends to the ordering of all material, receiving of the material at the factory, proper warehousing of it and maintaining records which will show at a glance the amount on hand and the amounts that have been sent into the shop according to the order the material was used on.

The plant engineer is responsible for the maintenance of all machines and tools. He becomes a staff member because it is of the utmost importance that the operating conditions of all machines can be known and controlled from the source from which the machines are to be used or called upon to perform certain work.

The chief of standard times and bonus performs the function of securing and making time-study observations on machines and men for the purpose of developing schedules which will show the time and conditions with which an operation is to be completed. The payment of the incentives to the employees is also included in this function because the chief of standard time is the only one that is fully in touch with the conditions upon which the bonus is to be paid. Whenever an employee has trouble in maintaining the schedule he reports this to the chief despatcher, who in turn details the chief of standard times and bonus to investigate the conditions and make adjustments accordingly.

The despatching clerk operates from the office almost entirely. In doing this he is constantly called upon to give out the new jobs to the men in the shop; he is governed in this entirely by the daily planning schedule with which he is provided. This will be described more fully later.

The service auditor compiles all statistical data that may be of value to all members of the entire organization, and he also maintains cost information covering the material and the labor that are expended on any and all orders. He secures his original information from the requisitions turned in to him by the chief of stores for all material drawn from stock and from the service cards turned into him by the despatching clerk for all labor that has been expended.

The variable labor foreman becomes a staff member because it has been found highly desirable to centralize the activities of all labor that is not directly engaged in the various boiler-making operations. From the close control over this division of labor a high degree of efficiency is obtained, and the gang is kept to a minimum size. All work is laid out for them each day upon a schedule the same as for the regular shop men and despatched by the despatching clerk. The work they perform covers the moving of material into the shop, cleaning shop and yard, painting, oiling, loading and unloading cars, etc. Much of this work has been standardized; so that an incentive could be offered this group of men, thereby increasing their efficiency.

(To be concluded.)

TAPPING HOLES TRUE.—In tapping holes on any level surface, use a square to keep the tap true; the eye, however experienced, is not to be trusted. When tapping holes in a boiler or other circular work, lay off the hole, then describe a circle of any convenient size, and when the tap is well entered try dividers from the end of the tap to various points of the circle and observe that the tap is being kept equidistant from the circle.—*Railway and Locomotive Engineering.*

The Necessity for a Uniform Boiler Construction Law Rather Than for a Uniform Boiler Inspection Law*

BY A. V. CANNON

Last year at your convention you had the honor of being addressed by the Hon. W. O. Hart, of New Orleans, who for many years has been one of the Commissioners on Uniform State Laws appointed from Louisiana. At his suggestion, at the twenty-second annual conference of Commissioners on Uniform State Laws, Mr. L. E. Connelly, one of your members, appeared before that body and requested that the Commissioners consider the advisability of aiding you in having such a law enacted by the various States.

It may be of interest to know that the Commissioners first consider whether there is a want of a general law, and if they so determine then a committee is appointed to draft and submit to the conference a proposed law. This is discussed, and usually is recommended to the committee, and after being discussed at several conferences—and the final draft having been approved by the conference—the Commissioners endeavor to have it passed in their several States.

The Commissioners have approved at various time laws on negotiable instruments—a sales act, a warehouse act, and they are now considering a partnership act, and one for the regulation of corporations. They considered, at the session in 1912, an employers' liability act and the Torrens act for the registration of land. Bills of general operation and of general interest are considered rather than those of special interest and of limited applicability.

COMMITTEE APPOINTED TO CONSIDER UNIFORM STATE BOILER LAW

It was first thought, when the matter was brought before the conference, that a law such as you wished did not have general applicability; nor was it of general interest, but rather of a restricted nature. While the conference fully recognized the necessity for laws on the subject, some of the Commissioners felt that the conference should not at this time consider the question. However, after somewhat of a discussion, a resolution was passed authorizing the appointment of a committee to consider the question and report at the conference held this year at Montreal. That committee consisted of Mr. C. A. Severance, of Minnesota; Mr. C. C. Alden, of New York; Prof. Ernest Freund, of Illinois, and George B. Young, of Vermont. Owing to a change in the political complexion of Vermont, Mr. Young was not reappointed, and therefore did not serve on the committee.

The matter was taken up largely by correspondence; bills from Massachusetts, Minnesota and Ohio were considered, and the committee came to the conclusion that any uniform law, merely covering the matter of the appointment and organization of inspectors, is a comparatively unimportant detail and is not worthy of the consideration of the conference; that unless the tests to which the boilers of different sizes and kinds, made for different uses, shall be subjected are definitely provided for in the act, no uniformity in legislation is possible. That is, if a board of inspectors in each State is permitted to make rules for inspection, thus governing methods of construction, no uniformity is possible, and therefore a legislation along the lines of the Massachusetts and Ohio law would not be efficacious in bringing about uniformity.

As to whether the tests provided in the Minnesota Act are sufficient, is a matter requiring the careful consideration of mechanical engineers, and the committee is not authorized, by resolutions appointing them, to employ the services of experts,

* A paper read before the American Boiler Manufacturers' Association, Cleveland, Ohio, September, 1913.

and that the conference be requested, by proper resolution, to decide whether it is desirable to go to this expense, and if so the committee should be continued or a new committee appointed to further consider the subject, with instructions to report at the conference of 1914.

In other wards, as was stated by Mr. Severance in his letter to the speaker, in the words of Professor Freund, what was possibly most desired was "uniformity of construction rather than of inspection." An examination of all of the laws passed in this country will show that the legislation aimed at was inspection rather than construction. Both the Massachusetts and the Ohio law provide for inspection, and again quoting from Mr. Severance's letter, he says:

"In both cases the rules for the inspection, which, of course, must involve the test which the boilers must come up to, are left to the made by the board having charge of the inspection. Therefore the board in each case decides what is, or is not, a safe construction, and as forty-eight different boards might have forty-eight different ideas on that subject, no uniformity would be produced at all."

I think from an examination of the various statutes—and I have hurriedly gone over the statutes of all of the various States—that at the present time none of the States have passed laws which look to the uniformity of construction. The complaint, or the difficulty, which you gentlemen who sell throughout the country have in the manufacture of boilers for different States, comes not from any law relative to the construction of the boiler, but rather from the rules which are laid down by the different boards for inspecting the same. Take the law in Ohio, for instance, quoting from Sec. 1058-8, Section 3:

Ohio Law

"It shall be the duty of the Board of Boiler Rules to formulate rules for the construction, installation, inspection and operation of steam boilers, and for ascertaining the safe working pressure to be carried on such boilers, to prescribe tests, if it is deemed necessary, to ascertain the qualities of materials used in the construction of boilers, to formulate rules regulating the construction and sizes of safety valves for boilers of different sizes and pressures, for the construction, use and location of fusible plugs, appliances for indicating the pressure of steam and level of water in the boiler, and such other appliances as the board may deem necessary to safety in operating steam boilers, to make a standard form of certificate of inspection, and to examine applicants for certificates as boiler inspectors, as hereinafter provided."

Massachusetts Law

The law in Massachusetts, as amended by Chapter 531, Acts of 1912, provides:

Section 1. (As amended by Ch. 531, Acts of 1912.) "All steam boilers and their appurtenances, except boilers of railroad locomotives, motor road vehicles, boilers in private residences, boilers in public buildings and in apartment houses used solely for heating, and carrying pressures not exceeding 15 pounds per square inch, and having less than 4 square feet of grate surface, boilers of not more than 3 horsepower, boilers used for horticultural and agricultural purposes exclusively, and boilers under the jurisdiction of the United States, shall be thoroughly inspected internally and externally at intervals of not over one year, and no person shall operate, or cause to be operated, any boiler not exempted by the provisions of this section until the boiler has been inspected as hereinafter provided, nor until the certificate of inspection as hereinafter provided has been issued and so placed as to be easily read in the engine or boiler room of the plant where the boiler is located, except that such certificate of inspection for a portable boiler shall be kept on the premises and shall be accessible at all times; and no person shall operate, or cause to be operated, any boiler not exempted by the provisions of this section at pressures in excess of the safe working pressure stated in the certificate of inspection hereinafter mentioned, which pressure is to be ascertained by rules established as hereinafter provided; and shall be equipped with such appliances to insure safety of operation as shall be prescribed by said board. All such boilers installed after January frst, nineteen hundred and eight, shall be so inspected when installed. A boiler in this Commonwealth at the time of the passage of this act, which does not conform to the rules of construction formulated by the Board of Boiler Rules, may be installed after a thorough internal and external inspection and hydrostatic pressure test by a member of the boiler inspection department of the district police, or by an inspector holding a certificate of competency as an inspector of steam boilers, as provided by section six of chapter four hundred sixty-five of the acts of the year nineteen hundred and seven, and employed by the company insuring the boiler. The pressure allowed on such boilers is to be ascertained by rules formulated by the Board of Boiler Rules. No certificate of inspection shall be granted on any boiler installed after May first, nineteen hundred and eight, which does not conform to the rules formulated by the Board of Boiler Rules."

Minnesota Law

The law as passed in the State of Minnesota, provides, among other things, as follows:

"2170. Deputy Inspectors. Each boiler inspector may appoint one or more deputies, who shall possess the same qualifications and have the same authority as are prescribed for inspectors in Sec. 2169. Each such deputy, before entering upon the duties of his office, shall take and subscribe the oath required by law, and file the same with the Secretary of State. (481,494; '03, c. 131, s. 2.)

"2171. Meetings, Rules, Violations. In February of each year said inspectors shall meet as a board at the capitol in St. Paul, and establish regulations for the inspection of vessels and boilers and for the performance of their other duties. They shall prescribe regulations for the inspection of the hulls, machinery, boilers, steam connections, fire apparatus, lifesaving appliances and equipments of all vessels propelled in whole or in part by steam and navigating the inland waters of the State, which shall conform as near as may be to the requirements of the United States in similar cases, and when approved by the Governor such regulations shall have the force of law. They shall designate the number of passengers that each steam vessel may safely carry, and no such vessel shall carry a greater number than is allowed by the inspector's certificate. Any owner, master, or other person violating any regulation prescribed by said board shall be guilty of a misdemeanor. (482.)"

You will see from all three of these laws that it provides for the formulation of rules for the inspection of boilers. It places the manner of construction, or the standard to which the inspection must comply, in the Board of Boiler Inspectors, who formulate the rules. Therefore you can see if we should have a law such as either the Massachusetts or the Ohio, or the Minnesota—or the one in Montana, which perhaps goes farther than any of the others—passed in all of the States, you would not have uniformity of construction; you would be under the same disadvantages as you now are in dealing with the various cities. For instance, Detroit may have one law enacted by its common council, Pittsburg another, Chicago another and Philadelphia another. All of them seek in a way to inspect boilers; all of them seek in a way to protect the public; yet there is no uniformity.

Necessity for Uniform Standard for Construction

In order to have a uniform law which will meet the wish of the manufacturers, so that you can manufacture a standard boiler, knowing that when you ship it to any of the States in the Union you are complying with the standard enacted in that State, you will have to have a committee of engineers carefully fix the standard for the construction and the various specifications which the boiler must comply with in order to pass the inspection.

The conference of Commissioners at no time would give their aid to the passing of a law which would make forty-eight different standards of inspection. You would have to do what is done in some of the Canadian provinces, like the Province of Alberta—not only provide for the inspection, but provide what and how and in what manner the boiler should be designed; you should provide for the specifications, how it should be constructed, and adopt a standard type, so that when the law is enacted in the various States you will have a standard boiler and will have standard specifications in reference thereto. Now, whether this is good or bad for your organization—whether you manufacturers wish to have a standard or standards for boilers uniform in the different States, is a matter which I cannot, with my limited knowledge of boiler manufacturing and limited knowledge of mechanics, determine. All that I can say to you is, that there is no use of passing uniform laws relative to inspection when the inspector prepares the rules and they vary according to the different States.

List of States which Have Boiler Laws

It may be of interest to you to know what States have passed any laws concerning the manufacture and inspection of boilers. Many of them, as far as I can learn, have no laws, and a considerable number have laws relative to the insurance of boilers and what the inspectors can do for the insurance company, but have no general State inspectors, or general type to which the boilers shall conform. I am speaking of States now rather than of cities. Of cities my information is limited, but I understand there are all kinds of types and all manner of inspection.

Among the States which have no boiler inspection are Nebraska, Kentucky, Illinois, Georgia, Colorado, Connecticut, California, Arizona, Virginia, Tennessee, South Dakota, South Carolina, Rhode Island, Oregon, North Carolina, New York, Missouri, Maryland—at least in the various codes, some of which are several years old, which I examined, I was unable to find anything concerning boilers.

Others, like Louisiana, Iowa, Pennsylvania and Oklahoma, have laws in reference to boilers, but largely with reference to the insurance thereof and the inspection by the insurance company.

Vermont has this law: Upon the application of three citizens, the Mayor of the city, or a person duly authorized by him, may, after notice to the parties interested, examine any stationary steam boiler or steam engine within such city, and for that purpose may enter a house, shop or building, and if, upon examination, it appears probable that the use of such engine or boiler is unsafe, they shall, upon reasonable notice to the owner or person in charge thereof, and upon hearing, issue an order prohibiting the use until it is rendered safe. The penalty if they fail to do it is $10 a day. Of course, that law is only of interest to us to show what some of the States have passed.

West Virginia has no boiler law of any character, although the State has seen fit to pass a law to give licenses to booksellers, so that they can sell books, and to sewing machine agents, stove peddlers and lightning rod sharks.

New York has no law on the subject, although it has a law on many other subjects akin to this.

Maine has a law which provides that on the complaint of any citizens that a chimney, stovepipe, stove-oven or boiler is defective, out of repair, or so placed in any building as to endanger it or another building, in a municipality of over 2,000 inhabitants, shall give written notice to the owner or occupant of such building, and if he unnecessarily neglects for three days to remove or repair he forfeits not less than ten nor more than one hundred dollars.

Indiana Law

The law of Indiana is as follows: (Burns' Annotated Indiana Statutes, Revision of 1908, Acts 1903, in force April 23, 1903.)

Sec. 8048. Boilers, Safety Appliances.

"1. It shall be the duty of every person, firm or corporation owning or using, or causing to be used, any steam boiler for generating steam to be applied to machinery in all industrial institutions subject to inspection by the Department of Inspection, to provide them with a full complement of gage cocks, some visible means of indicating the water level, one steam gage, one fusible plug properly inserted, one safety valve; all to be kept in good working order (the area of said valve, if known as a pop-valve, shall be in the ratio of 1 square inch of area to 3 square feet of grate surface), a lever and ball safety valve in the ratio of 1 square inch of area to 2 square feet of grate surface; provided that fusible plugs shall be required only in boilers having crown sheets."

Sec. 8049. Inspecting Boilers.

"2. That the owner, agent, manager or lessee of any boiler or boilers described in Sec. 1 of this Act, of 10 or more horsepower, shall cause such boiler or boilers to be inspected internally, once in six months, by a practical boiler maker of not less than five years' experience; or a practical steam engineer who has had not less than ten years' experience with steam boilers carrying not less than 70 pounds pressure per square inch; or by a boiler inspector of any company doing business under the laws of the State, who shall furnish to the owner, agent or lessee of such boiler a certificate of inspection, stating the kind and showing the condition of said boiler, the connections and maximum pressure to be carried by said boiler; such certificate to be retained in the office of said establishment, and to be shown to the chief inspector of the Department of Inspection, or his deputy, when required."

Montana Law

The law of Montana is as follows: (Revised Code of Montana, 1907.)

"Sec. 1643. Inspection of Boilers. The inspector of boilers must inspect all steam boilers and steam generators before the same are used, except in the case of new boilers, which must be inspected within ninety days after they are put in use, unless accompanied by a certificate that such boiler has been inspected by a regular State inspector, and all boilers must be inspected at least once in every year. And the inspector of boilers must subject all boilers to hydrostatic pressure, and satisfy himself by a thorough internal and external examination that the boilers are well made and of good and suitable materials; that the openings for the passage of water and steam, respectively, and all pipes and tubes exposed to heat are of the proper dimensions and free from obstructions; that the flues are circular in form; that the fireline of the furnace is at least 2 inches below prescribed minimum waterline of the boilers; that the arrangement for delivering the feed water is such that the boilers cannot be injured thereby, and that such boilers and their steam connections may be safely employed without danger to life.

"Sec. 1644. Same. He must also satisfy himself that the safety valves are of suitable dimensions, sufficient in number and area and properly arranged, and that the safety valve weights are properly adjusted, so as to allow no greater pressure in the boilers than the amount prescribed by the inspection certificate; that there are a sufficient number of gage cocks properly inserted to indicate the amount of water, and suitable gages that will correctly record the pressure of steam, and adequate and certain provisions for an ample supply to feed the boilers at all times, and that suitable means for blowing out are provided, so as to thoroughly remove the mud and sediment from all parts of the boilers when they are under pressure of steam. In subjecting boilers to the hydrostatic test the inspector must assume 125 pounds to the square inch as the maximum pressure allowable as a working pressure for new boilers of 42 inches in diameter, made in the best manner, of plates one-fourth of an inch thick, and of good material; but the inspector must rate the working power of all high-pressure boilers according to their strength as compared with this standard, and in all cases the test applied must exceed the working pressure allowed in the ratio of 100 to 75. Should the inspector be of the opinion that any boiler, by reason of its construction, or material, will not safely allow so high a working pressure, or will allow a greater working pressure than is herein provided, he may, for reasons to be stated specifically in his certificate, fix the pressure of such boiler at more or less than three-fourths of the test pressure, as the case may be."

So that these comprise practically all the laws that I could find that had been passed by the States.

As stated before, some of the provinces of Canada have passed elaborate laws and regulations governing the construction and the inspection of boilers. They set forth the design, the material, workmanship, fitting, and how it shall be inspected. The same is true also of the Province of British Columbia.

Recommendations

My recommendations to your association, therefore, would be: If you wish to have a uniform law relative to the construction of various classes of boilers, engineers should be employed to provide specifications and determine the type or types, so that when the law is drafted it can become a standard law for each of the States. If this is done I think there is no question but what the Conference of Commissioners would be willing to consider, and I have no doubt would aid you, in having such a law passed by the various States. It is not an easy matter to have any uniform law on any subject adopted by all of the States.

The Negotiable Instruments Act was adopted some eight or ten years ago by the Conference of Commissioners. Yet, while it has been adopted by many it has not been adopted by all.

The Uniform Warehouse Act, backed by the Warehousemen's Association, has been passed in a number of States, but not in all; and the Sales Act—in fact, all of the laws which have received the approval of the Conference of Commissioners are still unpassed by many of the States. While we can give you assistance in drafting, and we can give you assistance in the passage, yet you must look to yourselves to create the necessary public opinion, public approval, and you yourselves will have to do a large amount of work in securing a uniform law, either of inspection or construction.

Large Non-Superheater Mikado on the Reading.—A series of freight locomotives of the Mikado type, which, according to the *Railway Age Gaettze,* are the heaviest of their type, weighing in working order 331,000 pounds, have been designed and built in the shops of the Philadelphia & Reading Railway. The boilers are of the Wooten type, with an exceptionally large firebox arranged for burning a mixture of anthracite and bituminous coal. Contrary to the custom in recent years, the boilers are not fitted with superheaters, but to take the place of the superheater a large amount of heating surface has been provided in the boiler, totaling 5,508 square feet, which, with a grate area of 108 square feet, gives a ratio of heating surface to grate area of 48.24 to 1. The boiler is fitted with a combustion chamber 43 inches in length. The tubes are 17 feet 8 inches long, 2¼ inches diameter. The barrel of the boiler is made up of three sections, the forward one 84 inches in diameter and the third one 96 inches in diameter, with the middle one of conical shape to connect the two. The shell plates range from ⅞-inch thickness in the first course to 15/16-inch in the second and third courses. The dome is flanged from a single piece of 1⅛-inch steel plate and is 10½ inches high. The boiler is built for a working steam pressure of 225 pounds per square inch. The usual brick wall used in the Wooten type of firebox is found in this design, and flexible staybolts are used in the corners of the sides and in the roof sheets. The combustion chamber is supported by sling stays.

Autogenous Boiler Welding

It has been the editor's privilege to spend some pleasant hours with Theodore Kautny, the leading authority of the world upon autogenous welding. Under his direction numerous classes have been established in the industrial schools for teaching the process. He is the author of several standard works upon this subject, and finds time in the intervals of an extensive consulting practice to direct the publication of *Autogene Metallbearbeitung,* a monthly journal devoted to this specialty.

In reply to an inquiry as to the possibility of the replacement of the riveted joint by the autogenous weld in steam boilers, Mr. Kautny said that there are promising possibilities in that direction, but that he is exerting his influence to withhold any serious attempt in that direction until a means has been found of proving the soundness of the weld. To this end a prize of 1,500 marks has been offered for the best suggestion of a method of testing, which offer has brought out twenty-six replies. These are to be referred to a committee consisting of Prof. Dr. Schlesinger, of the Technical High School, Charlottenburg; Geheimrat Prof. Dr. Ing. Wüst, of the Metallurgical Institute, Aachen; Prof. Baumann, of the Royal Technical High School, Stuttgart; Ing. Herrn. Richter, of the Technical State Schools of Hamburg; Overingenieure K. Schröder, of the Huldschinskywork at Gleiwitz (Silesia), and Mr. Theodore Kautny himself, for the award of the prize. The suggested methods include heat and electrical conductivity, sound, vibration, etc.

The autogenous weld is already extensively employed to join nozzles onto large work, like receivers, etc., and when the joint is properly made it is as strong as the metal itself. It only remains to be able to check the workmanship.

Mr. Kautny has also an ingenious demonstration of the effect of changes of temperature and stress in producing distortion and strain in riveted joints. This consists in plotting the expansion of the various parts under differences of temperature and making some 500 drawings showing the successive positions. When these are photographed and run through a kineomatagraph the movement of the sheets and rivets will be visually reproduced. As an instance of the effort to avoid the riveted joint, Krupp is making some drums for watertube boilers for the Russian Government, about 10 feet in length and between 2 and 3 feet in diameter, by boring out large forgings, leaving a cylinder or shell of something over an inch thick.—*Power.*

The Thickness of Boiler Sheets

The steel sheets that are used in the manufacture of boiler shells are usually sold by weight instead of by actual thickness, because the cost of manufacture depends mainly upon the number of pounds of metal that the sheet contains. There would be no important difference between the two methods if every sheet were uniform in thickness and density, because the weight of a sheet of given size and thickness could then be calculated very easily, provided the weight of a cubic foot of the material were known. The weights of plates of various standard thicknesses have been calculated in this way, and the results have been tabulated. Then, when a plate of a certain thickness is wanted, a reference to the table gives the corresponding weight per square foot that such a plate would have, and a plate with this average weight per square foot is considered to fulfill the specifications, except when it has been specifically agreed that this method of gaging shall not be employed.

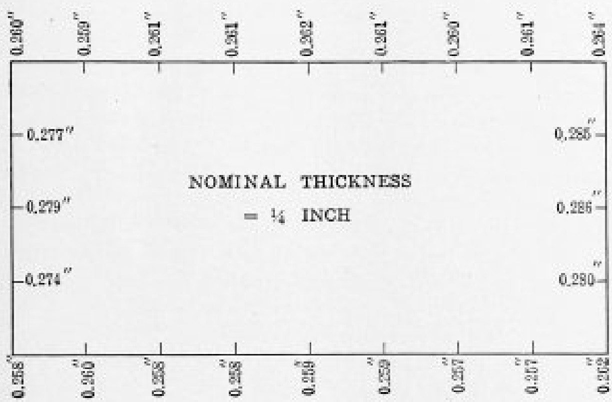


FIG. 1.—ACTUAL THICKNESS OF A SHEET OF BOILER PLATE MEASURED AT VARIOUS POINTS ALONG THE EDGE

In preparing a table for use as here described, the true weight of the material, per cubic foot, should be taken as the basis of the calculations. For approximate estimates, however, it is usual to assume that steel boiler plate weighs exactly 480 pounds per cubic foot, because this figure is very near the truth, and it, moreover, lends itself readily to calculation. On this basis a plate 1 foot square and 1 inch thick would weigh 40 pounds; or, stating this fact in another way, a piece of boiler plate 1 foot square would weigh 2½ pounds for each sixteenth of an inch of its thickness. A ¼-inch plate, for example, is not understood by the trade to be a plate that calipers 0.25 inch in thickness, but to be one which weighs 10 pounds per square foot. This point of view is convenient, and the foregoing rule gives results that are quite good enough for most purposes.

As we have already said, there would be no objection to buying boiler plate by weight in this way if each plate were everywhere of the same thickness; but in selecting sheets for the construction of boiler shells it is particularly important to remember that this condition is never accurately fulfilled. The thickness of each sheet varies to a certain extent as we pass from one part of it to another, the difference being due to the fact that the rolls by which the plates are produced spring apart a little at the middle under the strain to which they are subjected, and thus cause the plates to be somewhat thicker in the middle than they are along the side edges. There may also be a variation due to the rolls being not quite parallel with each other, but serious variations from this cause are far less likely to occur than irregularity from the springing of the rolls.

In buying a plate by weight we merely obtain one that is of a certain *average* thickness, and there is no guaranty that the thickness will be adequate and proper at the weakest points—that is, at the places where the riveted joints come. In fact, the unevenness in thickness that is due to the spring of the rolls must always tend to weaken the boiler, whether the sheets are used in their original sizes or are cut into smaller parts, because the thinnest places, being originally along edges, must always remain along edges, and hence the riveted joints will always traverse the thinnest parts of the plate. This line of reasoning shows the importance of measuring the thickness of boiler plate with care *where the joints are located;* for the strength of a joint depends upon the *actual* thickness of the plate at the point where the joint occurs, and not at all upon its average thickness, considered as a whole.

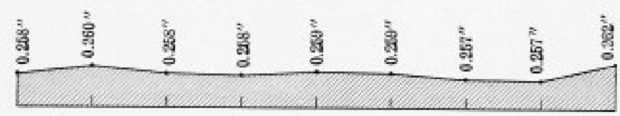


FIG. 2.—DIAGRAM, SHOWING THE THICKNESS ALONG ONE OF THE LONG EDGES OF THE PLATE SHOWN IN FIG. 1

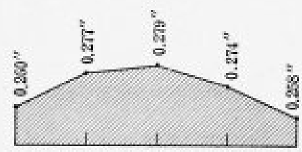


FIG. 3.—THICKNESS ALONG ONE END OF THE PLATE SHOWN IN FIG. 1

The fact that boiler sheets vary in thickness as here described is well known to boiler makers and others, and it can also be easily verified in a few minutes in any boiler shop that carries a stock of plates. We present herewith several diagrams showing the thicknesses of three actual boiler plates. The original measurements were taken to the ten-thousandth of an inch; but as the presence of scale and dirt is likely to affect the reading to the extent of several ten-thousandths, even when the plates are cleaned before calipering, it was considered sufficient to give the results to the nearest thousandth.

Fig. 1 is a diagram of a boiler plate that was rolled to order, with the understanding that it was to be a full quarter of an inch thick, even at the thinnest point. This condition is evidently fulfilled. In the trade sense, therefore, the plate is not a "quarter-inch plate." It was 16 feet 8 inches long and 8 feet 6 inches wide, and the thickness was determined along each of the four edges at uniform intervals of about 2 feet 1 inch. It will be seen that the least observed thickness was 0.257 inch, while the greatest was 0.286 inch. The variation in thickness was therefore more than 11 percent.

In Figs. 2 and 3 the variation in thickness along the edges of this plate is illustrated to scale, the height of the shaded part representing the excess in thickness above 0.25. Fig. 2 corresponds to one of the long edges, and Fig. 3 to one of the ends.

It will be seen that the thickness along the long edge is very uniform. Moreover, its variations do not follow any definite law, and they are plainly of an accidental nature. In Fig. 3, however, the case is quite different. A marked systematic variation is here evident, the plate being thickest near the middle and thinnest along the side edges. (It is believed that this particular plate was of firebox steel, though no stamp was found upon it.)

It is instructive to measure the thicknesses of plates at the edges of openings cut near the middle for manholes, steam nozzles and the like; but it happened that there were no such openings in the particular plates that were measured to illustrate this article.

Fig. 4 shows the end profile of a plate that was 6 feet 10 inches wide, with a nominal thickness of ⅜ inch full. In ordering this plate it was specified that it should nowhere be

FIG. 4.—VARIATION IN THICKNESS ALONG ONE END OF A PLATE NOMINALLY ABOUT ⅜ INCH THICK

thinner than 0.375 inches, and, as will be seen, this condition was fulfilled so far as the section here shown is concerned. The variation in thickness was 0.010 inch in this case, or about 2.6 percent of the minimum thickness. It will be noticed that this plate was decidedly thicker at one side than at the other. This difference may have been caused by trimming off one edge, or by poor adjustment of the rolls, or by running the plate on the last pass much nearer to one end of the rolls than to the other end, so that although the maximum spring that occurred may have been central so far as the rolls were concerned, it produced its maximum effect on the plate at one side of the middle line. This plate could not be examined for stamps, because it lay in a pile with others, and could not be conveniently removed.

Fig. 5 gives measurements taken from the end-edge of a materially thicker plate, which was stamped "firebox steel."

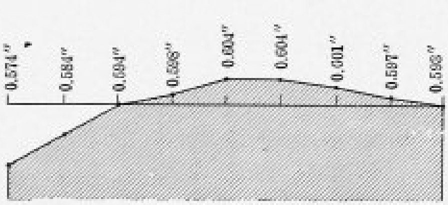


FIG. 5.—VARIATION IN THICKNESS ALONG ONE END OF A PLATE NOMINALLY 19/32 INCH THICK

The nominal thickness of this plate was 19/32 inch, but the actual thickness varied from 0.574 inch to 0.604 inch—a range of 0.030 inch, or nearly 5¼ percent. It will be noted here, as in Fig. 4, that the reduction in thickness is not the same on the two sides; but in this case we can hardly suppose that the plate had been trimmed, or that it was passed non-centrally between the rolls, because it was 8 feet 3½ inches wide.

From the examples here given (and further illustrations of the same fact are easy to obtain in any boiler shop) it is evident enough that full-sized boiler plates are sensibly thinner along their long edges than they are elsewhere, and this means that when such plates are bought by weight in the usual manner (which is the same thing as buying them according to their *average* thickness), they may be sensibly weaker along these edges than they are usually assumed to be in preparing boiler specifications.

When full-sized sheets are used in boilers with their long edges running circularly, it is the girth joints that are mainly weakened on account of the springing of the rolls, and the variation in thickness is then of comparatively little importance, because the stress on the girth joint is relatively small. The effect of the thinning of the plates at the edges is of maximum importance when the sheet is turned lengthwise of the shell and used entire, as in building a horizontal tubular boiler with a single bottom sheet. The least thickness will then lie along the long fore-and-aft joint, which is a source of weakness in such boilers in any event, on account of the lack of stiffness that characterizes shells that are built in this way; and any diminution in the thickness of the sheets at this point makes the boiler still more likely to give trouble.

The loss of strength in a boiler from having the plates thinner than the average at the place where the joint comes is sometimes very serious, particularly when the exigencies of the work make it desirable to allow the boiler to carry all the pressure that is consistent with maintaining a proper factor of safety. Many cases have come to our notice in which boiler owners have been seriously disappointed and incommoded by finding that their boilers were not considered to be satisfactory for insurance at the pressures they wished to carry, for the simple reason that the boiler maker had built them of plate having a certain nominal or average thickness, whereas the pressure that can be allowed must be determined by the *actual* thickness at the edge where the rivet holes come. When the margin of safety is quite large the lack of uniformity in the thickness of the sheets, due to the springing of the rolls, is usually of small importance; but when the boilers are to carry pressures that approach the limit of safety a difference of a few pounds may become quite significant. The effect of the spring of the rolls is particularly important when the average thickness of the sheets is somewhat less than the standard, because in that case the total amount of thinning, due to the two causes in combination, may be sufficient to make quite a marked difference in the allowable pressure.

A reduction in boiler pressure of even a few pounds often has a large and seemingly disproportionate influence upon the economical operation of a plant; particularly when the steam is to be used for heating purposes in connection with processes that require a definite and rather high temperature.

Boiler makers who wish to realize the full-rated thickness of material at the joints can have their plates specially rolled for a small additional charge, so that this condition will be fulfilled. The thickness in the middle of the plate will then exceed the nominal thickness, and the weight of the plate may be increased in this way by from 2 to 8 percent, or even more. —*The Travelers Standard.*

NEW MIKADO LOCOMOTIVES FOR THE NORTHERN PACIFIC RAILWAY.—Up to the present time 270 Mikado locomotives have been built for the Northern Pacific Railway by the American Locomotive Company. The new locomotives recently delivered are a development of the original design. The Mikado design contains a Schmidt superheater, firebox arch, smoke consumer tubes in the side of the firebox and a 36-inch combustion chamber. The general dimensions of the boilers of the latest engines of this type, as given in *Railway and Locomotive Engineering*, are as follows:

Working pressure	180 pounds
Diameter, front end	83⅝ inches
Diameter, back end	96 inches
Firebox, length	120⅛ inches
Firebox, width	84¼ inches
Grate area	70.4 square feet
Tubes, number and diameter	212, 2¼ inches
Superheater flues, number and diameter	40, 5½ inches
Tube length	18 feet
Combustion chamber, length	36 inches
Heating surface, tubes	3,266 square feet
Heating surface, fire-box	290 square feet
Heating surface, arch tubes	35 square feet
Total	3,591 square feet
Superheating surface	846 square feet

The Northern Pacific is now using more Mikado locomotives than any other railroad in the United States.

Safety First in the Boiler Shop

BY C. E. LESTER

The "Safety First" campaign inaugurated a few years ago on a leading railroad has received a great impetus of late, and is becoming more or less general on railroads and in industrial plants throughout the country. Employers are recognizing the very apparent fact that it pays, in divers ways, not only to protect the public but to protect employees as well.

The movement is primarily one of education and is for the purpose of making every man a "Safety First" man. The campaign of education, by means of instructive literature, safety committees, lectures and moving pictures, delineating dangerous practices and showing wherever many such practices can be eliminated, or can be done in a safer manner, is increasing employers' assets and reducing their liabilities by having a more careful set of employees.

Employees and their families, as well as the general public, are benefited in the reduction in the number of deaths and permanent injuries to the bread winners. Many accidents that could be avoided by a little care are the means of reducing many a man's earning capacity, often bringing poverty to the family dependent, making them public charges and burdens to the public at large.

"Familiarity breeds contempt." This old axiom is especially adaptable to industrial plants where men flirt with death repeatedly in a day's toil by carelessly performing tasks where a great amount of danger could be eliminated by the exercise of a little more care. The "Safety First" movement is teaching men to see the danger they have become oblivious to by daily contact.

The origin of the term or the exact beginning of the movement is not known to the writer, but to give "credit to whom credit is due," it would appear that to the boiler designer of the past belongs a major share of the credit, for in no field of mechanical endeavor is there such a margin of safety provided as in boiler construction. The term "factor of safety" is undoubtedly father to "Safety First," and the whole boiler industry is based on a factor of safety.

The first thing considered in the design and construction of a boiler is the factor of safety, for on it depends entirely the thickness of the plate, the size and pitch of the rivets, the location and design of the bracing, and, in fact, anything and everything that affects in any way the strength of the boiler.

It is now a lawful requirement in most civilized communities that all boilers constructed or used shall have a certain factor of safety. The exact factor varies slightly in various States, provinces, etc. In some it is as low as 4 and runs as high as 6½. A factor of 5 is a fair margin of safety and is extensively used. To the uninitiated it may be said that a factor of safety in boiler work means the difference between the allowable working pressure and the ultimate or breaking strength.

For example: calculating the efficiency of the joints, strength of braces and tensile strength of materials, it is found that the weakest portion will burst when the steam pressure reaches 1,000 pounds per square inch. With a factor of safety of 5, or, in other words, one-fifth the ultimate strength, the allowable working pressure would be 200 pounds pressure per square inch; a factor of safety of 4 would give one-fourth, a factor of 6 would be one-sixth, etc., etc.

The factor of safety used in construction does not, however, prevail after an air or steam receptacle ages, unless the allowable working pressure is reduced from time to time to keep pace with the deterioration of the boiler. In the life of a boiler, particularly locomotive boilers, there are many causes that lead to the weakening of the different parts.

In construction, the forming of the plates changes the structure of the material, frequently weakening it. In service there is a practically constant expansion and contraction caused by a variation in the amount of heat supplied by the fuel on account of the effect of the grades, stops, slow orders, etc., and the injection of cold water, and also by climate changes in a few miles' travel.

At times when the boilers are washed out and the water let out for other purposes, and the boilers are filled and fired rapidly, enormous strains are set up by the materials trying to adjust themselves to the varying temperatures. The frequent recurrence of these conditions cracks plates, loosens seams, breaks staybolts and braces and otherwise impairs the efficiency of the boiler.

Impure water is a prolific cause of boiler trouble, causing foaming, priming, pitting, grooving and incrustation. The regulation of the water supply is, of course, out of the boiler foreman's or inspector's domain, but the defect brought about by these conditions calls for a careful and minute inspection at all times, especially in bad-water territory.

At the internal inspection time, the seams and joints should be made absolutely clean if there is any doubt about the seams' efficiency, and a few rivets should be removed to locate possible defects. Remember that "Safety First" is the slogan, and that missing a small crack at inspection time might result in a bad boiler explosion. A boiler inspection should be most thorough at all times and improper repairs not tolerated. The plugging of cracks in unstayed surfaces should be absolutely prohibited. It is common custom to allow plugging a flat surface up to six times the thickness of the plate. This practice, the writer believes, is not a good one to follow in plugging locomotive fireboxes, and he believes that any plug greater than 1 inch in diameter should be applied from the water side with a tapered thread or tied to the outer sheet with a staybolt.

In patching boiler shells care should be exercised in the design of the patch. Under no circumstances should the repairs reduce the efficiency of the boiler unless the pressure is reduced accordingly. In bracing boilers see that each brace is taut and bearing its own share of the load.

Once the head is off a flue there is nothing left to hold it in the sheet but the grip of the expanders. A lowering of the firebox temperature causes the flue to contract, and it immediately becomes a source of danger. Arch tubes and water bars cannot be too closely inspected. A little neglect on the part of the boiler washer to keep them free from scale or other obstructions may cause one to blow out and take a fireman's life.

The use of pneumatic tools as a part of shop equipment and air brakes on locomotives has necessitated the use of air storage reservoirs. These, being under high pressure, are as dangerous as a steam receptacle unless they are constructed with proper regard for safety and are well maintained. The practice of constructing shop air reservoirs from old locomotive shells and air-brake drums is one that should be discouraged if not prohibited. The writer has personal knowledge of three lives lost through one such reconstructed drum bursting, and of another one bursting without any loss of life. Each of these cases was entirely due to excessive pressure on a worn-out drum. It is but a few weeks ago that a workman had a hand blown off while testing an old drum to which he had applied a soft patch, because the shell was not heavy enough to take a patch-bolt thread. This was a clean case of carelessness or of incompetency on the part of the foreman.

Shop reservoirs should be constructed with the same factor of safety as a boiler shell. The heads should, preferably, be dished—one concave and one convex—and the reservoir set vertical with a drain cock at the very lowest point. They should also be equipped with a manhole, safety valves and pressure gage. Each reservoir should be given a hydrostatic test at least yearly, and at this time the safety valves and pressure gage should be carefully tested and the reservoir be given an internal and external inspection. Each reservoir should be plainly stenciled, giving the assigned shop number, pressure and date when the next test is due. Locomotive air reservoirs should be given a hydrostatic test each time the locomotive is given an overhauling and a hammer test at each boiler washing. Some inspectors seem to fear punching a hole in a drum with a hammer pean when making a test. If it can be done it is just what should be done.

The "Safety First" ideas should not, however, be confined to the big things in the shop, as there are divers ways in which the safety of the workmen may be enhanced. The handling of heavy plates and boilers is usually given but little consideration; that is, as regards a safe manner of handling. The ordinary workman does not as a rule pay much attention to the size of a chain or the manner in which a boiler might be hoisted and turned in a safe manner.

The writer has in mind a plant where this particular kind of work has been carefully considered, the management full realizing the opportunities for accidents. Blue prints with sketches, showing the safest way to lift a plate by one or both edges, handling flanging blocks, lifting and turning boilers with the traveling crane and the several movements necessary to place or remove a boiler from the bull riveter, and, in fact, fully two score safe methods of doing this hazardous work have been framed and placed in the most conspicuous places in the shop. In watching this work to a considerable degree, it was noted in a period of time covering about three weeks that but once was there any attempt to deviate from the printed instructions, and in this case by a man new in the plant.

The inspection and care of chains and slings in plants of any magnitude should be detailed to responsible persons, and they held strictly accountable for their condition. In smaller plants the department foremen should be instructed to follow this work. Chains, slings and hooks should be inspected before being placed into service and at frequent intervals thereafter, and should be annealed at least every six months. The cooling after annealing should take at least ten hours. They should be minutely inspected after annealing and thoroughly lubricated with oil or grease to lessen friction before being placed in service.

It is often found that a careless smith will put in a link of smaller diameter than the original chain. This serious defect would scarcely be noticed in a long chain unless someone was looking for defects. Each chain or sling should have an identification number on the first link, and an office record kept of (*a*) description; (*b*) location; (*c*) date of inspection and annealing; (*d*) date of test.

Whenever the strength of any chain or sling is questioned, the entire part should be given a test load to determine its efficiency. The following table has been given by an authority on the subject as a safe and reliable one to follow:

Diameter of Rod Composing Link Inches	Safe Load for Chain Pounds	Proof Test Pounds
9/16	6,300	11,000
5/8	8,000	14,000
3/4	12,200	20,000
7/8	16,100	26,000
1	20,500	33,750
1 1/8	25,500	41,500
1 1/4	31,200	52,000
1 3/8	36,100	60,000
1 1/2	43,400	70,400

Specifications of chain iron should be as follows: Tensile strength, 50,000 pounds per square inch; elongation, 25 percent; reduction of area, 40 percent.

It is good policy to have the capacity of chains and slings printed and posted in the shop that the workmen may familiarize themselves with the same. Inasmuch as a large number of men now employed are foreigners, and speak but little English, it is a good plan to have the instructions printed in Italian, Polish, Slavish, etc., for the benefit of those who do not read English.

There are many, many ways in a day's work in the boiler shop that the safety of oneself and others may be enhanced. All moving parts of machinery should be guarded where possible; that is, gear wheels, flywheels, pulleys, etc., that are near the floor or where a person could accidentally come in contact with them.

It is interesting to note that in many different industries those in authority are making a study of the "Safety First" problem, and in many cases going so far as to order the dismissal of employees who insist on disobeying or not following instructions laid down for safety.

A report from the American steel foundries says: "Should workmen be compelled to wear safety goggles?"

"The employer, knowing the risks of accidents to eyes of his employee, is under a moral obligation to them and to the State to take positive steps to safeguard their eyes. The fact that the employee, because of a grievance or foolhardiness, may try to evade the use of the protection afforded does not relieve the employer of this moral obligation. The obligation of the employer, together with the natural incentive to protect his own interests, and also reduce to a minimum the cost of his liability for compensation for injuries to his employees, should cause the employer to make eye protection his settled policy.

"The question is often asked, 'How can workmen be induced to wear safety spectacles?' The answer is: start an educational campaign at the time safety spectacles are introduced into the plant and emphasize it by photographs and detailed description of the workmen in their own or other plants, showing the absolute necessity for eye protection. Collect and exhibit every broken spectacle and emphasize the protection it has afforded. Advertise serious eye accidents occurring in other industries. Show the spectacles to the foremen and report at every foremen's meeting every eye accident.

"If the State legislature has the right to force upon the employer compulsory State compensation laws, surely the employer has the right to protect himself by insisting on the workmen using proper devices to prevent accidents.

"The whole eye accident problem is primarily in the hands of the department foremen. Employers will not have much trouble in inducing workmen to wear safety spectacles if *all* the foremen are actually in sympathy with the use of them and if they will follow ordinary methods of discipline in their use.

"The workmen soon find out when the foremen are not in sympathy with the use of spectacles or are indifferent to their use. It is then the so-called difficulties of inducing the workmen to wear safety spectacles begin to appear and finally become absolute."

The foregoing extract, from a report of a man who has made a careful study of the subject and one who has experienced great difficulties in getting safety spectacles worn, puts the matter up to the foremen entirely. This report is especially applicable to the boiler shop, and writing from twenty years' experience in the boiler shop and around the shop generally the safety appliances can be enforced by the dismissal of the worst offenders if they persist in it. Firmness should be maintained in this as in other things and by keeping eternally after it.

It may be well to add that in shops where traveling cranes are used the weight of the principal heavy articles to be moved should be placed on a card in the crane man's cage in plain view, and the crane man be instructed to refuse to lift anything if he fears an overload.

In conclusion a few "dont's" may be added that may prove of benefit.

Don't go under a crane load of material, unless absolutely necessary.

Don't try to shear small pieces of plate without a dog or tongs.

Don't watch any one using a pneumatic chipper.

Many companies furnish goggles for chipping, etc. Use them.

Report anything that does not appear safe.

Don't strike tempered steel with a hammer.

Be careful of the long-stroke riveting hammer. If you let the hammer down for a few minutes put the plunger in your pocket.

Keep the ragged burrs broken off your hand tools.

Don't use a hand hammer or sledge with a loose handle.

When knocking off rivet heads, hold an old broom in front of the rivet.

Don't take hold of a staybolt tap until the motor stops.

Don't punch half holes on the power punch.

Don't monkey with electrical equipment.

Don't wear gloves when operating an air motor.

Don't watch the acetylene or electric welder unless you wear colored glasses.

If it isn't safe—don't do it.

Appoint yourself a committee of one on "Safety First."

"All that a man hath will he give for his life."

Boiler Setting for Smokeless Combustion

In a pamphlet issued by the smoke department of the city of Cleveland the following rules are given for setting hand-fired, horizontal tubular boilers for burning coal. The rules are based on the experience gained by the smoke department of Cleveland in investigating the conditions prevailing where smoke from boiler plants was excessive, and if taken only as a general guide, with due consideration to the variation in conditions found in each plant, they should prove of great value in suppressing smoke. Other requirements are necessary, of course, for wood burning:

1. Height between dead plate and shell:

Shell Diameter, Inches	Height, Inches
36	42
42	36
48	34
54 to 72	32
78 to 84	30

2. Suitable firebrick construction above and behind bridge wall, followed by a deflection arch of firebrick.

3. The thickness of the firebrick shall not be less than:

a. Nine inches of first grade firebrick over firing doors on inner side.

b. Nine inches of (arched) firebrick over the firing door liners.

c. Side walls adjacent to grates up to height of bottom line of shell back as far as the rear edge of the bridge wall, 9 inches of first grade firebrick.

d. Side walls *above* the height of the bottom line of the shell from front to end of arch system, 4½ inches of first grade firebrick; headers every fifth course. Also side walls between rear end of bridge wall and 12 inches back of rear arch, 4½ inches of first grade firebrick, with headers every fifth course.

e. Side walls from combustion chamber floor throughout setting behind arch system, a good second grade brick 4½ inches thick, with headers every fifth course.

f. Bridge walls, front and back faces and top, to be not less than 9 inches of first grade firebrick.

g. All arch spans of more than 48 inches to be of 9-inch wedge brick. (No double arch of 4½-inch brick will be allowed in place of the 9-inch.)

h. Brick over door openings in combustion chamber to be arched.

i. Combustion chamber to be paved with firebrick on edge; these may be second grade.

j. Blow-off protection. Pier in front of blow-off pipe.

k. Back wall and back arch construction to be of first grade firebrick.

l. Front girth seam to be protected by firebrick covering.

m. Deflection arch under courses to be of wedge or bullhead brick.

4. Thickness of walls. Side walls to be not less than 20 inches for shells up to 54 inches diameter, and 24 inches for shells 60 inches and upward in diameter.

5. Side walls to be solid.

6. Vertical stays to be placed with reference to arch construction. Rods to extend from outside wall to outside wall, and lower rods to be below combustion chamber floor. Longitudinal stay rods also to extend from outside to outside.

7. Metal reinforcement must be exposed on outside of setting walls to take up arch thrust on Department setting No. 2. Advised on No. 1.

8. When pans are necessary they must extend through the length and breadth of setting.

9. Herringbone or Tupper grates not permitted.

10. For steam pressure of 60 pounds or greater use steam jets, either operated by hand or automatic, the latter advised. Steam jets to enter front of furnace. Minimum number: Boilers up to 48 inches diameter, 2; boilers above 48 inches to 66 inches, inclusive, 3; boilers above 66 inches, 4.

11. Firing doors to have panels having openings aggregating 4 square inches per square foot of grate and doors to control such openings. The operation of the doors preferably to be automatic.

12. Breeching:

a. Area of up-take above tubes and all sections before entering stack to be at least 25 percent in excess of the tube area which it serves, or one-quarter of the grate area.

b. Minimum section never to be less than one-half the section entering chimney.

c. Make breeching straight as possible. If turns are unavoidable make them with as long a sweep as possible, avoiding sharp turns. Avoid drops in the breeching.

d. A damper must be provided for each boiler. If placed in the up-take the effective opening must be at least 25 percent in excess of the tube area, or one-quarter of the grate area.

e. Place a damper in breeching controlling all boilers.

f. The opening in the extension sheet of the boiler for connection to the breeching to be at least 25 percent in excess of the tube area, or one-quarter of the grate area.

g. Use a round or square breeching rather than one which is wide and shallow. A breeching of a section in which one dimension is over twice the other should never be used.

h. Cover long exposed breechings.

13. Chimney:

a. Area to be 20 percent in excess of the combined tube area, or one-fifth of the grate area. For stacks of exceptional height, a somewhat less area may be approved.

John, Geometry and Square Root

BY JAMES F. HOBART, M. E.

"What's the difficulty, John? Judging from that long face you are wearing, you must have a job on hand like building another Panama Canal or a railway to the moon. What's the trouble?"

"Dunno' what you call it, Mr. Hobart, but it's sure fierce, and it is just this way: The 'Old Man' wants me to dope out a circular tank, 10 feet deep, which will hold 7769.4 gallons of water. I asked him what there was about it that needed to be so exact, and he asked me what difference it made whether the tank held one quantity or another."

"Well, why don't you work it out? There's nothing hard about that proposition, just a bit of easy figuring to do and there you are."

"Yes, but he has got me all balled up with those gallons and feet dimensions for depth and diameter. Oh, yes, it's to be a circular tank, all right, and I don't exactly catch on as to how the connection is made between them."

FIG. 1.—FIRST STEP IN SQUARE ROOT

"So that's the 'nigger in the wood pile,' is it? Can't turn cubic feet into gallons? Well, John, build that tank, then put your head to soak in it over Sunday, and see if you can't get something into your noddle except that pint of soup you call brains. John, John! After all our talks, I am sure ashamed that you fall down on that proposition!"

"Yes, but where have I ever been up against cubic feet and gallons in the same tank before? Gee! but they don't seem to mix even a little bit."

"John, here is something to chalk down in the back of your head. I want you to write it down three times a day—morning, noon and night—and write it ten times each evening, until you get it so fixed in your mind that you couldn't forget it if you tried. It is——"

"Say, Mr. Hobart, what is this wonderful thing, and what is it good for?"

"As you are in so big a hurry to learn about it, why just wait until your hurry is over. You would have known all about it by this time if you had kept your mouth shut and your eyes open."

"Oh, I won't butt in again, Mr. Hobart. Truly, I won't."

"All right, John. The wonderful thing is this:

"Water: $8.33 \times 7.48 = 62.3$."

"Well, I don't see anything about that bunch of figures to go daffy over. What's it all about, anyway?"

"It means that water weighs 62.3 pounds to the cubic foot, or 7.48 gallons of 8.33 pounds each."

Oh, say! I thought a cubic foot of water weighed 62.5 pounds. That's what they figure it at, isn't it?"

"Yes, they usually take that figure for the sake of convenience in using round numbers; but, really, water at about 39 degrees, which is its greatest density, weighs 62.425 pounds to the cubic foot. As this fraction is hard to remember, they call it 62.5 pounds, and let it go at that. But really at about 70 degrees a cubic foot of water weighs about 62.32 pounds, therefore we are safe in calling it 62.3 pounds per cubic foot."

"But, Mr. Hobart, why do I need to write down that line of figures so many times? If I put in my note book

$$8.33 \times 7.48 = 62.3,$$

can't I look it up whenever I need it?"

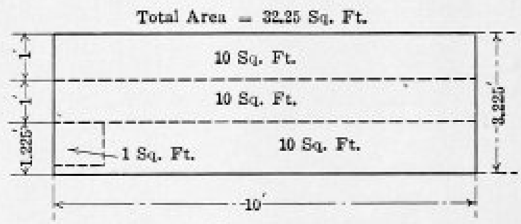


FIG. 2.—SECOND STEP

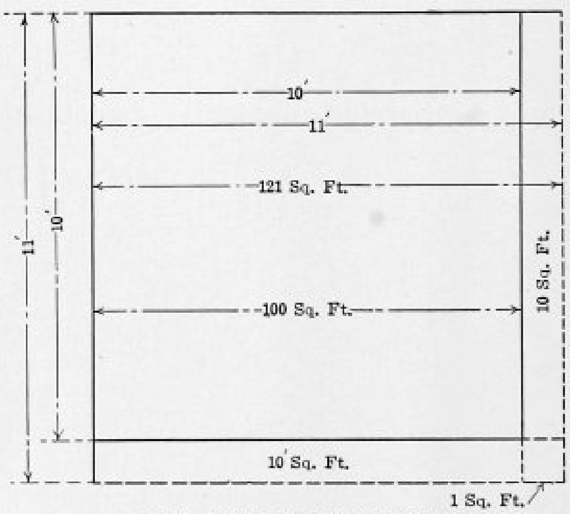


FIG. 3.—THIRD AND FOURTH STEPS

"No; that won't work. You have got to so fully memorize the figures that you can say them backwards in your sleep. If you don't, you will be just simply hung up the very first time you try to use the figures and can't get at your note books. If you try to memorize that line only partially, for ten years you will be bothered to determine whether it is 8.33 or 7.48 pounds to a gallon, or whether it is 7.48 or 8.33 gallons to the cubic foot. But just thoroughly memorize the line of figures I have given you and you will always be able to figure tanks and such things without having to turn to the books for data."

"Say, Mr. Hobart, I will chalk that down in the back of my head, and 'paste it in my hat,' too. But what has it got to do with laying out that tank to hold just 7769.4 gallons of water?"

"It has a whole lot to do with it. To begin with, you want to get the gallons into cubic feet as soon as possible, therefore you divide 7769.4 by 7.48, obtaining 1038.6915, and there you have the cubic feet of space the tank must have. Then just divide by 10, and there you have 103.86915, which is the area of your tank in square feet."

"But, say! That gallon and cubic foot line of dope is all right, isn't it? And now we have the size of that tank about dead to rights—103 square feet. That means a little more than 10 feet on a side will fill the bill."

"Ring off there, John. You're 'way off. It would be about 10 feet were the tank a square one; but as it is round, the diameter, you will find, will be more than 11 feet, when you come to figure it closely."

"How is that figured, Mr. Hobart? And has geometry anything to do with it?"

"Sure, John, geometry has to do with about everything, in one way or another and with this problem in particular. Do

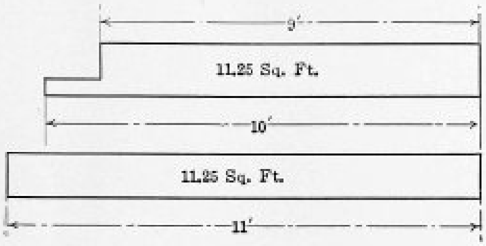


FIG. 4.—FIFTH STEP

you remember that talk we had some time ago as to where decimal .7854 came from?"

"Sure, Mr. Hobart. I'll never forget that as long as I live. It is just one-fourth of pi—of 3.1416!"

"That's right. And here we use .7854 again, for our 103 square feet is the area of a 'square with the corners knocked off,' as a circle was described during the conversation in question. Now, then, to get the corners upon 103 again, we will divide it by .7854, and find that the quotient is 132.25. And this means that a square sheet just big enough to make the bottom of our tanks will contain 132.25 square feet, and it will be a square piece as large one way as the other."

"How will we find the dimensions of that sheet, Mr. Hobart?"

"We must 'extract the square root' of 132.25, and that root will be the side of the square, or the length and breadth of the sheet which will just make the bottom of our tank."

"But 'square root!' Phew! I never could see into that! By Jimmimy, that stuff is too tough for me!"

"Nonsense, John. While square root has scared more boys than ever ghosts did, there is nothing more to square root, when you understand it, than there is to the flimsiest ghost which ever—or never—made itself visible."

"But how do you get hold of a side, anyway? I have read the rules for square root in a lot of the books, but I don't see much sense in any of them. They all say: divide the given number into periods of two places each. But I can't see why they do it, or what they do that for."

"Guess I know what is the matter with you and square root, John; you are afraid of it—think it is something big and hard, when really it is only a collection of several very easy, simple things. Now, just get busy and we will let geometry straighten out square root for you, once and forever, so you never will have any more trouble with it."

"Come right across, Mr. Hobart. I'm here, right direct from Missouri!"

"Well, John, taking our number 132.25, and 'dividing it into periods of two figures each,' we get it like this: 1'32.25. And the reason why we do that, John, is this: Any figure multiplied by itself can fill only two places. For instance, $8 \times 8 = 64$; $9 \times 9 = 81$; $10 \times 10 = 100$. The latter fills three places, but there is more than one figure in the quantity multiplied by itself—'squared' they call it—therefore our rule of two places in the square for each in the side holds good. It looks reasonable, too, that when we have one side given, as 3, 4, etc., occupying one digit place, that when we get a whole surface, consisting of a side in two directions, that there should be two places in the number representing that surface—and this is true, always, except with the left-hand 'period,' which may contain either one or two figures, accordingly as the figure it represents is less or more than 3. And, John, the same thing holds good when we have a body with three sides—length, breadth and thickness. Then the number must have three places for each figure in the side, or root, and they call this 'cube root,' thus finding the side of a solid, while to-day we are only dealing with 'square root'—the finding a side of a square which will contain 132.25 square feet."

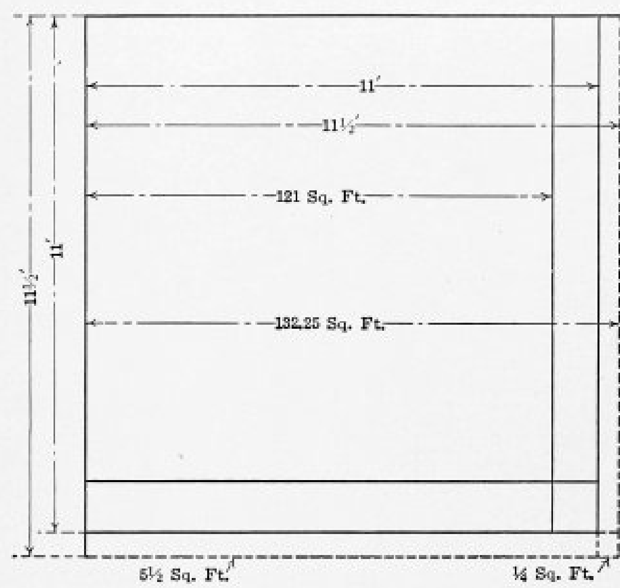


FIG. 5.—LAST STEP

"But what do you do with that number after it is divided into periods?"

"We work each period by itself, John, and have nothing to do with any of the others, taking each in its turn, beginning at the left. And, John, there will be a figure in the side for each period in the number, so we can tell beforehand that the answer will have two whole digits and one decimal, and we can also tell that the left-hand figure will be 1, for nothing else can be divided into 1."

"Crackee! You have got the answer half-worked out already. It must be more than 10, less than 20, and contain one decimal place; and we can write what we know of it as '*1x.x*,' couldn't we?"

"Yes, John, that's the idea, exactly. And as we have found the first figure by inspection, we will take the next step and find the second figure. And that is the way we will work, finding each figure separately until we have found the value of each '*x*' in the number."

"Say! That's some stunt. I never thought that was the way you worked out square root."

"That is the principle of it, John; just one little thing at a time, and there you are."

"And what do we do next, Mr. Hobart?"

"Take a look at Fig. 1, John; that will show how to go to work. That figure contains 132.25 square feet, out to the dotted lines, and in our 10×10 feet we have accounted for the 100 square feet shown by the solid lines, leaving 32.25 square feet to be looked after. Now, John, just listen: This remainder is equal to a strip 10 feet long and 3.225 feet wide, and to take care of it we must spread it evenly along two sides of the 100 square feet already accounted for."

"But say, Mr. Hobart, isn't this way of finding square root a sort of cut and try business?"

"Yes, it is. And so is any way of working square root, and cube root also. Look in any arithmetic and there you will find directions how to make up a 'trial divisor,' won't you?"

"By George! That is so, isn't it? Say, I never thought of that before. So when we work square and cube root we keep trying and trying until we get the exact answer, or as close to it as necessary."

"That's the way, John, and we make a new try and guess each time we bring down another 'period' of two figures. And if we don't get close enough with the figures we have, then we bring down another 'period' of decimals, and keep on trying, guessing and correcting, until we get a square root which is as close as we require."

"But what do you do with the 32.25 square feet which is left in Fig. 1 after the first operation?"

"Divide it up, John, and spread it around two sides of the 100 square feet, so as to make the figure larger, but still keep it in the form of a square."

"How do you do that, anyway?"

"Fig. 2 shows how it is done, John. We have left a strip 10 feet long and 3.225 feet wide. We can cut from this two strips 1 foot wide and they will reach around two sides of the large 10-foot square, except a little corner, which will be taken care of later."

"Oh, say! We can cut off a strip 1½ fet wide as well as 1 foot wide——"

"Don't you try it, John, or you will get into trouble, and lots of it. All we have to do with is the 32 square feet in the second period—we don't really have any business with the 0.25 foot, but we can let it go along, or leave it off, as we choose, so we will just try the second figure of the root, which we find to be 1. It cannot be 2, for we have only 32 square feet to spread over 20 feet of length, hence the width must be less than 2 feet, and we take the 1 foot and let the remainder go for another trial and guess. This gives us 11 as the root for which we are seeking, and it takes care of 120 square feet of surface out of the 132.25. But we can add a little more—there is a little open corner, as shown in Fig. 3, after the 12-inch strip has been stretched around two sides of the square. Taking another foot for this corner, and we have accounted for 121 square feet, leaving 11.25 feet to be put in place, as shown by Fig. 4, in the upper sketch in this figure. But we now have a 11-foot square to work around; and reducing the remaining strip to an 11-foot length, we find it to be as shown by the lower sketch in Fig. 4, a little more than 1 foot wide. But as there are 22 feet in length to be added to, we can put but one-half, or .5 foot, around the 11-foot square, so 5 goes in as the third figure in the root, and we have now a square 11.5 feet on a side, with a little material still left over."

"And what do we do with that bit which is left over?"

"Do just as we did when we had a remainder of 32.25 square feet—first find out how much remains, then spread it around two sides of the square again, same as before. We have an 11-foot square, which contains 121 square feet, and we have spread 11 feet more on two sides of that, thus taking care of 132 square feet, leaving only 0.25 foot to be disposed of. But, John, we still have a corner to fill—a little corner one-half a foot square—and this calls for .25 square foot, exactly the amount we have left over, therefore the square root of 132.25 is exactly 11½, and we must make your tank 11½ feet in diameter and 10 feet high, to hold 7769.4 gallons of water."

"Great whizz! Oh, Mr. Hobart, is that all there is to square root? Just finding a square and then spreading thin strips around the square until you use up all the surface?"

"That's it, John. Not much to be afraid of there, is there?"

"Not on your life! And if that is all there is to square root, then I'm never going bug-house on account of it."

"That's right, John. I told you that the reason you were afraid of square root was because you thought it so hard, when really it is one of the most simple things out."

"Well, you can just write it down that I never will run away from square root again. But, say; do the books do it in the same manner that you have shown?"

"The principle is the same, John; exactly the same. And now, if you will get an arithmetic and go over the rule for finding square root and compare each step of the rule with the figures and description given above, then you will quickly understand the rule as given in the book, and you can soon work into cube root also, only then you will have to add three instead of two side pieces to the square or cube already found. But the book rules will be easy if you go after it with these pictures at hand."

"Say, Mr. Hobart, the 'Boss" is surely some foxy, isn't he? I'll bet I know now why he gave me that funny number of gallons to make a tank for—'7769.4.' I just believe the 'Old Man' did it to try me out. He knew that the number of gallons would just fill a 11½-foot tank, and he wanted to find out if I was 'on the job' or not. Oh! But he's a foxy one, all right."

"That may be, John, but you have made good on that problem, so now just get busy and absorb square root so thoroughly that you never will forget how to work it, even if you don't have a book at hand."

Repairs to Boilers by the Electric or Oxy-Acetylene Processes

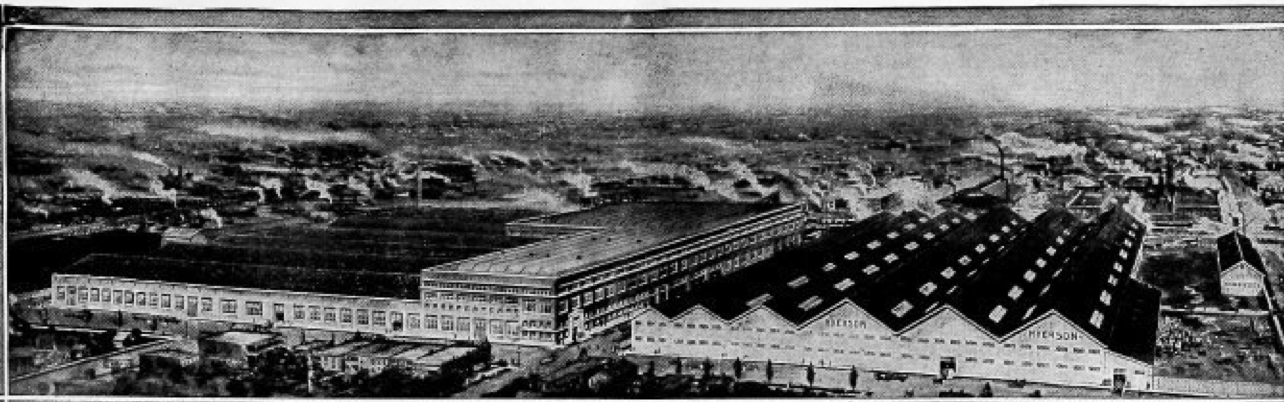
Instructions regarding the repair of boilers by autogenous welding were issued recently by the British Board of Trade to its surveyors as follows:

The repairing of the boilers of passenger steamers by the above processes has been tentatively in operation for a considerable period; and, in view of the experience gained, the surveyors are informed that, provided the work is carried out to their satisfaction by experienced workmen, these processes may be employed, within limits, for repairing cracks in furnaces, combustion chambers and end plates of boilers, and in the same parts for reinforcing the landing edges of leaky riveted seams which have become reduced by repeated chipping and calking. Repairs by the above processes to any of the parts of boilers which are wholly in tension under working conditions, such as cylindrical shell plates and stays, are not allowed.

In some old furnaces which have been repaired by the above processes, it has been found that, after a few months' working, cracks have again developed at parts adjacent to those welded, probably owing to the material of the furnace having become fatigued and worn out by long and severe usage. In dealing with old furnaces, therefore, this fact should be taken into consideration.

In any case in which the proposed repairs to the boilers of passenger vessels by either of the above processes are of an uncommon or unusually extensive character, the particulars should be submitted for the Board's consideration and approval.

After repairs by welding have been completed, the parts at or adjacent to the welds should in all cases be hammer-tested; and a hydraulic test of not less than one-and-a-half times the working pressure should, as a rule, be applied to the boiler after the hammer testing has been effected.



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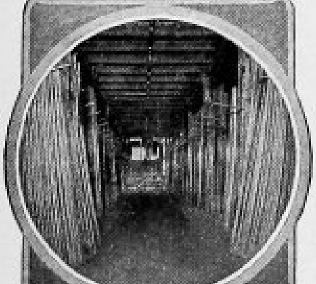
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BARS
Bars, Bands, Hoops, Twisted and Cold Drawn.

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RIVETS AND BOLTS
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Ryerson Flue Cleaning Machines, Otto Flue Cleaning Machines, Ryerson Combination Hot Saw and Tube Expander, McGrath Safe-End Machine, Hartz Super-heater and Tube-Welding Machine, Ryerson Pneumatic Flue Welding Machine, Ryerson Flue Cutter, Mathews Combination Tube Cutting and Cleaning Machine, Expanders, Forges, etc.

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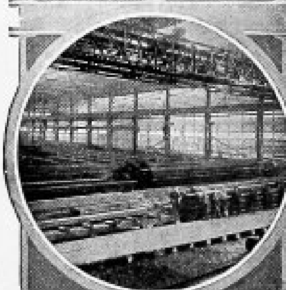
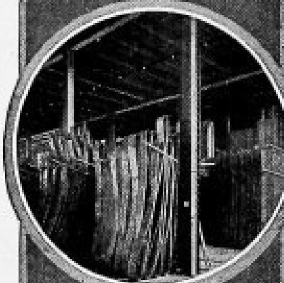

Structural Shapes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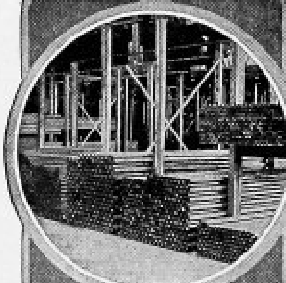
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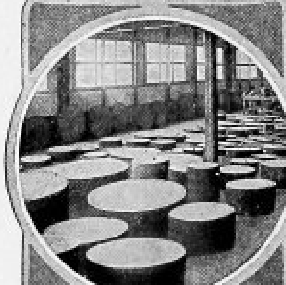
Boiler Heads

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Defects of Design and Workmanship of Locomotive Boilers

In an interesting article on "Locomotive Construction," published in recent issues of *The Railway and Engineering Review*, some important points are brought out regarding the common defects found by experience in the design and workmanship of locomotive boilers. In order that boiler makers can profit by these disclosures the following excerpt from this article is reprinted:

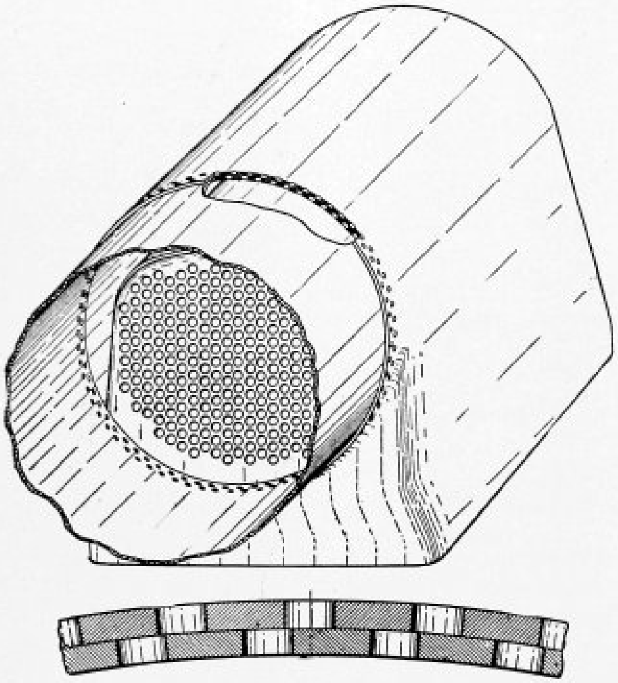
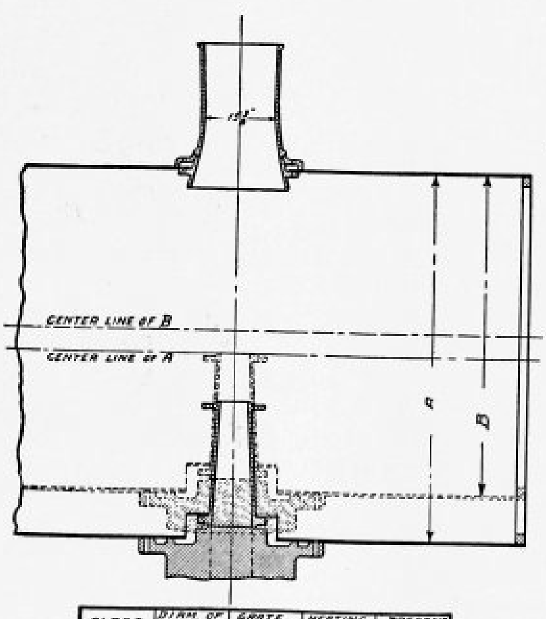


FIG. 1.—LACK OF STANDARDIZATION IN LAYING OUT RIVET HOLES

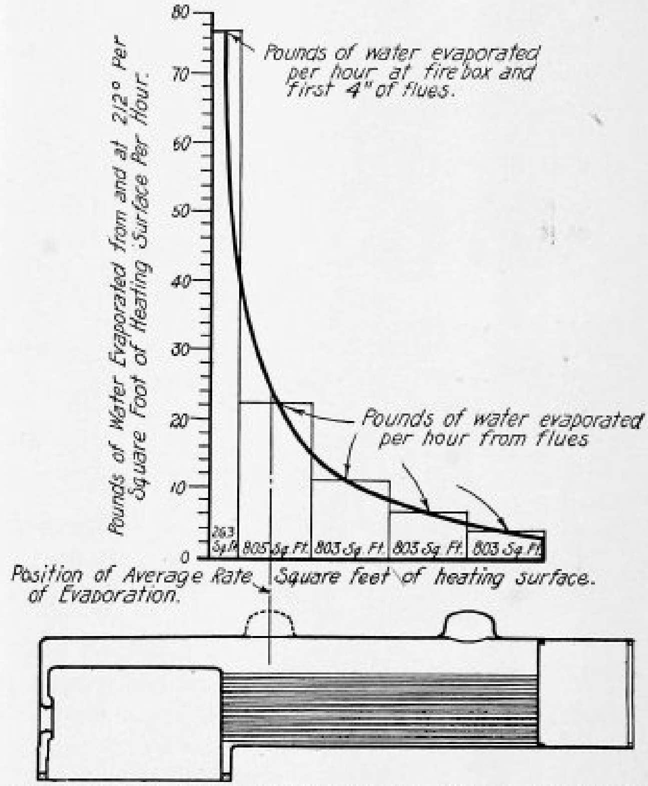


CLASS	DIAM. OF BOILER	GRATE SURFACE	HEATING SURFACE	PRESENT STACK DIAM.
A	80"	58.5 Sq.Ft.	5390 Sq.Ft.	15¼"
B	69"	47.2 Sq.Ft.	2626 Sq.Ft.	15¼"

FIG. 2.—IDENTICAL NOZZLES AND STACKS ON BOILERS OF DIFFERENT SIZES

MAINTENANCE COST

The cost of maintenance is a most important point on the part of the railway company and is often lost sight of by the locomotive builders. All parts, in so far as possible, should be to a common standard and absolutely interchangeable. At least it should be possible to take off an important part from one locomotive and expect it to fit another locomotive of the same class built at the same time. But this is seldom the case. One very conspicuous example of this was brought to attention when it became necessary to renew the fireboxes on a consignment of some 140 locomotives on a large railroad. Owing to a large number needing fireboxes at practically the same time it was deemed advisable, in order to save time in the shop, to build an entirely new firebox, including the wrapper sheet, which could be quickly applied to the old boiler. This was found to be absolutely impossible, as it was discovered that the rivet holes were not spaced at the same pitch in any two boilers, and that the holes in the firebox sheet and back or dome course would not match up by from ½ inch to 1½ inches. See Fig. 1. Therefore, it is and always will be necessary to hold each locomotive in the shop about two weeks longer when applying a new firebox than would have been the case had the locomotive builders laid out the boilers to one common standard.



Heating Surface - Firebox 202 Sq.Ft. Flues 3275 Sq.Ft. 16 lbs. of Water Evaporated from and at 212° Per Sq.Ft. of Heating Surface Per Hour.

FIG. 3.—DIAGRAM ILLUSTRATING IMPROPER LOCATION OF STEAM DOME

Curve shows relative rate of evaporation in firebox and flue sections of boiler. The steam dome should be so located that steam would come in equal amounts from either direction and should be placed in position shown by the dotted lines.

Exhaust Nozzles and Smoke-Stacks

The tests of smoke-stacks made by Prof. Goss at Purdue University several years ago for the American Railway Master Mechanics' Association and the *American Engineer* resulted in a formula for determining the proper size of smoke-stack for a given locomotive. This formula has been used on several railroads with perfect satisfaction, and has indicated that smoke-stacks are generally made too small in diameter. However, some of the largest locomotive works have never used it when the design of locomotives has been left to them. One particular locomotive company believes in standardizing (?) smoke-stacks after its own idea, as a stack of the same diameter is put on all engines regardless of the size of boiler or engine. A composite illustration of this is given in Fig. 2. This shows two locomotives, one with 2,626 square feet of heating surface and smoke-box 69 inches diameter, and the other with 5,390 square feet of heating surface and smoke-box 80 inches diameter, with exactly the same exhaust nozzle and smoke-stack.

Location of Steam Dome

A certain consignment of Mallet locomotives gave most unsatisfactory results on account of water being carried over in the steam by what is technically known as priming. A study of the cause developed the fact that the locomotive builders had placed the steam dome near the front flue sheet, 15 feet 6 inches ahead of the back flue sheet, at the same time allowing a minimum of steam space. This is clearly illustrated in Fig. 3.

The curve above the boiler represents the pounds of water evaporated per square foot of heating surface per hour. In the firebox this amounts to 77 pounds, while in the section representing the front one-fourth of the flues the evaporation is less than 5 pounds per square foot of heating surface. The steam dome on these locomotives is located at a point immediately over the center of the front half of the flues, and as only 15 percent of the steam is generated from the front half of the flues a great volume of steam has to rush over the surface of the water from the firebox end to the dome. The effect of the rapidly-moving steam on the surface of the water is to sweep the water with it and carry it into the dry pipe.

The steam dome should be so located that the steam would come in equal amounts from either direction, front and rear, thus minimizing the sweeping action on the surface of the water. The dome of this particular class of locomotive was moved back, as shown by the dotted line on the illustration, and no further priming has been experienced.

In the locomotive tests made at the St. Louis World's Fair in 1904, the Hanover (German) locomotive showed the highest quality of steam at the dome of any of those tested. This boiler had a very large steam space and dome. The steam space with water level at the second gage cock amounted to 23.7 percent of the boiler volume, while on the American locomotive above referred to the steam space was but 10.1 percent of the total boiler volume. The Pennsylvania Railroad report for the performance of this (German) locomotive says: "The quality of steam in the steam dome (before entering superheater) was obtained by means of a throttling calorimeter, and it is of interest to note that it was exceptionally high, the moisture was much higher, and as a rule increased as the rate of evaporation increased. In some cases the moisture amounted to 4 or 5 percent.

The 1914 Convention of the Master Boiler Makers' Association.—At a meeting of the executive board of the Master Boiler Makers' Association, held in Chicago, Ill., Sept. 27, it was decided to hold the next annual convention of the association in Philadelphia, Pa., May 22, 23, 24 and 25, 1914.

Superheater Tools and their Care*

BY FRED. PETERSON†

In regard to the Colorado & Southern engines, we have what is known as the Emerson superheater in our engines, which consists of twenty-four flues 5½ inches in diameter. These flues are swaged to 4½ inches, 18 inches from the back flue sheet, and the 1¼-inch superheater pipes run from the steam pipes back to within 18 inches of the back flue sheet.

When we first received these engines we experienced some trouble in keeping those flues tight, our chief trouble being at the front end. After looking into this matter very closely we discovered that the flues were not beaded at the front flue sheet, and this was the cause of some of the leaks. This was a hard matter to overcome without taking out the steam pipes and superheater tubes; but being compelled to do so we turned the flues over, beaded and expanded them and our trouble was relieved. Later on we found that instead of removing the steam pipes to get those tubes out, we sawed the superheater tubes off and then pulled them out, thereby causing us to put a coupling between the steam pipe and the tubes, so this makes it easier for us to remove the superheater pipes inside the large tubes.

We found, again, that the feed pipe or checks in the boilers were close to the front flue sheet, and the water striking the 4½-inch superheater tubes seemed to cause them to leak at different times. While this leak used to take up once in a while, and also leak very badly at times, it did not seem to have much effect on the steaming qualities of the engine. Not nearly so much as in the other common engines where a steam pipe or leak would exist. We found, however, that it would be better to have the check placed back further—30 or 36 inches from the front flue sheet—so the change and temperature of the water would not have such effect on the large superheater tubes.

In putting in those tubes we swage the firebox end to fit a No. 30 copper ferrule. We roll them with a Standard Boss Roller, with five rolls in, and then after turning over we expand them with a sectional leaf expander, and the flue is worked practically the same as the standard 2-inch flues in our other locomotives. We find that in using these rollers it is not necessary, after the engine has been in service for some time, to roll those flues very hard, and merely the weight of the rollers will make the flue tight and give better results than heavy rolling. The front end is also rolled, and we also use a prosser or sectional leaf expander after the flue has been turned over. By this means we seem to have no trouble in keeping those flues tight.

After removing the flues the first time we have welded on the large end of the flue. This weld is made by the O'Neill Rapid Tube Welding Machine. The flue is scarfed and also the piece is scarfed, then put together and welded, and a very nice job is made of the same, as the O'Neill Rapid Flue Welder is a special tool designed for welding large tubes and will weld from 2 to 6 inches. This machine we are now running by a 3-horsepower electric motor, and is doing the very finest work on our large superheater tubes, and we consider it far superior to any other machine known for this purpose, as there is no danger of the flue turning when it is put into the machine for welding. The piece that we weld is generally from 10 to 12 inches long, and the scarf that is made by this machine is superior to any that can be made in a lathe or in any other machine, therefore assures a fine and nice, neat weld.

Our flue-cutting machine is also run by an electric motor, where the flue is trimmed to its right length. Therefore we

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* Report presented at the fifth annual convention of the American Railway Tool Foremen's Association, July, 1913.

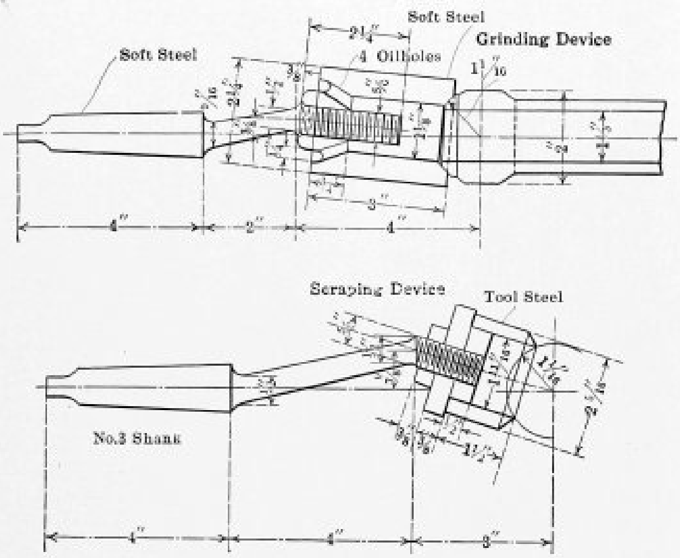
† Connected with the Colorado & Southern Railway, Denver, Col.

think we are very well equipped for handling superheater tubes of the Colorado & Southern shops at Denver.

Report by A. R. Davis*

The tools used to install and maintain the superheaters of the engines of this type are to be divided into two classes—the tools for the tubes and tools for the header and other accessories.

In the header are many brass ball joints for the pipes in the tubes, which must make a tight joint. To maintain these joints they should be a true radius, as it is impossible to bend the pipes so that any but a true radius joint can be depended upon. The tools shown in the sketch were made as recommended by the superheater company, and will produce a true radius,



TOOLS RECOMMENDED BY THE SUPERHEATER COMPANY FOR MAINTAINING HEADER JOINTS

as desired for repairs. These tools may be used with an air motor or under the drill press.

Thin socket wrenches of three lengths will be found most convenient to tighten the header pipe joints.

We have made no special tools for the damper control valves so far, and any tools necessary will be of the type regularly used on air-brake equipment work.

The various designs of oil spreaders in the steam passage require reamers of the design as regularly used in brass department on general work.

We have made but one set of new tube sheets for the superheater tubes, and had good results from the type of pilot cutter regularly used on bridge work for large pin holes where the requirements are much closer. The pilot cutter is made with a 1¼-inch pilot of tool steel, fitted in a machine steel body with a No. 6 Morse shank. There are three cutting tools of high-speed steel, ⅝-inch square stock, the tools set with 1/32-inch lead in length and 1/16-inch lead in width. The lead tool ground as a round-nose lathe tool with rake.

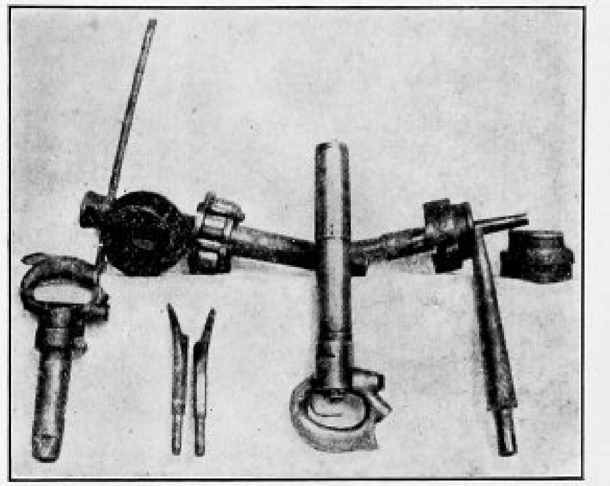
As yet we have not had to enlarge any tube holes to allow tubes that are badly scaled to be removed from the boiler, but in anticipation of this I have made a reamer to enlarge the hole ¼ inch, a bushing to be applied when tubes are replaced.

The reamer is made with soft steel body, No. 5 Morse shank, with high-speed steel blades, eight in number. The pilot acts as a binding plate for the blades, being fastened by six ⅜-inch cap screws. The blades enter the work at an angle of 30 degrees.

In handling the tube work the tools are similar to the regular tools for flue work. We have no special tool for cutting the tube loose from the sheet.

After tubes are removed they are cut off and scarfed in the turret lathe. The safe ends are scarfed to suit, and when the tube is heated and the safe end driven in there is about ⅛ inch overlap, which gives plenty of stock for welding, which is done on a large Draper pneumatic welding machine, with good results. The tubes are swaged as usually done on the regular flues, the amount left for the bead being the same. They are cut to length in the turret lathe.

In applying, the tubes are rolled, prossered and beaded at both ends. The tools for these operations are the same as for flue work, except the tools being of larger size to suit the diameter of the tube.



TOOLS USED TO APPLY SUPERHEATER TUBES

The beading tools have the radius in the throat increased from 3/16 inch to ¼ inch and 1/32 inch deeper in the throat.

We have not had enough experience in handling the superheater tubes for me to state what the expense is apt to be in maintaining the tools for this class of work, but from present indications I do not believe that it will be any heavier in proportion than the regular flue-working tools.

One tool the tool foreman will not have to contend with for this work is the electric welding apparatus which is being generally used for the firebox end of the tubes.

* From Central of Georgia Railway, Macon, Ga.

Welding of Steam Boilers

In the June issue of the *Journal of the American Society of Mechanical Engineers* an abstract is given of an article by H. Jaeger on Die Schweissung von Dampfkesseln, published in the *Zeitschrift für Dampfkessel und Maschinenbetrieb*. The abstract is as follows:

In 1912 in Prussia occurred three serious explosions of watertube boilers with headers which have attracted attention to the question as to the safety of this type of boilers generally and welded seams in boilers in particular.

In the first case, in the central station of the Phœnix Company in Lierenfeld, exploded a boiler built by the Borsig Company in 1910, 4,408 square feet heating surface and 15 atmospheres working pressure; the immediate cause of the accident being rupture of the flanged plate in the lower part of the header, 19.9 feet wide and 10 inches deep.

The second explosion occurred in the rolling mill of the Menden & Schwerte Steel Works, with a new (built in 1911) Piedboeuf boiler, having a header 11.7 feet wide by 11.8 inches deep, the immediate cause of the explosion being the loosening of the welded seam of the header plate, which sprung open up to the corners.

In the third explosion at the rolling mill Deutscher Kaiser in Dinslaken, a wall of the rear header became loose at the welded seam and rolled up to the second row of staybolts. The boiler was built in 1897 for a working pressure of 12 atmosphere, and was heated by exhaust gases.

In all three cases the explosions were quite violent, the boilers being thrown at 165, 190 and 20 feet, respectively, and investigation showed that there were other causes besides possible weakness of the welded seam, which in themselves might have been sufficient to account for the explosion. Thus in the Borsig boiler explosion it was found that the lower welded seam of the header was exposed to the direct action of the heating gases owing to insufficient protection by the boiler setting, which had been defective for some time. In addition, boiler scale was washed out from the tubes into the front header, where it caused imperfect cooling of the lower welded seam. Similar conditions have been found in the Menden-Schwerte explosion, while in the Dinslaken accident it was

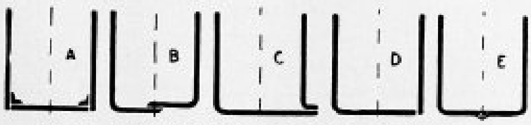


FIG. 1.—VARIOUS METHODS OF BOILER SEAM WELDING

found that the lower row of staybolts was unusually far from the welded seam (8.9 inches), and in that row six staybolts were broken and several more cracks. Nevertheless, both the Prussian Government and the manufacturers have organized a series of tests to determine the strength of welded seams generally, as well as to answer the particular question as to the design of this type of boiler arising from the data given by these accidents.

The Piedboeuf Company has made a series of tests with butt welded seams, and found that rupture occurred only at stresses many times exceeding those to which the seam would be subjected in boiler operation. The fracture showed a brilliant metal surface, colored here and there by oxidized iron slags, the same as the surface of fracture of the exploded boiler. Since all possible care was exercised in the preparation of the tests seams and the welded pieces were sufficiently warm, it appears that with the present methods of work enclosure of oxidized slags cannot be prevented; and with thick sheets, such as are used in watertube boilers, the specific pressure of the two welded surfaces against each other cannot be made large enough by hammering to force out from the joint the slags formed by the oxidizing welding flame.

The following questions have also been investigated:

(1) *The advisability of limiting the width and depth of headers, the former when there are two upper drums.* The use of two aggregates side by side would be about as economical in operation as one with two upper drums, while the handling of excessively large headers would be avoided; on the other hand, with the present hoisting apparatus, the latter does not present any serious difficulties, while two units would be more expensive than one, and the total length of welded joints would be longer in the first case than in the second; there is therefore no reason for recommending a limitation of the width of headers.

(2) The advisability of looking for a header design, avoiding the use of butt welding entirely, or at least eliminating the lower welded seams of the headers lying towards the fire side. The following types were considered: (*a*) Return to the riveting of the headers, either by connecting the side plate with the straight walls by means of angle irons (Fig 1A), or (Fig. 1B), as in the Willmann boiler, by riveting together the front and rear walls, provided for this purpose with broad flanges, so that the rivet joint lies in the middle of the flanges serving as side plate; (*b*) by flanging both walls and making an external riveted seam (Fig. 1C); (*c*) by flanging the firewall and butt welding to it the outer wall (Fig. 1D); (*d*) by flanging both walls and autogenously welding them in the middle, as shown in Fig. 1E. The design shown in Fig. 1A is not advisable, because it does not ensure complete safety of operation, and the row of rivets on the fire side forms a weak place in the boiler. The same applies to the design of Fig. 1B. A seam such as shown in Fig 1C would be very expensive to make on account of the tall flanges of the inner walls, and in addition is not absolutely safe as to tightness, on account of there being only a single calking edge. Some factories now contemplate the adoption of the design shown in Fig. 1D, which has the advantage of not having the dangerous inner welding seam.

(3) All experts agreed that the staybolts should be placed as near as possible to the welded joint and not further than 3 inches from the wall. As to the advisability of reinforcing the staybolts and drilling their ends, opinions differ, but it appears advisable to do so, since in the Dinslaken boiler explosion it was found that six staybolts of the lower row had broken before the explosion, while several more started to crack.

(4) The proposal to test the headers at a pressure double that of the operating did not meet with favor; considerably higher stresses are required to rupture the welded seam, so that such a test would not really show much, and it is difficult to make (difficult to make the header watertight), and the high-pressure may start cracks in the header. The advisability of hammering up the seam with heavy hammers during the pressure tests was universally recognized, as well as the possibility of injuring the seam by the use of too heavy hammers (sledges). Tests will be made to determine this point.

(5) The author considers the annealing of the headers after the execution of welding work, even though the boring of holes and opening in the header relieves the metal to a certain extent from the stresses created by the welding process; this is not complete and a certain amount of stresses remains; when annealed some of the weaker places open up, while others can be recognized by the coloration of the metal sheet when cooled.

Steam Boiler Efficiency and the Most Economical Method for Absorbing Heat from Gases of Combustion

The cost of generating steam consists of two main elements, one the expense for fuel and the other the expense for interest, depreciation, labor and other fixed charges upon the boiler, boiler setting, grate, draft apparatus and fittings. If the amount of boiler surface employed to develop a boiler horsepower, that is to evaporate 30 pounds of steam per hour, be increased, the amount of heat recovered from each pound of fuel will, within the limits of ordinary operation, also increase. That is, more heat will be absorbed, and the gases will be discharged to the stack and to atmosphere at a lower temperature.

At the same time, however, that the cost of steam is being reduced by increasing the efficiency of heat absorption, the element of cost due to the fixed charges on the boiler and its appurtenances is rising. The rate at which heat is absorbed by any element of the boiler surface depends directly upon the difference between the temperature of the contents of the boiler and the temperature of the gases of combustion in contact with that part of the boiler. If the amount of heat absorbed by that particular part of the boiler is worth more than the fixed charges corresponding, that particular element of heating surface is paying for itself, but as the temperature of the gases falls and approaches the temperature of the steam and water within the boiler, a point must soon be reached where the heat absorbed will no longer pay the fixed charges upon additional boiler surface.

Just where this limit is will, of course, depend upon the price of fuel, the charges upon boiler surface and the proportion of the whole time that the boiler surface is being used. For plants operating ten hours per day, 300 days per year, and using $3.00 coal, the limit is reached when the gases are reduced to a temperature 285 degrees F. above the temperature of the steam.

If we assume steam at 150 pounds pressure gage, which corresponds to a temperature of 366 degrees F., it will be seen that the lowest temperature to which it will pay to reduce the flue gases under the above conditions is 650 degrees F., showing that it will not pay to put in more than 4 or 5 square feet of boiler heating surface per boiler horsepower developed.

However, as is at once apparent, considerable heat would be wasted under these conditions. If we assume a coal containing 14,000 British thermal units per pound, burned with 26 pounds of air per pound of coal, and the boiler room temperature at 70 degrees F., the temperature in the fire will be about 2,230 degrees F., and if the same gases of combustion are discharged at 650 degrees, approximately 27 percent of the total heat of the fuel will be lost in the chimney gases.

If there were no body colder than the water and steam within the boiler by which the heat from these gases might be taken up, this loss would be inevitable, but, fortunately, there is a use for this heat, viz., in warming up the cold water which is to be fed to the boiler. This water may have an initial temperature of anywhere from 50 degrees or 60 degrees F., in case the water is taken from a well or stream, up to 200 degrees or 210 degrees F., in the case of returns from heating and drying coils or water heated in an exhaust steam-feed water heater. Taking water at 200 degrees F., for instance, it will be seen that between such water and flue gases at a temperature of 650 degrees F. there is a difference of 450 degrees F., under which conditions the provision of additional heating surface would again become profitable.

If the water, however, be sent directly into the boiler it is at once heated up to the boiler temperature by the steam and water already there, and has no opportunity to perform the service of absorbing heat economically from gases of combustion. The remedy, obviously, is to divide the process of steam generation into two parts, one of which consists of heating the water up to the boiling point, and the other the evaporation of boiling of the water; that is, to apply the counter-current principle, which has proved most economical in heat transferring apparatus of all kinds.

The apparatus in which the feed water is heated is ordinarily called an economizer, and the boiler and economizer become in effect a counter-current apparatus for the transfer of heat from hot gases of combustion to water which is to be turned into steam. The economizer costs somewhat less than the boiler per square foot of heating surface, and the temperature difference at which it ceases to be profitable is therefore lower.

As an example, suppose that fuel costs $3.00 per ton, and the plant is operated 300 days per year and ten hours per day. The lowest economical temperature difference is about 110 degrees F. If the initial temperature of the water entering the economizer is 200 degrees, as just assumed, this will give as a final temperature to the flue gases 310 degrees F., which is still hot enough to produce sufficient draft with a good chimney.

Assuming that the boiler is operated at 200 pounds gage pressure, giving a steam temperature of 388 degrees F., if 6 to 7 feet of boiler surface be installed, as is usual in recent practice, the gases will leave the boiler at 550 degrees F., and if the water enter the economizer at 110 degrees F., as from the hot well of a surface condenser, 3 to 3½ square feet of economizer surface will suffice to heat it to 290 degrees F. at the point where it enters the boiler, saving 14.6 percent of fuel. It would be possible, however, to curtail the boiler surface to between 4 and 5 square feet per boiler horsepower, leaving the gases at 700 degrees F. at the point where they leave the boiler and enter the economizer, and with these hot gases 6 or 7 square feet of economizer surface would suffice to give the same final gas temperature as before, and maintaining the same efficiency of heat absorption. In other words, approximately 1 square foot of economizer surface would replace 2 square feet of boiler surface without impairing economy, and since economizer surface is cheaper than boiler surface per square foot, this change would result in a considerable over-all saving in fixed charges.

In the design of large steam power plants, such as central stations for electric light and power in the large cities, power stations for electric traction systems, etc., this principle has been recognized and is being applied; that is, the boiler surface is being considerably curtailed, while the efficiency of heat absorption is maintained or even improved by substituting the cheaper and more effective economizer surface.

In addition, there are other causes leading to the increased adoption of economizers. For one thing, there is a tendency towards higher and higher pressures, 200 pounds per square inch being not uncommon in steam turbine plants. As will be evident from the preceding arguments, any increase in the steam pressure, with accompanying increase in the boiler temperature, renders boiler surface correspondingly less efficient in the absorption of heat from the gases of combustion, since it reduces the available heat "head" causing the flow of heat from the gases to the water or steam. This leaves a greater duty to be performed by the economizer, and makes the latter correspondingly more profitable.

Another factor working in favor of the economizer is the greater efficiency obtainable from auxiliary apparatus, such as boiler feed pumps, circulating pumps, fan engines, stoker engines, etc. The less the steam consumed by these appliances, the less exhaust there is available to heat the feed water in exhaust heaters, so that instead of obtaining 200 degrees, or even 210 degrees F., with some exhaust to waste, it is not uncommon to find plants in which there is difficulty in maintaining a temperature of 160 degrees F. in the water leaving the heater. Naturally the colder the water entering the economizer the greater will be the activity of the surface in transmitting heat from the gases.

Another factor of special importance in many plants is the large heat and water storage capacity of the economizer, giving it the ability to deliver large quantities of hot water in a short time, as when water is drawn from the boilers for filling dye or wash tubs, or when excessive drafts are made for steam for any purpose. While in the latter case the economizer does not supply the steam directly, it assists the boiler surface by supplying to it water upon which part of the work of steam making has already been performed, reducing thereby the proportion of work which must be performed by the boiler in transmitting heat to the water.

The fuel saving to be expected from the installation of economizers may be estimated roughly at the rate of 1 percent for each 10 degrees F. through which the water is raised in temperature; or, in the average plant, 1 percent for each 20 degrees F., by which the temperature of the flue gases is reduced.

The Boiler Maker

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STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC., of THE BOILER MAKER, published monthly at New York, N. Y., required by the Act of August 24, 1912.

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H. L. ALDRICH.

Sworn to and subscribed before me this 13th day of September, 1913.
(Seal) O. M. PICKRUHL,
Notary Public.
(My commission expires March 30, 1915.)

What effect the revised tariff bill, which has now become a law, and which will be in force within a month, will have on the boiler making industry is difficult to predict. In general, the new tariff provides for a reduction on such materials as boiler plate, rivets, tubes and structural shapes, which eventually will probably mean some reduction in the price of boiler materials. This, however, is a matter which affects the consumer rather than the boiler maker. The most important effect upon the boiler making industry will be the effect of the tariff bill on manufacturing in general as well as upon transportation. It will be recalled that at the Boiler Manufacturers' convention a year ago, a vigorous protest was made against the placing of sugar on the free list, as it would have a disastrous effect on a well-established business in the Southern States in which steam boilers play a very important part. A tariff which forces manufacturers to seek other countries for the production of their goods will be detrimental to the boiler making industry, but a tariff which tends to increase imports and exports will have a corresponding beneficial effect on the manufacture of marine and locomotive boilers. It is probable that the conditions will be speedily adjusted to the new requirements of the tariff bill and that the changes will not be important.

How the cost of production was reduced fourteen percent and the gross earnings increased twenty-nine percent in a medium sized, well equipped boiler shop by the adoption of basic efficiency methods is told in a serial article beginning in this issue. Contrary to the general impression that in order to reduce costs and increase earnings it is necessary to make extensive changes in the equipment of the shop, or to cut down the working forces and speed up the remainder beyond normal capacity, it should be noted that in this case satisfactory results were obtained with the addition of only a single machine tool and a system of industrial tracks to aid in the movement of material, which entailed only a limited outlay, while the increased output of the shop was due principally to the increase of efficiency throughout the plant. The object sought was to obtain the maximum efficiency of whatever equipment was available at the start, by reorganization of the operating forces so that they would conform to certain well established principles of management. Some benefits along this line can be obtained by almost every boiler manufacturer if the work of reorganization is undertaken with the assistance of constructive advice from an outside source which will bring the necessary experience and training for such work to avoid the evils of over-equipment and the application of haphazard plans which would result only in false economies. The procedure as outlined in the article referred to consisted, first of a preliminary investigation for securing information and data regarding the methods originally employed in the shop and the relative capacities of the various departments after which the existing force was reorganized by the development of staff and line divisions, the function of the staff being to plan the work in advance of the line and the function of the line being to execute the work in accordance with the plans developed by the staff. By so doing congestion and delays were avoided, the estimates were accurate, the work promptly executed, the labor was better paid, the earnings increased and the indirect costs reduced, all of which was accomplished without working any permanent injury to the business. With such achievements in view the subject of shop efficiency should be given careful consideration in every case regardless of the size of the plant or the character of its product.

Engineering Specialties for Boiler Making

Hervey Reversible Rotary Stocker

Figs. 1, 2 and 3 show a new type of mechanical stoker patented by D. F. Hervey, Logansport, Ind. The photographs, Figs. 1 and 2, show the method of attaching the stoker to the furnace or firebox, while the drawing, Fig. 3, shows its application to a representative type of locomotive boiler in connection with a Crawford coal conveyor. In this installation the coal is brought from the tender to the firebox door by means of the Crawford conveyor, where the Hervey stoker, which is constructed like a fan, distributes or scatters the coal to all parts of the firebox. Proper distribution of the fuel from this stoker is accomplished by the speed of the distributing member and the manner or direction in which it is rotated. The simplicity of construction and the adaptability of this stoker to the ordinary types of furnaces are apparent from the illustration. In Fig. 1 the stoker is in position for operation, while in Fig. 2 the stoker is swung away from the firebox door so that the grates can be fired by hand if necessary.

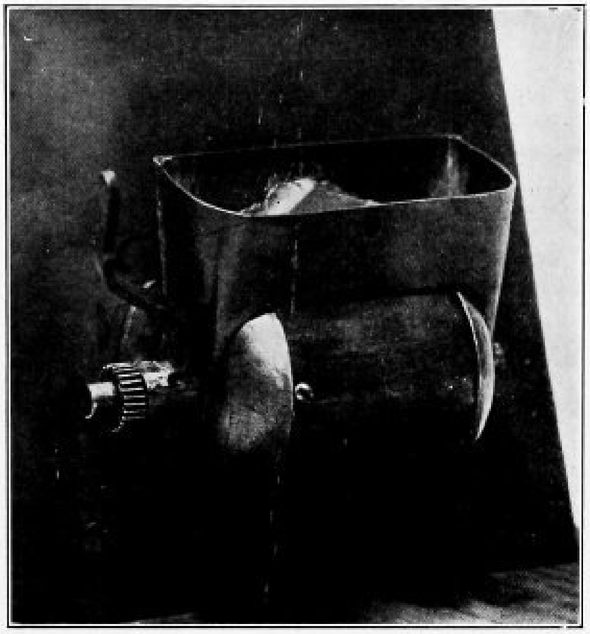


FIG. 1

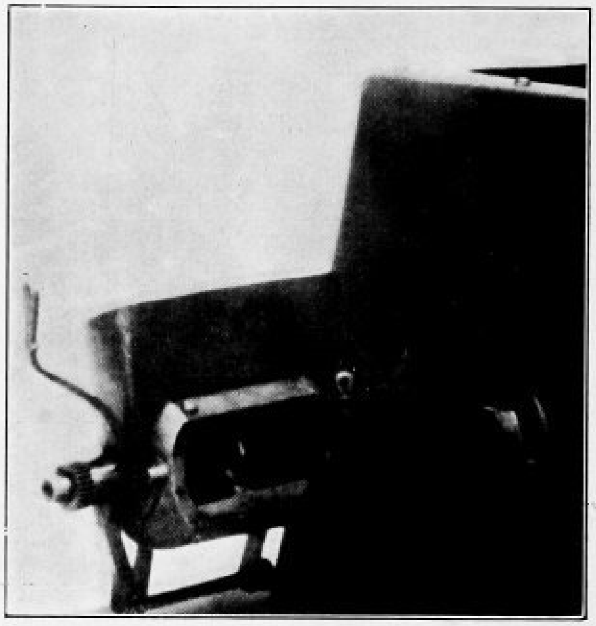


FIG. 2

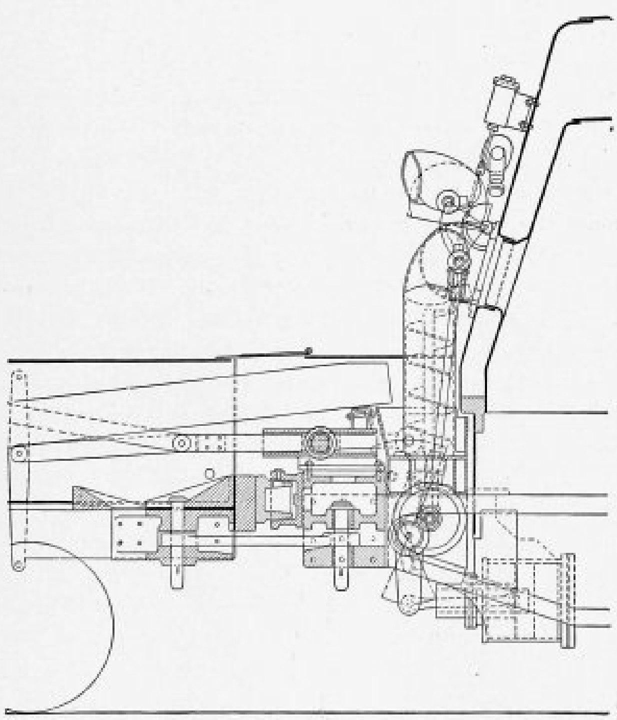


FIG. 3

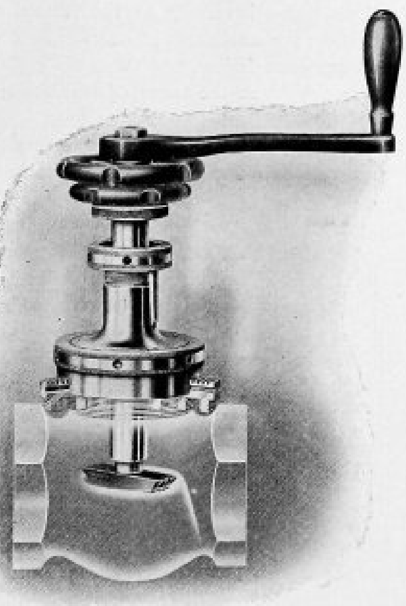
Ruins Removed by Oxy-Acetylene Apparatus

Early in January of this year the Carnegie Steel Company's plant in Baltimore, Md., was completely destroyed by fire, leaving a huge mass of buckled iron and steel twisted into every imaginable shape. Apparently it would require several months before this tangled mass of iron and steel could be cleared away, but by installing an oxy-acetylene welding and cutting plant the twisted mass of iron and steel was cut into

short, movable lengths, so that it could be hauled away in a remarkably short time. The plant installed for this work, supplied by the Alexander Milburn Company, Baltimore, Md., was mounted on a truck and moved from place to place as the work required. Fifty-foot lengths of hose were used, which gave a fairly long range of work. The work progressed without trouble or mishap, and one operator and helper, with a single torch, were able to cut up the iron into movable lengths faster than a force of five men could load it on rail trucks and take it away.

The Improved Dexter Valve Reseating Machine

The improved Dexter valve reseating machine (Williams' patent), manufactured by the Leavitt Machine Company, Orange, Mass., is the result of many years' experience on the part of the manufacturers in specializing on tools for repairing valves. The model of the machine shown in the illustration is made in two sizes for reseating all flat and taper-seated valves, from ¼ to 3 inches and from ¼ to 4 inches. These machines, it is claimed, are positive in operation, as they true up a worn valve seat and its disk exactly alike, making a perfectly tight seat for water or steam. The illustration shows the machine attached to a globe valve with a taper cutter at work on the valve seat. An improvement in the jaws provides for securely attaching the machine to valves that have threads



on the outside of the body as well as for attaching to valves that are threaded on the inside and also for flanged cap valves.

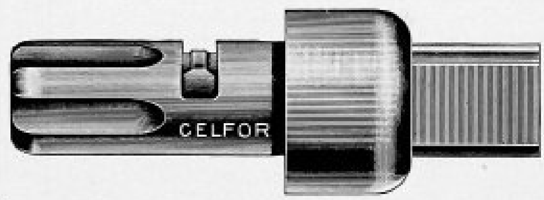
The operation of the machine is a simple matter. Its jaws are quickly adjusted to the valve casing by merely rotating the scroll of the chuck. This centers the machine and the tool spindle is placed in perfect alinement. A few turns of the handle and the seat is accurately recut, the entire job occupying only a few minutes. After the operation is finished, it is claimed, the valve is as good as new, and the same valve can be reseated from ten to twenty times, thus saving the cost of a new valve each time, and giving an opportunity to reclaim valves which have been consigned to the junk heap.

Some features of construction of this machine are distinct improvements. The bearing sleeve, which holds the tool spindle, extends through the chuck and is threaded on the inside of its upper end. These threads engage with the threads of the feed screw on the tool spindle. The bearing sleeve with the tool spindle slides through the chuck, and is instantly lowered to or raised from the valve seat, and is held in position by rotating the large nut shown on the body of the machine. The bearing sleeve supports the tool spindle practically its entire length, which not only strengthens the tool shaft but keeps it in perfect alinement regardless of the strain upon it, thus adding greatly to the life and usefulness of the machine.

The work of reseating the valve with the Dexter machine can be done by an ordinary mechanic without disconnecting the valve from the pipe line. Breaking connections and removing a valve because it leaks and putting in a new one is unnecessary and expensive, and frequently a source of trouble, for new valves may be leaky themselves. The value of this machine, therefore, for repairing leaky valves is apparent.

An Improved Flue Cutter

The Celfor Tool Company, Buchanan, Mich., has placed on the market an improved flue cutter which, it is claimed, is a distinct advance over former methods and appliances for removing flues from a boiler. The tool is made from a high grade of tool steel, and is of extremely strong proportions. A fluted reamer point is provided for removing the scale, to allow the cutter to enter the tube its full depth. Upon revolving the cutter in the right-hand direction, the cutting



tool promptly engages the tube and severs it. It is claimed that a flue can be cut out by one revolution of the cutter. The cutter is made in four sizes, and is equipped with a square shank, to which can be applied a wrench or an air motor connection.

"Thread-Tight"

"Thread-Tight," furnished by the Nathan Manufacturing Company, New York, is a comopund for making tight either screw or flanged joints on high-pressure steam, ammonia and pneumatic lines, high-service hydraulic work, acid lines, gas piping or boiler caps, manholes, etc. It is claimed by the manufacturers that neither heat nor cold will affect the compound, and that it can be put on a wet surface, such as an iron pipe submerged in water, and that it will adhere to the wet surface as firmly as if the pipe were dry. It is also claimed that "Thread-Tight" does not become hardened in the joints, thereby injuring the threads when breaking them. With "Thread-Tight" a regular rubber gasket is not required, as it is claimed the compound makes the joint absolutely tight itself.

Personal

OLIVER WEIGLE, formerly assistant foreman boiler maker for the C. G. W. R. R. at Oelwein, Ia., is now general foreman boiler maker of the Pere Marquette Railroad Company, with headquarters at Grand Rapids, Mich.

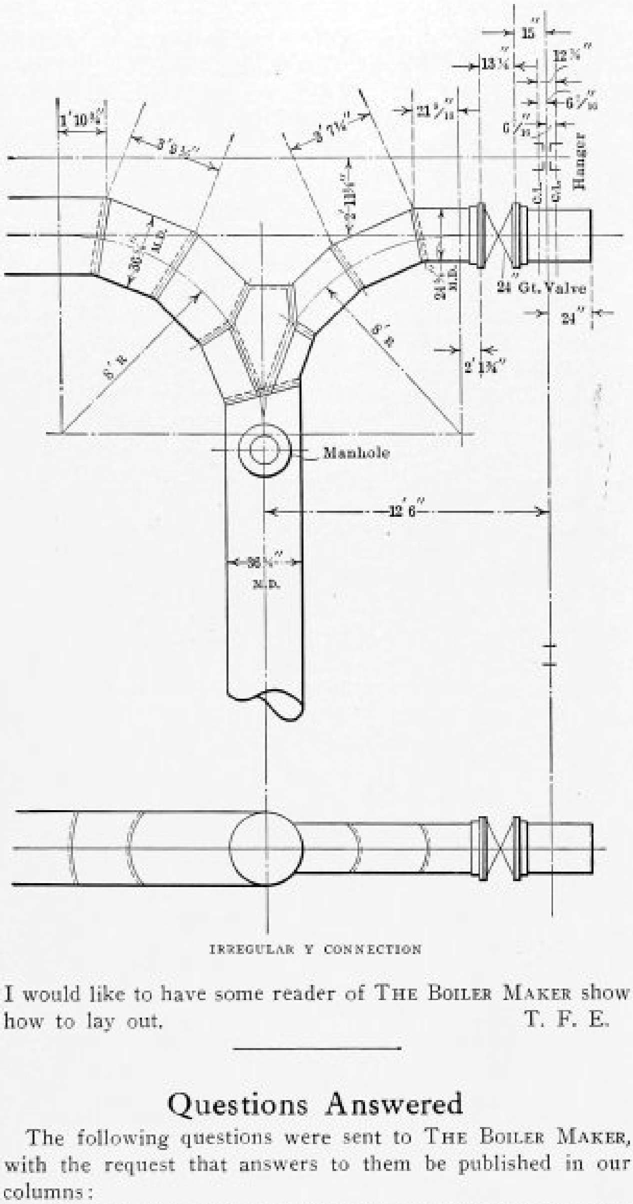
JOHN D. UTZLER, of the Bakersfield shops of the Southern Pacific Railway, Bakersfield, Cal., called at our office recently while on a seventy-five days' leave of absence from his work. Mr. Utzler is making an extensive tour of the principal cities of the East and Middle West, visiting many of the important boiler shops.

JOHN F. ENSIGN, chief inspector, Division of Locomotive Boiler Inspection, Inter-State Commerce Commission, died at his home in Washington, D. C., Sept. 24, at the age of 51. Mr. Ensign was the first man to hold the office of Chief Inspector of the Federal Locomotive Boiler Inspection Service.

Letters from Practical Boiler Makers

Layout Wanted

The accompanying drawing shows a branch pipe job which



IRREGULAR Y CONNECTION

I would like to have some reader of The Boiler Maker show how to lay out. T. F. E.

Questions Answered

The following questions were sent to The Boiler Maker, with the request that answers to them be published in our columns:

1. What do the Boards of Boiler Rules consist of and who are the publishers of the Rules?

2. Would it require a larger safety valve for 100 pounds pressure than it would for 25 pounds?

3. Why are the generating tubes in watertube boilers placed in an inclined position?

4. Why are the ends of tubes in watertube boilers flared or beaded?

5. What provision is made for the expansion and contraction of tubes in watertube boilers?

6. What two ingredients in water are the chief causes of incrustation in boilers?

7. How many heat units are there in 1 pound of carbon?

8. How would you determine the size of a steam header for a battery of boilers?

9. What is the meaning of combustion as used in steam engineering?

10. Give the bursting pressure of the tube ligament and riveted seam of a Stirling boiler, 36-inch drum, ⅜-inch shell, 9/16-inch tube sheet, ⅞-inch steel rivets, double lap seam 3-inch pitch, 3¼-inch tubes spaced 5½ inches by 6¾ inches, tensile strength 55,000 pounds per square inch.

The above questions have been examined by a well-known engineer, who gives the following answers:

1. In States where laws governing the construction and inspection of steam boilers are in force, a Board of Boiler Rules is usually appointed by the Governor, or as the law may specify, consisting of representatives from the various interests connected with the manufacture and use of steam boilers, to formulate rules covering the construction and inspection of steam boilers or other pressure vessels. All boilers used in the State have to conform to these rules. Unfortunately, the law is not the same for all States, although a movement is on foot for bringing about uniformity in State boiler laws. The rules are published by the Board and can be obtained from the chief inspector, whose office is at the State capitol.

2. A larger safety valve will be required for a pressure of 100 pounds than for 25 pounds, because the area of a safety valve varies directly as the weight of steam in pounds delivered per second and inversely as the steam pressure. At the higher pressure the steam would be generated more rapidly than in a low-pressure boiler.

3. The inclination given the tubes of watertube boilers is to facilitate circulation.

4. The flaring or beading of tubes prevents them from being drawn through the sheets as well as protecting the ends of the tubes.

5. In many small watertube boilers, say of the Thornycroft type, the tubes are bent to allow for expansion and contraction.

6. The incrustation in boilers does not come from the component parts of water, that is, oxygen and hydrogen, but from certain foreign elements or substances which are carried in suspension by the water. Such foreign elements are caused by the heat to precipitate, or, in other words, settle onto the heating surface of the boiler. Lime is the chief cause of incrustation.

7. There are no heat units in a pound of carbon as usually understood.

8. The question is not clear. The capacity of any steam header is sometimes equal to the volume of steam consumed by the engines to which the battery is supplying steam in 20 seconds.

9. Combustion is merely the phenomenon of burning. We speak of combustion under the boiler, and we simply mean the fire under the boiler.

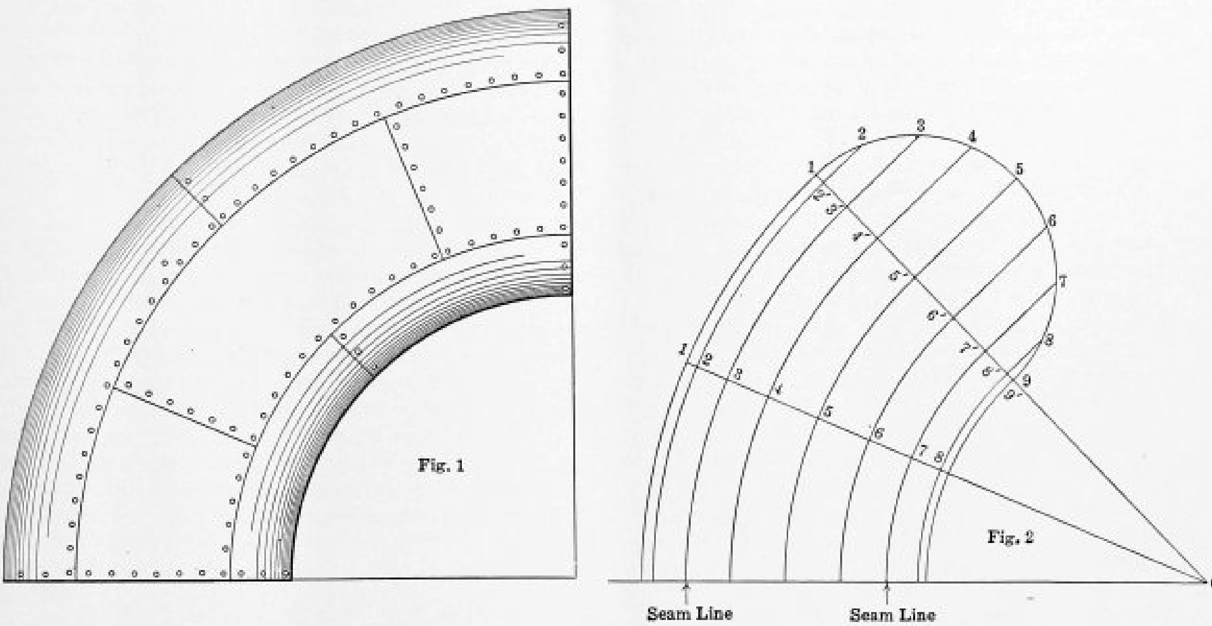
10. In order to answer this question a drawing of the boiler should be submitted.

Layout of Double Curvature Elbow

In submitting this article the writer is fully aware that it treats of a style of elbow or pipe work which is not in general use so much now as it was some years ago, but to the beginner in the art of pattern drafting it presents a rather interesting example of the conditions that have to be met in the production of sheet metal work that has to be drawn or hollowed out. At the best a fairly approximate pattern is all that can be hoped for, as only experience in shaping up this class of work can teach the worker the different allowances that will have to be made to get good results.

Fig. 1 shows the elevation of such an elbow, consisting of two back sections, two throat sections and two side sections with four half-side sections.

Draw up the half elevation and plan as shown in Fig. 2; divide the half plan into equal parts, and from the points found draw lines intersecting the top line of the elevation.



LAYOUT OF DOUBLE CURVATURE ELBOW

FIG. 3.—PATTERN FOR BACK

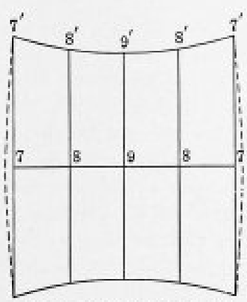


FIG. 4.—THROAT PATTERN

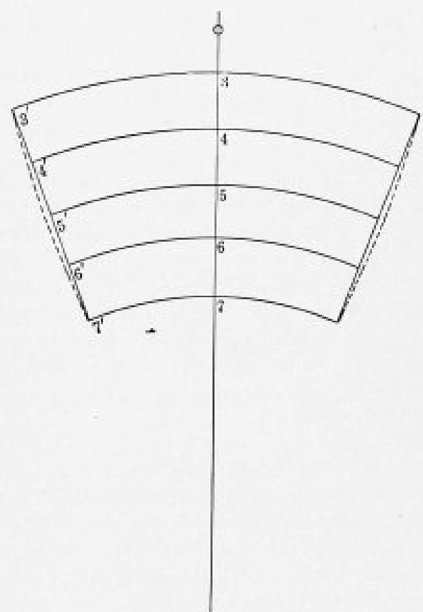


FIG. 5.—PATTERN FOR SIDE PIECES

From point *o* draw arcs through the elevation from these points. Bisect the elevation with the line *o*-8-1. To lay off the pattern for the back, set off the line *o*-*o* in Fig. 3. On each side of the center of this line set off the distances 1-2, 2-3 as found around the plan. Strike up lines and make them equal in length to the same numbered lines in the elevation, measuring around the different arcs. Connect the points found, and the pattern is complete with this exception: In working up to shape it will be found that points *o*-3, *o*-3 will shorten somewhat, so it is desirable to allow a little extra material on the sides, as shown by the dotted lines on all the patterns. The same procedure is followed in setting out the pattern for the throat.

To mark off the pattern for the side piece, draw up line *o*-*o*, Fig. 5; set the dividers to the point *o* on Fig. 2, and touching point 7 carry to Fig. 5, and strike up the radius 7-*o*. From the point 7 set off distances 7-6, 5-4, 3-2, as found around the plan; set the dividers to the point *o*, and touching these points strike off the arcs as shown, which should be made equal in length to the same numbered arcs in the elevation. Connect up these points as shown, giving an approximate pattern to the rivet lines. Where the end of one section overlaps another, this end should be made about one and one-half the thickness of the material longer, the plan and elevation being drawn to the neutral diameter of the elbow required.

Lorain, Ohio. JOSEPH SMITH.

The Brick Arch

My experience with the brick arch takes me back some thirty-five years to the London & North Western Railway shops at A———y, England. I was then just starting out in the boiler making trade, and everything interested me, and among other things the brick arch attracted my attention. At that time I was working under Dan O'B———, a big, good natured Irishman and a splendid mechanic, who thoroughly understood the use of the brick arch.

The arch as used by the London & North Western was of the built-in kind, composed of 9-inch firebrick set in fire-clay. I do not remember how long these arches lasted, but they were well taken care of, for each engine had a regular crew, and after each day's work the fire was drawn and the flues cleaned out. These arches fitted close to the flue sheet but well below the flues, so that any repairs could be made without removing the arch, which extended back about 24 inches and had no pitch, so that it was possible to clean it off without going into the firebox.

Since then I have had many years' experience with the brick arch. For nine years I handled arches in various types of locomotives, and find that when properly installed and cared for the arch is of great benefit as a protector of the flues and a fuel saver, but when not properly looked after it is an expensive addition to the locomotive firebox.

Many advocate a tight fitting arch, which no doubt would be all right if our engineers and firemen were careful men. To illustrate what I mean, take the Pacific type engine, with wide and shallow firebox, with arches resting on arch pipes fitted in between the bottom rows of flues and with a great pitch. Instal a new arch and it is but a short time (a day or so) when the top of the arch is covered with ashes, and when these engines are doubled in and out of terminals, scarcely allowing time to clean the fire; it is no surprise to us when we see the engineer's report of front end examined, arch cleaned off, and cut away from flue sheet, honeycomb cleaned off flue sheet and flues cleaned out and calked—engine won't steam; and upon examination what do we find?

Crawl into the firebox with me before the water is turned onto the arch, and you will find, as I have found many times, that the entire top of the arch, clear up to the sixth row of flues, is one mass of ashes caked there solid, cutting off the draft through the flues and causing them to leak.

What can be done in this case? Can we save the arch? It is a new one, having been in service only a few days. Hardly, for the arch must be cooled off and the accumulation of ashes on top removed, and this cannot be done without breaking the bricks. You ask what can be done to remedy this? Deepen the firebox in front, give the grate bars more slope, put in a good dump grate and use it. Keep the arch away from the flue sheet, giving room for the cleaning of the arch; this will help some, but will not remove the trouble. Instruct the engineer and fireman in the use of the arch; that it requires care and attention, and that its life depends in a measure upon the way they handle their engine.

For instance, Tom Y—— and S. C——, two engineers, had a run of 31 miles, which they covered four times daily. Tom Y's arch would last on an average five weeks, and would be completely melted away in the middle when removed. S. C's arch would be renewed every thirty days, and sometimes oftener, on account of leaking flues, and when not removed before the thirty days the arch would be double the original thickness, and the top covered, or partly so, with ashes, cinders and sometimes live coal. Now, to account for this condition, I went over the road with both men and found the following:

Tom Y—— started out with two solid gages of water, putting his injector on, and keeping it on the entire trip, supplying his boiler with just the amount of water used. His fireman carried a very light fire and had no trouble keeping up steam.

On the other hand, S. C—— carried three solid gages of water to start out with, and would not put the gun on until the water was well down in the glass, and then he would keep it until he had three or more gages and then shut it off and open the cylinder cocks. This treatment kept his fireman busy shoveling coal from start to finish. I could enumerate many cases of this kind, proving to me that the careful engineer gets the best results out of his arch, saves his flues, gives less trouble at terminal points, saves the most coal and draws the largest premium at the end of the month.

The arch has a beneficial effect on the flues when properly taken care of, and flues seldom leak or stop up, but the least neglect of the arch and we soon hear of it.

Repairing flues without removing the arch is a difficult job, and at the same time a risky one, and should never be allowed, for no matter how expert the flue man may be he is working under a disadvantage, which is unfair to him, and to stop the leaks may resort to the pernicious use of the hammer, which soon ends the life of the flues.

I am of the opinion that the bricks as made are entirely too large and thick for convenient handling, and large numbers of them are broken on this account while putting them on top of arch pipes. All bricks should be kept in a dry place, perfectly free from moisture, grouped and classified, so that there may be no mistake made when taking bricks out of stock.

If our boiler shop foremen, general foremen and master mechanics would occasionally don a suit of overalls, crawl into a firebox just after the fire is dumped, and, as I said before, see the condition of arches for themselves, instead of getting it second-hand, I am sure there would be still better results from the much-abused brick arch. Flex Ible.

Pittsburg, Pa.

Rules for Safety Valve Problems

Although there are several methods and rules for working out safety valve problems, some inspectors of the United States Steamboat Inspection Service prefer to have candidates for license use what are known as "Roper's Rules." In fact, I have been told that some of the inspectors in times past would not accept any problem relating to safety valves that was not operated by Roper's Rules, although there are other rules that are just as correct as Roper's, and will give exactly the same results.

Now I am not going to enter a discussion of the various rules that may safely be used for safety valves, nor attempt to prove their usefulness, but I think there may be some of the younger set of engineers who do not know about Roper's Rules, and as those rules may be preferred by examining engineers, and also, as those rules are absolutely correct, they should be well known.

In order to make the matter clear, and suit both the man who can better understand a rule than a formula, and the man who prefers a formula to a rule, I will give both rules and formulas, and so make it possible to accommodate all who may be interested in the subject.

First, I would say that the distance from the fulcrum to the weight is usually called the length of the lever; but on account of confusing the length of the lever *from end to end* with this term, I will not use it in this article. There are but three rules to consider, and these three should meet all requirements as far as the engineer is concerned. If an engineer understands these rules and how to apply and use them, he has practically all the essentials relating to the subject.

The first rule is to find the *weight* necessary to put on a lever. Multiply the area of the valve by the pressure per square inch to be carried in the boiler, and multiply this product by the distance between the center line of the valve and the fulcrum. Next multiply the actual weight of the lever by one-half its length, if the lever is straight and parallel, or by the distance between the center of gravity and the fulcrum if the lever is tapered. Multiply the weight of the valve and stem by the distance between the center line of the valve and the fulcrum. Add the last two products together, and subtract their sum from the first product found. Divide the remainder by the distance the weight is from the fulcrum.

This rule stated as a formula will appear like this

$$W = \frac{A P D - (w l + V D)}{L},$$

in which the letters have the following values, and it is the same for all the formulas used in this article:

A = area of valve in square inches.
D = distance from center of valve to the fulcrum in inches.
L = distance of weight from fulcrum in inches.
P = steam pressure in pounds per square inch.
W = weight of the weight to be placed on the lever in pounds.
V = weight of the valve and stem in pounds.
w = weight of the lever in pounds.
l = distance from fulcrum to center of gravity of lever in inches.

The second rule is to find the distance at which the weight is to be placed on the lever, as measured from the fulcrum. Multiply the area of the valve by the steam pressure to be carried, and multiply this product by the distance between the center of the valve and the fulcrum. Multiply the lever by one-half its length, or by the distance from the fulcrum to the center of gravity, as referred to in the first rule. Multiply the weight of valve and stem by the distance between the center of the valve and the fulcrum; add the last two products together, and subtract their sum from the first product. Divide the remainder by the weight of the weight.

This rule expressed as a formula will appear like this:

$$L = \frac{A P D - (w l + V D)}{W}.$$

The third and last rule in this series is to find the pressure at which the valve is about to blow off.

Multiply the weight of the weight by the distance it is from the fulcrum. Multiply the weight of the lever by the distance its center of gravity is from the fulcrum (as explained in the first rule). Multiply the weight of the valve and stem by the distance from the center of the valve to the fulcrum. Add these three products together, and divide the sum by the product obtained by multiplying the area of the valve by the distance from the center of the valve to the fulcrum. Stated in a formula it would read:

$$P = \frac{W L + w l + V D}{A D}.$$

To illustrate the application of the foregoing rules and formulas, I will use the following examples:

A safety valve is 4 inches diameter; the weight of the valve and stem is 10 pounds, the weight of the lever is 20 pounds, the total length of the lever is 44 inches, and it is not tapered. The weight is to hang at 40 inches from the fulcrum, and the distance from the center of the valve to the fulcrum is 4 inches, and the valve is to blow off at 100 pounds per square inch. What weight is necessary?

Using rule one we have:

$$\frac{4^2 \times .7854 \times 100 \times 4 - (20 \times 44/2 + 10 \times 4)}{40} = 113.66 + \text{ pounds weight.}$$

Using rule two, to find at what distance the weight should be placed on the lever, we have:

$$\frac{4^2 \times .7854 \times 100 \times 4 - (20 \times 44/2 + 10 \times 4)}{113.66} = 40 \text{ inches from the fulcrum.}$$

And using rule three, to find the pressure at which the valve will blow off, we have:

$$\frac{113.664 \times 40 + 20 \times 44/2 + 10 \times 4}{4^2 \times .7854 \times 4} = 100 \text{ pounds per square inch.}$$

Let the interested reader try this example in its several phases and see what can be made of it.

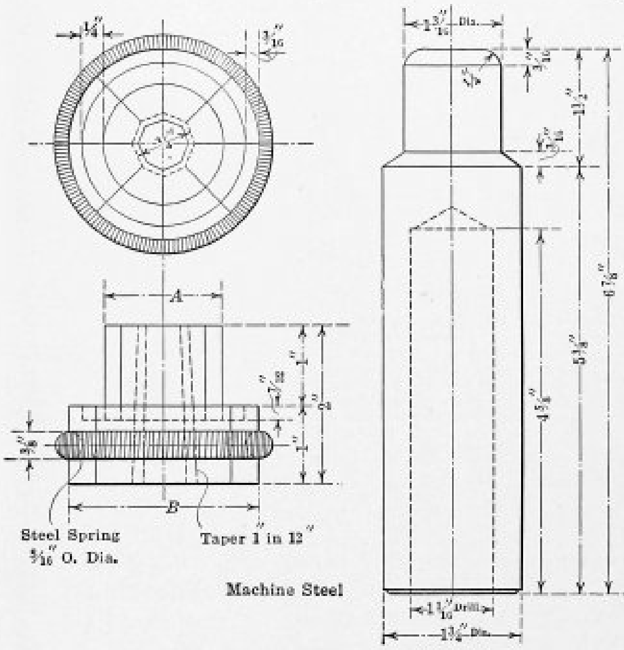
Scranton, Pa. CHARLES J. MASON.

Flue Setting Prosser and Mandrel Extractor

A new prosser for setting flues is shown in Fig. 1. The construction of the tool is evident from the illustration. By using this tool in setting flues in a firebox two operations are done away with. In the illustration is also shown a mandrel extractor to be used when prossering tubes with the lip prosser. This tool is very much appreciated by boiler makers who have used it, as it has brought about a great saving in time and labor. D. MARTIN-YULE,

Foreman Boiler Maker, Boston & Maine Railroad Shops.

Keene, N. H.



PROSSER AND MANDREL EXTRACTOR

A New Punching Process

In punching metal articles out of fairly thick plates it is found that the cut surfaces are not smooth, but show cracks, so that a further trimming is required. In a recent invention this trimming is effected by a punch which has a pressure surface too large to enter the die and a conical surface diverging therefrom. It is essential that the pressure surface and conical surface are formed of one piece of metal. The blank is first slightly forced into the cutting die so that a shaving is being removed all round. During the further descent of the punch the material projecting is forced outwards, and when the punch arrives quite close to the cutting die the conical part breaks the material away from the blank, so that only a very thin and narrow burr is left. The punch is then raised and a new blank placed on the work in the cutting die. The punch is again moved downward and the new blank forces the previous one entirely through the die, the burr being sheared off smooth. Experiments show that smooth lateral faces of the work can be obtained with this tool in one operation. The punch is patented by a firm of machine makers in Vienna.—*The Practical Engineer.*

Registration at the Boiler Manufacturers' Convention

At the twenty-fifth annual convention of the American Boiler Manufacturers' Association, a complete report of which was published in our last issue, there were present thirteen officers, fifty-one members, seventy guests and seventy-two ladies, making a total attendance of 206. The registration list was as follows:

OFFICERS

Thos. Aldcorn, Chicago Pneumatic Tool Co., New York City.
M. H. Broderick, The Broderick Co., Muncie, Ind.
W H. S. Bateman, Champion Rivet Co., Cho. P. T. & Co., Parkesburg Iron Co., Philadelphia, Pa.
D. J. Champion, Champion Rivet Co., Cleveland, Ohio.
J. F. Corbett, Jos. T. Ryerson & Son, Chicago, Ill.
W. O. Duntley, Chicago Pneumatic Tool Co., Chicago, Ill.
Geo. W. Denyven, Arthur C. Harvey, Boston, Mass.
J. D. Farasey, H. E. Teachout Boiler Works, Cleveland, Ohio.
E. D. Meier, Heine Safety Boiler Co., New York City.
H. D. MacKinnon, MacKinnon Boiler Mfg. Co., Bay City, Mich.
T. M. Rees, Jas. M. Rees & Sons Co., Pittsburg, Pa.
J. Don Smith, Valk & Murdoh Iron Works, Charleston, S. C.
F. B. Slocum, Continental Iron Works, Brooklyn, N. Y.

MEMBERS AND GUESTS

R. E. Ashley, Muskegon Boiler Works, Muskegon, Mich.
B. F. Abel, Cleveland Punch & Shear Works, Cincinnati, Ohio.
Bartholomew Scannell, Scannell Boiler Works, Lowell, Mass.
John J. Borger, Union Boiler Works, Columbus, Ohio.
S. E. Barlow, The Huber Mfg. Co., Marion, Ohio.
D. A. Brown, Official Reporter, Cincinnati, Ohio.
Mayor Baker, Mayor of Cleveland, Cleveland, Ohio.
H. A. Baumhart, Hartford Steam Boiler, Cleveland, Ohio.
Ben R. Cogswell, Oil Well Supply Co., Boiler Works Dept., Oswego, N. Y.
A. H. Chapman, Walsh & Weidner Boiler Co., Chattanooga, Tenn.
W. C. Connelly, The D. Connelly Boiler Co., Cleveland, Ohio.
F. B. Cole, R. D. Cole Mfg. Co., Newnan, Ga.
H. S. Covey, Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Wm. H. Connell, Jr., Hillis & Jones, Pittsburg, Pa.
Henry Chisholm, Champion Rivet Co., Cleveland, Ohio.
Frank F. Chiles, Carnegie Steel Co., Cleveland, Ohio.
M. Champion, Champion Rivet Co., Cleveland, Ohio.
T. J. Champion, Champion Rivet Co., Cleveland, Ohio.
W. M. Collier, McKenna Bros. Brass Co., Cleveland, Ohio.
A. B. Carhart, Crosby Steam Gage & Valve Co., Boston, Mass.
M. P. Cogswell, Mt. Vernon Bridge Co., Mt. Vernon, Ohio.
Geo. W. Cravens, C. & C. Ele. & Mfg. Co., Garwood, N. J.
H. F. Cook, McNeil Boiler Co., Akron, Ohio, Cleveland, Ohio.
H. F. Cockburn, J. F. Corlett & Co., Cleveland, Ohio.
J. F. Corlett, J. F. Corlett & Co., Cleveland, Ohio.
T. P. Champion, Champion Rivet Co., Cleveland, Ohio.
H. D. Deverell, Otis Steel Co., Cleveland, Ohio.
J. W. Exler, The Jas. Lappan Mfg. Co., Pittsburg, Pa.
W. S. Eggers, Otis Steel Co., Cleveland, Ohio.
Carl Freeman, S. Freeman & Sons Co., Racine, Wis.
E. A. France, Jones & Laughlin, Cleveland, Ohio.
Wm. Farasey, H. E. Teachout Boiler Works, Cleveland, Ohio.
Mr. Faren.
J. J. Graham, Hartford Boiler Insurance Co., Pittsburg, Pa.
Frank Garven, The Huber Mfg. Co., Marion, Ohio.
D. W. Glanzer, Otis Steel Co., Cleveland, Ohio.
J. T .Graves, Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Robert Geddis, Jones & Laughlin, Pittsburg, Pa.
B. M. Gardner, Worth Brothers, Cleveland, Ohio.
J. T. Graves, Cleveland Pneumatic Tool Co., Cleveland, Ohio.
C. R. Houston, Houston-Stanwood & Gamble Co., Cincinnati, Ohio.
Henry J. Hartley, Wm. Cramp & Sons Co., Philadelphia, Pa.
Chas. S. Hoofer, Union Iron Works, Erie, Pa.
W. G. Homhorst, McIlvain & Spiegel Boiler & Tank Co., Cincinnati, Ohio.
Robert Heinsohn, J. S. Schofields Son Co., Macon, Ga.
W. B. Harris, Worth Bros., Cincinnati, Ohio.
L. M. Henoch, A. M. Castle & Co., Chicago, Ill.
Chas. S. Holton, Hartford Steam Boiler Insurance, Toledo, Ohio.
J. E. Jones, The Brownell Co., Dayton, Ohio.
Geo. W. Johnson, Collins Iron Works, Phelps, N. Y.
W. D. Johnson, Milwaukee Boiler Works, Milwaukee, Wis.
Ben Jacoby, Marion Steam Shovel Co., Marion, Ohio.
J. C. Jones, Cleveland Steel Co., Cleveland, Ohio.
E. E. Krablach, Union Iron Works, Erie, Pa.
Wm. Kehoe, Kehoe Iron Works, Savannah, Ga.
D. C. Kennedy, Union Iron Works, Erie, Pa.
D. H. Kemper, Glen City Boiler Works, Dayton, Ohio.
Albert Geis, Geis & Bichler, St. Joseph, Mo.
Geo. H. Kittoe, Kittoe Boiler & Tank Co., Camden, Ohio.
J. W. Kelley, National Tube Co., Pittsburg, Pa.
R. M. Kilgare, Jones & Laughlin Co., Cleveland, Ohio.
Henry H. Lynch, Pres., Hodge Boiler Works, Mass. Board of Boiler Rules, Boston, Mass.
J. O. Leech, Carnegie Steel Co., Pittsburg, Pa.
R. S. Le Barre, Carnegie Steel Co., Cleveland, Ohio.
John M. Lukens, Chief of Bureau of Boiler Inspectors, Philadelphia, Pa.
Emerson McDuffie, Coke Co. Marion Iron Works, Marion, S. C.
John Murphy, John H. Murphy Iron Works, Hodge Boiler Works, New Orleans, La.
M. M. McCallaster, Erie, Pa.
M. F. Moore, Kewanee Boiler Works, Kewanee, Ill.
Hector D. MacKinnon, MacKinnon Boiler & Machine Co., Bay City, Mich.
G. R. McAlleenan, McAlleenan Bros. Co., Pittsburg, Pa.
A. S. Mitchell, Champion Rivet Co., New York, N. Y.
A. M. Mueller, Jos. T. Ryerson & Son, Chicago, Ill.
G. F. Mason, Scully Steel & Iron Co., Chicago, Ill.
McGroder, Champion Rivet Co., Cleveland, Ohio.
I. A. Miller, The Miller Studio, Cleveland, Ohio.
Walter R. Mount, The Engineering Catalogue, Chicago, Ill.
L. P. Mercer, Parkesburg Iron Co., Chicago, Ill.
Mr. McKeown, J. F. Corlett & Co., Cleveland Ohio.
Capt. N. B. Nelson, Steamboat Inspector, 9th Dist., Cleveland, Ohio.
J. Nono, Chicago Pneumatic Tool Co., Cleveland, Ohio.
J. H. Optenburg, Optenburg Iron Works, Sheboygan, Wis.
Wm. Olenburg, Ohio Machine & Boiler Co., Cleveland, Ohio.
John V. Petty, John Petty & Co., Ltd., Lebanon, Pa.
Walter K. Petty, John Petty & Co., Ltd., Lebanon, Pa.
C. R. Phillips, Pittsburg Steel Pro. Co., Pittsburg, Pa.
Geo. H. Partridge, The Engineering Catalogue, New York, N. Y.
C. B. Rowland, The Continental Iron Works, Brooklyn, N. Y.
E. W. Ritter, Burke Furnace Co., Chicago, Ill.
Geo. C. Roberts, Enterprise Boiler Co., Cleveland, Ohio.
E. P. Roberts, City Smoke Inspector, Cleveland, Ohio.
F. M. Rankel, Worth Brothers, Cleveland, Ohio.
A. D. Schofield, Jr., J. S. Schofields Sons Co., Macon, Ga.
A. J. Schaaf, Monongahela Cin. Coal & Coke Co., Pittsburg, Pa.
A. T. Scannell, Archer Iron Works, Chicago, Ill.
E. F. Simon, Ohio Machine & Boiler Co., Cleveland, Ohio.
S. R. Sayre, Penna Boiler Works, Erie, Pa.
J. T. Spry, Marine Boiler Works, Toledo, Ohio.
Paul F. Slocum, The Continental Iron Works, Brooklyn, N. Y.
Geo. Slate, THE BOILER MAKER, New York City.
Dr. J. M. Scannell, Brooklyn, N. Y.
C. T. Smith, Chicago Pneumatic Tool Co.
W. C. Sayle, Cleveland Punch & Shear Works, Cleveland, Ohio.
W. D. Sayle, Cleveland Punch & Shear Works, Cleveland, Ohio.
W. B. Simpson, A. M. Castle & Co., Chicago, Ill.
L. E. Skinner, Jos. T. Ryerson & Son, Cleveland, Ohio.
G. Shirk, National Tube Co., Pittsburg, Pa.
M. T. Slattery, Inspector Steam Boiler (Dis.), Cleveland, Ohio.
Cliff M. Tudor, Tudor Boiler Mfg. Co., Cincinnati, Ohio.
W. M. Taylor, Chandler & Taylor Co., Indianapolis, Ind.
Chas. W. Wangler, Jos. F. Wangler & S. I. Works Co., St. Louis, Mo.
J. K. Williamson, Porcupine Boiler Co., Bridgeport, Conn.
Chas. H. Wirmel, Chief Boiler Examiner, Columbus, Ohio.
L. I. Yeomans, Chicago Pneumatic Tool Co., Chicago, Ill.
J. T. Georgeson, Vulcan Eng. Sales Co., Chicago, Ill.
Geo. Thomas, 3d, Parkesburg Iron Co., Parkesburg, Pa.
Geo. A. Luck, Depileh Boiler Insurance, State House, Boston, Room 8.
Geo. N. Riley, National Tube Co., Pittsburg, Pa.
F. H. McCabe, E. McCabe & Co., Lawrence, Mass.
J. B. Campbell, McNeil Boiler Co., Akron, Ohio.

LADIES

Miss R. E. Ashley, Muskegon, Mich.
Mrs. J. B. Ayres, Cleveland, Ohio.
Miss Jane Bowler, Cincinnati, Ohio.
Mrs. W. H. D. Bateman, Philadelphia, Pa.
Mrs. D. A. Brown, Fort Thomas, Ky.
Mrs. J. J. Borger, Columbus, Ohio.
Mrs. W. C. Connelly, Cleveland, Ohio.
Mrs. Elizabeth Chute, Cleveland, Ohio.
Mrs. L. E. Connelly, Cleveland, Ohio.
Mrs. J. B. Campbell, Akron, Ohio.
Mrs. D. C. Champion, Cleveland, Ohio.
Miss Ethel Champion, Cleveland, Ohio.
Miss Eleanor Champion, Cleveland, Ohio.
Miss Crawford, Philadelphia, Pa.
Mrs. Henry Chisholm, Cleveland, Ohio.
Miss A. B. Chute, Youngstown, Ohio.
Mrs. Matthew Champion, Cleveland, Ohio.
Mrs. W. C. Connelly, Cleveland, Ohio.
Miss Francis Cassidy, Cleveland, Ohio.
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Mrs. J. F. Cockburn, Cleveland, Ohio.
Mrs. H. F. Deverell, Cleveland, Ohio.
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Mrs. J. W. Exler, Pittsburg, Pa.
Mrs. J. D. Farasey, Cleveland, Ohio.
Miss Marie Farasey, Cleveland, Ohio.
Mrs. D. W. Glanzer, Cleveland, Ohio.
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Miss Beatrice Graves, Cleveland, Ohio.
Mrs. C. R. Houston, Cincinnati, Ohio.
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Mrs G. W. Johnson, Phelps, N. Y.
Mrs. J. C. Jones, Cleveland, Ohio.
Mrs. Wm. Kehoe.
Mrs. R. M. Kilgore, Cleveland, Ohio.
Miss I. W. Lalime, Cleveland, Ohio.
Mrs. R. S. Le Barre.
Mrs. H. D. McKinnon, Bay City, Mich.
Miss Sue Murphy, New Orleans, La.
Mrs. Geo. R. McAleenan, Pittsburg, Pa.
Master Eugene McAleenan, Pittsburg, Pa.
Miss Jane McAleenan, Pittsburg, Pa.
Miss Mazie Mullarky.
Miss Mamie Murphy, Cleveland, Ohio.
Miss Nellie Murphy, Cleveland, Ohio.
Mrs. M. P. Mooney, Cleveland, Ohio.
Mrs. S. J. McNally, Cleveland, Ohio.
Mrs. J. H. Optenburg, Sheboygan, Wis.
Mrs. W. Oldenburg, Cleveland, Ohio.
Miss Gladius Oldenburg, Cleveland, Ohio.
Mrs. H. C. Quigley, Cleveland, Ohio.
Mrs. E. W. Ritter, Chicago, Ill.
Mrs. Thos. M. Rees, Pittsburg, Pa.
Miss K. Scannell, Lowell, Mass.
Mrs. A. J. Schaaf, Pittsburg, Pa.
Mrs. Chas. T. Smith.
Miss Lenore Smith.
Miss Ruth Smith.
Mrs. W. D. Sayle, Cleveland, Ohio.
Miss Winifred Swift, Cleveland, Ohio.
Mrs. E. F. Simon, Cleveland, Ohio.
Mrs. L. E. Skinner, Cleveland, Ohio.
Miss E. Skinner, Cleveland, Ohio.
Mrs. G. F. Spry, Toledo, Ohio.
Miss J. Seidel, Cleveland, Ohio.
Miss Mary Scannell, Lowell, Mass.
Mrs. Frank Vleck, Cleveland, Ohio.
Mrs. John McGroder, Cleveland, Ohio.
Mrs. S. R. Sague, Cleveland, Ohio.
Mrs. J. O. Leech, Pittsburg, Pa.

Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
LOAN AND TRUST BUILDING,
Washington, D. C.

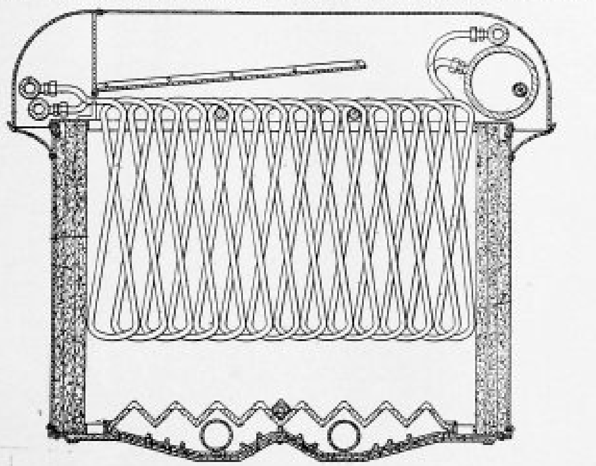
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,064,217. PROCESS FOR MANUFACTURING HEADERS FOR WATERTUBE BOILERS. CAMPBELL P. HIGGINS, OF NEW JERSEY, ASSIGNOR TO THE BABCOCK & WILCOX COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

Claim 1.—The process of forming a boiler header which consists in subjecting a wrought metal plate of substantially the thickness of the metal of the header to successive transformations of the flange from a substantial cylinder to a cone of less than twenty-five degrees, and then to a cylinder, while at a red heat substantially below welding heat, whereby the metal is permitted adequate freedom of flow. Four claims.

1,065,419. FLASH-BOILER. WILLIAM H. WINSLOW, OF RIVER FOREST, ILLINOIS, ASSIGNOR TO THE STEAM POWER DEVICES COMPANY, OF CHICAGO, ILL., A CORPORATION OF ILLINOIS.

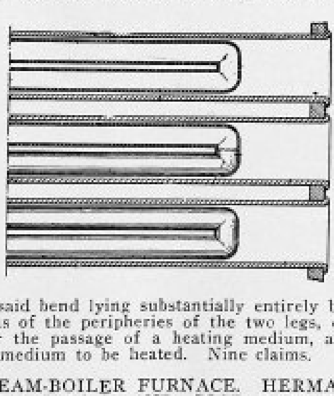
Claim 1.—In a boiler, the combination of a water header, a steam header, a plurality of tubes having vertically extending loops between



the water header and the steam header, and means connected with such tubes between such headers for redistributing the water and steam contained therein. Fifty-nine claims.

1,066,223. STEAM SUPERHEATER FOR BOILERS. THEODOR MARTIN RENDCHEN, OF ALTONA-OTTENSEN, GERMANY, ASSIGNOR, BY MESNE ASSIGNMENTS, TO LOCOMOTIVE SUPERHEATER COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

Claim 1.—In a heating apparatus, two tubes in combination, one of said tubes being located within the other and comprising two legs united by a return bend having an internal cross-section at least as great as



that of the legs, said bend lying substantially entirely between the opposite outer portions of the peripheries of the two legs, one of said tubes being adapted for the passage of a heating medium, and the other for the passage of a medium to be heated. Nine claims.

1,064,857. STEAM-BOILER FURNACE. HERMAN A. POPPENHUSEN, OF EVANSTON, AND JOSEPH HARRINGTON, OF RIVERSIDE, ILL.

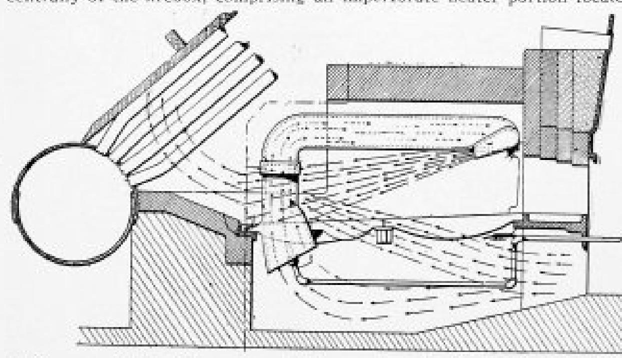
Claim 1.—A furnace embracing a grate and a deflecting partition over the grate, comprising a plurality of tubular, metal, water cooled supporting members, fire brick coverings on said supporting members, the covering for each member comprising lateral sections interlocked with each other at the upper sides of the members, and fire brick members extending between and supported at their side margins upon said fire brick coverings. Four claims.

1,065,057. OIL-BURNING FURNACE. HERBERT V. LEAHY, OF LOS ANGELES, CAL.

Claim 1.—An oil burning furnace comprising a combustion chamber having its floor provided with a longitudinal passage and having its rear wall formed with an upright channel with a horizontal passage at the bottom of said upright channel communicating with said longitudinal passage and with an opening at the top of said upright channel communicating with the combustion chamber, and an oil burner comprising supply piping extending longitudinally in said passage in the floor of the chamber, and a shank extending at right angles to said piping, upwardly within said vertical channel in the rear wall of the chamber, and a burner head at the upper end of said shank opposite the opening between said vertical channel and combustion chamber, the rear wall of the chamber extending in front of said shank when in upright position. Four claims.

1,066,041. FURNACE. JOHN H. PARSONS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO PARSONS ENGINEERING COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

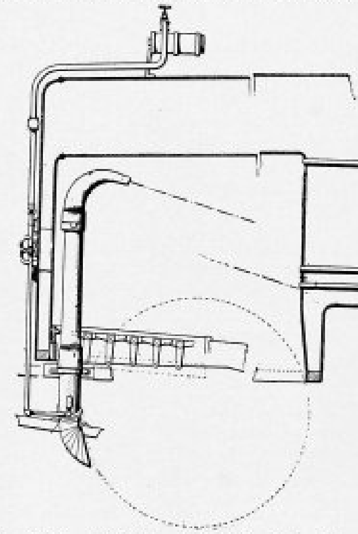
Claim 2.—In combination with a furnace having the usual firebox, grate and ash-pit, of an air-injecting attachment therefor arranged centrally of the firebox, comprising an imperforate heater portion located



at the rear of the firebox therewithin, and opening below the grate, an offset elongated imperforate heater portion constituting a continuation of said first-mentioned portion extending forwardly within the firebox, near the top thereof to near the forward wall of the same, nozzles at the end of said last-mentioned heater portion arranged at opposite sides thereof to discharge air from points adjacent said forward wall of the firebox rearwardly through the fire chamber in the general direction of the draft, said nozzles being flat and elongated transversely of the firebox to emit the air in sheet formation. Twelve claims.

1,066,043. METHOD OF SECURING COMBUSTION OF COAL AND SIMILAR PRODUCTS. JOHN H. PARSONS, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR TO PARSONS ENGINEERING COMPANY, OF WILMINGTON, DELAWARE, A CORPORATION OF DELAWARE.

Claim 1.—The art of promoting combustion in furnaces, consisting in igniting a body of fuel suported upon a grate, supplying air to the fuel from below the grate, and forcibly introducing above the fuel, while the



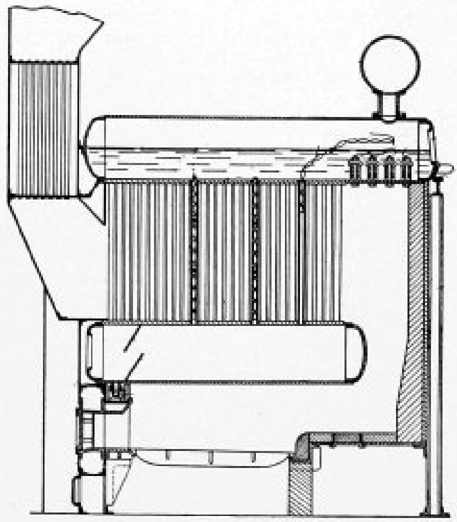
furnace door is closed, a volume of heated air in the general direction of the draft of the furnace and in sheet formation to intercept and in volume to insure the consumption of the combustible gases and particles arising from the body of fuel, the volume and velocity of the introduced air being such as to assist the draft through the grate and fuel and facilitate the maintenance of the required draft through the fuel, said volume and force of the introduced air being such that the sheet is not materially dissipated or consumed in its passage directly over the fuel whereby it is adequate upon reaching the combustion area beyond the fuel bed to fully commingle with the combustible products arising from the burning fuel and insure the consumption thereof, and augmenting the supply of heated air above the fuel by the opening of the furnace door for the introduction of fresh fuel. Two claims.

1,066,005. FIREBOX DOOR FOR STEAM BOILERS. ALBERT G. ELVIN, OF FRANKLIN, PENNSYLVANIA.

Claim 1.—In a firebox door appliance, the combination of a supporting frame adapted for connection to a steam boiler firebox and having an opening of dimensions and contour proper to surround a firebox door opening, vertically sliding upper and lower hollow or chambered door sections, the lower section having a passage for the admission of air to the chambered door sections and the upper section having an opening for the discharge of air into the furnace, said door sections being fitted to traverse on the door frame in direction to cover and uncover the opening therein, and means for simultaneously moving said door sections in opposite directions. Eighteen claims.

1,066,1111. WATERTUBE STEAM BOILER. JAMES HOWDEN, OF GLASGOW, SCOTLAND.

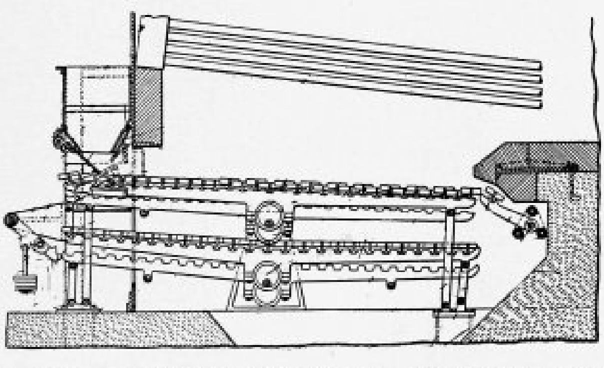
Claim.—In a watertube steam boiler, in combination, a top drum and a bottom drum, the said bottom drum overlying the furnace grate, the front part of said bottom drum being protected from the furnace gases,



upright rows of straight water tubes connecting the top and bottom drums, the front rows of tubes serving as downcomers, and rearwardly inclined baffle plates disposed in the bottom drum in the vicinity of the downcomers, said baffle plates being adapted to prevent passage of steam from the rear part of the drum into the front part of the drum, and so to the downcomers. One claim.

1,066,254. MECHANICAL STOKER. GEORGE BERKLEY CRAMP, OF HARRISBURG, PENNSYLVANIA.

Claim 2.—A mechanical stoker, comprising a progressive feed grate composed of upper and lower sets of rack bars, each set comprising a plurality of pairs, the members of the pairs being arranged in spaced relation, a plate arranged adjacent to each end of each of the pairs, links connecting the front ends of one pair of upper rack bars and one pair of lower rack bars to the plates at the front of the grate, links connecting the rear ends of the other pairs to the plates at the rear of



the grate, upper and lower shafts journaled transversely of the grate intermediate the ends of the rack bars, an eccentric for each upper rack bar secured to the upper shaft, an eccentric for each lower rack bar secured to the lower shaft, a bearing intermediate the ends of each rack bar, each bearing engaging an eccentric, the eccentrics of the rack bars connected at their front ends being oppositely arranged to the eccentrics of the rack bars connected at their rear ends, means for intermittently rotating the shafts at the same speed in opposite directions, a plurality of grate bars, each grate bar having oppositely extending flanges at its lower edge for engaging the rack bars, each of the said rack bars having its upper edge provided with spaced notches for engagement by the said ends, and means at each end of the grate for transferring the grate bars from one set of rack bars to the other set. Eighteen claims.

1,066,244. SOOT BOILER CLEANER. 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 combination with a boiler furnace, a boiler having a watertube section provided with horizontal baffles spaced vertically apart, means for causing the furnace draft to carry the gas in one direction in the space between the baffles, and suitable jet nozzles positioned at one end of said watertube section between the planes of the baffles and operating partly against the draft to clean the accumulations above the bottom baffle at said end, and partly with the draft to divert the dislodged material in the opposite direction over the upper baffle. Four claims.

1,067,117. FLUE CLEANER. ALFRED A. HULL, OF KNOXVILLE, TENNESSEE.

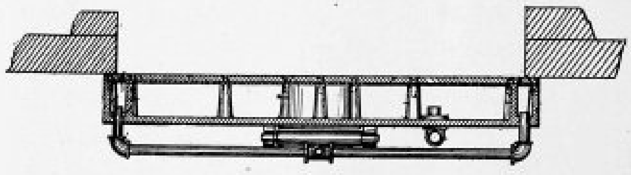
Claim 2.—In a flue cleaner, the combination with an axial member, of scraping elements arranged about said member, supports for said elements, including knife edges, and retaining means engaging said knife edges. Twelve claims.

1,067,188. AUTOMATIC SAFETY WATER GAGE FOR BOILERS. SWENEY MUNSON, OF FOWLER, COLORADO.

Claim 1.—An automatic safety gage cock for boilers, comprising a body arranged for attachment to the boiler and provided with a main valve seat and a check valve seat, a main valve movable lengthwise in the said body, and haing a removable gasket adapted to be seated on the said main valve seat, a check valve adapted to be seated on the said check valve seat, and a pin screwing in the said main valve and having a head engaging the said gasket to hold the latter removably in position on the main valve, the said pin extending through the said valve seats to move the check valve off its seat on closing the main valve and to allow the check valve to move onto its seat on removing the main valve from the body. Four claims.

1,067,255. FURNACE DOOR. CARL J. F. JOHNSON, OHIO.

Claim 2.—A door for highly heated furnaces adapted to be bodily raised and lowered and provided with a water-cooling chamber in its



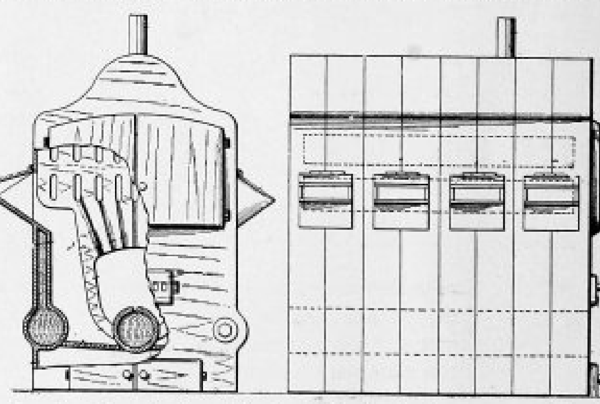
middle portion and a marginal air-supply chamber, said chambers arranged in the same plane, and said air chamber provided with outlet openings entering said furnace. Six claims.

1,067,394. REGULATOR. WILLIE C. BEAM, OF ROCKFORD, ILLINOIS, ASSIGNOR OF ONE-HALF TO THOMAS D. REBER, OF ROCKFORD, ILLINOIS.

Claim.—A regulator, comprising an outer shell, an inner shell supported within the same and spaced therefrom to form an integral liquid-holding chamber, said inner shell having an inlet port communicating with the lower portion of the chamber, an inwardly opening check valve controlling the lower port, an actuating rod for the check valve extending longitudinally in the chamber between the shells, said rod extending through the outer casing above the level of the liquid in the chamber, said inner shell having an outlet port in its lower portion communicating with the chamber, an adjustable valve controlling the latter port, an actuating device therefor extending longitudinally in the internal chamber and projecting from the chamber, a reciprocatory piston in the inner shell, and means for connecting the piston to the controlling apparatus of a furnace.

1,067,494. BOILER FURNACE AND FEED-WATER HEATER. JOHN RALPH SURRELL, OF NEW YORK, N. Y.

Claim 1.—A boiler furnace and feed-water heater for steam boilers having a water chamber and heat areas, said boiler furnace and feedwatre heater comprising a fuel combustion chamber fed from the top having a grate and an ash-pit, a water drum located within the fuel combustion chamber with the fuel therein in contact therewith, means for supplying water to the water drum, a set of piping mounted in said



fuel combustion chamber with the fuel therein in contact with the exterior of said set of piping, the pipes thereof connecting the water drum and the water chamber of the steam boiler for delivering the heated, water directly thereto, said set of piping forming a chamber for air and gases within it, means for communication between said chamber for air and gases and the heat areas of the steam boiler whereby a suction draft is provided through the chamber for air and gases, and a downward draft is provided through the fuel combustion chamber when the fuel combustion chamber is open at its top, said fuel combustion chamber comprising in cross-section the space between the interior of the sides of the boiler furnace and feed-water heater and the exterior of said set of piping and the exterior of the sides of the water drum, and said ash-pit being airtight. Seven claims.

1,066,670. FIRE DOOR FOR FURNACES. WILLIAM N. SPRINGER, OF PEORIA, ILLINOIS, ASSIGNOR TO AVERY COMPANY, A CORPORATION OF ILLINOIS.

Claim 2.—In a furnace door, a door frame, and door sections adapted to normally close the door opening and to swing oppositely about pivotal points in a plane on the outer side of the plane of the said door frame, each door section comprising a main outer plate and a removable inner plate having a curved surface concentric with the pivotal axis of the door. Seven claims.

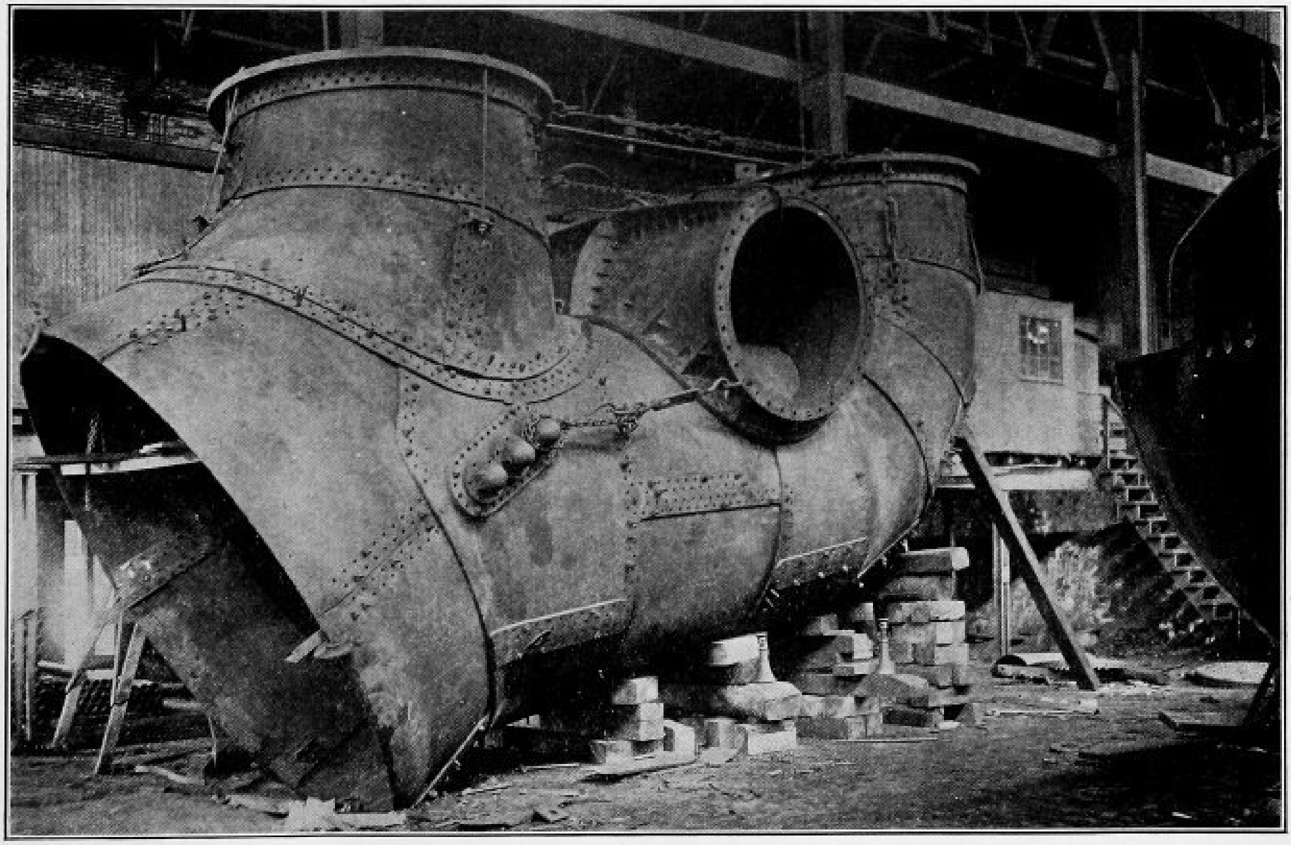
The Boiler Maker

NOVEMBER, 1913

A Difficult Piece of Laying Out Work

BY REX C. WILSON

As an example of an odd and difficult piece of heavy plate construction, the in-take elbow illustrated in this article may be considered typical of the many special contracts executed by the Coatesville Boiler Works, Coatesville, Pa., where the work was done. Two of these in-take elbows were built for a large hydraulic power plant in Eastern Canada, and each elbow was installed in connection with an 18,500-horsepower turbine. Both elbows comprised the fifth and sixth units in the same plant. The turbines were furnished by another contractor.



LARGE IN-TAKE ELBOW BUILT BY THE COATESVILLE BOILER WORKS FOR INSTALLATION WITH AN 18,500-HORSEPOWER TURBINE

The general appearance of the in-take elbow is shown in the photograph, Fig. 1, which is a view of one of the elbows assembled in the builders' shops. The dimensions are as follows:

Center to center of side outlets	19 feet
Center of rear side outlet to center of bell mouth	12 feet 8½ inches
Diameter of side outlets (inside)	8 feet 1½ inches
Diameter of bell mouth (inside)	14 feet 1¾ inches
Thickness of side outlet rings	¾ inch
Thickness of last ring and frustum	⅞ inch
Thickness of bell mouth	1 inch
Diameter of cast steel relief valve (inside)	5 feet 5¼ inches
Length, face to face of relief valve body	11 feet 6 inches
Thickness of cast steel relief valve body	1½ inches
Working pressure in pounds per square inch	75

The plates used in the construction of these elbows were of

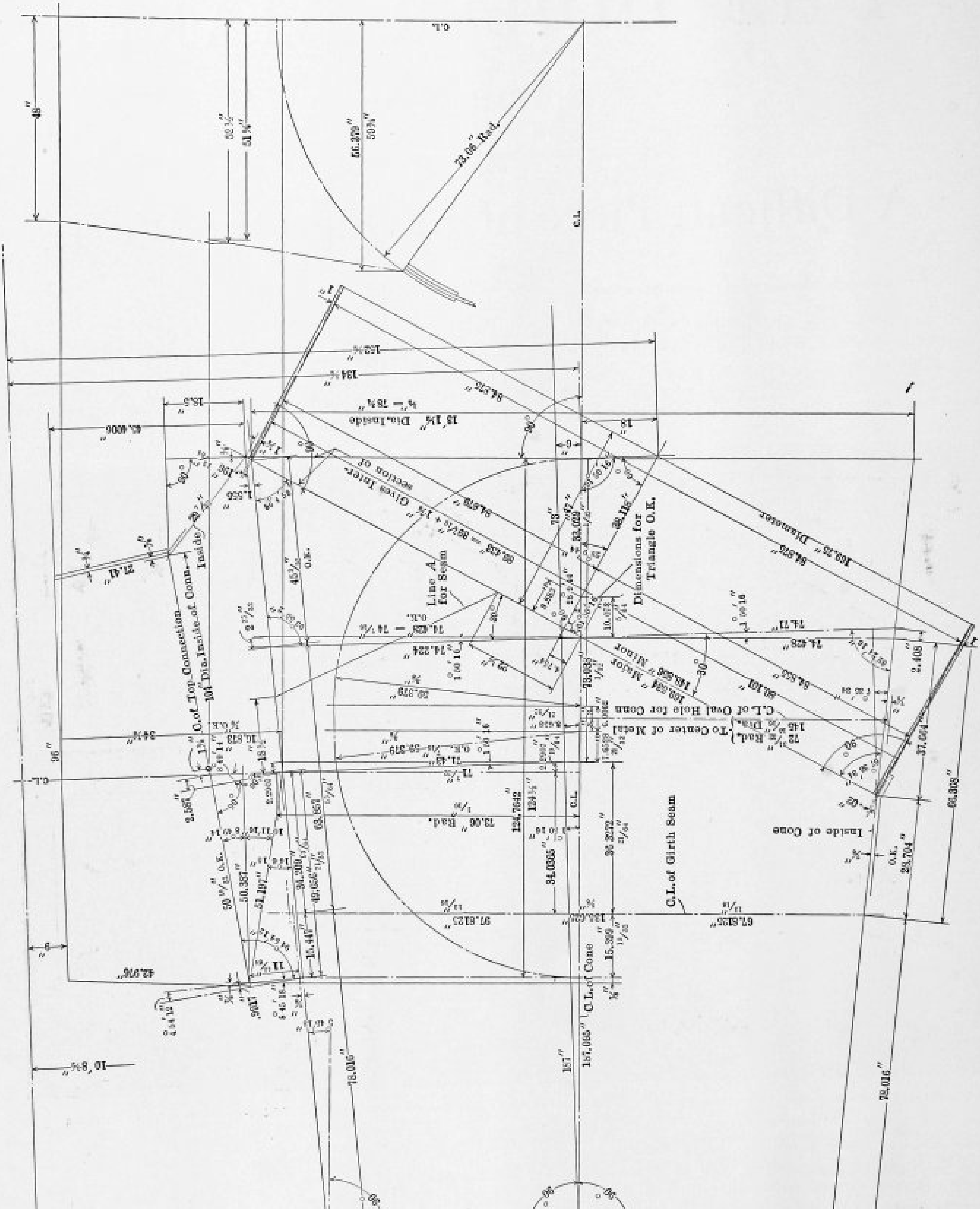


FIG. 2.—TRIANGULATION SHEET

the best quality flange steel, of about 55,000 pounds per square inch ultimate tensile strength. All of the girth seams were lapped and double riveted with the rivets staggered. All longitudinal seams were butted and strapped both inside and outside with straps ¾ inch and 1 inch in thickness respectively. All abutting edges of the plates were planed perfectly square and butted tightly together without leaving any crack or opening. All of the double-riveted girth seams, as well as the edges of the butt straps of the longitudinal seams, were neatly beveled for both inside and outside calking after erection. Rivets 1 and 1⅛ inches in diameter were used and all rivet holes were drilled. The minimum lap in all cases was one and one-half times the diameter of the rivet hole.

The utmost care was used by the builders in making the preliminary calculations in the drawing room for the many triangulation schemes that were necessary for a job of this character. The laying out of the work in the shop was performed in an equally careful manner by an expert in practical and theoretical triangulation. The actual fabrication of the plates was executed in accord with the best and most modern shop practices, made possible by the latest equipment and first-class supervision of the skilled labor employed.

The entire work was subject to regular and careful inspection by a capable engineer acting for the purchaser, both as to quality of the workmanship and as to the accuracy of the dimensions specified. It can be said to the credit of the builders that the final and last inspection before dismantling the elbows for shipment proved the absolute accuracy of all the dimensions specified, which might well be considered a triumph for the builders in consideration of the fact that such accuracy could be obtained only from absolutely correct work

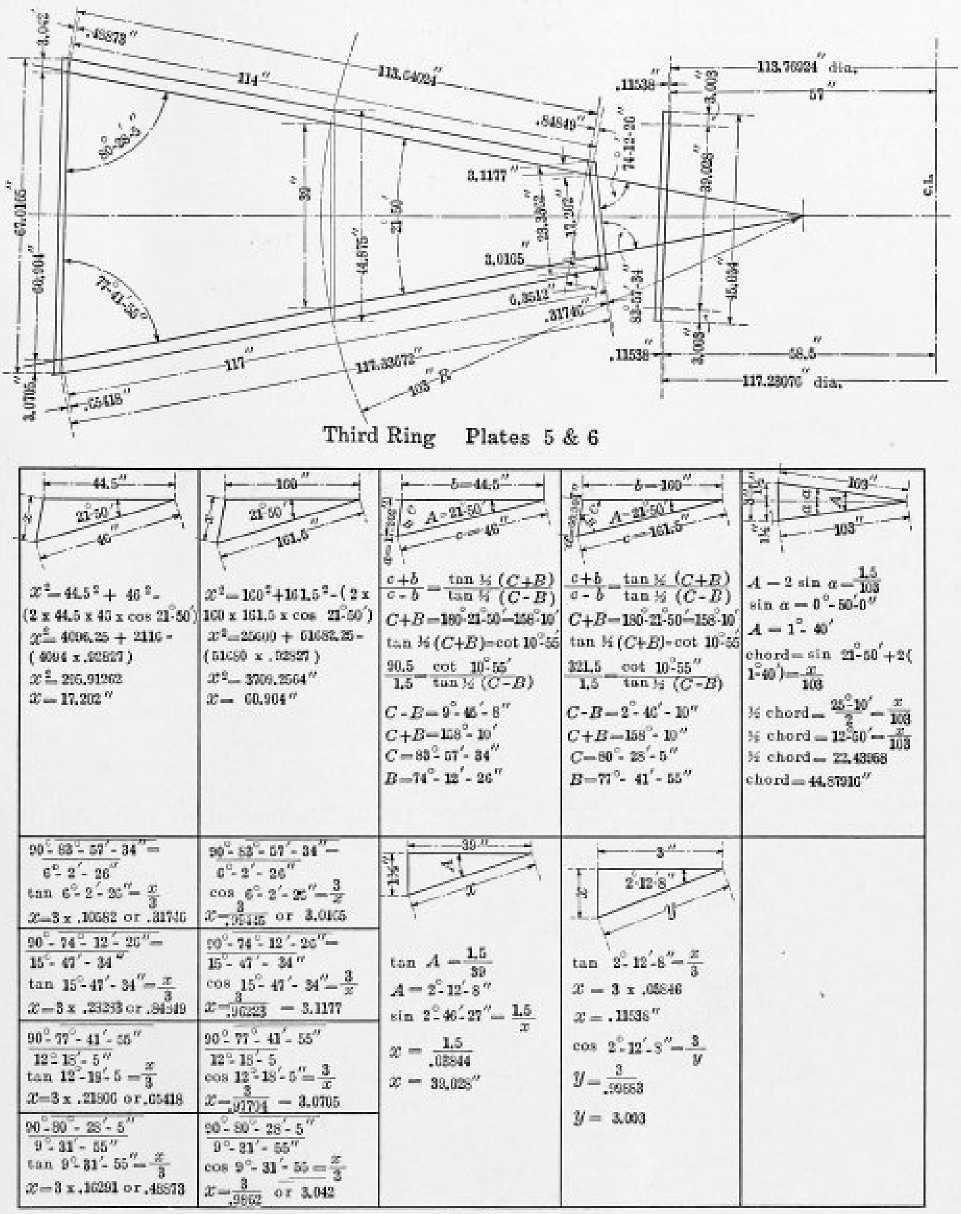


FIG. 3

by highly skilled mechanics. It is evident that the heavy material of which the elbows were constructed would not permit the sledging or pulling into place that lighter gage material would have permitted, so that it was imperative that every plate and every hole should be laid out exactly right in the beginning in order to effect such an accurate final result.

The sketch shown in Fig. 3 shows the method used by the writer in the drawing room to give the layer-out in the shop the correct and proper dimensions for each and every ring of the elbow as well as the method of computing the same. The data given in Fig. 3 apply to the third, or No. 3, ring of the curved end elbow.

The triangulation sheet, Fig. 2, shows the manner in which the dimensions were computed and given to the layer-out in the shop to make his "skeleton cut" for the development of the frustum, and the bell mouth and one side outlet. It is apparent that this triangulation sheet involved a good many calculations in order to obtain the few necessary dimensions.

It will also be noticed that the various rings of the elbow are not frustums of cones but that the dimensions increase in a disproportionate manner, forming shapes that required a special triangulation development in each case, and which were complicated more or less by the fact that the girth seams of the elbows were double-riveted lap joints requiring a special series of caluculations for the required offsets and angles.

The elbows were completely assembled in the shop, and after final inspection and approval were dismantled and shipped knocked-down in sections for final erection by the builders on foundations in the wheel pits at the power plant in Eastern Canada.

New York as a Market for Steam Boilers

A rough estimate of the total value of steam boilers purchased in the United States during the present year, estimated on a horsepower basis, is given by a prominent manufacturer of watertube boilers as between $40,000,000 and $45,000,000—a significant total. This statement is made in an article on the market for steam boilers in New York published in a recent issue of *Greater New York*, a bulletin of the Merchants' Association of New York, an abstract from which follows:

New York offers to the boiler manufacturer an important local market for his finished product, and, what is still more important, it is the great central market from which orders are received for the distribution of products throughout the United States. The local demand for finished products is undoubtedly the largest single field in the United States. Roughly, there are five different classes of markets in the city, each of which requires a different type and grade of boiler, and in each of which there is a large demand.

Diversified Local Demand

In the first place, there is a great and constantly increasing demand for boiler equipment for apartment houses. For most apartments, boiler equipment for heating the building is essential. While this demand requires a comparatively small and cheaper grade of boiler, yet it furnishes a very important market for the boiler manufacturer who has specialized in the production of this type of equipment.

Another large market is found in the equipment of large office buildings. This requires large and high-grade boilers, which will generate sufficient power to heat, light and operate elevator service for the entire building. While the demand for such equipment is limited, yet it has rich rewards for the manufacturer who specializes in this type of production.

Public Utility Equipment

The third local market comes in the demand for boilers to furnish the power for large public utility power houses, pumping stations for the water works system of the city, power stations for the great lighting companies, and power plants for the transit companies. These combined demands create an important market for boiler equipment. Its importance is illustrated by the fact that the new power plant of the New York Edison Company on the Harlem River will be equipped with thirty-two boilers of 650 horsepower each, and eventually the plans of the company will call for a total equipment of seventy-two boilers having 650 horsepower each. The single order for such a plant, amounting to hundreds of thousands of dollars, is in itself a significant factor in the market demands in New York City. Of course, this demand is also limited, but nevertheless it is constantly and steadily increasing with the growth and expansion of the city.

The Manufacturing Market

The fourth type of market is created by the constant demand for boiler equipment on the part of manufacturing concerns, either for loft buildings which house several establishments or for individual plants. When it is realized that during the five years from 1904 to 1909, 5,029 new manufacturing plants were established in New York, and that a large percentage of these needed boiler facilities, the opportunities of supplying factory establishments with boiler equipment is strikingly emphasized. Much of this demand for boiler equipment is confined to new loft buildings which house from five to ten separate manufacturing concerns; but one of the most noticeable things in the growth of the city has been the remarkable increase in the number of large loft buildings in all its boroughs.

These four types of markets, quite distinct in their demand, form an exceptionally large and profitable market for the boiler manufacturers.

Distribution of Marine Boilers

There is a fifth type which should be mentioned, and that is the market for marine boilers. New York is not an important shipbuilding center, although there may be a large increase in the near future in this industry, but the city furnishes the boiler manufacturer with an ideal location for distributing equipment to the important shipbuilding centers in the United States. In fact, for general boiler manufacturing, the advantages of New York as a distributing center are emphatic.

For the New York manufacturer, the saving in transportation rates on his finished products to Southern Atlantic and Gulf ports because of the admirable shipping facilities is important.

A striking illustration of the advantages which New York offers in low transportation costs is shown by the fact that a well-known boiler manufacturer, in shipping to the Pacific Coast, found that he could save 50 percent by sending his goods via the American Hawaiian Line across the Tehuantepec route rather than by the all-rail route, and that the rate via Tehuantepec compared favorably with the rail rate given to the Middle West manufacturer to the same markets. This emphasizes the strategic position which the New York industrial district presents to the manufacturer who has a widespread distribution of his products.

Diversity of State Laws

At the present time one of the great difficulties which confronts the boiler manufacturer is the fact that the different States require different specifications for boiler construction. Since these specifications demand certain types of raw materials, the boiler manufacturer has been forced to duplicate his materials and his methods of construction to meet the requirements of the various laws. It would be a great advantage to the boiler manufacturer and to the public if uniform and standard specifications could be adopted which would meet the requirements of all the States.

The Largest Steel Stack in the World.—What is said to be the largest steel smokestack in the world has been erected by the Kansas City Structural Steel Company for the Calumet & Arizona Mining Company, of Douglas, Ariz. The stack is 305 feet high, weighs 261.1 tons, and is 25 feet 10 inches diameter at the top.

Safety First Lecture.—J. B. Shatzer, of the Schutte & Koerting Company, will give a "Safety First" lecture covering automatic engine stops and triple service valves at the National Association of Stationary Engineers' regular meeting in the Fulton building, Pittsburg, on Nov. 17.

Securing Efficient Results in the Manufacture of Boilers *

BY DELBERT E. MERRIFIELD

Soon after the reorganization had been decided on the actual development of its various functions was begun. As all of the duties of each function centered about the shop it was decided that the shop would be the logical place to locate the office; accordingly the office was built in the main building and centrally located to all operations. The interior arrangement of the office provided flat-top desk accommodation for each member of the staff, and also for the general superintendent and the assistant superintendent. The office layout did not encourage the accumulation of information—that should be available for all members—in the hands of any one member, nor was there any attempt to separate one member from the others by means of partitions; in fact, this idea was carried out to the extent that no locks were allowed on the desks or on filing cabinets. It is only by guarding this feature that the planning department becomes a clearing house of pertinent information rather than a storehouse of uninventoried facts. This method was carried out fully along these lines, and readily differentiates from the vest-pocket direction that many factories are laboring under. In addition to the office equipment mentioned, a large despatching board was built on one wall within ready reach of the despatching clerk, who had charge of it. The despatching board was divided into many rectangular spaces, each space representing a certain machine, man or gang of men, according to the work they were engaged at. Within each space three wire clips were mounted, which were used to hold the service card that contained the description of the work that was to be done by the machine or man. The top clip held the service card for the work that was already being done, the second or middle clip held the service cards of the work that was known to be available and ready to be started when the work already in progress was done; the third or bottom clip held the service cards for the work that was known to be routed to the machine or man, but for certain reasons was not ready to be started without incurring delay. Among the various reasons that govern the jobs that are held in the bottom clip may be found the following: Work not scheduled yet, that is, the work is not desired at the time; a shortage of material may exist; previous operations not completed; a temporary hold-up due to changes in the drawings, that occur frequently but which are unavoidable. Near the despatching board a window that opened directly into the shop was provided through which the service cards were passed in and out to the men.

Since the purpose of the planning department was to develop a centralized control over all work in the shop, the one important responsibility resting on all members of the department is that of planning the work and despatching it into execution; within the range of purpose of this idea there is much to be gained by all departments.

SCOPE OF THE PLANNING DEPARTMENT

Planning is not a new innovation that is to be associated only with the methods of efficiency, as many activities in business have developed planning to a high degree along certain lines and for limited purposes, but the planning to which we give special emphasis is found carried to the highest extent in each operation of a single job, in each department and extended in a comprehensive manner to include the entire business. Briefly, we might describe planning as the ability to forestall delays and irregularities by being able to anticipate events and conditions which cause delay. That this can be done in factories which operate under a variation of conditions is true only after detailed analyses of all happenings are known and the contingencies which they reveal have been noted and the regularity of their reoccurence determined. From this it is apparent that capable and expert advice is constantly necessary to be coming from all members in order that incidents characteristic to a given operation will be known. In any industry where the assembling of many parts into a final unit is necessary, it matters considerably from an economic viewpoint whether all parts are being observed as they flow through the channels provided for them without delay or whether they are allowed to gravitate through a perfect maze of delays and are attended *en route* with constant confusion.

Planning is not to be considered as being entirely limited to the shop activities, as experience has shown that much good work can be done in applying the same methods to the selling and engineering departments. Planning, then, in actual practice should begin at the desk of the executive responsible for the selling of the product; this planning should aim to give advice about what to sell, when to sell, and above all else to give information that is reliable as to when shipments can be promised. Careful planning of the work on an order should be continued into the engineering department, not alone with the idea of expediting the completion of drawings and other detailed information, but also to exercise great foresight, with the aim of bringing about a standardization of operations that will be within the range of machines and appliances in the shop. Many temporary expediencies have to be resorted to in many instances due to a failure of the engineering department in not making advanced provision to avoid the condition.

THE REAL WORK OF THE PLANNING DEPARTMENT

The real work of the planning department commences when the engineering department has completed the drawings and bill of materials. All of this information, together with the original sales data that pertain to promises of shipment go direct to the chief despatcher. Upon receipt of these he sets in motion all of the functions of the staff. Each member begins a detailed analysis of the entire order. In bringing this about the chief of stores responds to furnish all information about the material that is required. If the material is not available at the factory he orders it, and until the material is actually at hand he keeps the chief despatcher constantly advised as to the progress that is being made to get it. When all operations have been standardized so that the standard time is known, the chief of standard time and bonus responds to furnish the department with the routing that each part will follow and the time that it will take. From this information pertinent data are in evidence from which routing and despatching plans can be developed and drafted into schedules.

Should the analysis of an order show that the work will require some special arrangement on the machines or other temporary facilities in order to expedite the work the plant engineer responds to effect these changes. From the detailed analysis the service auditor will be placed in possession of the standard time that will be set for the work; these he uses as a guide to the future cost and also as a basis upon which the men will be paid the incentive.

Having the cost predetermined in this way, should subsequent cost tabulations show an apparent loss occurring, immediate steps are taken to devise other plans that will bring about a reduction in the cost. The principal step to be taken to develop other plans would be to call together in a conference the engineering staff, certain members of the line and the planning staff. At this meeting the whole plan is analyzed, and new plans are evolved that will bring about the desired reduction in cost if possible. In this connection, however, it is well to state that before a contract price is given out careful analysis of the work in detail is made from the standards just the same as though the work was to be done. This reduces to a minimum faulty estimating or the overlooking of certain features that are connected with the order.

* Concluded from the October issue.

In addition to the information rendered by other staff members, the despatching clerk responds to furnish information as to the time the work can be started, or as to what changes are necessary in the shop schedule that will allow the order to move through the shop in the shortest period of time if this is desired.

The inspector and labor foreman are more directly concerned in an order after it has been scheduled rather than in furnishing information that is useful before the work has begun, so they are not brought in connection with the advanced analysis.

Planning to be useful depends upon a knowledge of details, alinement of details into operations, arrangement of operations into plans and despatching of plans into execution. The absence of any one of these factors belittles the final success; as it is much more important to have exercised a strong despatching control over operations of an unknown standard than to standardize operations that are not controlled by despatching. It is because of the failure to appreciate this fact that in many factories where carefully compiled incentive schedules have been held out to the employees this system has failed to bring the results expected. There exist many time-stealing contingencies that rob the employee of maximum output that are not known, and which do not come to the attention of anyone until a clearing house for this information has made a business of looking for it.

UNION BOILER COMPANY.

SHEET NO. DAILY SCHEDULE OF OPERATIONS DATE

	SHOP ORDER	DRW'G NO.	SHEET NO.	NO. OF PIECES	OPERATION & REMARKS	UNIT OF WORK	ST'D TIME	
					LAYER OUT NO.			
					DELAYED WORK.			
					PUNCH NO.			
					DELAYED WORK.			
					SPLIT SHEAR NO.			
					DELAYED WORK.			
					RACK PUNCH NO.			
					DELAYED WORK.			
					LARGE ROLLS.			
					DELAYED WORK.			

FIG. 2.—DAILY SCHEDULE OF SHOP OPERATIONS

The Weekly Planning Meeting

To bring about an arrangement of operations into plans for the purpose of despatching, a weekly planning meeting is held on a specific day. Present at this meeting are members of the engineering department, the general superintendent, the members of the planning department and the general manager. Each member comes prepared to render a complete account of the progress of all work in the shops or a certain department. The general manager presents the status of business as seen in the selling department, he also comes prepared to notify all departments of the rearrangement of orders from the schedule as they appeared during the past week. The conditions influencing these changes are only of an important nature, as, for instance, a notification from a customer that shipment is wanted at an earlier or later date than had been originally arranged.

After the new arrangement has been decided on, several copies are typewritten and distributed to the heads of the various departments. This schedule serves to regulate all the work passing through the shop for the ensuing week, and the schedule is to be considered inflexible; that is, no changes are to be permitted in the order in which the work is to be done that conflict with this plan. There will arise conditions that are beyond the control of all having this matter in hand, but in these events the general manager alone has the authority to order a change.

The Daily Meeting

With the weekly schedule at hand, that is, a recognized plan of procedure, a meeting is held for the purpose of planning work in detail. This meeting takes place at the planning office at a specific hour each day (excepting Saturdays with a half holiday). Present at the meeting are the general superintendent, assistant superintendent, all department foremen, and all members of the planning department. The chief despatcher is in charge of the meeting. If proper information has been secured in advance of the meeting it should not take over fifteen minutes to arrange the schedule.

At the meeting a complete daily schedule is gotten out which covers the planning arrangement for all operations that are to be worked on or begun during the day. The information relating to the material and all operations that it must pass through begins when the order was received. At that time the complete analysis was recorded on an analysis sheet to be used at the planning meetings or other occasions when it is desired to find out at a glance what work is to be done. The schedule when complete furnishes the foreman with a list of operations he is to do, the number of parts to the job, and the time set for the job.

Each foreman in coming to the meeting renders a full account of the conditions that are existing in his department. He should be prepared to give a full account of the conditions that have caused delay, or that may cause delay in the following day. This information is taken in shorthand, and becomes a working schedule for the members of the planning department, inasmuch as it becomes their duty to try and avoid the delays that are anticipated. In fact, at the meeting all short comings of each department are analyzed and completely gone over then and there. This is not done for the purpose of belittling the foreman, but for the purpose of discussion so that a full understanding can be be had and action taken to prevent the inefficient conditions developing.

To realize the greatest returns from the daily meeting requires considerable patience and coaching by those responsible for the planning, as the foremen are not apt to grasp the full importance of coming to the meeting with a complete statement of conditions, with the result that throughout the day delays will come up that were not expected, which if reported might have been avoided.

Daily Schedule of Shop Operations

The final evidence of planning appears in typewritten form called the Daily Schedule of Shop Operations. (See reproduction, Fig. 2.) Enough copies are made to provide each foreman, superintendent and member of the planning department with one, thus all acting members of the factory organization are provided with full and complete information pertaining to the work that is scheduled for the shop during the current day, classified to show the work to be done on each machine or by gangs of men. The printed schedule is the controlling feature of all shop activities, and as in the instance of the weekly schedule it is to be carried out in an inflexible manner. Since the schedule is rearranged from day to day, and each acting member is to a large degree responsible for the accuracy of the arrangement, it would be reasonable to assume that it could be held to rigidly for one day. It is only by exercising the greatest pressure at all times to protect the schedule that eventual plans are developed that will hang together and not be torn to pieces before the day is over. To those who have not watched a shop begin operation on a planning basis, it is almost impossible to convey the real importance of this method of shop control, but if a positive step is taken in this direction gratifying returns will soon become apparent.

Since careful plans have been developed by a large representation of members from the various departments there is little reason why the schedule cannot serve as a despatching schedule also, and in this respect there is a close connection between the functions of the despatching board and the daily schedule. The despatching clerk arranges the service cards on the despatching board each day to conform fully with the daily schedule. In this respect the despatching becomes routine, in so far as authority for changing the arrangements of the jobs on the board is concerned. There are, however, many features that necessitate close attention, as it is here that the despatching of the jobs into execution and the current control is kept over them.

The actual despatching consists of transcribing the information pertaining to a given job from the schedule to the service card. This card is in duplicate, and the copy is given to the workman when the job is started and returned by him when it is completed or at the end of the day, whether the work has been completed or not. In this manner the progress of the work is secured, which is also an important check on the foreman's knowledge of the affairs in his department. The service card carries the time when the job was started, when it was finished, and, finally, the elapsed time is recorded. The service card gives the workman full information about the job, the standard time that is allowed for the work, the amount of work, and what operations the work consists of. From the many items of information that centralize about the service card the service auditor is enabled to secure complete and original data for the purpose of pay rolls, costs, efficiency of men and machines, bonus earned, and any other items needed for factory statistical purposes.

TIME STUDIES

To bring about the most complete method of planning it is essential that the work be scheduled with reference to time. Securing standards of time is a huge undertaking where the operations are many and variable, but the effort expended in this direction is readily rewarded. The responsibility of securing standards of time and conditions rests with the chief of standard time and bonus as previously mentioned. The work of securing standards in a boiler shop would at first appear to be an endless task, and this would be true were it not for the fact that it is possible to form classifications and combinations from a few standards which are capable of wide extension and projection, until they cover a wide range of varying factors. This is especially true in operations of laying out plates, angles, bars, punching plates, angles, channels, etc., each item having an almost endless number of sizes and number of holes per piece.

The method employed in getting at the true data pertaining to all operations is that of time studying the operation while the work is being performed. In making time observations of the operation the observer is provided with a decimal stop watch, one on which the minute is divided into tenths and hundredths to facilitate in rapid calculation of the time. Later, during the operation, each movement is noted and recorded on a sheet which is also provided, and then later still from this sheet, after enough observations have been taken so that a true conception is had, a summary of the different observations is drawn off from which the standard time results. The observer will find that there are many motions and false passes entering into nearly all operations that are unnecessary; he will observe that frequently the workman runs out of material, or that the belts or machines give trouble, or that the workman is not attentive to the work; all of these conditions are recorded together with the amount of time that was used in a productive manner. After long and careful studies have been made the inefficient time is deducted, then the actual time expended in producing a certain amount of work represents the theoretical capacity of man or machine; this time, however, is not used as the standard, as it is obvious that there are factors to be considered that will cause some loss of time and which cannot be avoided. It is in making the allowances for this loss time that the experience of the

Standard Time Schedule for Laying Out Plates to Templet.
Time Shown in Hours.

Width 21" to 40" — Length 0" to 36"		37" to 84"		85" to 168"		169" to 240"		241" to 360"		Holes per Piece	Width 41" to 60" — Length 0" to 36"		37" to 84		85" to 168"		169" to 246"		241" to 360"	
1st	Bal.	1st	Bal.	1st	Bal.	1st	Bal.	1st	Bal.		1st	Bal.	1st	Bal.	1st	Bal.	1st	Bal.	1st	Bal.
.30	.05	.30	.06	.30	.08	.30	.10	.30	.10	20	.30	.08	.30	.08	.30	.10	.30	.10	.30	.10
.30	.05	.40	.10	.40	.10	.40	.15	.40	.15	40	.40	.10	.40	.15	.40	.15	.40	.15	.40	.20
.40	.10	.40	.10	.40	.10	.40	.15	.40	.15	60	.40	.12	.40	.15	.40	.15	.40	.18	.40	.20
.40	.10	.40	.10	.40	.15	.40	.25	.40	.25	80	.40	.15	.40	.15	.40	.15	.40	.20	.40	.25
.40	.15	.40	.15	.40	.15	.40	.25	.40	.25	100	.40	.20	.40	.20	.40	.20	.40	.20	.40	.25
.40	.15	.40	.20	.40	.25	.40	.25	.40	.25	120	.40	.20	.40	.20	.40	.20	.40	.20	.40	.25
.50	.20	.50	.20	.50	.25	.50	.30	.50	.30	150	.50	.20	.50	.30	.50	.25	.50	.25	.50	.25
.60	.25	.60	.25	.60	.25	.60	.30	.60	.30	200	.60	.20	.60	.25	.60	.25	.60	.30	.60	.30
.70	.25	.70	.25	.70	.25	.70	.40	.70	.40	250	.70	.25	.70	.25	.70	.25	.70	.30	.70	.30
.80	.30	.80	.30	.80	.30	.90	.50	.90	.50	300	.80	.30	.80	.40	1.00	.40	1.00	.40	1.00	.50
.80	.30	.80	.40	.80	.40	1.00	.50	1.00	.50	350	.80	.30	.80	.40	1.00	.40	1.00	.50	1.00	.50
1.00	.50	1.00	.60	1.00	.60	1.00	.60	1.00	.60	400	1.20	.60	1.20	.60	1.20	.60	1.20	.60	1.20	.60
1.00	.60	1.00	.60	1.00	.60	1.00	.65	1.00	.65	450	1.20	.65	1.20	.65	1.20	.65	1.20	.65	1.20	.65
1.20	.60	1.20	.65	1.20	.65	1.20	.70	1.20	.70	500	1.30	.65	1.30	.70	1.30	.70	1.30	.70	1.30	.70
1.30	.65	1.30	.65	1.30	.65	1.30	.70	1.30	.70	550	1.30	.65	1.30	.70	1.30	.70	1.30	.70	1.30	.70
1.30	.65	1.30	.65	1.30	.65	1.30	.70	1.30	.70	600	1.30	.65	1.30	.70	1.30	.70	1.30	.70	1.30	.70
1.40	.70	1.40	.70	1.40	.70	1.40	.80	1.40	.80	650	1.40	.70	1.40	.70	1.40	.70	1.40	.70	1.40	.75
1.40	.70	1.40	.70	1.40	.70	1.40	.85	1.40	.85	700	1.40	.70	1.40	.70	1.40	.70	1.40	.80	1.40	.80
				1.40	.70	1.40	.85	1.40	.85	750					1.50	.80	1.50	.80	1.50	.85
				1.50	.80	1.50	.85	1.50	.85	800					1.60	.85	1.60	.85	1.60	.90

FIG. 3.—STANDARD TIME SHEET FOR LAYING OUT PLATES

observer comes into play. The standardization of the work should proceed until all operations throughout the shop have been covered.

There is another important duty connected with the work of making time studies, and that is to see that the employees equal the standards that have been set up. Of course, a great deal of this responsibility lies with the superintendents and foremen, but since the standards were originally determined by the time-study man he must also be prepared to aid the workman in arriving at the time. This he does by coaching the workman during the operation and by pointing out to him just where the loss of time is occurring. It is a fact that men who have been working on a given task for many years have been brought up to a higher efficiency by the elimination of motions and false passes which they were doing unconsciously. A time study to be valuable must detail in a descriptive manner all of the incidents entering into the operation much the same as a moving picture portrays acts and motions, but the time analysis must in addition register the occurrence of motions and acts in reference to the time they take.

USE OF THE SCHEDULE BOOK

Upon the completion of the time studies, and after they have been compiled as time schedules, they are entered in a schedule book, from which information is drawn for estimating, incentives, etc., and the other uses already mentioned.

The manner in which an analysis of an operation is made for the purpose of planning can best be shown from this example:

From the bill of material on a certain order there are ten ½-inch by 40-inch by 120-inch steel plates to be fabricated. The detailed analysis might show that the plates had to have 125 holes laid out on each plate, that the ten plates had to be punched (making a total of 1,250 holes to be punched), that the ten plates had to be bevel-sheared on three sides (this making a total of —— inches of shearing), and, finally, that the plates had to be rolled to a certain diameter. During the analysis the machines that the operations are to be done on are also recorded, so that in the final analysis of all items of material covering he entire order a complete record of the amount of work entailed is at hand, together with the time that various machines are going to be required to complete the order. Thus, for laying out holes on the plates we would have the following time as taken from the standard time sheets compiled for laying out. (See Standard Time Sheet for Laying Out, page 351):

First plate (extra time allowed for studying drawings), .50 hour; nine plates at .25 per hour, 2.25 hours. Total time for the task, 2.75 hours.

Punching Plates on Machine A6—ten plates, 40 inches by 120 inches, at 125 holes each, = 1,250 holes; standard time at 500 holes per hour, = 2.50 hours.

This method is employed throughout all operations until the more complex assembly operations are included. While it is true that the cycles of operations entering into assembling are not easy to grasp and standards secured for them, nevertheless, many seemingly impossible conditions can be standardized from which schedules can be compiled that are far more accurate than the guesses advanced by the foremen.

A compilation of the time that is extended and covering all orders gives the planning and sales departments an immediate and current insight as to the amount of work that is in advance of the shop, or each department, machine and man. It is readily apparent that this in itself is valuable to the management, as this information can be used to good advantage in the selling department, where often desirable business is secured because the department can make definite shipping promises to a customer with the self-assuredness that the promises will be kept.

Benefits for the Workmen

The part that this work plays toward labor is considered as important as if it is to have plans, schedules and standards, without the moral support of the employees the whole structure falls flat. To bring about a spirit of co-operation on their part a liberal incentive based upon the individual or group efficiency is offered. In addition special attention is directed toward furnishing facilities that will aid the workman in every respect; some of these include providing sanitary conditions, good light, heat and ventilation, proper guarding of machines to prevent injury, etc. Making boilers is a real man's work, and as such those engaged in this occupation should be shown consideration far in excess of that ordinarily found existing. We are not accustomed to hearing that financial assistance is secured through a concern offering as security a stable and contented labor complement; but this would be just as reasonable a basis as the accepted practice, if enough good, sound work was done to bring about a full understanding between employer and employee. It is important to those trying to bring about efficient conditions that the labor engaged in all activities comes in for its full consideration. The question of wages and labor's reward will always be a subject for contention between employer and employee when just labor is the subject, but where efficient labor is under discussion there can be no argument. Efficient labor must be rewarded directly with the degree of efficiency attained; other labor will continue to be bought at the prevailing market rate.

Efficiency work that is begun with definite and known ideals in view, and these correctly understood by all, should certainly not be the cause of any rebellious demonstration on the part of any employee, but, on the contrary, the work should be fostered by the employees themselves knowing full well that they are to be directly and currently rewarded.

To outline a definite plan of procedure that is applicable to all boiler shops is impracticable as it is impossible. It is the hope of the writer, however, that the material included in this article will aid many who are desirous of increasing the efficiency of their shops, or at least to bring about on their part a realization of what efficient methods will accomplish if carried to a reasonable degree of completeness.

The writer hopes to follow this article at some future time with one devoted to manufacturing costs, which is as important a factor in the commercial division of the business as the efficiency of operation is to the manufacturing division.

New Locomotives for the Atchison, Topeka & Santa Fe Railroad

The Atchison, Topeka & Santa Fe Railroad has recently put into service thirty-two four-cylinder balanced compound passenger engines of the 4:6:2 class, and twenty-nine freight engines of the 2:8:2 class, all of which were built by the Baldwin Locomotive Works, Philadelphia. The boilers of the passenger engines have radial stay fireboxes and are fitted with Schmidt superheaters, the superheating surface amounting to 619 square feet and the heating surface 3,444 square feet. Thirteen of the engines are oil burners, while the rest use bituminous coal as fuel.

In the freight engines the boilers are similar to those in the passenger engines, except that they are smaller. The safety valves are mounted over a 16-inch manhole back of the main dome. The openings for the dome manhole are in the third boiler ring, which has a welded longitudinal seam on the top of the center line. The joint is strengthened by a large inside liner cut from a single piece of 11/16-inch plate. The dome is of compressed steel in one piece, and the furnace equipment includes a brick arch and power-operated fire-door and grate shaker. The boilers are built for a working pressure of 170 pounds per square inch and use soft coal as fuel. The diameter of the boiler is 6 feet 6¾ inches, the shell plates being ⅞ inch and 15/16 inch thick. The firebox, which is of the radial stay type, is 9 feet by 6 feet 6 inches, the side, back and crown sheets being ⅜ inch thick and the tube sheet 9/16 inch thick. There are two hundred and forty 2¼-inch tubes and thirty-six 5½-inch tubes, all 20 feet long. The heating surface of the tubes amounts to 3,849 square feet; the heating surface of the firebox, 237 square feet; the arch tubes, 25 square feet, making a total of 4,111 square feet. The superheating surface is 880 square feet and the grate area 58.5 square feet.—*Engineering News.*

Countersunk Rivets on Boilers.—I have worked in locomotive-repair shops several years, and where the rivets are inside the firebox of locomotive boilers the use of countersunk rivets is quite extensive; in fact, on some, if not all, railroads, the rivets inside the firebox are countersunk altogether, more especially along the side sheets and flue sheets. The mud-ring rivets are below the fire and they are not always countersunk, but quite frequently are. It seems that the intense heat inside the firebox of this class of boiler burns off the heads if they are not countersunk nearly flush with the sheet. In putting in a heavy flue sheet in the firebox the edge of the flange is generally scraped down quite a bit for the same reason, for if it is left very thick the heat injures it and makes it crack and leak all the more quickly.—Harold J. Wilkinson, in *Power.*

Punching Effort

In punch work there are a number of influences which affect the effort necessary to punch a certain sized hole through a given thickness. Principal among these are the relative proportions of the punch and die, for if the punch fit the die snugly, not only is there shearing action to be overcome, but in addition, a considerable binding of the punching in the punched plate and die. It has been found that the effort required is materially increased when the fit is snug, this also tending to shorten the life of the punch. If, however, the size of the hole be slightly increased, within certain limits the punching effort will be decreased, and the life of the die and die are so proportioned that the shearing effort alone need be considered, neglecting the previously mentioned binding action. In it are tabulated the pressures required to punch 0.25 carbon steel of a tensile strength of 65,000 pounds per square inch. It consitutes a very convenient reference table, making unnecessary much of the routine work usually accompanying such problems.

The effort required to perform this work is found by obtaining the product of the circumference of the hole by the thickness of the plate, which represents the area under shear, and multiplying this by the ultimate shearing strength of the plate. That is

PRESSURES REQUIRED FOR PUNCHING

Pressures required to punch 0.25 Carbon Steel of 65,000 Pounds per Square Inch Tensile Strength
Circumference of Hole × Thickness of Plate (both in inches) × 50,000 = Pressure required in Pounds, approximately

Thickness of Plate, Inches	Diameter of Punch, Inches														
	1¼	1⅛	1	15/16	7/8	13/16	3/4	11/16	5/8	9/16	1/2	7/16	3/8	5/16	1/4
1/8	24600	22100	19600	18400	17200	16000	14700	13500	12300	11100	9800	8600	7400	6100	4900
3/16	36800	33100	29500	27600	25800	24000	22100	20300	18400	16600	14700	12900	11000	9200	7300
1/4	49100	44200	39300	36800	34400	32000	29500	27000	24500	22100	19600	17200	14700	12300	9800
5/16	61400	55200	49100	46000	42900	39900	36800	33800	30700	27600	24500	21500	18400	15300	12300
3/8	73600	66300	58900	55200	51500	47900	44200	40500	36800	33200	29500	25800	22100	18400	14700
7/16	85900	77300	68700	64400	60100	55900	51500	47300	42900	38600	34400	30100	25800	21400	......
1/2	98200	88400	78500	73600	68700	63800	58900	54000	49100	44200	39300	34400	29600	......	......
9/16	110400	99400	88400	82800	77300	71800	66200	60800	55200	49700	44200	38700	......	......	......
5/8	122700	110400	98200	92000	85900	79800	73600	67500	61400	55300	49100	......	......	......	......
11/16	135000	121400	108000	101200	94500	87800	81000	74300	67500	60900	......	......	......	......	......
3/4	147300	132500	117800	110400	103100	95800	88400	81000	73600	......	......	......	......	......	......
13/16	159500	143500	127600	119600	111700	103700	95700	87800	......	......	......	......	......	......	......
7/8	171800	154600	137400	128800	120300	111700	103100	......	......	......	......	......	......	......	......
15/16	184100	165600	147200	138000	128800	119700	......	......	......	......	......	......	......	......	......
1	196400	176700	157100	147200	137400	......	......	......	......	......	......	......	......	......	......
1⅛	220900	198800	176700	165600	......	......	......	......	......	......	......	......	......	......	......
1¼	245400	220900	196400	......	......	......	......	......	......	......	......	......	......	......	......

lengthened. Practice shows that for plate work, if the die be 1/32 inch larger than the punch, giving 1/64 inch clearance all around, conditions are much improved. However, if this amount be increased too much, the resulting punched hole will be conical in shape, and consequently it is inadvisable to increase the clearance above the amount stated.

The punch and die are both given clearance to facilitate stripping the punched plate and punching, respectively. In the die, this clearance is given in various ways. In some cases the inner wall is given a slight batter, the diameter at the cutting edge being as stated, and increasing slightly from this point down. In other cases, the wall directly below the cutting edge is left parallel for possibly ⅛ inch, with the hole enlarged for the remaining part of the die. Similarly, the punch is made either tapering gradually back from the cutting edge, or else receding sharply to a predetermined body size of uniform diameter. In bridge work the latter is more generally used, and is preferred, for the reason that when the cutting edges are dulled it does not bind like the uniform taper punch.

In the accompanying table it is assumed that the punch

$$P = \pi\ d\ t\ f_s,$$

in which

P = punching effort or pressure.
d = diameter of hole.
t = thickness of plate.
f_s = ultimate strength in shear.

For an example, consider a 1⅛-inch hole in a ¾-inch plate, where the shearing strength of the latter is 50,000 as on the data sheet. Then

$$P = 3.1416 \times 1.125 \times 0.75 \times 50{,}000$$
$$= 132{,}500 \text{ pounds.}$$

The employment of the table thus saves much work.

Punching, while not the best method of making holes in plates or structural shapes, is in almost universal use, with the possible exception of heavy marine boiler work, in which case it is customary to drill the rivet holes. The drilling process is preferred in that case, as punching has a tendency to crystallize the metal around the hole and weaken it, a condition that might prove fatal in large work, which is more subject to this action than thinner plates.—From *Machinery*.

John and the Diagonal Braces

BY JAMES F. HOBART, M. E.

"Mr. Hobart, is there any way of getting the length of a diagonal brace, besides trying it in place two or three times, or fitting a stick and then marking off the brace from the wood?"

"There surely should be, John; but first tell me what you mean by 'diagonal' braces? A fellow is apt to mean one thing while t'other chap gets something entirely different in mind, then both will argue for half an hour, both right from his own standpoint, but each wrong from the other's view. Now, just define exactly what you mean by a 'diagonal brace' and then we'll tackle it!"

"All right, here it is in Fig. 1. The brace is attached to opposite sides of a space, but the feet of the brace are not in line with each other and the sides of the space—sort of a 'jack rafter' business, you know."

"Oh, that's the way of it, eh? You want to find the length of a brace placed cornerwise of a space—a rectangular space

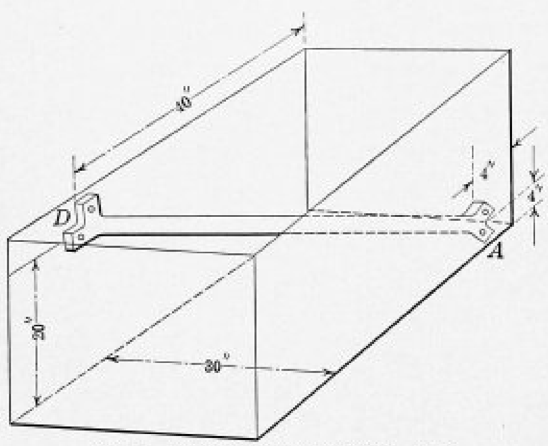


FIG. 1.—POSITION OF THE DIAGONAL BRACE

in this case, and the brace is to extend from A to D, being placed 4 inches from the bottom, top and ends of the space?

"Yes, that's the ticket. We have been getting the length of each brace by means of two sticks lapped past each other in the hand and extended until the ends reached A and D, then the sticks were clamped fast and the length measured. It is a slow, tedious way, and I often wished there was some other and more scientific method of finding the length of A D."

"I'll tell you about a couple of other ways, John; but you'll find the stick method a mighty fine and reliable way of 'getting there'—a way which requires no calculation and no work of any kind, except to place the sticks in position. Still, it has the disadvantage of not being able to determine the length of brace from a drawing, and that is something mighty important sometimes."

"That, Mr. Hobart, is one of the things we are up against now. We can't cut the braces ahead, and the work has to be made ready for the braces and then work must be stopped until the braces can be measured and fitted. We want to get the braces along with the other work, and as there are seldom two braces of exactly the same length, it holds up the work a good bit to use the stick method."

"All right—we will calculate a brace by figures, and then get the length of the same brace by means of the steel square and geometry. The geometry business comes in with the calculations as well. In fact, we have to cut a slice of geometry to be able to solve this problem at all, save by the stick method. John, do you remember, in one of our earliest 'talks,' how we found the long side (hypothenuse) of a triangle by taking the length of one leg on the blade of a square, the length of the other leg on the tongue, placing these points even with the edge of a straight-edge, and then measuring from one point to the other, for the length of long side required?"

"Yes, Mr. Hobart, I remember that!"

"Well, then, do you remember the rule for finding the long side by figures?"

"Yes, I believe I do. I had to use that the other day to find the length of a plain brace. It's this way, isn't it?—Add the squares of the two sides and extract the square root of the sum."

"That s right, John. You haven't lost that 'know-how' yet, have you?"

"No, and what's more, I never intend to let any of those things get away from me. They are mighty good tools to have in your kit, I tell you."

That's right; but also just remember that if you don't use tools, they will suffer from the neglect. If you neglect to use a physical tool it will, or may, rust out and become worthless. If you neglect to use a mental tool it will become worthless also. It will seem to slip away so you can't get hold of it when you need it the most. So get out all your mental tools once in a while and use them a bit. Just a little, even if it's only to work some problem in the book. If you use the dodges and short-cuts even only once a week or once a month, you will never let them get away from you or let them become covered and worthless with 'mental rust.' But if you don't run all these things through the mind once in a while, and pretty regularly at that, they will become so mentally rusty that you won't be able to get hold of that mental tool when you want to use it mighty bad—and even if you do manage to get hold of it, you will have to scrape off a whole lot of mental rust before you can make that tool work. So, go to it, John, and keep the mental tools in as good shape as the hammers and wrenches in your shop kit."

"Say, Mr. Hobart, that's some pointer. I wondered why it was that when I want to use one of the things we found in our talks that it was so hard to get hold of it again after it had been neglected for three or four months. The kinks and dodges which I use every few days seem to be always with me all right, but the others are harder and harder to bring to use again the longer they are left unused. Gee! But I never thought that there could be 'mental rust,' as well as iron rust and some other kinds. But there is, and it's up to me to keep my 'hat-tools' polished by using them pretty often. And I'll do it too! I'm not going to let a single one of those geometry tricks and tools get away from this chap—you just hear my air-gun pop, will you?"

"That's right. Just go after them all the time, in season and out, just as you do the tricks of baseball, and you will keep in condition all the time and be able to knock a home run every time you come to bat. Now, about that brace as shown by Fig. 1. What is the rise, run and reach of that brace?"

"Rise, run and reach? say—I didn't know a brace had such things! What are they, anyway?"

"There you go again! Didn't stop to think a bit, that time, did you? Say, you make me think of an apprentice I used to have in a jobbing blacksmith shop, one time, long ago. One morning I had a bit of work to do which required a certain kind of swaging; so I said: 'Bill, turn over the sow.' Bill looked all around, then turned to me and said: 'Where the h—ll is she!'"

"Say, Mr. Hobart, I bet I know now. The rise is the distance in Fig. 1 that is marked 20 inches; the run is that marked 40 inches, and the reach is that marked 20 inches also, the width of the tank in which the brace is to be placed."

"You've got the right idea, but not quite the right figures. For the rise, just look at *A* and you will find that the end of the brace is 4 inches from the bottom of the tank, hence there is to be 4 inches taken from the 20 inches, leaving 16 inches rise for the brace."

"Oh, yes! I see that now. And there will have to be 4 inches taken from the 40 'nches also, leaving the run exactly 36 inches."

"That's right, John, and as there is nothing to be taken from the reach, that dimension remains 30 inches, as shown for the full width of the tank, or 'space,' as we would call it were we full-fledged 'geometry sharps' instead of mere home-made, boiler-shop imitations! But the true rise, run and reach of brace *A D* is, therefore, 16 inches, 36 inches and 30 inches, respectively, as shown by Fig. 2. Now, John, bring out your rule for finding the third side of a triangle and apply it to this example. Take the run and reach first, because they are both horizontal. Now, what will be the length of the dotted line *A C*?"

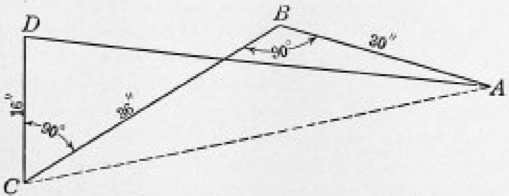


FIG. 2.—THE "RISE, RUN AND REACH"

"Oh, I see how you do it! Here it is all worked out:

$36 \times 36 = 1{,}296$
$30 \times 30 = 900$

Their sum = 2,196

The square root of this sum:

```
                     21'96 ( 46.8
                     16
                     ----
     2 × 40 = 80)    5'96
80 + 6 = 86 × 6 =    5 16
                     ----
   460 × 2 = 920   ) 80'00
920 + 8 = 928 × 8 =  74 24
                     ----
                     5'76'00
```

"That's right, John. The length of dotted line *A C* is 46.8 inches. And there is a small fraction of an inch more if you carry the process a little farther. But that is far enough, for we don't care for the length of *A C*, and can do the problem without finding that length at all."

"Say, how do you do that? You have got to find the length of *A D*, haven't you, and don't you first have to find the length of *A C*, then take that length and work it as the long side against the rise, 16 inches, in order to find the length of *A D*?"

"That's what, John; but just look here a bit: After you find the length of line *A C*, which is 46.8 inches, what do you do with it?"

"Why, square it, square 16 and add to it, then extract——"

"Hold on, John! So; as soon as you find the length of line *A C*, you proceed to square it, do you?"

"Sure, that's what the rule says!"

"Right, but when you want the square of 46.8, instead of that number, then why don't you content yourself with the number 2,196 and add the square of 16 to it, instead of extracting the square root of 2,196, and then immediately squaring that quantity again? What's the use, anyway?"

"Jingo crickets! Mr. Hobart—that's so, isn't it? And there is no need of that rooting and squaring at all, is there? And, say, why can't I just square the three numbers 16, 36 and 30, add their squares and extract the square root of their sum, as follows:

$36 \times 36 = 1{,}296$
$30 \times 30 = 900$
$16 \times 16 = 256$

Sum = 2,452

"And the square root of 2,452 = 49½ inches nearly. So, there you have it, John, without any further figuring—almost as good as the two short sticks, isn't it?"

"Yes; that gets it, all right, but I see a whole lot of trouble in locating the holes by that method. Where would you measure from in the crow-foot? From which hole, or from somewhere else?

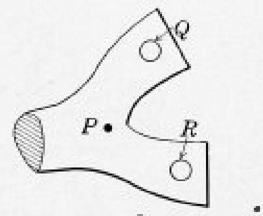


FIG. 3

"Any way you please, John. Perhaps the better way would be to make a center punch mark as at *P*, Fig. 3, placing this mark equidistant from either rivet hole, *Q* and *R*. Either end of the brace could be marked with a point the same as shown by Fig. 3, then both ends of the brace could be made from the same pattern and the calculated length would be from points *P P* at either end of the brace. And this point should be where a side or a center of the brace would naturally reach the wall of the tank or the side of the space through which the brace was to extend. Get that, John?"

"Yes, Sir, I got that the first time, and the holes came so fair I clapped in a rivet without using a drift or bolt. It sure came fair and plain!"

"All right; then I'll show you that other way of getting the length of brace *A D*, Fig. 2. Just take the length 30 and 36 on the blade and tongue of a square and place the——"

"Say, Mr. Hobart, throw the switch and clap on the brake. I haven't got any square which will let me take 40 on the tongue! The biggest square around the shop is a carpenter's steel square, with 24-inch blade and 18-inch tongue. Now how in misery am I going to take 36 and 30 on that?"

"Say, John, now you've dulled again and your soup brains sure need stirring up! How you kids do fire off your mouths sometimes without asking leave of your thinking machines! Say, what's the matter, if you can't take the 30 and 36 in whole inches, to taking them in halves, quarters, or even eighths of an inch——"

"Oh, say, Mr. Hobart, I didn't mean to make such a break as that. Honest Injun, I won't do it again. I'll take the lengths in quarter inches, and that makes 7½ inches and 9 inches."

"All right, John, measure across those points, or, better yet, place them on the blade of another square, with one point at the corner of tongue and blade, the other point will come mighty close to 11¾ on the blade, or, figuring it into quarters, 46.8 inches, same as was calculated. But never mind what may be the length on the blade. Just lay off 16 quarters = 4 inches on the tongue against the 11¾, and measure the new diagonal by placing the points 4 and 11¾ on the edge of the other square again. The distance from point to point will be found to be 12⅜ inches, which, upon being reduced to quarters, we find to be 49½ inches nearly. And John, if you don't have the second steel square, use the straight edge of a board or plate and mark the points thereon with a well-sharpened bit of soapstone. You can get the length in this way as closely as is necessary for accurate shop work. Now you have the three methods. Use them and practice, too, when you don't need to use them, so that they don't get covered with mental rust, lost, or misplaced in your think-tank."

"I'm on, Mr. Hobart. I acknowledge that I'm after the foreman's job, and I know that I'm a long way 'after it,' but not as far as I was last winter. I'll land that job before I'm twenty-five, or bust something. I realize that I have got my work cut out for me, but I can do it with the points you give me and the things I get hold of every day in the shop. Last winter I couldn't see any sense in lots of things they did, but

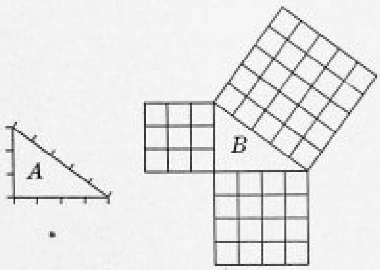


FIG. 4.—PROVING THE SUM OF THE SQUARES

now I can do a whole lot of 'em myself, and some of those things, I am sure, I could do in better ways than they are carrying them out."

"Go to it, John, it's the man who can do things better than other men that the owners want for foremen, superintendents and engineers. Go to it, and you'll get there, sure!"

"Mr. Hobart! Before you go home there's one little thing I wish you would clear up for me. In that long-and-short-leg triangle business, how do they know that the sum of the squares of the two short sides or legs equal the square of the longer side?"

"That is easily demonstrated. Just make a diagram and prove it. Take a simple triangle, with legs 3 and 4 long. Lay them down as at *A* (Fig. 4), and divide each leg into its number of equal parts, viz., 3 and 4, and then it will be found that the longer side will divide into just five spaces of the same length. Now, for the proof—$3 \times 3 = 9$; $4 \times 4 = 16$. And $9 + 16 = 25$. The square root of 25 equals 5, the length of the longer side. Now draw the figure shown at *B*, drawing all the little squares in place—9 of them on the short side, 16 on the long side, and 25 on the hypothenuse. And there you are, John. Those little squares prove the geometry of the matter right from the ground up. And there is another thing—the geometry sharps have a way of saying, which is the same thing in another shape, that the "product of the sum and difference of two numbers equals the difference of their squares. Fig. 4 will prove that matter, too. The sum of 3 and 4 is 7. The difference between 3 and 4 is 1, the product of 7×1 is 7. Now for the difference of their squares. The square of 4 is 16; less the square of 3, which is 9, the remander: $16 - 9 = 7$, as before. So they can prove their statement about the product of the sum and difference of two numbers being equal to the difference of their squares!"

"Suffering smoke-pipes, Mr. Hobart, those fellows can prove anything by geometry, it seems to me. Is there anything you can't do with it?"

"Not much, John, can be done without the assistance of geometry in one shape or another, directly or indirectly. It is a big help to a man, and the more he knows about it the more it helps him, and the easier he can do his work—and the better work he can turn out, too!"

"I'm going to soak in a pile of it, Mr. Hobart. Wonder if there is any danger of becoming geometry-heavy while doing it?"

"Not a bit, John, you can carry off every bit of it you can get!"

Welding Locomotive Boiler Tubes

At the annual convention of the American Railway Master Mechanics' Association, held in Atlantic City on June 11 to 13, the committee on designs, construction and inspection of locomotive boilers presented an interesting report dealing mostly with the maintenance of locomotive boilers. The committee had been instructed to investigate the results obtained by electric welding, and it also included results obtained by the oxy-acetylene process. Extracts from the report follow:

A road using the oxy-acetylene process welded in a number of small tubes and omitted copper ferrules, as with them they could not make satisfactory welds. The tube sheet was prepared, as shown in Fig. 1. View *A* shows a tube projecting through the sheet far enough so that when finished the beads will be the same size as when beaded in the regular manner. View *B* shows the tube after being welded. The same road also experimented with flues welded, as shown in Fig. 2. The tubes were allowed to extend through the sheet 3/16 inch, as at *A*, and were prossered and then welded as at *B*, after which a beading tool was used to smooth up the bead. These flues have been in service only a short time, but so far have been satisfactory.

Another road using the oxy-acetylene process for welding believes that the copper ferrules are not necessary. The flue sheet is prepared as follows: The old flue having been removed, the first operation is to draw the centers of the back and front flue sheets toward each other. The center of the back sheet is drawn forward about 1¾ inches and the front sheet about 1½ inches. This is accomplished by applying

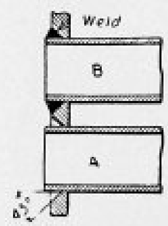


FIG. 1

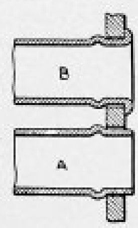


FIG. 2

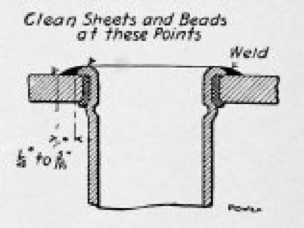


FIG. 3

eleven stayrods distributed in a circle about 2½ feet in diameter, one of the rods being located in the center. While these rods are under tension the back flue sheet is annealed around the edges by an oil torch. The rods are then removed, and there is a permanent dish in the back sheet of about 1¼ inches, and in the front sheet of 1⅛ inches. The holes are then countersunk on the fire side to a depth of ¼ inch. The flues are set in place, projecting ⅛ inch beyond the flue sheet, and are then rolled and welded.

One road had considerable difficulty with the large superheater tubes in the back flue sheet. One engine which had a flue mileage of 75,000 was brought to the shop and the large flues welded electrically. Nothing was done to the flues or beads except to clean them before welding. These flues were originally provided with copper ferrules. Metal was built around the head, as shown in Fig. 3, and the weld was made from the edge of the bead to the sheet. The reason that the ferrules and flues were prossered and rolled was that the welding was more in the nature of an experiment and proved so successful that the method was continued. The engine was placed in service, and has made 14,000 miles without giving any flue trouble.

From the reports received from different roads it was apparent that considerable difficulty is experienced in welding flues by the oxy-acetylene process, while with the electric process satisfactory results are obtained. One road especially tried out both methods, and has adopted the electric process for standard practice.

From cost figures given in the report it was shown that the cost of welding flues electrically is cheaper than by the oxy-acetylene process. The cost per flue is increased if the weld is made after the flues are set in the regular manner, but the maintenance cost is almost entirely eliminated and the engines can be kept in service a greater length of time. Present indications are that the flues can be run the three-year limit without removal.—*Power.*

Novel Feed Water Heater

Some time ago the the writer was visiting a small ice plant, and, among other items of interest, his attention was called to the method of heating the boiler feed water. The chief engineer of the plant said that the heater was proposed and installed by a local boilermaker who, while making some repairs on the boilers, suggested the installation of the heater.

In the boiler room of the plant there were two 150 horsepower internally fired boilers, carrying 125 pounds steam pressure. The smoke breeching from both boilers was connected to a 36-inch horizontal flue leading to a self-supporting steel stack outside of the building.

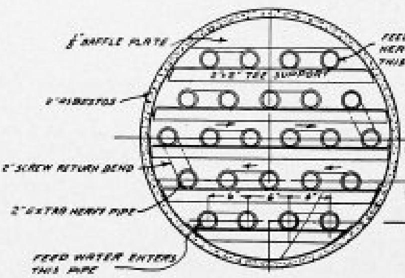
By aid of the sketch it is seen that the heater was placed inside the horizontal flue and was composed of twenty-four lengths of 2-inch extra heavy pipe connected to each other by inch bolts. To prevent a considerable loss of heat by radiation the flue was covered with 2-inch asbestos covering.

OPERATION AND RESULTS

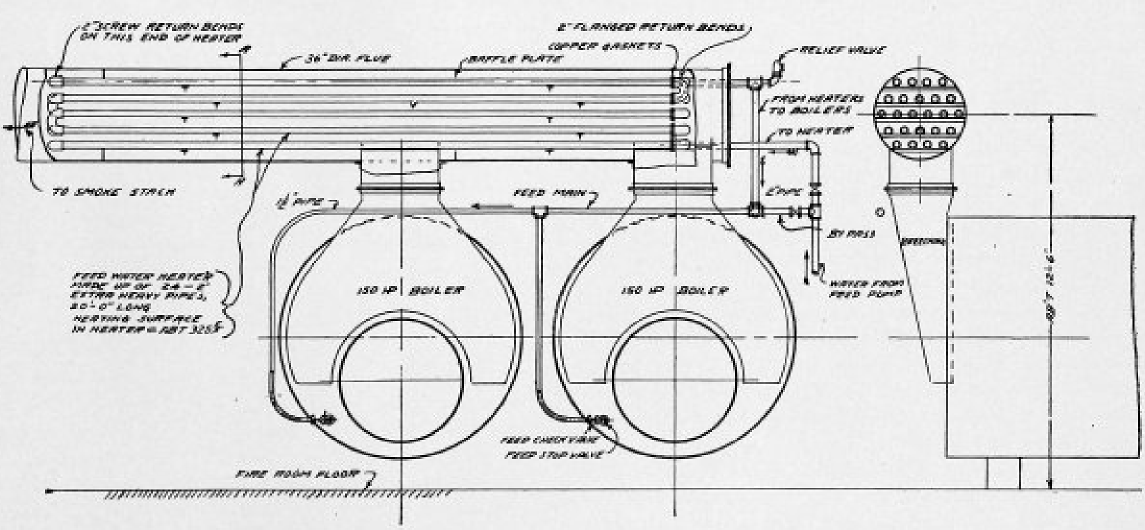
The water from the boiler feed pump enters the bottom of the heater and flows in succession through each pipe in the lower row, then up to the second row, through each of the pipes in this row, then to the next row, and so on, until it has passed through all of the pipes in the heater. The water then enters the boiler through the regular check and stop valves. There is a 1½-inch relief valve connected to the heater so as to avoid bursting the heater in case that the discharge valve on feed pump and the boiler stop valve were closed when the heater was full of water. Under such conditions steam might be formed and a dangerous pressure result if it were not for the relief valve.

In order to furnish water to the boilers at any time when the heater was out of order it was thought advisable to pipe up a 2-inch by-pass, so that it could be easily cut out. The heater herein referred to has been in operation three or four years, and at no time has it been necessary to use the by-pass.

There was much guessing among the engineers of this plant as to just what the heater would do. The twenty-four 2-inch



SECTION ON A-A



FEED WATER HEATER DESIGNED AND INSTALLED BY A BOILER MAKER

return bends so that the feed water from the feed pump would pass through all the pipes on its way to the boilers. As noted in the sketch, the bends on the end of the heater near the stack are of the standard screw type, while those on the opposite end, or towards the dead end of the flue, are of the tongue-and-groove flanged type. This latter style of bend readily permits of cleaning the pipes and also makes it possible to install the heater in sections or elements, each consisting of two pipes with flanges (to match flanged return bends) screwed into the screw return bend. These sections can be made up in the shop and easily placed on the supports in the flue, the flanged return bends then bolted on with 4⅝-

pipes were installed simply because that was the number of pipes which were left over from a previous refrigerating job and was not due to any calculations on heat transmission; in fact, none of the engineers was intelligent enough to make the simplest calculations along this line.

The two boilers were burning about 800 pounds coal per hour, and the temperature of the flue gas in the breeching was 575 degrees F. When the heater was put in operation the temperature of the flue gas varied from 400 degrees F. to 440 degrees F. This change in temperature heated the feed water from 180 degrees F. to 225 degrees F. The friction of the water in passing through the pipes was equivalent to about

5 pounds pressure. The draft in the flue was not lowered to any noticeable extent.

The coal consumption was reduced about 3 gross tons per week, or from 800 pounds per hour to about 760 pounds. In addition to the saving in fuel the fireman found it easier to keep up steam on the boiler when the fires were being cleaned. This was due to the storage of heat in the feed water which could be put in the boiler at almost steam temperature just after fires were cleaned.

This plant was operated equivalent to thirty-five weeks' full load during the year. The saving in fuel amounted to 3 tons of coal per week, which, at $3 per ton, is equivalent to $9 per week, or $315 per year. This was all clear gain, as no extra expense was attached to the operation of the heater. If the heater were to be installed in any plant where no available material was at hand, the cost would be about:

480 feet of 2-inch extra heavy pipe at 15 cents per foot..	$72.00
12—2-inch screw return bends at $1.80................	21.60
12—2-inch flanged return bends at $4.................	44.00
3—2-inch valves at $3..............................	9.00
1—1½-inch relief valve.............................	5.00
Tee iron for supports, bolts, gaskets, etc.,.............	15.00
Labor for erecting..................................	20.00
	$186.60

There is no doubt but that this type heater could be installed in a great many boiler plants similar to the one herein described. The heater would not cost over $200, and the saving in one year would probably be over $300. Thus the heater would pay for itself in about eight months, and ever afterward be netting a clear profit of $300 per year.

The writer wishes to call attention to the fact that boiler makers should be well informed on the subject of economical steam generation, so as to be able to advise the isolated plant owner on any subject pertaining to the care and efficient operation of steam boilers. ENGINEER.

Boiler Plate Corrosion by Paint

Professor C. Bach draws attention to a peculiar case of corrosion of a boiler which was quite recently brought under his notice by the manufacturers. The boiler had been installed four years ago, and an alarming corrosion was found on six spots of the internal furnace tube, which was partly plain and partly corrugated. On inspecting the boiler, it was noticed that the corroded spots were those where the stamps had been applied to show that the tests had been passed. To make these marks conspicuous, a ring of oil-paint had been drawn round each of these spots, and it was under the paint that the corrosion had set in. More than half the shell thickness had been eaten through in several spots. Under the microscope dark irregular patches, and also short streaky lines of paint, could be distinguished in the corroded areas. That oil paint may cause corrosion has long been known. It has also been asserted that rusting always begins in the layer of moisture between the paint and the iron surface, because there are potential differences between the iron and the pigment, zinc oxide, lead oxide, etc., of the paint. A peculiar statement has also been made to the effect that several coats of paint were, in general, worse than one coat, i. e., that iron would more rapidly rust when several coats of paint were applied to it than when only one coat was put on. One does not quite see why that should be, unless it be that a thick coat of paint is more apt to peel off and to let moisture get between the paint and the metal than a thin coat. At any rate, the case quoted by Bach should not be overlooked. As the paint was not meant to do more than to help finding the test mark, some unsuitable paint may have been used. Professor Bach does not discuss the particular, but he considers the case sufficiently serious to direct attention to it without delay.—*Engineering.*

Y and Elbow Development

BY C. B. LINSTROM

In accordance with T. F. E.'s request, which appeared in in October's issue of THE BOILERMAKER, the writer offers the following solution to the layout problem. According to the drawings furnished by the correspondent it will be understood that the *Y* portion of the connection is made up of a number of sections. This is also clearly shown in the accompanying drawings as at *C, D, E, F, G* and *H*. The object in view in making same in this manner no doubt is to use up some scrap plate. There are various ways of joining the elbows together without having so many sections in the object.

The first step in the solution of this development is to draw a view showing the respective parts in their relative position, as shown in a plan view in this case. As the large elbow and main pipe *K* are of the same diameter, it is obvious that the parts *C, D* and *E* can be readily constructed by projection, but in the drawings of sections *F, G* and *H* it will be noted that they are tapering and require, therefore, some other methods for producing their patterns. In this development they will be produced by the triangulation method.

CONSTRUCTION OF PLAN VIEW

Draw the horizontal line *R S* and erect a perpendicular as *A B* at right angles to it. The center for drawing the arcs of the respective elbows are both located on line *R S*, therefore from line *A B* lay off points *x-x* to the required distance, and therefrom erect perpendiculars as shown. Upon these perpendiculars lay off the respective diameters of the elbows as *c-d* and *c'-d'*. From the points *e* and *f* draw arcs. These represent the arc center lines of the elbows. To obtain the sections divide the arcs into one less than the number of sections desired. Divide the end sections so as to obtain half sections as at *X* and *Y*. The remainder of the elbow is constructed in the usual way. Sections *C* and *H* are shortened for the purpose of having straight portions in sections *D* and *F* where they join *K*, otherwise they would miter or join in an angle as indicated by the dotted lines. This would not be a satisfactory way of joining the pieces. The miter lines between the sections are established by construction. Having the plan view drawn, it is now an easy matter to ascertain the shape of the patterns. Draw profiles in *M* and *I*, which represent the shape of the elbow sections; divide them into any number of equal spaces. Through the points on the profile and parallel to the respective axes of the pipe sections draw lines which intersect in the miter lines between the elbows and *Y*. The lines of construction for parts *E* and *C* are then drawn in as shown in the plan view.

The development of patterns for *C, E* and *D* is, as previously stated, laid off by the parallel method.

Locate line *m-n* in view (*C*) and draw it at right angles to line *f-k*. This line is the stretchout line, and upon which spaces equal to those in one-half of the profile in *M* are to be placed. In the pattern of *C* this is clearly shown. The lengths of lines between the points on *m-n* in view (*C*) and points *f, g, h, i, j* and *k l* as *p q* are to be transferred to their corresponding positions in the patterns.

Pattern for *E* is laid out in a similar manner, and hence does not need an explanation. Pattern for *D* is a duplicate of *D* of view (*C*) and two are required.

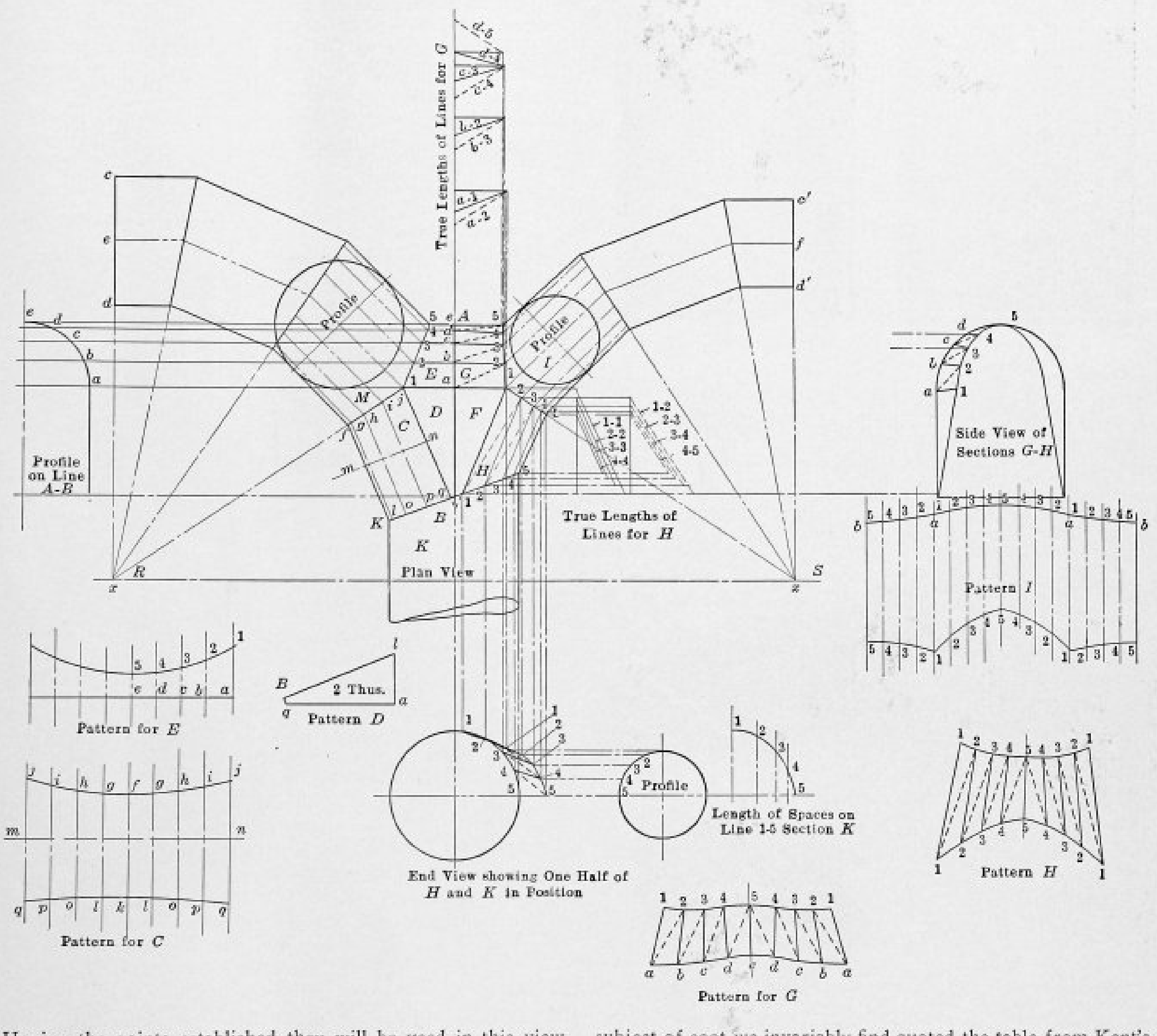
CONSTRUCTION OF SIDE VIEW AND END VIEW

Before patterns for the remaining sections *G H* and *F* can be laid off, additional drawings must be made showing the position of the foreshortened construction lines essential for complying with the requirements employed in the development by triangulation.

Having the plan view to work from, it is an easy matter to obtain the views mentioned. Below the plan erect the end view, but it is not needed to show the entire view, as enough data for the development of *H* can be found from a one-fourth view of this part of the *Y*. The circle represents a view through *K*. The irregular curved outline shows a section on the miter line between *H* and *I*, and it is determined by dropping perpendiculars from the points on the line as shown. Where horizontal lines projected from the profile intersect these perpendiculars just drawn fixes points in the curve. as that taken on *AB*, and which is drawn to the left of the plan view. The drawing to the right of the view pictures the shape of the sections *G* and *F* when *I* and *H* are removed from position.

Some Remarkable Examples of Soot

In talking of soot, the average engineer is liable to think of a soft carbon deposit such as is given by a smoky lamp on the chimney. That this impression of the character of soot that collects in boilers is widespread is evidenced by the fact that in practically all articles and catalogs dealing with the



Having the points established they will be used in this view for drawing the construction lines to the ones determined on the circle. Find their true lengths by erecting triangles, as are drawn to the right of *H* in the plan. Before the pattern can be laid off, it is necessary to have the true lengths of the spaces or the miter planes. These are usually taken from the distances between the corresponding points in the patterns of the parts to which they connect. In the top of the pattern for *H* they are taken from the relative distances in the pattern of *I*. In the lower part they would be obtained from the pattern of *K*. *K* is not shown developed, but the true spaces are obtained, however, by the development produced to the right of the profile in the end view.

Sections *G* and *F* join an opening in the shape of the profile,

subject of soot we invariably find quoted the table from Kent's Handbook giving the heat insulating values of different substances. The figure for lamp black is then used to show the harmful effect of soot accumulations on boiler tubes. As a matter of fact, the deposits that form on boiler tubes have a higher insulating value than lamp black because they increase the depth of the stagnant gas film as explained below.

Many engineers also seem to be under the impression that soot will only collect on boiler tubes when bituminous coal is burned. While it is true that soot, in the commonly accepted use of the word, is more liable to form in boilers burning soft coal, the accompanying photographs prove that the deposits actually found on the outside of the tubes of watertube boilers are composed of many substances besides soot (lamp black) and that practically all boilers, irrespective of the kind of fuel burned, are subject to these deposits. It is thus seen that the word "soot-cleaning" is a misnomer, unless we come to understand what really comprises soot in a modern boiler.

The photographs show that these deposits are largely made up of ash carried over by the draft and deposited upon the tube. They are also composed of inorganic matter from the fuel which volatilizes in the fire and then condenses when coming in contact with the comparatively cool tube. When the deposits first occur the ash is in the form of a dust or powder which can be easily removed, but if the deposit is

FIG. 1

FIG. 2

allowed to accumulate there is a very strong possibility that in time it will fuse together, giving some of the clinker formations shown. Undoubtedly the formation of this clinker, which accumulates on top of the first layers of powdered matter, is due to the fact that, as the deposit is allowed to become thicker, its heat insulating qualities become greater, therefore the hot gases can not come into contact with the cool

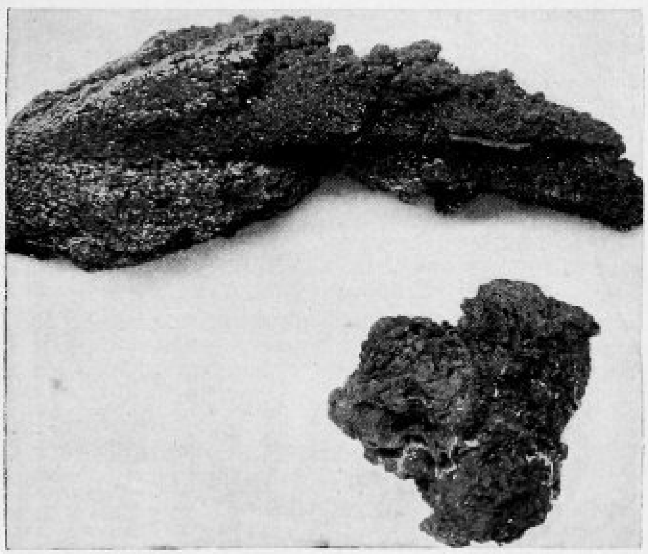


FIG. 3

tubes and finally the soot accumulation thickens until a temperature is reached which is sufficient to fuse the material in the top layers.

The sooty deposits found in modern boilers may be classified as follows:

1. Molten slag, which forms as stalactites on the lower row of tubes when set close to the fire. This formation is not common and cannot be blown off.

2. Clinker on top of the tube. Found only in the first pass. (See Fig. 1.)

3. Cemented mass of clinker. Found only in lower rows of first pass. (See Fig. 3.)

4. Scaly deposit due to moisture in products of combustion cementing the ash deposit. Frequently found throughout the boiler. (See Fig. 2.)

5. Loose soot; fine ash, clay and other earthy matter.

It is interesting to note that many of the modern tendencies in boiler practice are conducive to the formation of deposits such as those shown in the illustrations. One of these tendencies is the use of higher drafts and the forcing of boilers at continuous overloads. High drafts take up the lighter non-combustible particles from the fire and carry them over and deposit them upon the tube. The more general use of stokers also produces the same result; that is, the burning of larger quantities of fuel per square foot of grate area. High rate of driving also produces higher gas temperature throughout the boiler, making fusing more probable. The samples of soot illustrated herewith are not selected ones, but represent the general run of deposits now found on boiler tubes.

One of the harmful effects of such deposits, which up to the

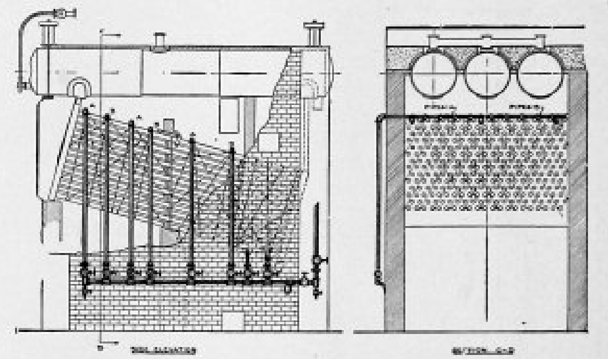
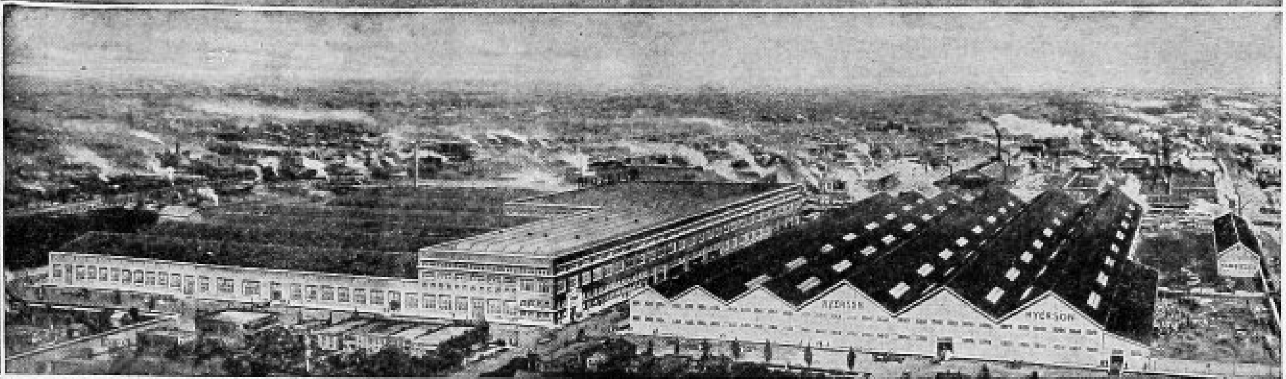


FIG. 4.—SOOT BLOWER INSTALLED ON B. & W. BOILER

present time has not been fully appreciated, is that besides its direct heat insulating values the porous character of the deposit forms a large number of small cells which are active in retaining the gases of combustion and thus greatly increase the depth of the stagnant gas film around the boiler tubes, which, as has been amply illustrated of recent years, has a marked effect upon reducing heat transmission. For instance, Prof. Dalby found that of the total temperature head necessary to force the heat from the hot gases of combustion into the water on the inside of the tube 90 percent is required to overcome the resistance of the gas film. While Mr. Hudson found that the gas side of the plate forming the heating surface was never more than 36 degrees hotter than the water side, an experiment by Sir John Durston proved the temperature of the gas side to be 58 degrees higher than the water side. In other words, the entire loss of temperature from the 1,600 to 2,000 degrees of the gases of combustion down to within 36 or 58 degrees of the water is due to loss through the gas film.

The formation of this porous clinker, which is so effective in entangling the gases and increasing the depth of the film, also renders ineffective the scrubbing action of high velocity gases in removing the film, which is receiving so much attention at present. Furthermore, when this clinker gets thick enough to bridge over adjacent tubes, as shown by the sample in Fig. 3, it seriously interferes with the draft. While most of the samples of soot shown were taken from horizontal boilers, vertical boilers are also just as liable to soot accumulations. In fact, most of the vertical boilers so generally used in New England are equipped with soot blowers.

With the undoubted fact before us that all boilers are subject to sooting which will greatly decrease efficiency, the problem is, then, how can this material be removed?



One of the most satisfactory methods of thoroughly removing soot and ashes is by means of a soot cleaner installed as part of the boiler equipment, such as shown in Fig. 4. This soot cleaner, which is manufactured by the Vulcan Soot Cleaner Company, discharges steam through perforated pipes and nozzles close to the tube surfaces. As a result, even the tubes in the center are as effectively cleaned as those on the sides; or in the case of boilers set in batteries, the tubes on the far side are cleaned as thoroughly as those on the alley side.

Superheated Locomotives*

BY P. C. LINCK†

In the designing and building of locomotives, the superheater appears to be the most important and valuable improvement applied to locomotives for years. It is claimed to effect a saving of 25 percent in coal, 35 percent in water and increase the horsepower or hauling capacity about 33 percent, while the cost of maintenance is comparatively little greater than saturated steam engines.

One of the most important items in maintaining superheater locomotives for successful operation is to keep the flues and superheater units clean. To obtain the best results a special man should be appointed to clean the flues, remove the clinkers or honeycomb that may form on return bends at firebox end, the crown sheet and the brick arch (if the engine is equipped with a brick arch). He should be held responsible that the engine is not allowed to go out without being thoroughly cleaned. For cleaning the flues a ⅜-inch gas pipe long enough to extend entirely through the flue should be used; this pipe to be inserted at the firebox end and gradually worked forward to the front end of the flue under the superheater unit, blowing the dirt off the front end of flue.

The flues should be given close attention; if leaking or they need reworking, the prosser expander only should be used; if the roller is used, it should be done carefully, as it tends to force the bead away from the flue sheet. If some of the beads are away, a standard beading tool should be used to tighten beads to sheet. Rolling also has a tendency to stretch flue sheet holes and put strain on bridges between flue holes.

At stated intervals the superheaters should be given a test with warm water at a pressure of about 100 pounds. If convenient, make this test correspond with monthly staybolt test. This test to include the boiler; seams and flues in front flue sheet should be carefully examined for leaks, all joints in the superheater steam pipes, rings, exhaust pipe, all joints to steam header; also for cracks or break in header, and the unit pipes just below the ball joint, as I understand on some roads this is where the most trouble is experienced. We have the most trouble with the return bends leaking at firebox end. These should be thoroughly inspected and the slightest leak repaired before the engine goes into service.

On one type superheater we have had trouble with steam pipes leaking. Considerable of the trouble was due to the rings made of brass; they seemed to deteriorate very fast. We have changed these to a good grade of cast iron. We also found the joints were not made perfectly; the joints would be faced, then ground in with air motor; they were probably ground too much, as they would appear to be a good fit, but on laying a straight edge across they would be hollow inside; if ring was not put in exactly central it would be on a strain, and leak in a short time; by seeing that joints are perfect and by using cast iron rings we have overcome most of this trouble.

We have experienced some trouble with both types of superheater unit pipes and return U's leaking where fitted together, generally at back end, but a few at front end. To make temporary repairs on the one type we plug the front end; but if left plugged too long, the back end will burn off, on account of having no circulation through pipe; as soon as practicable we remove the pipes that are leaking, repair, and test before replacing. These can be removed without disturbing the steam pipes on the outside ones; the boiler front has to be removed. We made a special flue cutter for cutting off superheater unit pipes at steam pipe connection, and rolls for applying as a regular flue.

The other type we have had very little trouble with steam pipes leaking. If the superheater pipe joint leaks at header or one of the return U's, to make temporary repairs we use a dummy coupler furnished by the Superheater Company. But as soon as possible we repair the pipe and test to see that return U's do not leak. We made a tool for testing one unit at a time; we used a piece of brass, making ball joints one side the same as on header and pipe connection on opposite side to apply the test. We had male and female reamers made so as to keep all joints standard and to make formers; these formers are made to fit air motors to be used in grinding the ball joints. On receiving general repairs, or when some of the superheater unit pipes have been out, we apply a hot water test and tighten all joints again after test. If any new pipes are applied, care should be taken that they are right length from header to bend, so they will be close to top of large flue, that heat and gases may circulate freely around pipes.

On receiving general repairs, flues or steam pipe work on one type, we remove the steam pipes and superheater unit pipes together. We have a boiler plate bracket to fasten and hold the pipes in proper position, handling them with the electric crane; they are repaired and joints made on steam pipes and given a hydrostatic test of 250 pounds. They are then handled with crane and replaced in engine. After all joints are tightened we apply a water test to see that all joints and connections are tight. The other type we handle one unit at a time; each unit is tested separately; we have a tool, which we mentioned before, that we connect to unit pipes and apply a water and air pressure of 200 pounds. Where one or two unit pipes are broken below the ball joint, it is the practice at some places to splice the pipe with a steel coupling, making the ball on short piece of the unit pipe in the smith shop, on a die similar to a bolt header die, afterwards finished to proper size. We have applied the ball end to new unit pipes in this way, finishing on turret lathe to a standard former for ball joint. We have just finished welding with acetylene a set of return bends on the firebox end, at time of this writing. The weld stood the 250-pound hydrostatic test, and made several trips on the road, with no defects developed yet.

The units should be provided with supports and bands to replace any that have been lost or damaged; units 18 feet long or over should have two supports, the first 6 inches from back end and the second midway between the first and the end of the straight portion of the unit. Unit bolts should be examined and replaced if not in good condition. Whenever units are removed from boiler, the tube supports and bands should be inspected and replaced by new ones if not in good condition.

We have made quite a number of small special tools; the formers for grinding superheater header and unit pipe ball joints we found gave the best service made of copper. We have reamers for these, so when they are worn or not standard, all that is necessary is to use a reamer to keep the formers standard. We made a cutter for cutting large holes in flue sheet, a ball reamer for removing sharp edge after cutting the holes, a roller for copper ferrules in back flue sheet, rolls for applying unit pipes on the Emerson, rolls and prosser expanders for working the large flues, machine for cutting

* From a report presented before the International Railway General Foremen's Association, Chicago, July, 1913.

†Address, 1106 E. Seminary street, Danville, Ill.

all size flues, gig to hold steam pipe rings, to be ground with air motor, one for drilling and reaming holes on superheater header, standard gages to keep all beading tools, prosser expanders and ball joints to a standard. These should be carefully checked, as an odd size beading tool or prosser may do considerable damage to the flue or flue sheet.

In renewing the flues at first we had to take the large superheater flues to the pipe shop, have the ends cut off in a pipe machine, back to boiler shop and weld on safe ends, back to pipe shop to cut right length. To avoid transferring, and to expedite the work, we had the flue cutting machine remodeled, the old machine worked with hand screw feed for cutting flues; we had new machine made with an air cylinder to feed the cutter through flue, also a clamp or steady rest to hold other end of flue while cutting; this operates with air; they are both operated by one foot pedal located about the center of machine, so the operator does not have to move from center of machine in handling the flues. The welding machine was changed slightly, and a new mandril made for welding the large flues. The flue plant is arranged so flues pass through with one handling; they are rolled out of cleaner on short inclined rails to flue cutting machine, passed on to furnace, then to flue welding, safe ends welded on, passed on to next flue cutting machine, and cut to rail length, passed to hydro-pneumatic testing machine, tested at 250 pounds pressure, then to grinder to have scale and burr removed, then loaded on car or wagon for delivery to engine or shipment.

In removing flues from boiler, the front end should be cut off as close inside the sheet as possible; the back end should be cut far enough to free it from prosser marks, or if safe ends have been applied they should be cut off to remove the old weld, maintaining only one weld on the swaged end of the flues. In cleaning the flues, care should be taken that there are no rivet heads or projections inside the rattler; the large flues are considerably heavier than the 2-inch or 2¼-inch flue, therefore must be handled more carefully, and any projections will dent the flues or cause the ends to start to crack, making it necessary to cut considerably off the flue in order to square up the end, or if dented and the dents not removed, it will make it difficult to insert the units in the flues.

The safe ending of the large flues is to be done at the firebox end, rather than smoke-box end; this provides new material where service conditions are most severe. It is recommended that the safe end be annealed after applied, in order to prevent liability of cracking and permit it being worked more easily in the flue sheet. When safe ends have been applied so that all space has been utilized between flue sheet and return bends, the flue should be reswaged, and a long safe end or extension applied to the front end of the flue, being careful to leave it smooth with no obstruction on the inside of flue that would prevent or make difficult to insert the units into the flue.

In welding 4½-inch tubing it is a good practice to scarf the safe end for a distance of about 5 to 8 inches and heat the end of the flue; bell-mouth it and insert the safe end while the flue is hot. This practice insures the piece sticking in the flues in proper place until it is heated and in position in the welding machine. It may be found, in attempting to weld the large flues, that trouble will be experienced in bringing the material down at the point of the weld uniformly to the thickness of the flue. The scarfing of the flue tends to lessen the difficulty experienced in bringing the metal down. It is important that the welded portion of the flue be smooth on the inside, thereby removing all obstructions and facilitating the cleaning of the flues.

On account of the weight of the flues, there may be some difficulty experienced in handling them. A heavy flue rest should be provided at the back of the welding machine and furnace, equipped with a spool or thimble, the same to be subjected to adjustment so that the flue may be uniformly supported and kept in line with the mandril and the furnace and the welding machine during the time that the heat is being made and the welding operation carried on. The difficulty in safe ending large flues may thus be readily overcome by the proper methods of handling, heating and a machine designed to do the work satisfactorily.

Among the general difficulties experienced in tube welding, in the past, has been the use of the improper dies, particularly if used on hammer welding machine; on roller machines, roller not properly adjusted, thus preventing the necessary pressure on the material, which must be obtained to secure a good smooth weld. Another trouble has been furnaces that do not heat fast enough, the result being an excess amount of oxidation or loss of material; furnaces where the heat is too harsh and the action of the air blast too severe on the material, resulting in a loss of material before the flue is ready to be taken from the furnace. Good flue welding demands that the flues and safe ends be heated in a furnace that gives a soft non-oxidizing heat, that will heat the material uniformly to a good welding heat as quickly as possible.

Installation of Superheater

In placing the header in the front end, it should be so set that the face will parallel to the center lines of the top row of flues, and each end of the face the same distance above center line of outside flues of the top row. The header supports should be securely bolted to smoke arch to hold header in proper place, and made so that the header will bear upon them throughout its entire width.

Care should be taken that the flue sheet is laid off the proper distance from the center of dry pipe flue sheet hole, and equal distances across; that it corresponds with header, and that units rest near the top of flue when they are tightened in place, that they may have free circulation, and flue cleaning pipe will go under the units. If the joints on pipe do not pull up true to correspond with holes in header, they should be bent or sprung in place and not be allowed to drag in place by turning up on the nuts. When the units are in place and tightened, they should be in the upper part of the flue.

When everything is tightened in place, apply a water test with 250 pounds pressure. After boiler has been steamed up and superheater tested with steam, the bolts should be gone over and tightened finally. Suitable wrenches should be provided that will reach all unit bolts. These wrenches consist of a single socket wrench made to fit nuts and clean unit pipes, with an extension long enough to allow a bar to be used in turning it without interfering with the units and short enough that it may be used without removing the table plate or damper. A peephole should be provided in the side of the smoke arch to permit the inspection of the front end flue sheet, superheater units and ball joint connections without removing the baffle plates.

All superheater flues should be beaded in front flue sheet. The baffle plates should be made to fit tight and should be so constructed that they can be removed without removing the door ring. The damper, when connected to steam chests, should be put up so that when weight is down the damper will be closed; when the weight is raised the damper should be open. When connected to the blower, its operating is reversed. Care should be taken that it operates freely.

Disastrous Explosion of a Watertube Boiler.—Seven men were killed and three seriously injured by the explosion of a boiler at the plant of the Richmond Light & Railway Company, Livingston, Staten Island, N. Y., on October 21. The boiler was of the vertical Wickes type, rated at 300 horsepower. The drums were about 7 feet in diameter and the boiler was carrying a pressure of 150 pounds per square inch. The failure occurred in the bottom head, which fractured on a line close to the flange of the head. The exact cause for the failure of the head has not been determined, as the metal showed no signs of wasting away.

Recording Memoranda on Accident Prevention*

BY THOMAS D. WEST

Every person exercising a supervising influence upon men, while seeing that he receives a full day's work from them, should interest himself keenly in the prevention of accidents. Very little attention was paid to the subject six years ago, but owing to the recent universal agitation along this line the present year, 1913, stands out as unexcelled in this respect.

In order to decrease the number of accidents materially, two factors must be taken into account. The first is that some accidents, or classes of accidents, could have been prevented by the simple exercise of judgment on the part of men who can reason. The other factor is the less patent one, as it has to do with happenings which cannot be foreseen. Thus a wreck may occur on a railroad either as the result of an open switch or a broken rail. The first case falls within the range of readily preventable accidents, as the man throwing the switch should have reasoned properly. The latter case, however, could not have been foreseen ordinarily as things go. It may be stated that for every one accident of the latter class there are many of the first which are readily preventable.

Even the development of the multitude of safety devices, though doing much good along correct lines, has not reduced the accident percentages to any very notable extent, simply because the personal factor—the continually anticipating what would happen if certain conditions would prevail—has not been emphasized properly.

It seems unfortunate that our social and business fabric is such that credit is given the man who cures rather than the man who prevents accidents to life and damage to property. Nevertheless, this should not deter us from doing our manifest duty as citizens and men in removing every factor that may lead to injury to or actual loss of life and property.

In the nature of things it is the supervisor of things and men, or the manager of works, who should anticipate possible injury by providing guards of the right kind. He who is deficient in this will soon become obsolete in industrial life. There need only be called to mind the many accident compensation laws passed by the different States between 1911 and 1913. The day has passed when a person may be maimed and receive nothing in the way of compensation. It would need only a few accidents of the very highly-paid kind to effectually put a firm out of business, even if covered by insurance, unless the resources were ample.

It is an idea of the author's, and which he has used in a limited way, that the supervisors of a plant should regularly make it a habit to jot down in a memorandum book any matter arising which might have led to an accident, and how this can be forestalled the next time. He has found this to work admirably, the cost is trifling, and need not be more than half a dollar a year per man acting as foreman, superintendent or manager. Either let the memoranda be jotted down during the day, or at home in the evening in thinking matters over. Doing this soon becomes as habit, and finally a satisfaction. If one can think, "Well, I saved that poor fellow's finger to-day," or maybe his leg or life, or prevented a mistake which would have cost heaps of money, this must be a genuine gratification.

While the keeping of such a memorandum book of risks annulled might be overdone by someone using it as a means of advancement for himself, yet employers of labor should foster the idea, and by showing a substantial appreciation, gradually encourage every one interested to do the same and thus enormously reduce accidents. Prevention is always better than cure.

It would indeed be well if regular blank forms were given to the supervisors of a plant with this purpose in view, as from the record of what occurred and what might have resulted therefrom will be learned the advisable safety devices a plant stands in need of specially. Moreover, this can be extended to include accidents of what might have been injurious to the property itself, and even the business.

He who has never given a thought to these things, on trying this memorandum record method, will be soon surprised to learn how much can be accomplished by it. He will soon see how many accidents and how much damage he can forestall in making his daily rounds about the shop and among the machinery. There will be many, of course, who will try this method and not find it help them much. This is a matter of individual disposition, and hence the system should not be condemned for failure when the real difficulty lies in the man who uses it.

The recent expansion of accident liability is quickly increasing the rate of those works in which the hazards are extra large on account of the indifference of the supervisors. It will eventually cause the rejection of many, or at least limit the compensation amounting to extra premiums. It is quite evident that the original plan that every line of business shall have a rating to cover all chances of accident within it will not hold. It will happen that individual concerns will find their premiums advanced beyond others, even if in the same line of work, according to the prevalence of accidents they have and the character of these accidents. The ultimate effect will be the bankruptcy of those concerns not giving proper attention to accident prevention.

State liability laws are being closely watched as to their effect, and some results have come that have not been anticipated, to the discouragement of those who are anxiously seeking proper protection while desiring justice for their employees. There is a general interest displayed, and the hope seems to prevail that everything will work out right and equitably.

Everything possible should be done by an establishment to hold its supervisors alive to the importance of preventing chances for accident, to adopt accident prevention and safety devices wherever possible, but not to depend upon these devices to the exclusion of the eternal vigilance required from every individual connected with the place to consider "safety first." It is admitted that all this makes an extra load to carry, but humanity alone would require it, if indeed the selfish side of it did not make it obligatory at the present time.

* From a paper read at the American Foundrymen's Association, Chicago, October, 1913.

Executive Committee of the Boiler Makers' Supply Men's Association for 1913-1914

E. T. Hendee, president of the Boiler Makers' Supply Men's Association, has appointed the following men as members of the executive committee of this association for 1913-1914:

Le Grand Parish, president of the American Arch Company, New York; Charles Dougherty, Ingersoll-Rand Company, New York; L. R. Phillips, National Tube Company, Chicago; George Seavy, Otis Steel Company, Cleveland; George Mason, Jr., Scully Steel & Iron Company, Chicago; George R. Boyce, A. M. Castle & Company, Chicago; J. W. Faessler, J. Faessler Manufacturing Company, Moberly, Mo.; Robert Scott, Independent Pneumatic Tool Company, Chicago, Ill.

W. H. S. Bateman, of the Parkesburg Iron Company and Champion Rivet Company, has been appointed chairman of the entertainment committee for the annual convention of the Master Boiler Makers' Association, which will be held in Philadelphia (the hotel to be announced later) on May 25, 26, 27 and 28, 1914.

The Boiler Maker

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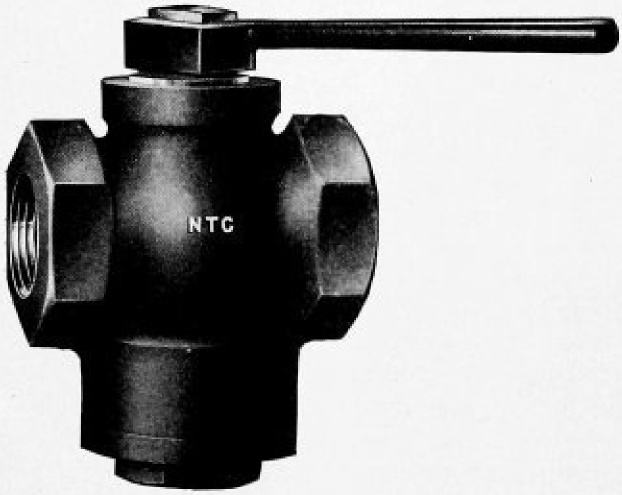
"Safety First" should be the watchword in every boiler shop. Wherever machinery is in operation, wherever heavy weights are handled, or wherever steam, compressed air or hydraulic pressure are used, danger in one form or another is usually present. Safety devices, such as have been introduced in recent years, may minimize the danger to a great extent, but they cannot be depended upon to cover wholly the mistakes of careless and inexperienced workmen. The responsibility for preventing accidents resulting from ignorance or recklessness lies with every man in the shop from the employer down to the newest apprentice, and a reminder of this fact should be constantly in evidence whether accidents are prevalent or not. Besides the ordinary safeguards that common sense will tell are a good investment for the prevention of personal injury and damage to property, a constant supervision should be maintained over every appliance and method of operation in the shop to discover defects and remedy them before failures and accidents occur. Instructions and warnings issued from time to time and displayed in conspicuous places in the shop serve a useful purpose as part of an educational campaign to distinguish between safe and dangerous methods of performing certain operations, but, as is pointed out elsewhere in this issue, the reduction of preventable accidents usually depends, more than anything else, upon the personal factor. Sound judgment and logical reasoning go a long way towards safeguarding life and property in the face of danger, and it is men who possess such characteristics that will look with favor upon the suggestion made that notes should be taken regarding matters that might have led to an accident and how that danger could be forestalled in future. Notes of this kind should receive careful consideration by the management and every man in the shop should be made to feel that it is a part of his duty to offer such suggestions.

The difficult job of laying out described on page 345 of this issue illustrates the advantage of close relationship between the drafting room and the shop. The work described was unusual both in point of size and in complexity. It consisted of two intake elbows of irregular shape, each built for installation in connection with an 18,500 horsepower turbine in a large hydraulic power plant. The preliminary calculations for the many triangulation schemes that were required for laying out the work were made in the drafting room, and the actual work of laying out was carried on in the shop by an expert in practical and theoretical triangulation. As the diameter of the elbow varied from 8 feet 1½ inches at the side outlets to 14 feet 1¾ inches at the bell mouth, and as the thickness of the material required for withstanding a working pressure of 75 pounds per square inch varied from three-fourths to one inch, it is evident that every plate and every hole had to be laid out with precision, so that when the elbow was finally assembled it would conform exactly to the required dimensions. The weight of the material precluded any sledging or pulling into place that might have been resorted to with lighter material. Although the actual dimensions needed by the layer out for each plate were comparatively few, nevertheless the computations involved in working out the triangulation sheets in the drafting room were very extensive, and it is evident that to accomplish work of this kind efficiently the work in the shop and the work in the drafting room must be closely related. Too often in work of this kind there is a tendency to cut down drafting room expenses by placing the burden of working out detailed calculations on the layer out in the shop, whereas the work could be done more quickly and with less interference in the drafting room, and at the same time the layer out with complete drawings and detailed calculations at hand could push the work through the shop without delay so that the entire job could be manufactured more efficiently. It is usually a sign of poor management when an attempt is made to reduce the expenses of an individual department by throwing the burden on some other department not so well fitted to perform the same work. It would probably surprise some managers to find out exactly how much time is spent by the men in the shop trying to read the drawings furnished from the drafting room. Unless the drawings are clear and complete, time which should be spent in getting out the stock and preparing it for fabrication will be wasted in trying to interpret misleading or indefinite drawings or correcting needless mistakes. Both the laying out and drafting departments should work together.

Engineering Specialties for Boiler Making

National Spring Plug Cock

The National spring plug cock, manufactured by the National Tube Company, Pittsburg, Pa., was designed to overcome the disadvantages of the ordinary style or through-plug cock. When the plug becomes loose in the ordinary type of



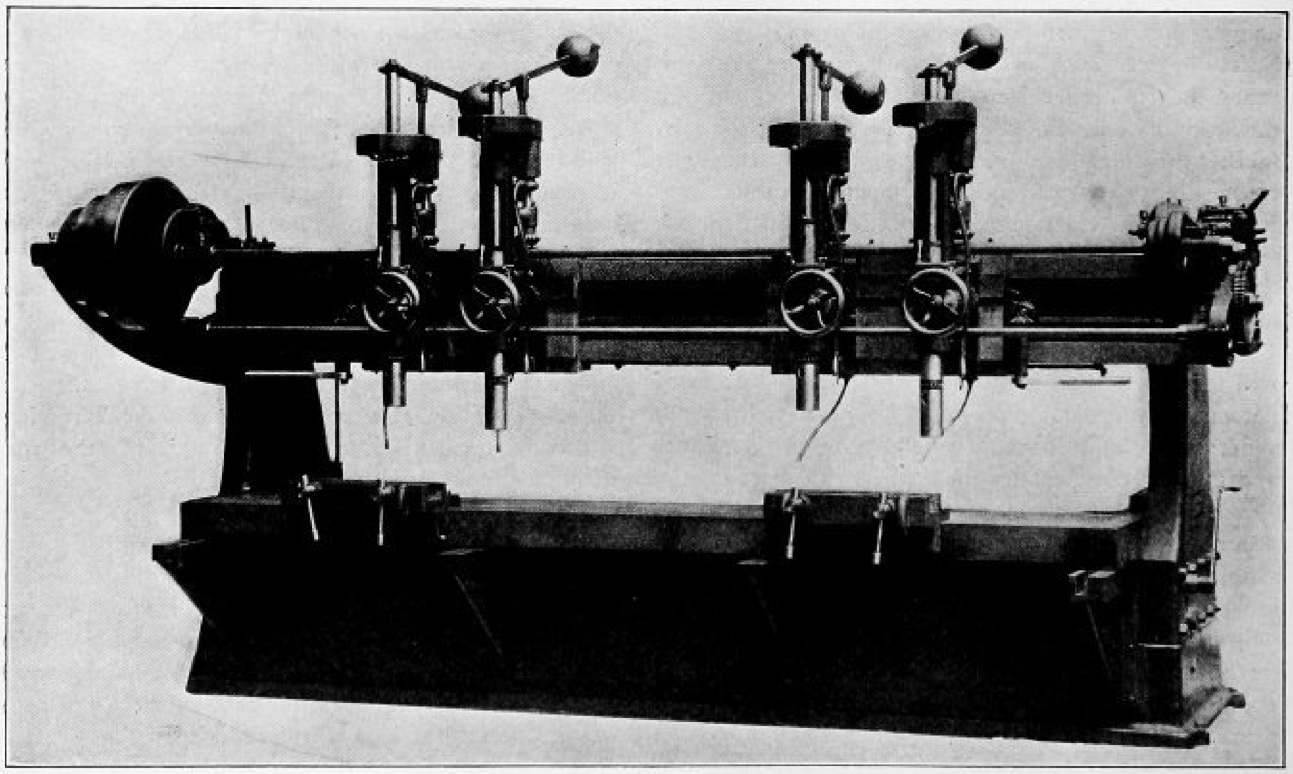
cock, the workmen frequently injure the plug in tightening it. Also, if the plug becomes cemented to the body, it is common practice to loosen the nut and drive up the plug with whatever tools are at hand, no special care being taken to properly adjust the plug afterwards. The National spring plug cock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

No. 2 Mud Ring and Flue Sheet Drill

The four-spindle drilling machine illustrated, which is manufactured by the Foote-Burt Company, of Cleveland, Ohio, is built for use in railroad locomotive boiler shops and general boiler shops for drilling the rivet holes around a mud-ring and for cutting out the flue holes in a flue sheet.

The spindles are of the independent feed type, each one being arranged with automatic knock-off to the power feed, and the quick return of same is taken care of by the use of a hand wheel located on the front of the head. Each spindle is also arranged with a clutch for stopping and starting and with an interlocking mechanism so that the feed cannot be thrown in with the spindle stopped or vice versa. With this independent feed feature some of the spindles are always drilling while the operator is setting the other spindles, so that the full efficiency of both the machine and the operator is obtainable, and no time is lost as on the gang feed type of drills.

The spindles of this machine are arranged in pairs which are mounted on auxiliary cross-rails, and the spindles are adjustable on these cross-rails to a minimum center distance of 8 inches. The advantage of this feature is that it is possible to set the spindles to the proper spacing of the rivet or flue holes, and then adjust two spindles along the main rail of the ma-



chine, maintaining the proper spacing and eliminating the necessity of spacing each one individually.

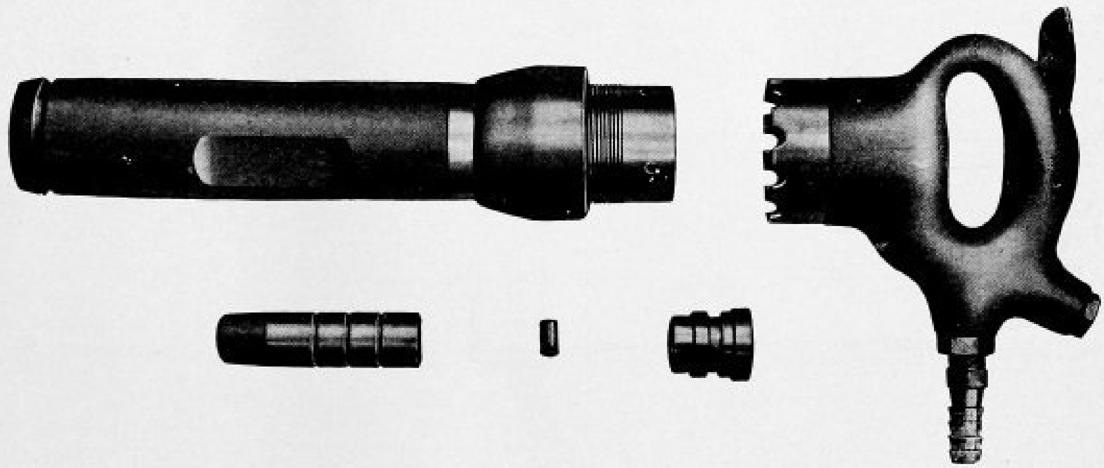
The spindles overhang the front edge of the base 8 inches to take care of the mud-ring work, and the table is provided with chucks for holding the mud-rings. The table has an in-and-out motion of 36 inches, and is supported out under the spindles by the bracket slides on the front of the base.

Three changes of power feed are provided, any one of which is instantly available by simply shifting a lever at the right-hand end of the machine. Six changes of speed are provided by three-step cone and throwout back gears. The machine weighs approximately 21,000 pounds.

Pokorny Riveting Hammer

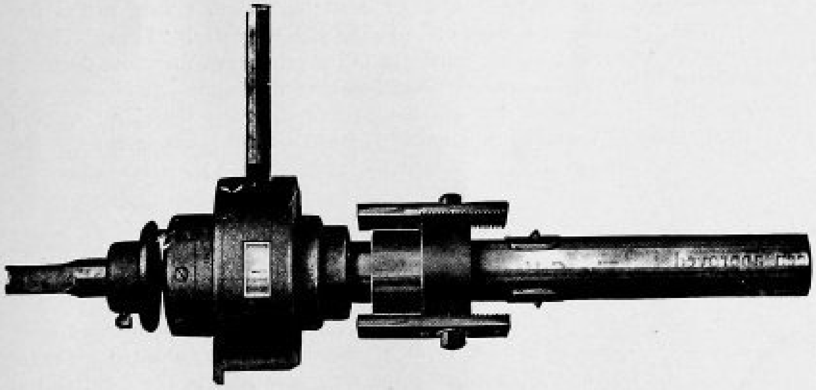
The Wiener Machinery Company, New York, has on the market a line of pneumatic tools and appliances known as the "Pokorny" tools, one of which, a riveting hammer, is illustrated.

The "Pokorny" hammers are built without a valve box. They have a patented tubular valve which is designed in such a manner that the piston goes through the valve, thus enabling



the production of a very short tool, maintaining, however, the full length of stroke. In consequence of this design it is claimed the workman does not feel any recoil when handling the tool, because the valve provides a proper air cushion for the piston.

Care is taken also to prevent the piston from falling out. A special tapered form of the piston and a ring placed inside of the barrel prevent this and also prevent injury of the piston by this ring. Furthermore, the button sets are provided with a



circular notch and spring ring, so that the button set cannot fall out, even should the air valve of the hammer be touched accidentally. The piston is stopped by the previously-mentioned ring, and the button set will only slide out about ½ inch, after which it cannot be hit by the piston.

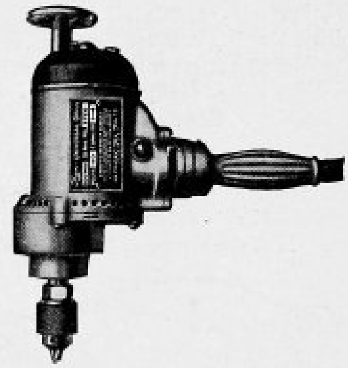
The Pokorny hammer is made with a minimum number of parts, and operates very economically on air at about 95 pounds pressure. The rivets are driven very quickly, which means that the rivet head is formed while hot. The hammers are made in various sizes, capable of dealing with rivets up to 1½ inches diameter. The piston diameter in each hammer is 1 3/16 inches. The piston stroke varies from 4¼ inches to 10¼ inches; the total length of the tool from 14 3/16 inches to 22 1/16 inches, and the weight from 19⅞ pounds to 27½ pounds.

"Number 3" O'Neill Rapid Tube Cutter

Christopher Murphy & Company, Chicago, Ill., have put upon the market a new size O'Neill rapid tube cutter for locomotive superheater tubes. The tool, which they call "Number 3," cuts tubes either inside or outside the flue sheet, and takes all sizes from 4½ inches diameter to 6 inches diameter, inclusive. The tubes are cut with roller cutters on about a 45 degree bevel, which do not require retrimming after being taken out. Cutting close to the flue sheet saves something in the length of the tube, which is no inconsiderable item, especially with large tubes. Furthermore, it is claimed that roller cutters do not strain or tear the tube. Taking several sizes requires but one machine for tubes that are swaged down at one end.

Thor Electric Drill

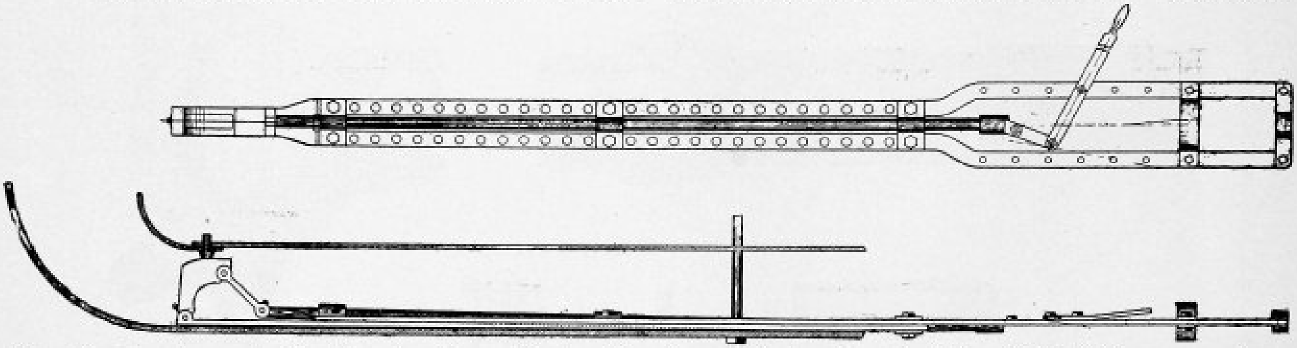
The illustration shows a marvelously compact tool, manufactured by the Independent Pneumatic Tool Company, Chicago, for drilling in steel or wood on 110 or 220 volts, direct



or single-phase alternating current. The tool is built in two sizes, with a capacity for drilling ¼-inch and 5/16-inch holes in steel or ⅜ inch and ½ inch in wood. As the tool can be attached to an ordinary incandescent lighting socket, with alternating or direct-current line, its usefulness is apparent. The spindle and armature shaft are suspended in roller and anti-friction ball bearings. The revolving parts, it is claimed, are perfectly balanced, insuring absence of vibration with great speed and power. The case is made of aluminum, and an ingenious switch at the throttle prevents short circuiting or arcing, and allows interchange of different extension lengths of cord. The brush holders are automatic and self-adjusted, and the armature is quickly accessible for cleaning by the removal of one nut. The motor is air-cooled by drafts of air drawn through perforated holes in the brush cover at the top of the drill, passing the motor and ejected through a number of small holes around the case, which connect with a groove on the outside of the fan. These tools weigh 6 and 7 pounds, respectively. The speed under load is 1,500 and 750 revolutions per minute, and the reaming capacity 3/16 inch and ¼ inch.

New Device for Holding on Rivets in Firebox Side Sheets

Boiler makers familiar with the ordinary methods of holding on rivets in the side sheets of locomotive boilers realize that a number of different sized cups are required and also wedge bars of different lengths and thicknesses. With this method time is required to put the cups on the rivets and also to put



the wedges in place and drive them in. Frequently, too, the cup will slip off the rivet head, and the rivet will get cold before the head is formed, and sometimes it becomes too cold to loosen the wedge bar after the rivet is finished. To overcome such difficulties, Mr. H. Kroskovski, 128 Ferry street, Milwaukee, Wis., has invented a holding-on device which, by means of a powerful leverage, operated by hand or by pneumatic or hydraulic power, enables the workman to drive the rivet while it is hot and to quickly release the holder-on without the necessity for driving in or loosening wedges. The construction of the machine is simple and can be seen from the illustration. It is so designed as to reach any part of the firebox on the locomotive boiler, and is supported by a bolt through a staybolt hole or from the mud-ring. Dies of different sizes can be used, but all are 1½ inches long. The use of this device, the inventor claims, saves time, prevents the holding-on die from slipping off the rivet head, and enables the workman to drive the rivet while it is hot, and to do a first-class job in a minimum amount of time.

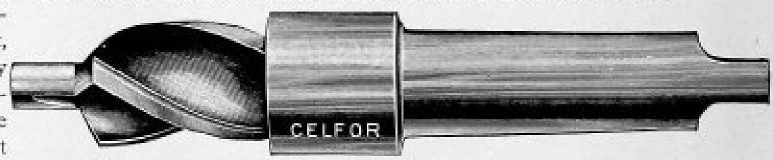
"Saniglas" King's Safety Goggles

The "Saniglas" King's safety goggles, manufactured by the Julius King Optical Company, New York, has been approved

by the American Museum of Safety and has been standardized by many of the largest steel mills, railroads and manufacturers in the country. In these goggles the glass is absolutely transparent, and is the strongest and toughest that can be manufactured. As in the case illustrated, flying particles of steel may fracture the glass but it holds together and very seldom shatters. The frames are made entirely of white metal, which will not corrode. No leather, cloth, velvet or chenille is used in any part of the construction of the frame, so that the goggles are thoroughly sanitary and can be sterilized. The goggles are made with different heights of bridges and assorted widths between the eyes, so that a frame may be selected that will conform to each individual case and can be worn with comfort. As fully 50 percent of the accidents which happen in industrial plants affect the eyes of the workmen, serious consideration should be given to the proper protection of the eyes of the workmen.

"Thread-Tight"

In an article on page 337 of our October issue it was erroneously stated that "Thread-Tight" was furnished by the Nathan Manufacturing Company, New York. "Thread-Tight" is manufactured by the "Thread-Tight" Company, 2 Rector street, New York. It is a compound for making tight either screwed or flanged joints on high-pressure steam, ammonia or



pneumatic lines, high-service hydraulic work, acid lines, gas piping, or boiler caps, manholes, etc. It is claimed by the manufacturers that neither heat nor cold will affect the compound, and that it can be put on a wet surface, such as an iron pipe submerged in water, and that it will adhere to the wet surface as firmly as though the pipe were dry. "Thread-Tight" does not become hardened in the joints, and therefore does not injure the threads when breaking the joints. It is used as a preservative for gaskets, preventing their deterioration, and the gaskets are readily removed should occasion arise.—*The Engineer.*

The Celfor Flue Sheet Drill

The Celfor Tool Company, Buchanan, Mich., has on the market a special flue sheet drill. It is three-fluted in form, and is twisted from an especially rolled section of high-speed steel. There is a pilot ½ inch long, and of any desired diameter which is intended to enter the punch hole in the sheet and to guide the drill. The drills are furnished in sizes ranging from 1¾ inches to 2½ inches, and are furnished with a No. 5 Morse taper shank unless otherwise specified.

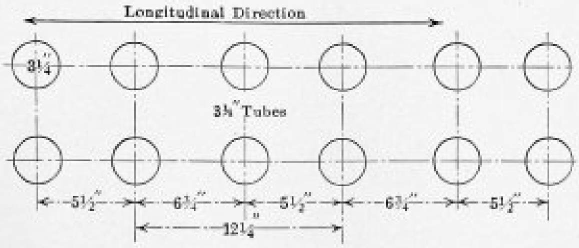
BOILERS IN NEW ZEALAND.—In New Zealand all steam boilers, other than on government railway locomotives, must be certified to be safe for work by the inspector of Machinery Department every year. In its annual report to Parliament the Department states that during the past year 7,011 boilers were examined, and that in 1,239 cases defects were discovered, of which 33 were very dangerous.

Letters from Practical Boiler Makers

Bursting Pressure of Tube Ligament in Stirling Boiler

The questions and answers which appear on page 338 in the October issue of the paper interest me, particularly Question No. 10, because there are many who do not seem to understand what is involved in figuring the strength of the tube ligaments in the type of boiler referred to in the question, nor how to proceed to make the calculations.

I think it will be found that in many, if not in all, Stirling boilers the tubes are spaced as shown in the accompanying



TUBE HOLE SPACING IN DRUM OF STIRLING BOILER

sketch, and placing the dimensions given in Question No. 10, the method of finding the strength of the ligament is this:

$$\frac{12.25 - 6.5}{12.25} = .469, \text{ say 47 percent.}$$

This is from the formula $\frac{P - 2d}{P}$, in which

P = the pitch in inches to be considered for a given strip.

d = diameter of the tubes in inches.

The pitch to be taken with the arrangement of tubes shown is 12.25 inches, in which there are two tube holes to be subtracted, as a close inspection of the figure will show. Thus the efficiency of the ligament may be accounted as 47 percent; then, to find the *bursting* pressure of the drum under the considerations of the question, we find

$$\frac{.375 \times 55{,}000 \times .47}{18} = 538.5 \text{ pounds per square inch.}$$

The question also calls for the *bursting* pressure when taking the strength or efficiency of the riveted longitudinal seam into account.

The pitch of the rivets is 3 inches, ⅞ inch diameter (which means 15/16 inch driven, double riveted lap joint with steel rivets. The strength of a given solid strip of plate under the terms of the question is

$3 \times .375 \times 55{,}000 = 61{,}875.0$ pounds per square inch section.

With 15/16-inch holes, or .9375 the decimal equivalent, the net section of plate will be

$$\frac{3 - .9375}{3} = .6895 \text{ or } 68.95,$$

say 69 percent, of the strength of the solid plate.

But the rivets are to be considered also. There are two rivets in single shear in a given strip, and as they are steel, and in single shear, 42,000 pounds per square inch is usually allowed. The area of a 5/16-inch rivet is .6903 square inch. The statement becomes:

$$2 \times 42{,}000 \times .6903 = 57{,}985.2 \text{ pounds.}$$

This, compared with the solid plate, is

$$\frac{57{,}985.2}{61{,}875} = .93, \text{ or 93 percent.}$$

Therefore, as far as the riveted joint is concerned the plate section is weaker than the rivet section, so the statement becomes

$$\frac{.375 \times 55{,}000 \times .69}{18} = 788 \text{ pounds,}$$

closely, bursting pressure as related to the riveted joint.

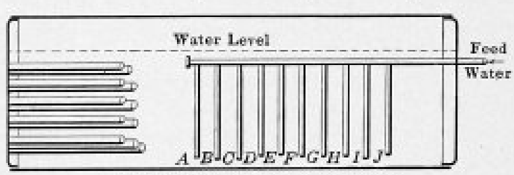
The safe working pressure will be based on the 538.5 pounds value found. In the neighborhood of 100 pounds per square inch will probably be allowed. CHARLES J. MASON.

An Unnecessarily Elaborate Feed Water Pipe Design

An example was recently called to my attention where a designer tried to get around the dangers that usually accompany the injection of cold water into a boiler Said he, "Why not keep the water away from the tubes and boiler shell until the contained water is as hot as the steam in the boiler, or nearly so? Excessive contraction, stresses and grooving would be effectively stopped." So he designed a feed water pipe about as shown in the sketch entering at the rear of the boiler, and with small pipes tapped into it extending downward to within about 6 inches of the bottom of the boiler.

"Weisenheimers" told the designer that his system would soon choke up with scale and that he would have no end of trouble with it, but he influenced the company to try it out, anyway, pointing out the practicability of converting the design back to the old method should this one fail.

Apparently the scheme worked well. The pump never gave a sign of excessive pressure. The designer was slapping himself on the back and was boosting his process among fellow deigners. He did this prematurely, however, as he soon



UNUSUAL FEED PIPE ARRANGEMENT

learned. In fact, under the circumstances, he should not have boosted it at all.

After six months, at which time he was advocating his scheme for further installations, a superior suggested that some of the pipes in the boiler actually installed be examined.

The designer was enthusiastic about an examination himself. Accordingly, next time the boiler was cleaned, some of the pipes were removed, and those not removed were examined by means of wires. The pipe *A* was completely choked. So were *B*, *C* and *D*. *E* was almost closed, and *F*, *G*, *H* and *J* were comparatively clean. There was some scale in all of them.

Undoubtedly the velocity of the water through *J* and adjacent pipes was always higher than through the endmost pipes. Hence the latter heated the water hotter, precipitated scale first, and thus cut down the velocity even more. Despite the heat insulating property of scale the water in the scaled pipes still had sufficient time to be heated beyond the temperature of precipitation, with the result that the end pipes were soon completely plugged. As for pipes *F*, *G*, *H* and *J* sufficient scale formed in them to maintain a temperature lower than that of precipitation, the velocity in these pipes constantly increasing as the end pipes choked.

The method was abandoned for further use, inasmuch as it did not seem to present any distinct advantages over the usual practice of exhausting through a single ample-sized pipe. Where the feed water is absolutely free from scale it would seem, however, that such a method as this should possess merit.

New York. N. G. Near.

Comments on Questions and Answers

The following comments are offered regarding the questions and answers published on page 338 of the October issue of The Boiler Maker:

Question No. 2—The answer to this question seems to be entirely wrong. Steam at 25 pounds pressure occupies 2.6 times the volume of steam at 100 pounds pressure, hence for the same velocity of steam through the valve and capacity, a safety valve for 25 pounds steam pressure would be about 2.6 times the area of one for 100 pounds steam pressure.

The Massachusetts formula is

$$A = \frac{W \times 70 \times 11}{P}, \text{ in which}$$

A = area of valve in square inches for each square foot of grate surface.

W = pounds of water evaporated per second per square foot of grate surface.

P = absolute pressure per square inch.

From this formula it is seen that as P the pressure grows larger, then A, the area of the valve, becomes smaller.

The last sentence in "Answer No. 2" does not seem correct. With the lower steam pressure the temperature within the boiler is lower, and hence there is a greater thermal head between the flue gas temperature and the water, also it requires less heat to generate 1 pound of steam at 25 pounds pressure than is required for steam at 100 pounds pressure. These last two facts show that with the same condition of furnace, boiler, etc., steam would be generated faster in a low-pressure boiler carrying 25 pounds than in a high-pressure boiler carrying 100 pounds pressure.

Question No. 4—It is not customary, nor is it necessary, to bead the tubes in watertube boilers. It is done in firetube boilers to prevent burning the end of the tube. In regards to flaring, the answer is correct.

Question No. 5—This could have been answered in a more explanatory manner. Many boilers, such as Babcock & Wilcox, Heine, Hornsby, etc., do not allow for any expansion. This is a defect in the design of these boilers, and often results in considerable trouble from leaky tubes. It is a very common occurrence to find the lower tubes in a Babcock & Wilcox boiler sagging 3 or 4 inches below their original position. One of the best features in the design of the Stirling boiler is that each tube can expand or contract independent of all others.

Question No. 6—The question implies boiler feed water, and not chemically pure water. Lime and magnesia salts should have been the answer.

Question No. 7—One pound of carbon burned to CO_2 yields very nearly 14,650 British thermal units.

Question No. 8—The question seems perfectly clear. Ans.: Ascertain the volume in cubic feet of the pounds of steam to be generated each minute; divide this by 6,000, and the answer will be the required cross section area (in square feet) of the header.

Question No. 9—Combustion is the chemical change which takes place when the oxygen in the air unites with the carbon and hydrogen contained in the coal. The result being the formation of two entirely different substances—carbon dioxide and water.

Question No. 10—All the information necessary is given in order to answer this question, although I believe that the tubes are spaced 5¼ inches and 6¾ inches, and not 5½ inches by 6¾ inches, as stated. The former spacing is standard practice. The fundamental formula for bursting pressure of thin cylinders is

$$pd = 2\,t\,S,$$

in which p = bursting pressure = ?

d = diameter of cylinder = 36 inches.

t = thickness of plate = 9/16 inch.

S = tensile strength = 55,000.

Let e = efficiency of the joint or the ratio of the section of plate before cutting tube holes to that remaining after cutting.

Then $pd = 2\,t\,Se$.

$$p = \frac{2\,t\,Se}{d}.$$

In the Stirling boiler two holes, 3 9/32 inches diameter, are cut out of every 12-inch length of drum, hence there remains to overcome the pressure only

12 inches — (2 × 3 9/32) = 5 7/16 inches = 5.4375 inches, and then

$$e = \frac{5.4375}{12} = .453,$$

and

$$p = \frac{2 \times 9/16 \times 55{,}000 \times .453}{36}$$

= 778 pounds per square inch = bursting pressure of two ligaments between three tubes.

2. The bursting pressure of the joint.

If the joint is properly designed its strength will be that of the plate between the rivet holes, and the efficiency of the joint

$$= \frac{\text{pitch} - \text{diameter of rivet hole}}{\text{pitch}};$$

then

$$e = \frac{3 - 15/16}{3} = .6875,$$

and the bursting pressure of the drum

$$= p = \frac{2\,t\,Se}{d} = \frac{2 \times 3/8 \times 55{,}000 \times .6875}{36} = 787 \text{ pounds}$$

per square inch. G. M. Kohler.

Syracuse, N. Y.

Layout of Branch Pipe

Figs. 1 and 2 show the layout of an irregular Y-connection made a short time ago by the writer. As this problem is worked out on the same principles as the layout asked for by "T. F. E." on page 338 of your last issue, I trust the drawings will be of assistance to your correspondent.

The various parts of the layout are clearly numbered and lettered, so that any one familiar with the usual method of laying out by triangulation can follow the various steps in this layout without detailed explanation. H. Hatten.

Toronto, Ont., Can.

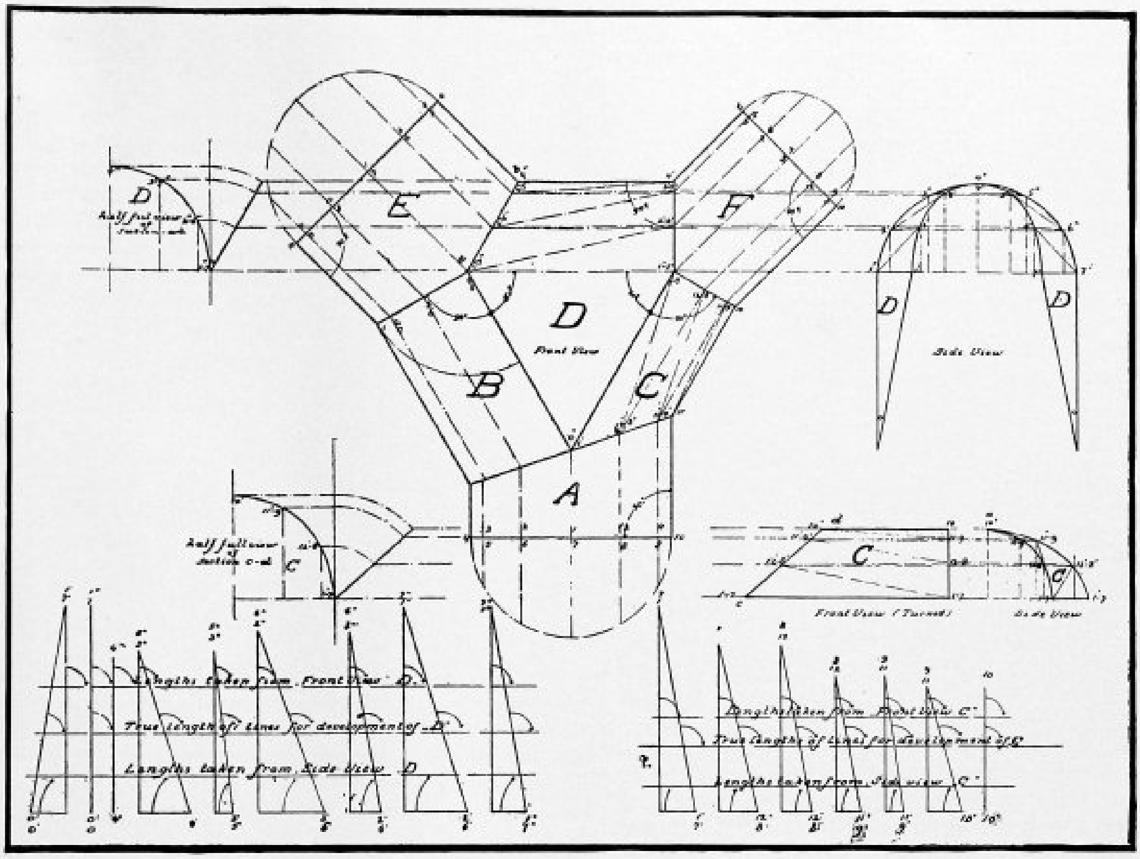


FIG. 1.—IRREGULAR Y CONNECTION

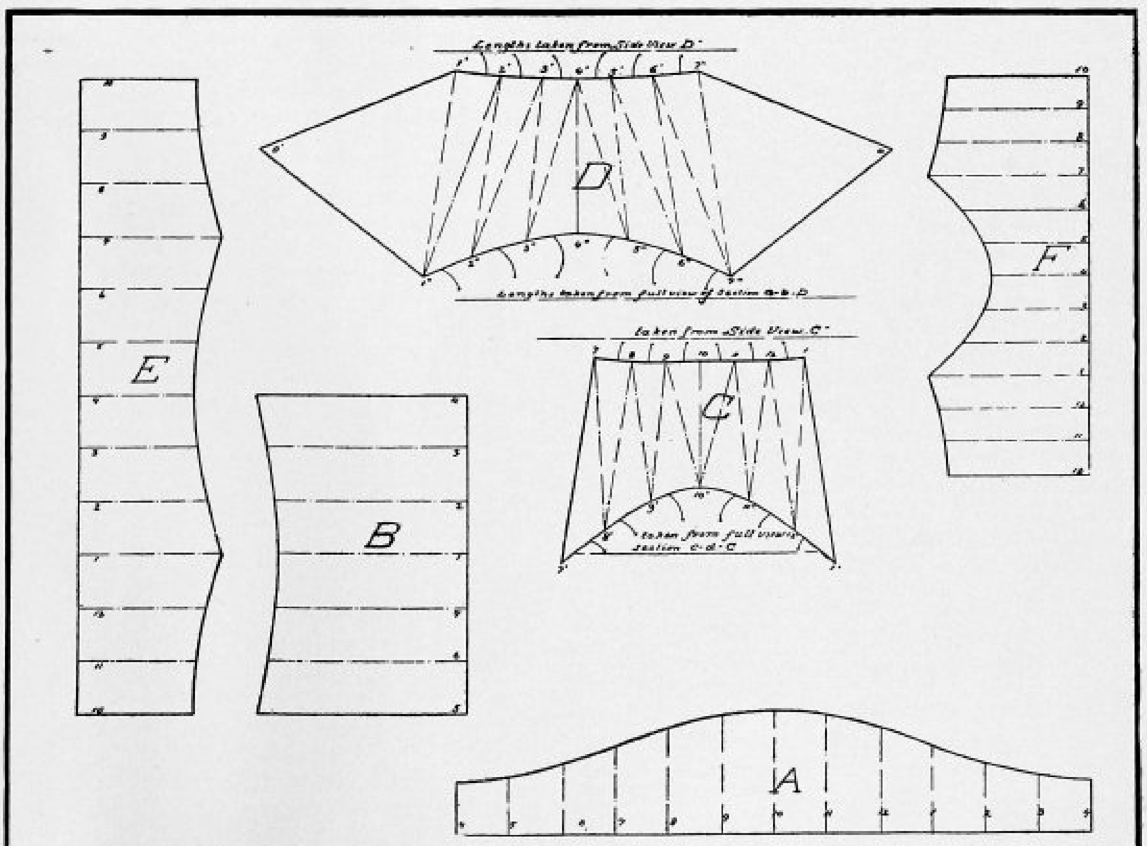


FIG. 2.—PATTERNS FOR IRREGULAR Y CONNECTION

Boiler Efficiency

A steam generator is composed of two distinct parts, each with its independent function. The furnace is for the proper combustion of the fuel, and its duty is performed to perfection when the greatest amount, but not necessarily intensity, of heat is obtained from the given weight of combustible. The boiler proper is for the transfer of the heat thus generated into useful effect by evaporating water into steam, and its function is fulfilled completely when the greatest possible quantity of heat is thus utilized. To a lack of appreciation of this fact, and of a knowledge of the principles involved, is chargeable much waste of money and disappointment both to inventors and steam users.

As a boiler is for making steam, it can only utilize for that purpose heat of a greater intensity or higher temperature than the steam itself; therefore the gases of combustion cannot be reduced below that temperature and the heat thereby represented is lost. The amount of this loss will depend upon the air admitted to the furnace and the increase of temperature at which it escapes. The more air admitted the greater the loss; hence the fallacy of all those schemes which admit air above the fire.

The rate of combustion should not exceed 0.3 pound of coal per hour per square foot of heating surface, except where quantity of steam is of greater importance than economy of fuel. Where a blast is used the grate surface should be proportionately reduced to secure best economy.

The accumulation of scale on the interior, and of soot on the exterior, will seriously affect the efficiency and economy of the boiler. Only one-eighth of an inch deposit of soot renders the heating surfaces practically useless. Only one-sixteenth of an inch of scale or sediment will cause a loss of 12 percent in fuel. A boiler must, therefore, be kept clean outside and in to secure a high efficiency. The result of a bad setting for a boiler has been known to be a loss of 21 percent in economy. The maximum conductivity or flow of heat is secured by so designing the boiler as to secure rapid, steady and complete circulation of the water within it.

Albany, N. Y. Charles Miller.

Cause and Prevention of Boiler Corrosion

It is universally known that sea water contains practically every substance imaginable in minute particles, few only causing any serious trouble in the boiler.

They are salt (chloride of sodium), lime (carbonate and sulphate), and magnesia (sulphate and chloride). If an analysis is taken of 1 ton of sea water at average density (1/33 or 5 ounces of salt to the gallon) it will be found to contain the following proportions held in solution:

	Pounds
Chloride of sodium	58
Chloride of magnesia	8
Sulphate of magnesia	5
Sulphate of lime	3½
Carbonate of lime and magnesia	¼
Other matter	1¼

Making a total of 76 pounds of solids held in solution.

When the sea water containing the chloride of magnesium finds its way into the boiler, it is, under some conditions, converted into hydrochloric acid and magnesia, the hydrochloric acid attacks the steel of the boiler and forms chloride of iron; but this is scarcely the case, for as soon as it occurs it is decomposed by the already liberated magnesia, resulting in the oxide of iron being precipitated and the re-formation of chloride of magnesia; in other words, the acid formed is developed locally only while the water and the heated surface are in contact, and is destroyed immediately after by reuniting with the magnesia. This accounts for the fact that iron is never found in solution in the boiler water, so that if no acid came in with the feed none would be found in the boiler water.

To prevent corrosion from the ferrous oxide (which changes to ferric oxide on exposure to the air), all sea water must be excluded from the boiler; to do this, make certain that the condenser is perfectly tight. Carbonate of soda is considered by many marine engineers of experience as being the best preventative for corrosive effects of sea water; lime is sometimes used, but forms a very hard scale, the carbonate of soda neutralizes any acids in the water; it should be placed in the boiler in small doses, but often, if a large quantity is used, priming may result, due to the violent ebolution caused by the neutralization of the acid by the soda; a blue litmus paper will tell us when our boiler water is free from acid by keeping its color.

If an evaporator is used, care must be taken to keep the density within reason; that is, a maximum of 3/32, if it rises to, say, 6/32 seconds, hydrochloric acid will be given off by the decomposition of the chloride of magnesium. The practice of filling the boilers with dock water, which is usually brackish, that is, neither pure fresh water, or pure sea water, is a bad business as a rule, for it contains many foreign substances—a large percentage of carbonate and sulphate of lime, sand, mud, etc., are found.

In the case of new boilers a small amount of lime solution is beneficial, as it forms a nice, thin protective layer on all the surfaces.

Animal and vegetable oils contain acids, and should therefore be excluded from interior engine lubrication; use only pure mineral oil, as this latter contains absolutely no acids whatsoever; the acids in animal oil (staric) always attack the surfaces which are hottest, and for that reason some parts of the boiler corrode more quickly than others. This trouble is usually termed "pitting," so be careful to use plenty of carbonate of soda.

Zinc slabs are often used in boilers, in contact usually with the furnaces; a current of electricity will be generated and destroy the zinc, and thus preserve the steel of the boiler interior. M. E.

Woodbridge, N. J.

Safety First Again

Having read the excellent article by Mr. C. E. Lester in the October issue on "Safety First in the Boiler Shop," I would like to put in a plea for the "Safety First Campaign" in regard to the boiler on the road. Surely the engine men should be given their chance at safety too, especially since in numerous cases it is not through their own carelessness that they are injured or lose their lives.

How many times on picking up our engineering papers, or even our daily newspapers, have we seen accounts of boiler explosions which, as the reports say, were probably due to low water. I find in your September issue an article which gives statistics for one year as follows: Ninety-four accidents due to low water, resulting in 54 deaths and serious injury to 168 persons, and the year before 27 people were killed and 41 seriously injured in explosions due to excessive pressure."

From this paragraph it seems that engine men are not the only ones to need protection in this respect, and yet no one seems to think that anything else might be the cause or that these explosions can be stopped.

Mr. Lester explains that a factor of safety is the first thing considered in the design and construction of a locomotive boiler, and that upon it depends the thickness of the plate, the size and pitch of the rivets, the location and design of the bracing and anything and everything that in any way affects the strength of the boiler; but, inversely, as a new design or construction is advanced, a new safety factor must be brought forward, which seems an extremely hard thought for many to grasp.

For instance, if a firebox be formed of corrugated sheets, because of the strength added by corrugating, less weight or work falls on the stays, and the pitch of the stays may be increased from the average of 4 inches to 5 inches, and the composite strength be more than equal to the flat plate and the 4-inch pitch.

The reason for this is, that always in corrugating a metal you provide for the expansion and contraction under climatic changes, and in the case of the firebox, where these changes are due to numerous causes, such as (quoting from Mr. Lester), variation in amount of heat supplied by fuel on account of effect of grades, stops, slow orders, and the injection of cold water, expansion and contraction must of a certainty be great. Therefore where this firebox formation is corrugated and properly balanced so that all these different strains are looked out for and the stays protected from being broken, you must necessarily find a more perfect boiler, and one much less likely to explode. Wm. H. Wood.

Media, Pa.

For the Good of Boiler Manufacturers

I have just finished reading the September number of The Boiler Maker, especially the report of the proceedings of the A. B. M. A. This organization should be congratulated for what it has accomplished in the past for the boiler manufacturing industry, and for making such a meeting as that held at Cleveland a possibility.

When the writer contributed the article signed "Progressive," about a year ago, he hoped to create a stir of some kind that would cause the boiler manufacturers to wake up and try to realize their position in the industrial world, as compared with others having the same amount invested.

The papers read by Mr. Connelly and Mr. Durban indicate that many already have a clear realization of the actual conditions, but are handicapped in their efforts to bring about a better state of affairs, by the smug self-satisfied indifferent attitude of their neighbors in the same line who are groping along in the dark and using up a considerable part of their energy in keeping the sheriff off the premises.

As stated in the previous article above referred to, there is no good reason why the boiler manufacturer should continue to run his business for the accommodation of the steam-using purchaser. The amount of intelligent effort required to successfully operate a boiler manufacturing concern at the present time should bring larger returns.

I noted with much interest Mr. Kellog's remarks on the Tubular Manufacturers' Association. The thirty-four members of this organization are being moved by the right spirit, and will undoubtedly do good in many ways by their united effort. The tubular branch of the business certainly needed what the modern reformer calls "the uplift" more than any other branch of the trade.

It is now to be hoped that the watertube boiler manufacturers may be able to form some kind of an association which would bring about some unity of thought as to standards, etc., in this important branch of the business, which is becoming sadly demoralized of late years on account of a ruinous competition.

The concern with which the writer is connected decided about two years ago to add a watertube boiler to its other line of production. We selected one of the best, as well as one of the oldest types, for our standard, and spent many months and considerable money in making up a complete line of drawings, getting out printed matter, etc.

After we got everything ready we advertised the boiler very extensively in the technical papers, and received hundreds of inquiries, and have made prices on many thousands horsepower at what we considered reasonable prices, but we have not yet succeeded in securing a single order, for the reason that other boiler manufacturers, who, like ourselves, lately entered this field, are selling the same type of boiler at considerably less than our cost.

We have the best shop and equipment within the limits of the State in which we are located, and in fact equal to most shops in any State, yet we find conditions as explained in the preceding paragraph, and are practically debarred from this branch of the business, unless we wish to work for accommodation, which we will not do.

In conclusion, I would state that the writer believes Mr. Connelley's paper on shop costs will do a lost of good, especially to the class that have considered material and labor only as a basis for their estimated cost. Mr. Connelley is also right in his ideas of figuring the cost on a basis of wages rather than on sales, in my opinion, as I have found the latter system can be very misleading on certain classes of work produced in a boiler shop. The average overhead in well managed shops will, or should, be less than 100 percent of the wages paid for labor, but at the present time, and under present conditions, the overhead in all boiler shops is probably considerably over 50 percent of the wages paid out for labor. The average for the entire country, in the writer's opinion, would be about 70 percent.

If The Boiler Maker will open its pages to a free discussion of this subject it will probably do more for the benefit of the manufacturers who have ignored overhead charges than they have ever done for themselves. R. Joy.

Oswego, N. Y.

[Editor's Note:—The Boiler Maker welcomes gladly any discussion on this subject, and urges its readers to express their opinions freely regarding it.]

Remarkable Records of Old-Style Western River Steamboat Boilers

The old-style Western river steamboat boiler, which is still almost universally used on these boats, has been condemned and maligned and proved by "theoretical calculations" to be very inefficient and wasteful in fuel consumption. It is a matter of fact, however, that a number of watertube and other modern types of marine boilers which have been installed on Western river steamers have in a short time been removed, and the old-time horizontal two, five and six-flue boilers, as the case might be, put back on the steamers. A case in point is that of a towboat owner who has had in use for a year what was claimed to be the most efficient and safest boiler for towboat use, but who is about to remove this boiler and install in its place the old-time horizontal two-flue Western river boiler.

The company with which the writer is associated now has in use one boiler over twenty-two years old of the old horizontal type with two flues, which at times has been forced to its utmost capacity twenty-four hours every day, for as much as sixty days at a stretch, and which in all of the twenty-two years it has been in service has not been out of use over six months' time; yet the cost of repairs on the boiler for this almost continuous service for twenty-two years has not been over $35. Another battery of six horizontal two-flued boilers on one of the towboats belonging to the same company has been in use for fifteen years and has cost but $6 for repairs.

The horizontal river type boilers are externally fired, and fire cracking of the laps in the shell plates outside of the rivet holes in the seams over the fires is about the only trouble that is experienced with this type of boiler. Occasionally a boiler is burned by an accumulation of scale, but this fault is often remedied by changing the disposition of the feed water inside the boiler.

Considering the fact that this type of boiler has been in use for three generations; that it meets the requirements of the special class of traffic and type of boats used on the Western rivers; that it is efficient; that it is capable of producing far greater horsepower than its theoretical rating; that it is not excessive in fuel consumption, considering the grade and kind of coal used; that it is reasonable in first cost, and that it is easily accessible for repairs, it seems safe to conclude that it will be many years before any boiler is built that will supplant the old-time two-flued cylindrical boiler for use on the Western river stern-wheel steamers. E. A. BURNSIDE.

Layout of Elbow from Oval Pipe to Round Base

On page 306 of the September issue of THE BOILER MAKER, "Y. W." asks for the layout of a 90-degree elbow connecting an oval to a round section. I submit herewith in Figs. 1 to 5 sketches which show the layout of this problem, and which I hope will meet the requirements of the subscriber.

The first step in this problem is to draw a plan and elevation of the elbow full size, as shown in Fig. 1. The height of the elbow was not stated in the September issue, but we will assume that it is 32 inches. Having formed a right angle, we will divide it into six equal spaces, each containing 15 degrees.

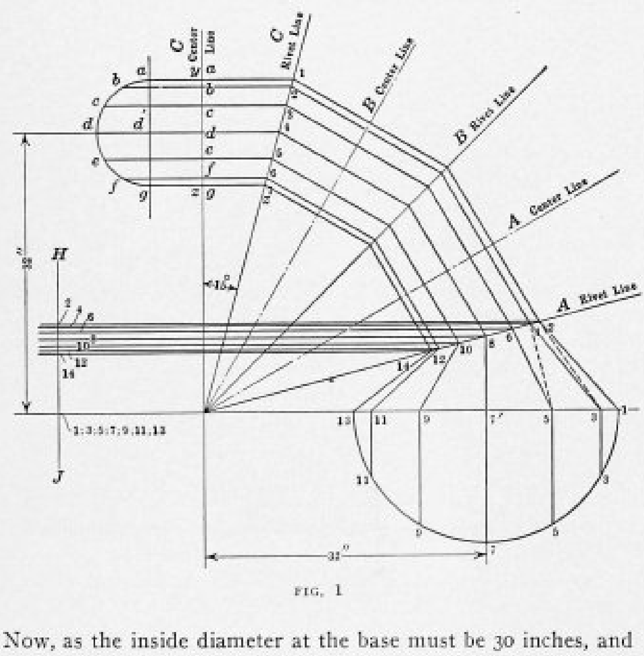


FIG. 1

Now, as the inside diameter at the base must be 30 inches, and as our stock is ¼ inch thick, the neutral diameter of the base to which we must work will be 30¼ inches.

Using 7′ in Fig. 1 as a center, and with a radius of 15⅛ inches, strike the arc 1-7-13, and divide the arc into any number of equal spaces. The more spaces taken the more accurate will be the result. For convenience in this case, however, we will take the six divisions as indicated by points 1-3-5-7, etc. From these points of division draw lines perpendicular to line 1-13, establishing corresponding points on the line 1-13.

Going now to the oval part of the elbow, in Fig. 1, we will draw a plan view of it; taking a radius of 6 inches, plus ⅛ inch, or 6⅛ inches, and using *d′* as a center, draw the arc *a-d-g*. Next draw *a-y* and *g-z*, each 6 inches long, which gives the neutral diameter for the oval part of the elbow. Arc *a-d-g* should be divided into six equal spaces, as was done at the other end of the elbow. From these points of division draw parallel lines perpendicular to the line *a-g*, and continue these lines to the rivet line *C*, establishing the points 1-2-3-4, etc. From rivet line *C* continue the parallel lines, but in this section make them perpendicular to the center line *B;* also continue the lines to the next section, drawing them perpendicular to the center line *A* until they intersect the rivet line *A*. Then from the points of intersection with the rivet line *A* draw lines to meet the points of division 1-3-5, etc., in the base.

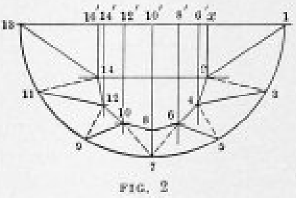


FIG. 2

These lines are imaginary surface lines on the elbow, and their true lengths must be obtained for the layout of the pattern.

From the points 2-4-6-8-10-12 and 14 on rivet line *A*, Fig. 1, draw lines parallel with the base line 1-13, and carry them to the line *H-J*, which is drawn perpendicular to the line 1-13.

Now as the oval section *a-d*, Fig. 1, is somewhat smaller than the section through the rivet line *A*, the latter must be determined by projection. To accomplish this proceed as follows: In Fig. 2 draw the arc 1-7-13 equal to 1-7-13 in Fig. 1. Now, going back to the oval in Fig. 1, take lengths *a-a*, *b-b*, *c-c*, etc.. and transfer them to Fig. 2, as on 16-14, 14-12, 12-10, etc. Referring to the rivet line *a-f*, Fig. 1, take the heights of the points 2-4-6, etc., and transfer them to Fig. 2, as at 2-4-6, etc. This gives the exact size of the plan for Fig. 1.

The next step is to get the true lengths of the imaginary lines on the cone piece in Fig. 1. Take the length of the line 1-2, Fig. 2, and place it on 1-2′, Fig. 3; then take the height from 1 to 2 on the line *J-H*, Fig. 1, and transfer it to 2-2′ in Fig. 3. Draw a line from the point 2 to the point 1 in Fig. 3, and this will be the exact length of the line 1-2 shown in Figs. 1 and 2. Proceed in the same manner to get the true length of

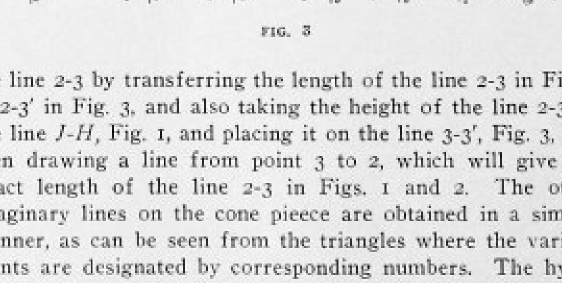


FIG. 3

the line 2-3 by transferring the length of the line 2-3 in Fig. 2 to 2-3′ in Fig. 3, and also taking the height of the line 2-3 on the line *J-H*, Fig. 1, and placing it on the line 3-3′, Fig. 3, and then drawing a line from point 3 to 2, which will give the exact length of the line 2-3 in Figs. 1 and 2. The other imaginary lines on the cone pieece are obtained in a similar manner, as can be seen from the triangles where the various points are designated by corresponding numbers. The hypotenuse of the triangle in each case is the exact length of the lines shown in the cone piece of the elbow.

The pattern for this, as finally laid out, is shown in Fig. 4. In Fig. 4 draw the line *J-H*, and perpendicular to it at the point *x* draw the line 2-2. From Fig. 2 take the length of line *x*-2, and transfer it to *x*-2 from left to right in Fig. 4. Then take the length of the line 1-2 in Fig. 3 on the trams, and with points 2, 2, Fig. 4, as centers, strike arcs intersecting at point 1. Next take the lengths of lines 2-3 in Fig. 3 on the trams, and with points 2, 2 as centers strike arcs at 3 and 3 in Fig. 4. From Fig. 2 take the length of the cord 1-3, and with 1 in Fig. 3 as a center strike arcs intersecting those previously drawn at points 3.

Proceed in a similar manner to take the proper lengths for the various spaces, and lay them off in Fig. 4, until the de-

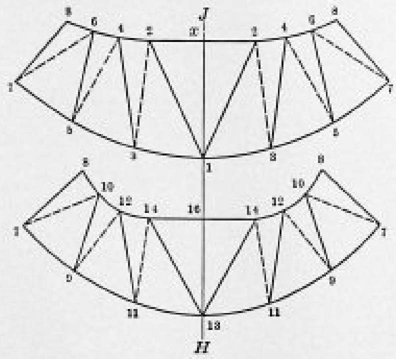


FIG. 4

velopment is complete. Having located all the points in Fig. 4, trace a line through the points, which will give the exact pattern of the cone piece in two halves.

As the diameter of the base in Fig. 1 is 30¼ inches, its circumference must be 30¼ times 3.1416, or 95.0334, which is very nearly 95 1/32 inches. Half of this circumference will be the length of the line 7-1-7 in Fig. 4.

We will now proceed to lay out the oval piece of the elbow. The diameter, *a-g*, Fig. 1, is 12¼ inches, and to find the circumference we multiply 12¼ by 3.1416, obtaining 38.4846, or very nearly 38 15/32 inches. Now, taking half the circumference and laying out half from *a* to *g*, Fig. 5, we will divide

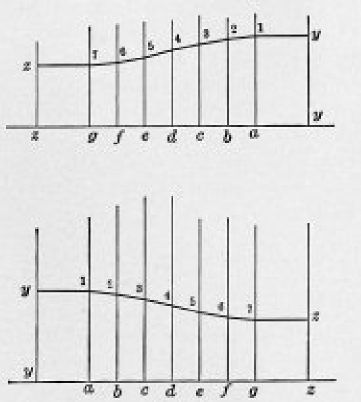


FIG. 5

this distance into six equal spaces, as *a-b*, *b-c*, *c-d*, etc. Take the lengths of *a-y* and *g-z*, Fig. 1, and transfer them to Fig. 5 at *a-y* and *g-z*. From these points draw lines of indefinite length perpendicular to the line *y-z*; take the lengths *y-y*, *a*-1, *b*-2, *c*-3, etc., from Fig. 1, and lay them off on corresponding lines in Fig. 5, as *y-y*, *a*-1, *b*-2, etc. Through points thus located trace the line *y*-1-5-7-*z*, which will outline half the pattern for the oval part of the elbow.

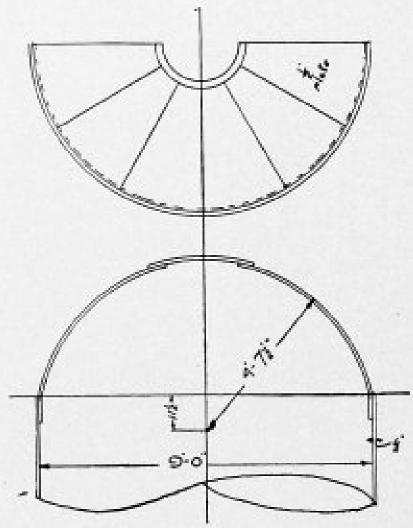
The outlines shown in Figs. 4 and 5 establish in each case the rivet lines, and usually 1½ times the diameter of the rivet should be added for lap. If we take a thin strip of board and bend it along the lines *y*-4-*z*, Fig. 5, and do the same in Fig. 4 along the lines 8-*x*-8, then both strips must be of the same length. As two parts of the elbow will lap inside and two parts will lap outside, two of them must be made 6½ times the thickness of the iron smaller. In this case 6½ times ¼ equals 1⅝ inches, and one of the strips of board must be made just this much shorter than the other. Taking these two strips of board, and dividing them into an equal number of spaces, the pitch of rivets can be worked out.

As Fig. 5 is an outside piece, the next section must be 1⅝ inches smaller, so that it can be fitted as an inside course. Using Fig. 5 as a templet, as many plates can be laid off from it as necessary to make the elbow. E. EATON.

Jersey City Heights, N. J.

Layout of Round-Top Tank Wanted

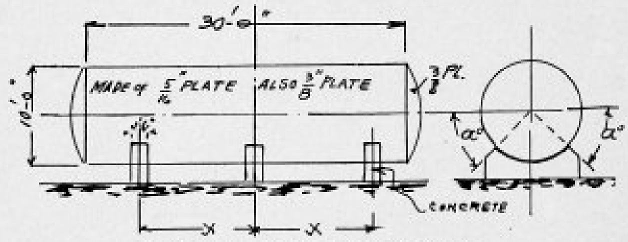
The accompanying sketch shows a round-top tank which the writer would be pleased to have some reader of THE BOILER MAKER show how to lay out. The writer also wishes to know if any round-top tank can be laid out in the same manner regardless of the size of its radius? ROUND TOP.



PROBLEM IN LAYING OUT

Supports for a Round Tank

Readers of THE BOILER MAKER are asked to answer the following questions regarding the method of supporting a tank or tanks of the style shown in the sketch. The writer wishes to know what the distance *x* should be; also what the angle *a* should be, and if there is any theoretical or practical rule for determining this value. BOILER MAKER.



HORIZONTAL STORAGE TANK FOR WATER

Furnace Efficiency

Combustion may be defined as the union of two dissimilar substances evolving light and heat. In ordinary practice one of these is always the oxygen in the atmosphere, and the other is the fuel employed. Every pound of fuel requires a given quantity of oxygen for its complete combustion, and thus a given quantity of air. This varies with different fuels, but in every case less air prevents complete combustion and an excess of air causes waste of heat to the amount required to heat it to the temperature of the escaping gas.

With chimney draft the ordinary furnaces require about twice the theoretical amount of air to secure perfect combustion. A moderately thick and hot fire with rapid draft uniformly give the best results. Combustion of black smoke by additional air is a loss. Different fuels require different furnaces and no one furnace or grate bar is equally good for all fuels.

Albany, N. Y. CHARLES MILLER.

Personal

M. M. MCCALLISTER, formerly superintendent of the Erie City Iron Works, Erie, Pa., has accepted a similar position with John Brennan & Company, boiler manufacturers, Detroit, Mich.

JAMES T. LEE has been appointed manager of sales of the Vulcan Engineering Sales Company, with offices in the Fisher building, Chicago, Ill.

E. A. GEOGHEGAN, for the past two years with the Union Iron Works, Erie, Pa., has accepted the position of superheating specialist with the Erie City Iron Works, also of Erie.

Obituary

David Martin-Yule, foreman of the boiler making department of the Boston & Maine Railroad shops at Keene, N. H., died Sept. 14 at the City Hospital as the result of the injuries received at the shop the previous day. While at work in the shops, Mr. Martin-Yule was badly scalded by steam, and the shock caused by the accident was too great to be overcome. Mr. Martin-Yule was born in Dundee, Scotland, April 25, 1876, and came to the United States when quite young. He entered the employ of the Boston & Maine Railroad about fifteen years ago at the Charlestown (Mass.) shops as a boiler maker. He came to Keene, N. H., about two and one-half years ago to accept the position of foreman of the boiler making department. Mr. Martin-Yule was a member of a number of fraternal organizations, and was an active member in the Master Boiler Makers' Association. Only a short time before his death he sent to THE BOILER MAKER a brief illustrated article which was published in our last issue. As a master craftsman he was thoroughly respected and esteemed by the men in the shops.

Technical Publications

HENDRICKS' COMMERCIAL REGISTER. Size, 7¼ by 10 inches. Pages, 1,635. New York, 1913: S. E. Hendricks Company. Price, $10.00.

The twenty-second annual revised edition of Hendricks' Commercial Register of the United States for Buyers and Sellers has just been issued. Its aim is to furnish complete classified lists of manufacturers for the benefit of those who want to buy as well as for those who have something to sell. It covers very completely the architectural, engineering, electrical, mechanical, railroad, mining, manufacturing and kindred trades and professions. It establishes a direct link between the buyer and seller. The present is by far the most complete edition of this work so far published. The twenty-first edition required 122 pages to index its contents, while the twenty-second edition requires 138 pages, or 16 additional pages. As there are upwards of 400 classifications on each page, the 16 additional pages represent the manufacturers of over 6,000 articles, none of which has appeared in any previous edition. The total number of classifications is over 55,000, each representing the manufacturers or dealers of some machine, tool, specialty or material required in the architectual, engineering, mechanical, electrical, railroad, mine and kindred industries. The twenty-first edition numbered 1,546 pages, while the twenty-second edition numbers 1,635, or 89 additional pages. Add to the latter about 348 pages of cancellations, errors, etc., omitted from the present edition, and there is a total of 437 pages of new matter, the whole representing upwards of 390,000 names and addresses. An important feature of the Commercial Register is the simplicity of its classifications. They are so arranged that the book can be used for either purchasing or mailing purposes. The value of the Commercial Register for purchasing purposes is not confined to its complete classifications alone; it also gives much information following the names of thousands of firms that is of great assistance to the buyer, and saves the expense of writing to a number of firms for the particular article required. The trade names of all articles classified in the book are included as far as they can be secured.

SMOLEY'S TABLES. By Constantine Smoley, C. E. Size, 4½ by 6¾ inches. Pages, 174. New York, 1912: McGraw-Hill Book Company. Price, $3.50 net.

This work contains parallel tables of logarithms and squares of feet, inches and fractions thereof, expressed in decimals of a foot and varying by 1/32d of an inch, from zero to 50 feet and by 1/16th of an inch from 50 to 100 feet. Other books have been published containing tables of squares, but in this book a new element is found which is a distinctive feature. This is the table of logarithms, which opens up a wider field of application than the squares themselves, and the combination of both tables increases the value of each of them. It is of special value to the structural draftsman, as the most frequent problems he has to deal with are handled by means of these tables with a great saving of time and fewer chances of making errors. The parallel combination of the tables of logarithms and squares finds its most effective field of application in the solution of triangles for the purpose of figuring the data required for structural detail drawings. In addition to the tables above mentioned, there is added a special device for solving right triangles of comparatively small dimensions. This device is in the form of a diagram, which is supplemented by a table giving in parallel columns the logarithms and squares of numbers varying by intervals of 1/64th of an inch from zero to 16 inches. Other features of great value are the multiplication tables for rivet spacing, decimal equivalents, five-decimal logarithmic-trigonometric tables and tables of natural trigonometric functions.

LUKENS HANDBOOK. Size, 4⅝ by 6½ inches. Pages, 264. Numerous illustrations. Coatesville, Pa., 1912: Lukens Iron & Steel Company. Price, $2.00.

This is the fourth edition of a very useful handbook in which have been compiled data valuable to boiler makers and engineers. The Lukens Iron & Steel Company was the first firm in America to make boiler plates, and the brief history of the growth of this concern, which is given in the first few pages of the handbook, contains some interesting information regarding the methods used in the early days in making boiler plates. While much of the book is given up to a description of the products of the company, the engineering data which have been compiled will be found very useful. Specifications for boiler and structural steel are given in full, a chapter is devoted to boilers and boiler construction, in which such subjects as horsepower, ratios of heating surface to the grate area, rates of combustion and rules for finding allowable pressure are discussed. To many boiler makers the part of the book which shows how to find the efficiency of riveted joints of various kinds and the bracing of circular segments, will be of particular value. Chimneys, fuels, heat, water, steam, etc., form the subjects for additional chapters, and in the back of the book nearly 100 pages are devoted to sundry and miscellaneous tables of weights and dimensions.

Selected Boiler Patents

Compiled by
DELBERT H. DECKER, ESQ., Patent Attorney,
Loan and Trust Building,
Washington, D. C.

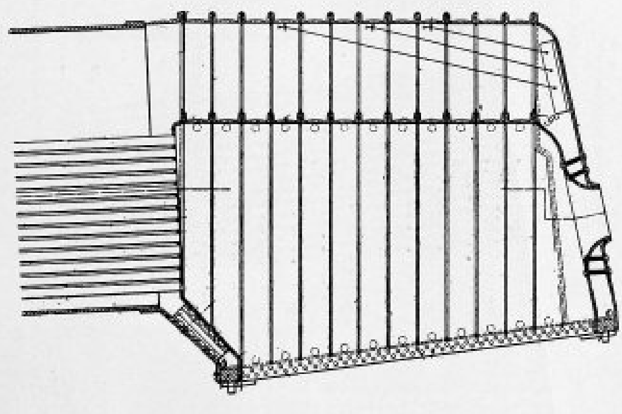
Readers wishing copies of patent papers, or any further information regarding any patent described, should correspond with Mr. Decker.

1,066,281. AUTOMATIC FUEL FEEDER. DAVID R. KEITH, FORT SCOTT, KANSAS.

Claim 1.—In an automatic feeder, the combination with a furnace wall having an inlet opening, of a base plate fixed to said wall, alining bearings arranged in pairs at right angles to each other, a driving shaft journaled in one pair of bearings, a driven shaft journaled in the other pair of bearings, gear connections between the shafts, brackets extending outwardly from the base plate, a rotor casing supported upon said brackets and having an open side coextensive with the opening in the wall, a rotor fixed to the driven shaft and located within the said casing, inwardly tapering pockets formed on and projecting radially from the rotor, one wall of each pocket terminating short of the center of said rotor to provide an opening at the inner end and at one side of the pocket, and a feed hopper rising from the casing and communicating therewith. Two claims.

1,067,674. LOCOMOTIVE BOILER. GEORGE B. PHILLIPS, OF CHESTER, PENNSYLVANIA, ASSIGNOR TO THE BALDWIN LOCOMOTIVE WORKS, OF PHILADELPHIA, PENNSYLVANIA, A CORPORATION OF PENNSYLVANIA.

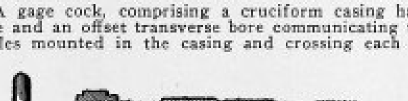
Claim 1.—The combination in a wagon-top boiler, of a shell; longitudinal tubes therein: a tube sheet to which said tubes are secured; a series of inner and outer channel sections and stay sheets connecting



said sections, and forming the fire-box section; said stay sheets being arranged at an angle to the line of the slope of the inclined top of the fire-box section of the boiler, the rear tube sheet being arranged on the same line as the channel section and having the portion to which the tubes are attached offset so as to be at right angles with the longitudinal line of the tubes. Seven claims.

1,068,333. GAGE COCK. HIRAM C. GIBBS AND MATHIAS GANGLER, OF CHICAGO, ILLINOIS.

Claim.—A gage cock, comprising a cruciform casing having a longitudinal bore and an offset transverse bore communicating therewith, and valve spindles mounted in the casing and crossing each other, one of



the bore adapted to connect with a boiler, and the other bore opening into the atmosphere, both valves adapted to independently close communication between the boiler and the atmosphere. One claim.

1,067,826. SMOKE PREVENTER. GEORGE H. MAYNARD, OF NEW YORK, N. Y.

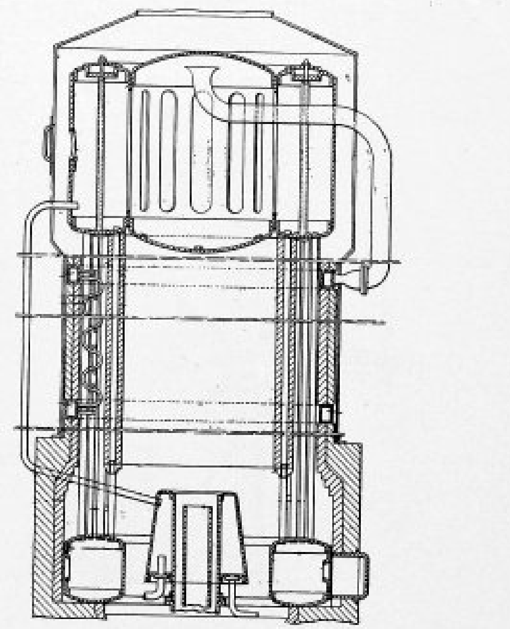
Claim 3.—A steam feeding attachment for boiler furnaces, embodying a main pipe, a series of branch pipes attached thereto, a series of curved tubular nozzles each having an open delivery end and provided in the under side thereof with transverse outlet slots, and nipples for coupling the nozzles individually to the branch pipes, said nozzles extending forwardly and downwardly from the branch pipes. Four claims.

1,067,904. FEED-WATER REGULATOR. THOMAS ELLIOTT, OF SEATTLE, WASHINGTON, ASSIGNOR OF TWO-NINTHS TO SAMUEL D. CROCKETT, TWO-NINTHS TO HARLEY J. ARMSTRONG, AND TWO-NINTHS TO STACY E. GRAYSON, ALL OF SEATTLE, WASHINGTON.

Claim 1.—In combination, a steam generator, a valve casing provided with inlet and outlet ports and with an intermediate passage communicating with and extending in angular relation to said outlet port, a plug valve in said casing having one end portion provided with a passage for establishing communication between the inlet and outlet ports of said casing, the opposite end portion of said valve having a passage constantly communicating with the intermediate passage of said casing, a valve in the intermediate passage of said casing, a vertically movable water chamber fixed to said valve and constantly communicating with the last-named passage thereof, a pipe extending from the steam space of said generator, a flexible connection between said pipe and said water chamber, a pipe leading from the outlet port of said casing to the water space of said generator, and a counterbalance means for said chamber. Two claims.

1,068,301. STEAM GENERATOR. CLAUDE ALBEMARLE BETTINGTON, OF PICADILLY, LONDON, ENGLAND.

Claim 1.—In a water-tube steam generator, the combination with the combustion chamber, independent top and bottom plates of the steam and water drum, independent top and bottom plates of the header



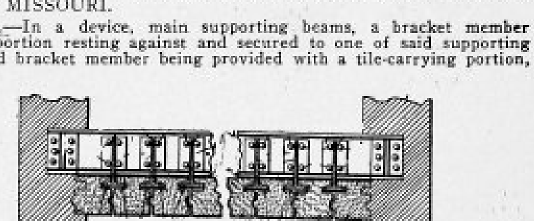
surrounding the drum, water tubes in the form of a ring surrounding the combustion chamber and communicating with said header, of a wall forming the outer sides of the drum and the inner sides of the header, the said walls being formed with apertures so that ready access can be had to the drum and header, and an annular trough in said header. Seven claims.

1,068,368. QUICK-ACTING STEAM GENERATOR. WILHELM SCHMIDT, OF CASSEL-WILHELMSHOHE, GERMANY, ASSIGNOR TO SCHMIDT'SCHE HEISSDAMPF-GESELLSCHAFT M. B. H., OF CASSEL, GERMANY, A CORPORATION OF GERMANY.

Claim 1.—In a steam generator, the combination of a boiler comprising a coiled pipe having an inlet for water and an outlet for steam, and a surface condenser above said boiler and directly connected thereto so that steam flows to said condenser and thence returns as water to the boiler. Ten claims.

1,068,581. FURNACE ARCH. FREDERICK GIRTANNER, OF ST. LOUIS, MISSOURI, ASSIGNOR TO LACLEDE-CHRISTY CLAY PRODUCTS COMPANY, OF ST. LOUIS, MISSOURI, A CORPORATION OF MISSOURI.

Claim 1.—In a device, main supporting beams, a bracket member having a portion resting against and secured to one of said supporting beams, said bracket member being provided with a tile-carrying portion,



said portion extending transversely of and located below said beam, a similar bracket located in the same plane as the first-named bracket and having a portion similarly resting against and secured to another of said beams, said beams being spaced apart, said bracket members being secured to opposite sides of said beams, and each having an extremity of their tile-carrying portions adjacent when in assembled relation. Four claims.

1,067,838. BOILER SEDIMENT SEPARATOR. ALFRED A. OLSON, OF RIVERSIDE, ILLINOIS.

Claim 1.—In combination with a water drum, sediment separating means, comprising a plurality of plates adapted to be supported above the bottom of the drum and to form a chamber therewith, said plates being adjustable relative to each other whereby they may be readily shifted to provide access to the bottom of the drum. Eleven claims.

1,068,295. BOILER PRESSURE REGULATOR. ISAAC ALFRED BACKLUND, OF SPOKANE, WASHINGTON.

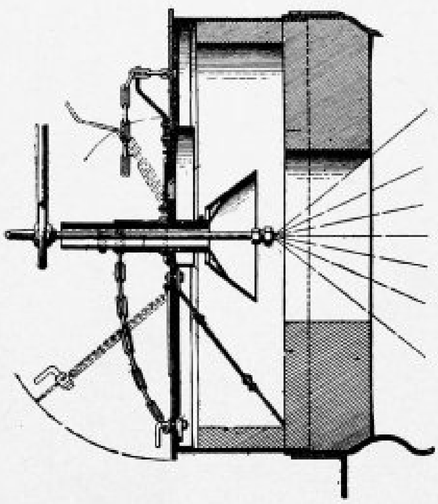
Claim 2.—In a draft regulator, the combination of a boiler having a flue, a damper in said flue provided with a horizontal shaft, a lever disposed on said shaft to move in a substantially vertical plane and having an adjustable weight on one end thereof, a tank structure adjustablly mounted on the other end of said lever and having a flexible connection with the water space of the boiler, and means for adjustably connecting said lever on said shaft to vary the action of the tank and weight on said damper. Three claims.

1,068,438. BLOWER FOR WATER-TUBE BOILERS. JOHN MAGEE, OF DETROIT, MICHIGAN, ASSIGNOR TO "DIAMOND" POWER SPECIALTY COMPANY, OF DETROIT, MICHIGAN, A CORPORATION OF MICHIGAN.

Claim 6.—A tube blower comprising a casing having a steam inlet, a steam tube arranged in said casing, a header mounted transversely on the front end of said tube and communicating therewith, the header being rotatable on its axis to deliver the steam jets in different directions, and means for rotating the header on said tube. Thirteen claims.

1,068,744. OIL-BURNING FURNACE. KNUT MARTIN DAHL, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR TO UNION IRON WORKS CO., OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF NEW JERSEY.

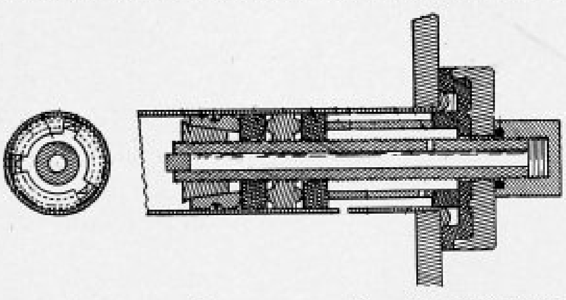
Claim 1.—An extension front for an oil-burning furnace, comprising a side wall, a non-conducting lining therefor, a front plate secured to said side wall, a non-conducting lining therefor, a lower door pivoted to



said front plate, and extending across substantially the entire lower portion of said front plate, and an inclined baffle plate attached to the inner portion of said front plate, and adapted to permit the ingress of air over its upper and lower edges to the point of combustion. Ten claims.

1,068,793. PLUG FOR BOILER TUBES OR HOLLOW SHAFTING. HENRY T. MASON, OF DETROIT, MICHIGAN.

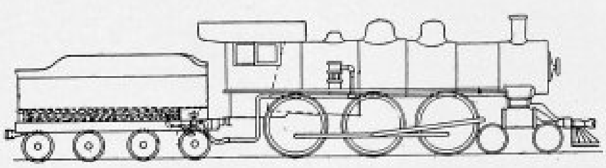
Claim 2.—In a stopper for boiler tubes the combination of an expanding bolt, including an operating rod provided with a bore, an expansible



packing on the latter, and means co-operating with said bolt for expanding the packing, said bore being adapted to communicate with the interior of the tube. Seven claims.

1,069,360. FEED-WATER HEATER. HENRY H. VAUGHAN, OF MONTREAL, CANADA.

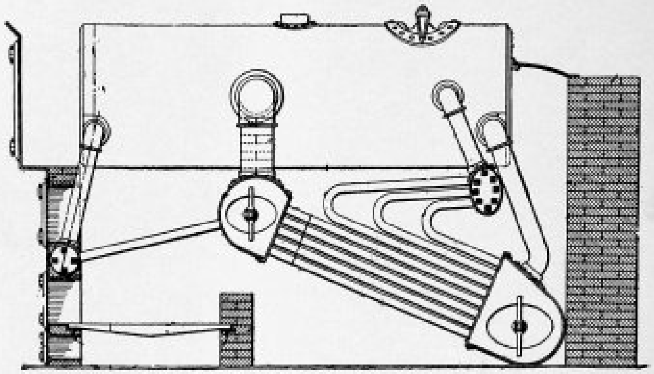
Claim 1.—In combination in a feed-water heater, a main tank, a heating chamber therein, but having no communication therewith, a water



chamber at each end of said heating chamber, one of which communicates with the main tank, a series of tubes extending through the heating chamber and opening into the water chambers, a steam inlet to the heating chamber and a discharge outlet from one of the water chambers. Five claims.

1,069,184. BOILER. PHIL ROHAN, OF ST. LOUIS, MISSOURI.

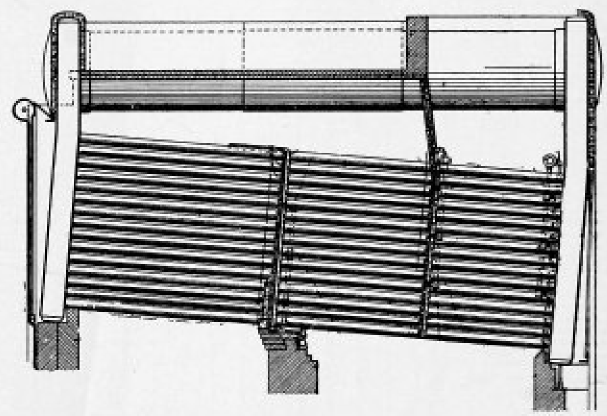
Claim 1.—A watertube boiler comprising a horizontally disposed shell, transverse drums below the same, one of which drums is located centrally of the shell and another of which is located below the rear end of the shell, water connections between these drums and the shell entering the shell at points about half way up the side thereof, and a mud drum



positioned below the shell and at a lower elevation than the two first-mentioned drums and connected with the two first-mentioned drums by inclined tubes and to the shell near its bottom. Five claims.

1,069,105. WATER-TUBE BOILER. HENRY B. BRADFORD, OF EDGEMOOR, DELAWARE, ASSIGNOR TO EDGEMOOR IRON COMPANY, OF EDGEMOOR, DELAWARE, A CORPORATION OF DELAWARE.

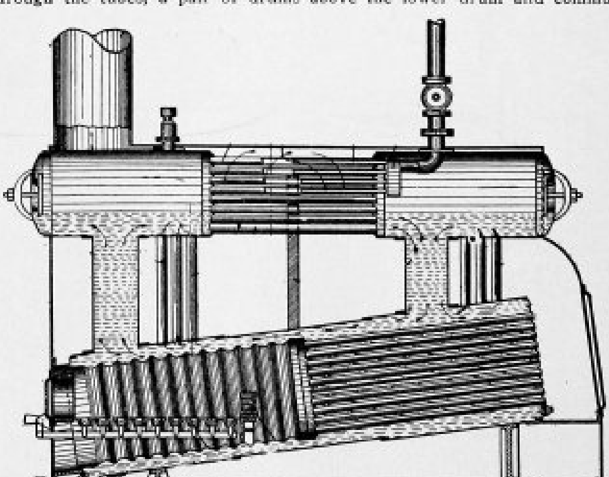
Claim 1.—In a water-tube boiler, the combination with a bank of water tubes and a transverse division wall which divides the intertube



space into separate passes for the hot gases, and comprises a body portion of non-metallic refractory material, of tube-cleaning apparatus comprising a series of pipes embedded in said body portion and provided with nozzle outlets through which jets of a cleaning fluid, supplied to said pipes, may be discharged into said intertube space in a direction parallel to said tubes. Seven claims.

1,069,583. BOILER. GEORGE J. SCHANZ, OF ERIE, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO M. M. McALLISTER, OF ERIE, PENNSYLVANIA.

Claim 2.—A boiler comprising, in combination, a lower drum having fire tubes leading therethrough, a furnace for supplying heated gases through the tubes, a pair of drums above the lower drum and commu-



nicating therewith, a plurality of tubes connecting the two upper drums, a bridge wall between the lower drum and the intermediate portion of the plurality of tubes, and a discharge outlet for the gases of combustion to the front of the said bridge wall. Four claims.